Effect of severity of illness on cesarean delivery rates in Washington State

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BACKGROUND: Hospitals and providers are increasingly held accountable for their cesarean delivery rates. In the perinatal quality improvement arena, there is vigorous debate about whether all hospitals can be held to the same benchmark for an acceptable cesarean rate regardless of patient acuity. However, the causes of variation in hospital cesarean delivery rates are not well understood.

OBJECTIVE: We sought to evaluate the association and temporal trends between severity of illness at admission and the primary term singleton vertex cesarean delivery rate among hospitals in Washington State. We hypothesized that hospitals with higher patient acuity would have higher cesarean delivery rates and that this pattern would persist over time.

STUDY DESIGN: In this cross-sectional analysis, we analyzed aggregate hospital-level data for all nonmilitary hospitals in Washington State with ≥100 deliveries/y during federal fiscal years 2010 through 2014 (287,031 deliveries). Data were obtained from the Washington State Comprehensive Hospital Abstract Reporting System, which includes inpatient demographic, diagnosis, procedure, and discharge information derived from hospital billing systems. Age, admission diagnoses and procedure codes were converted to patient-level admission severity-of-illness scores using the All Patient Refined Diagnosis Related Groups classification system. This system is widely used throughout the United States to adjust hospital data for severity of illness. Mean admission hospital-level severity-of-illness scores were calculated for each fiscal year among the term singleton vertex population with no history of cesarean delivery. We used linear regression to evaluate the association between hospital admission severity of illness and the primary term singleton vertex cesarean delivery rate, calculated Pearson correlation coefficients, and compared regression line slopes and 95% confidence intervals for each fiscal year.

RESULTS: Hospitals were diverse with respect to delivery volume, level of care, and geographic location within Washington. Hospital aggregate admission severity-of-illness score correlated with primary term singleton vertex cesarean delivery rate in all fiscal years (R^2 0.38-0.58, $P < .001$). For every year in the study interval, as admission severity of illness increased so did the primary term singleton vertex cesarean rate. The slope of the regression line decreased during the study interval, suggesting that statewide decrease in primary term singleton vertex cesarean rate occurred across the range of severity of illness.

CONCLUSION: Admission severity-of-illness score is strongly associated with the primary term singleton vertex cesarean delivery rate among hospitals in Washington State. Approximately 50% of variation in hospital primary term singleton vertex cesarean delivery rates appeared to be related to admission severity of illness. This relationship persisted over time despite a statewide decrease in cesarean delivery, suggesting that patient acuity will likely continue to contribute to hospital variation in cesarean delivery rates despite perinatal quality improvement efforts. The major implication of this study is that patient acuity should be considered when determining optimal cesarean delivery rates. High-acuity hospitals are likely to have high cesarean rates because they provide a specific role in serving regional needs. To hold these centers to an arbitrary benchmark may jeopardize the funding necessary to support regional safety net institutions.

Key words: cesarean delivery, primary term singleton vertex, quality improvement, severity of illness

Introduction

Recent perinatal quality initiatives have focused on best practices to safely reