The Effect of Clinical Chorioamnionitis on Cesarean Delivery in the United States

Kerry M. Bommarito, Gilad A. Gross, Denise M. Willers, Victoria J. Fraser and Margaret A. Olsen

Objective. To examine the association of clinical chorioamnionitis on cesarean delivery in a national sample of hospital discharges.

Data Source. Hospital discharge data from the 1998–2010 Nationwide Inpatient Sample.

Study Design. We performed a cross-sectional study and general linear modeling was used to determine the association of clinical chorioamnionitis on risk of cesarean delivery.

Principal Findings. A total of 10,843,682 deliveries and 51,799,431 nationally weighted deliveries were identified. Clinical chorioamnionitis was present in 2.9 percent of cesarean and 1.3 percent of vaginal deliveries ($p < .001$). In multivariate analysis, clinical chorioamnionitis was associated with a 1.39-fold increased risk of cesarean delivery. Compared with women without clinical chorioamnionitis at an urban/teaching hospital, women with clinical chorioamnionitis at an urban/teaching, urban/non-teaching, and rural hospital were 1.4–1.5 times more likely to have cesarean delivery. Compared with women without clinical chorioamnionitis in the Midwest, the relative risk for cesarean in women with clinical chorioamnionitis was 1.54 for women in the South, 1.47 in the Northeast, 1.39 in the Midwest, and 1.34 in the West.

Conclusions. Women with clinical chorioamnionitis were more likely to have cesarean delivery than those without clinical chorioamnionitis, and the risk of cesarean delivery varied significantly by hospital location, teaching status, and U.S. region.

Key Words. Clinical chorioamnionitis, cesarean delivery, administrative data

Maternal infection is one of the most common perinatal complications, affecting 4–6 percent of deliveries (Berg et al. 2009; Goff et al. 2013), and it is an important cause of maternal and neonatal morbidity and mortality (Creasy, Resnik, and Iams 2004). Chorioamnionitis is an infection of the fetal membranes and can be associated with short- and long-term adverse

maternal outcomes (Goldenberg, Hauth, and Andrews 2000; Creasy, Resnik, and Iams 2004; Rouse et al. 2004). Even though there is little evidence that cesarean delivery offers an advantage over vaginal birth in the treatment of chorioamnionitis (Wendel et al. 1994; Casey and Cox 1997), pregnancy complications such as chorioamnionitis may influence the mode of delivery for childbirth.

Over the past 15 years, the cesarean delivery rate in the United States has increased, reaching an all-time high of 32.9 percent in 2009 (Podulka, Stranges, and Steiner 2006; Menacker and Hamilton 2010; Martin et al. 2011). In 2008, cesarean delivery was the most commonly performed operative procedure in the United States (Podulka, Stranges, and Steiner 2006). Previous studies have found that a cesarean delivery in the presence of intra-amniotic infection increases the risk of surgical complications (Hillier et al. 1988; Satin et al. 1992; Mark, Croughan-Minihane, and Kilpatrick 2000; Rouse et al. 2004). It is important to identify factors that affect delivery mode as cesarean delivery is associated with higher maternal morbidity when compared with vaginal delivery (Burrows, Meyn, and Weber 2004; Liu et al. 2007). In addition, once a woman has a cesarean, she will likely have a cesarean delivery for any subsequent deliveries since vaginal birth after cesarean (VBAC) is uncommon in the United States (MacDorman, Declercq, and Menacker 2011).

Chorioamnionitis is not considered an absolute indication for cesarean delivery. What is not clearly delineated in the literature is the association of chorioamnionitis on delivery method and if variation exists by hospital type and geographic location. We used national hospital billing data to look at the association of clinical chorioamnionitis on delivery method and believe this study will provide important information for obstetricians and health policy researchers due to the current overutilization of cesarean delivery in the United States.

Address correspondence to Kerry M. Bommarito, Ph.D., M.P.H., Division of Infectious Diseases, Washington University School of Medicine, 2664 Victron Drive, Saint Louis, MO 63129; e-mail: bommarkm@gmail.com. Gilad A. Gross, M.D., is with the Department of Obstetrics, Gynecology and Women's Health, St. Louis University School of Medicine, St. Louis, MO. Denise M. Willers, M.D., is with the Department of Obstetrics and Gynecology, Washington University School of Medicine, St. Louis, MO. Victoria J. Fraser, M.D., is with the Division of Infectious Diseases, Washington University School of Medicine, St. Louis, MO. Margaret A. Olsen, Ph.D., M.P.H., is with the Division of Infectious Diseases, Washington University School of Medicine; Division of Public Health Sciences, Department of Surgery, Washington University School of Medicine, St. Louis, MO.

METHODS

This was a retrospective cross-sectional study using hospital discharge data from 1998 to 2010 from the Healthcare Cost and Utilization Project (HCUP) Nationwide Inpatient Sample (NIS), from the Agency for Healthcare Research and Quality. The NIS is the largest publicly available all-payer inpatient care database in the United States and contains data from 5 to 8 million hospital stays per year from about 1,000 hospitals sampled to approximate a 20-percent stratified sample of U.S. community hospitals. The 2010 NIS represented 1,051 hospitals from 45 states that comprise 95 percent of the U.S. population (Agency for Healthcare Research and Quality and Healthcare Cost and Utilization Project [HCUP] 2011). The NIS is a stratified sample of hospitals within the frame, with sampling probabilities calculated to select 20 percent of the universe contained within each stratum. The universe of hospitals is divided into strata using five hospital characteristics: ownership or control, bed size, teaching status, urban or rural location, and U.S. region (Agency for Healthcare Research and Quality and Healthcare Cost and Utilization Project [HCUP] 2011). This allows selection of a sample of hospitals that are generalizable to the entire United States. This study was determined exempt by the Washington University Human Research Protection Office.

Records were limited to discharges with a procedure or diagnosis code for delivery as identified by International Classification of Diseases, Ninth Revision (ICD-9-CM) codes. Deliveries were identified using the method of Kuklina et al. (2008). Outcome of delivery (V27), normal delivery (650), and ICD-9-CM procedure codes for forceps (72.0, 72.1, 72.21, 72.29, 72.31, 72.39, 72.4, 72.6); breech extraction (72.5x); vacuum extraction (72.71, 72.79); other specified delivery (72.8, 72.9); other manually assisted deliveries (73.59); episiotomy (73.6); and cesarean delivery (74.x) were used to identify discharges with deliveries. Vaginal delivery was assumed if the discharge was not coded with the ICD-9-CM procedure code for cesarean delivery. Records were excluded if they were coded for ectopic and molar pregnancy (630–633) or abortive outcome (634–638), missing gender, or age less than 13 years.

The primary outcome of interest was cesarean delivery. Women who had cesarean deliveries were identified by ICD-9-CM procedure code 74.0–74.2, 74.4–74.99 (Gregory et al. 1998). Clinical chorioamnionitis was the primary independent variable of interest and was identified by ICD-9 diagnosis code 658.41 since the fifth digit of 1 indicated that the condition was identified during a delivery hospitalization. This diagnosis code refers to clinical

chorioamnionitis since we cannot assume microbiologic or pathologic confirmation of chorioamnionitis from billing data. Comorbidities were identified using the Elixhauser Comorbidity Index (Elixhauser et al. 1998). Other relevant medical conditions and antepartum obstetric conditions defined by ICD-9-CM diagnosis and/or procedure codes were included in the analyses (Appendix). To determine cesarean delivery, comorbidities, and clinical chorioamnionitis, only the first nine ICD-9-CM diagnosis and the first six ICD-9-CM procedure codes were used to be consistent across states and years in the NIS.

To identify patients who labored, we used a previously validated algorithm with ICD-9-CM diagnosis codes for conditions that occur during labor (Henry et al. 1995; Korst, Gregory, and Gornbein 2004). These included ICD-9-CM codes for disproportion (653.x), obstructed labor (660.x), cephalic version (652.1), fetal distress (656.3), failed mechanical induction (659.0, 659.1), abnormality of forces of labor (661.x), long labor (662.x), prolapse of cord (663.0), or vaginal delivery.

A scheduled repeat cesarean delivery was defined as a discharge coded for a previous cesarean delivery and with a current cesarean delivery with no labor. A “prelabor” cesarean delivery was defined using a validated algorithm for potential clinical indications for prelabor cesarean delivery (Gregory et al. 2002) or a woman who had a scheduled repeat cesarean. The clinical indications for prelabor cesarean delivery included malpresentation (652.2), antepartum bleeding or placental conditions (641.x), herpes (054.x), severe hypertension (642.5,6), uterine scar other than for cesarean (654.9), multiple gestation (651.x), macrosomia (656.6), unengaged fetal head (652.5), maternal soft tissue condition (654.0, 654.1, 654.4–7), other types of hypertension (642.4), preterm gestation (644.2), and congenital fetal CNS anomaly or chromosomal abnormality (655.0,655.1).

A failed VBAC was defined as a discharge coded for a previous cesarean delivery, labor, and cesarean delivery. Failed labor was defined as a discharge not coded for a previous cesarean, had an ICD-9-CM diagnosis code that indicated clinical labor, as described above, and was coded for a cesarean delivery. Preterm premature rupture of the membranes (PPROM) was identified as a delivery with ICD-9-CM code 658.1 (premature rupture of the membranes) and 644.21 (early onset of delivery).

Hospital characteristics in the NIS dataset included bed size (small, medium, and large), location and teaching status (rural/nonteaching, urban/nonteaching, and urban/teaching), and geographic location (Northeast, Midwest, South, and West).

Data Analysis

Univariate analysis was performed using the Pearson's chi-square test. To determine the association of chorioamnionitis on risk of cesarean delivery, we created a subpopulation of discharges for women who had the opportunity to have either vaginal or cesarean delivery. This subpopulation included all discharges for women who labored and those who had PPRM. We excluded discharges in women determined to have a prelabor cesarean delivery for the subpopulation analyses, as described above.

Because the main outcome of interest was cesarean delivery, it was important to control for possible confounding due to factors associated with both clinical chorioamnionitis and cesarean delivery. Due to the large number of demographic factors and medical and obstetric conditions that can affect the risk of cesarean delivery, we selected all covariates a priori and included them in the regression model regardless of their significance. Due to the number of discharges with missing race, that variable was not included in the final model.

Potential interactions between clinical chorioamnionitis and hospital region, location, and teaching status were tested. Since cesarean delivery is not a rare outcome, multivariate analysis was performed with calculation of relative risks and 95 percent confidence intervals (CIs) using the GENMOD procedure in SAS with a Poisson distribution. We used a modified Poisson approach to estimate the relative risk and CIs using robust error variances, which results in more precise CIs (Zou 2004; Lindquist 2012). All statistical analyses were performed in *SAS* 9.2 (Cary, NC, USA).

RESULTS

A total of 10,843,682 deliveries and 51,799,431 nationally weighted deliveries were identified in the NIS from 1998 to 2010. Forty-one percent of the delivery population had Medicaid or Medicare as their primary payer; 55 percent of deliveries occurred in a teaching hospital, and 12 percent occurred in a rural hospital. Vaginal delivery accounted for 72 percent of the delivery discharges during the 13-year time span. The proportion coded for cesarean delivery increased from 21.0 percent in 1998 to 32.9 percent in 2010 ($p < .001$) (Figure 1). Women undergoing cesarean delivery were significantly older than women who had vaginal delivery (mean age, 28.7 years vs. 26.9 years, respectively, $p < .001$, Table 1.) The prevalence of cesarean delivery in dis-

Figure 1: Overall Rate of Cesarean Delivery and Rate of Cesarean Delivery in Women with Clinical Chorioamnionitis and Overall Rate of Clinical Chorioamnionitis from 1998 to 2010

charges of patients with clinical chorioamnionitis increased from 44.3 percent in 1998 to 48.5 percent in 2010 (Figure 1).

The focus of subsequent analyses included only the subpopulation of discharges for women coded for labor or PPRM and without an indication for prelabor cesarean delivery, since the subpopulation of women would have had the opportunity for either vaginal or cesarean delivery. In multivariate analysis in this subset of discharges coded for labor or PPRM, women with clinical chorioamnionitis were 1.39 times more likely to have cesarean delivery (CI, 1.38–1.40) than women without clinical chorioamnionitis, controlling for demographics and obstetric and medical conditions associated with risk of cesarean delivery (Table 2). A dose response was evident for preeclampsia; women with hypertension were 1.35 times more likely to have a cesarean delivery, women with mild preeclampsia were 1.50 times, women with severe preeclampsia were 1.83 times, and women with eclampsia were 1.86 times more likely to have a cesarean delivery than women without hypertension or preeclampsia/eclampsia ($p < .001$). Discharges for women with the code for

Table 1: Demographics and Hospital Characteristics for All Deliveries from 1998 to 2010

	<i>Cesarean Delivery</i>	<i>Vaginal Delivery</i>
Nationally weighted, <i>N</i> (%)	14,323,439 (27.6)	37,475,992 (72.3)
Age (mean years)	28.7	26.9
Race		
White	40.1	39.3
Black	10.4	9.5
Hispanic	17.4	16.9
Asian/Pacific	3.4	3.5
Native American	0.5	0.4
Other	3.4	3.5
Unknown/missing	24.8	26.9
Median household income		
0–25th percentile	25.5	25.5
26th–50th percentile	24.3	25.4
51st–75th percentile	23.9	24.3
76th–100th percentile	24.7	23.3
Missing income	1.6	1.5
Primary payer		
Medicaid/Medicare	40.6	43.3
Private insurance	56.3	52.7
Self-pay/no charge/other	3.1	4.0
Hospital location/teaching status		
Urban	88.3	87.8
Rural	11.7	12.2
Teaching hospital	45.2	45.7
Hospital region		
Northeast	16.5	16.1
Midwest	18.9	21.6
South	40.8	36.5
West	23.8	25.8

fetal distress were 3.87 times more likely to have a cesarean delivery than a vaginal delivery. Women who labored and were coded for a previous cesarean delivery were 2.11 times more likely to have cesarean than vaginal delivery.

Women in the South were 1.18 times more likely to have cesarean delivery than women in the Midwest (reference group). Women in a rural hospital were 1.10 times and women in an urban nonteaching hospital were 1.08 times likely to have a cesarean than women in an urban teaching hospital (reference group, Table 2). To examine the effect of hospital location and teaching status on delivery type and the association with clinical chorioamnionitis, we tested the effect of these interactions. Both hospital location and teaching status were found to have an association with delivery type for women with clinical

Table 2: General Linear Model of Risk Factors for Cesarean Delivery with Subset of Discharges Coded for Labor and PPROM and without Indication for Primary Prelabor Cesarean Delivery

<i>Risk Factor*</i>	<i>Vaginal Delivery % with Risk Factor (N = 7,669,607)</i>	<i>Cesarean Delivery % with Risk Factor (N = 957,483)</i>	<i>aRR (95% CI)</i>
Age (years)			
≤17	4.29	3.90	1.03 (1.02–1.03)
18–21	16.82	16.05	1.03 (1.03–1.03)
22–25	22.00	19.85	1.0 (Reference)
26–29	22.68	22.10	1.00 (1.00–1.01)
30–34	22.13	23.19	1.01 (1.01–1.02)
≥35	12.05	14.89	1.08 (1.07–1.08)
Primary insurance payer			
Medicaid/Medicare	43.31	39.63	0.96 (0.95–0.96)
Self pay/no charge	3.73	2.68	0.87 (0.87–0.88)
Private	52.71	57.45	1.0 (Reference)
Obstetric and medical conditions			
Chorioamnionitis	1.26	6.11	1.39 (1.38–1.40)
Obstructed labor	2.85	29.19	2.38 (2.38–2.39)
Abnormal forces of labor	2.94	56.30	7.70 (7.68–7.71)
Malpresentation of fetus	2.10	19.83	2.50 (2.50–2.51)
Fetopelvic disproportion	0.16	24.41	3.14 (3.13–3.15)
Induction without prostaglandins	17.27	24.73	1.23 (1.22–1.24)
Induction with prostaglandins	0.90	2.75	1.43 (1.42–1.44)
Artificial rupture of the membrane	28.98	18.18	0.63 (0.62–0.63)
Premature rupture <24 hours prior to labor	3.75	7.59	1.47 (1.47–1.48)
Premature rupture >24 hours prior to labor	1.23	2.54	1.10 (1.09–1.10)
Delayed delivery after artificial rupture	0.06	0.12	1.23 (1.20–1.26)
Cord prolapse	0.09	2.16	4.91 (4.88–4.94)
Abruption	0.63	1.27	1.46 (1.45–1.48)
UTI	1.52	2.37	1.14 (1.13–1.15)
Hypertension	3.75	7.24	1.35 (1.34–1.35)
Mild preeclampsia	1.79	4.47	1.50 (1.50–1.52)
Severe preeclampsia	0.52	1.74	1.83 (1.82–1.84)
Eclampsia	0.04	0.13	1.86 (1.81–1.90)
Preexisting hypertension with preeclampsia or eclampsia	0.18	0.55	1.71 (1.69–1.74)
Fetal distress	0.72	5.51	3.87 (3.86–3.89)
Excess fetal growth	1.63	5.47	1.44 (1.43–1.44)
Abnormal fetal heart rate	9.56	22.91	1.44 (1.44–1.45)
Sepsis	0.05	0.06	1.03 (1.00–1.07)
Group B Streptococcus	14.03	12.32	0.96 (0.96–0.97)

Continued

Table 2. *Continued*

<i>Risk Factor*</i>	<i>Vaginal Delivery % with Risk Factor (N = 7,669,607)</i>	<i>Cesarean Delivery % with Risk Factor (N = 957,483)</i>	<i>aRR (95% CI)</i>
Herpes [†]	0.22	0.29	1.22 (1.20–1.24)
Sexually transmitted disease	0.15	0.11	0.91 (0.89–0.93)
HIV	0.07	0.08	1.35 (1.31–1.39)
Insufficient prenatal care	2.68	1.63	0.84 (0.84–0.85)
Previous cesarean delivery	3.00	9.59	2.11 (2.10–2.11)
<i>Hospital characteristics</i>			
Small bed	11.87	11.47	0.98 (0.97–0.98)
Medium bed	27.39	26.74	1.0 (Reference)
Large bed	60.73	61.77	1.00 (1.00–1.00)
Northeast	15.73	16.36	1.11 (1.10–1.11)
South	36.72	40.03	1.18 (1.17–1.18)
West	25.90	24.40	1.00 (1.00–1.00)
Midwest	21.63	19.19	1.0 (Reference)
Rural	22.71	23.32	1.10 (1.09–1.10)
Urban nonteaching	37.09	37.14	1.08 (1.08–1.09)
Urban teaching	38.59	37.60	1.0 (Reference)
Weekend admission	21.97	19.19	0.91 (0.90–0.91)
1998	8.63	8.81	1.0 (Reference)
1999	7.78	6.78	1.10 (1.10–1.11)
2000	8.30	7.24	1.10 (1.09–1.10)
2001	7.75	7.25	1.14 (1.14–1.15)
2002	8.17	7.74	1.15 (1.15–1.16)
2003	7.80	7.87	1.20 (1.20–1.21)
2004	7.88	8.22	1.23 (1.22–1.23)
2005	7.66	7.97	1.28 (1.27–1.29)
2006	7.77	7.96	1.31 (1.30–1.31)
2007	8.07	8.54	1.32 (1.31–1.33)
2008	7.54	8.19	1.27 (1.26–1.28)
2009	7.03	7.66	1.32 (1.31–1.33)
2010	6.73	7.01	1.27 (1.26–1.28)

*Also controlled for in model—amnioinfusion, intrauterine pressure catheter, prolonged labor—2nd stage, precipitate labor, abnormal uterus, abnormal cervix, grand multiparity, meconium, early labor, late pregnancy, edema/weight gain, other antepartum hemorrhage, habitual aborter, liver problems, renal disease, thyroid dysfunction, gestational diabetes, congenital heart disorders, other heart diseases, drug dependence, mental disorder, other maternal complications, Rh isoimmunization, other fetal abnormality, poor fetal growth, polyhydramnios, oligohydramnios, maternal fever, deficiency and other anemia, sickle cell anemia, coagulation and hemorrhagic disorders, schizophrenia and other psychotic, alcohol-related disorders, substance-related disorders, asthma, lupus, endometriosis, diabetes, obesity, tobacco use, years.

[†]Discharges who were not coded for labor but were coded for herpes and cesarean section were excluded from these analyses because they were determined to have a prelabor cesarean delivery.

chorioamnionitis. Compared with women without clinical chorioamnionitis at an urban teaching hospital (reference group), women with clinical chorioamnionitis who delivered at an urban teaching hospital were 1.40 times more likely to have cesarean delivery. Women with clinical chorioamnionitis who delivered at an urban nonteaching hospital were 1.52 times more likely and women with clinical chorioamnionitis who delivered at a rural hospital were 1.53 times more likely to have a cesarean delivery, controlling for all obstetric and medical indications for cesarean delivery (Figure 2).

The interaction of clinical chorioamnionitis and hospital geographic location was also significantly associated with cesarean delivery. Compared with women without clinical chorioamnionitis in the Midwest (reference group), women with clinical chorioamnionitis in the South were 1.55 times more likely to have a cesarean delivery. Women with clinical chorioamnionitis in the Northeast were 1.48 times more likely, in the Midwest were 1.40 times

Figure 2: Adjusted Risk of Cesarean Delivery for Clinical Chorioamnionitis and Teaching Status/Location in a Subset of Discharges Coded for Labor and PPRM. (The reference group was women with no chorioamnionitis who delivered at an urban teaching hospital)

more likely, and in the West were 1.34 times more likely to have a cesarean delivery, controlling for all obstetric and medical indications for cesarean delivery (Figure 3).

Comment

To our knowledge, this is the first large national and most comprehensive study to examine the association of clinical chorioamnionitis with obstetric delivery method. We examined the prevalence of cesarean delivery over a 13-year period. Similar to previous studies (Podulka, Stranges, and Steiner 2006; Menacker and Hamilton 2010; Barber et al. 2011), we found that the overall prevalence of cesarean deliveries steadily increased from 21 percent in 1998 to a high of 33 percent in 2010. While the overall prevalence of clinical chorioamnionitis decreased from 1.93 percent in 1998 to 1.70 percent in 2010, the prevalence of cesarean delivery in women coded for clinical chorioam-

Figure 3: Adjusted Risk of Cesarean Delivery for Clinical Chorioamnionitis and Geographic Location in a Subset of Discharges Coded for Labor and PPRM. (The reference group was women with no chorioamnionitis in the Midwest)

nionitis increased from 44 to 49 percent. This suggests that the threshold for performing a cesarean delivery in women with chorioamnionitis may have decreased during this time span.

We found that women with clinical chorioamnionitis were 40 percent more likely to have a cesarean delivery than those without clinical chorioamnionitis, after controlling for obstetric and medical confounding variables. The diagnosis of clinical chorioamnionitis may be considered sufficient criteria for some providers to perform a cesarean delivery independent of medical or obstetric risk factors, although a causal effect cannot be established using cross-sectional data. Women with clinical chorioamnionitis in the Northeast and South were more likely to have a cesarean delivery. This could be due to the medicolegal environment in these regions. States in the South and Northeast have some of the highest malpractice premiums in the United States (Zwecker, Azoulay, and Abenhaim 2011), and several studies have shown that malpractice litigation pressure and malpractice premiums affect obstetric management and are correlated with higher cesarean delivery rates (Murthy et al. 2007; Yang et al. 2009; Zwecker, Azoulay, and Abenhaim 2011). The increase in the South may also be due to the higher percentage of African Americans living in the South since the rate of cesarean delivery is higher in African Americans (34 percent) than in Caucasians (32 percent) (Menacker and Hamilton 2010; Martin et al. 2011; Rastogi et al. 2011). The increased likelihood of cesarean delivery in women with clinical chorioamnionitis in a rural hospital could also be due to the medicolegal environment and the relative availability of resources in rural areas. Physicians may be more likely to perform a cesarean delivery in hospitals in which neonatal intensive care units or other specialized neonatal services are not available.

Cesarean delivery is performed when delivery is indicated and when induction of labor, a trial of labor, or vaginal delivery of the fetus is deemed to impose greater risk to the mother or the fetus than abdominal delivery (Creasy, Resnik, and Iams 2004). Time-to-delivery following antibiotic therapy for clinical chorioamnionitis has not been shown to affect maternal or neonatal morbidity (Hauth et al. 1985; Gilstrap and Cox 1989; Rouse et al. 2004); therefore, cesarean delivery to expedite delivery in the absence of other indications is not typically recommended. While clinical chorioamnionitis, by itself, is not an indication for cesarean delivery, the increased occurrence of cesarean delivery among discharges in women coded for clinical chorioamnionitis patients may suggest a lower decision threshold to perform a cesarean delivery by some physicians, particularly in rural hospitals and in the Northeast and South.

It is important to reduce the cesarean deliveries in general, but especially those performed without appropriate medical indications. Compared with spontaneous vaginal delivery, cesarean delivery is associated with increased risk of endometritis, need for transfusion, pneumonia, and hysterectomy (Burrows, Meyn, and Weber 2004; Quiroz et al. 2009; Bailit et al. 2010; Karlstrom, Lindgren, and Hildingsson 2013). Karlstrom, Lindgren, and Hildingsson (2013) found that maternal complications occurred more frequently among women undergoing cesarean delivery without medical indication compared with women undergoing births through spontaneous onset of labor.

There are certain limitations in our study. Chorioamnionitis may be the direct cause of cesarean delivery, even though it is not an accepted indication, but chorioamnionitis may also be an intermediate risk factor along the causal pathway. Even though we controlled for many obstetric and medical confounding variables in our analyses, there may still be residual confounding resulting in an overestimate of the association between chorioamnionitis and cesarean delivery. The NIS only included 22 states in 1998 and 45 states in 2010; however, for 2010, those 46 states comprised 95 percent of the U.S. population. Data from the NIS are limited to information from discharge abstracts, and undercoding of diagnoses is likely, particularly in patients with multiple procedures and diagnoses (O'Malley et al. 2005). Due to the variability of missing race by state, we did not include race in our multivariate model. We used insurance status as a proxy for socioeconomic status due to lower cesarean delivery rates in Medicaid and self-pay populations. Additionally, using administrative data does not allow us to take into account the influence of patient preference for delivery method or the different practices of individual physicians.

This study has several strengths, including the very large sample size and ability to assess significant practice variation due to the inclusion of patients treated by many different physicians in many hospitals over broad geographic regions. This sample also allowed for a robust analysis of cesarean deliveries across different U.S. regions and hospital types. The NIS has been widely used in health services and clinical research. The NIS is the only national hospital database with information on all patients regardless of insurance coverage, which is very important because insurance coverage has been shown to be strongly associated with cesarean delivery in previous studies (Huesch 2011).

Our study suggests that clinical chorioamnionitis is an independent risk factor for cesarean delivery, controlling for confounding variables including

an extensive list of obstetric and medical indications for surgery. Since clinical chorioamnionitis is not considered an indication by itself for cesarean delivery, and given the high proportion of cesarean deliveries in the United States, it is important to examine the potential overuse of cesarean delivery in women with chorioamnionitis without other medical or obstetric indications for cesarean delivery.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Appendix SA1: Author Matrix.

Appendix SA2: Diagnosis and Procedure Codes for All Medical and Obstetric Covariates.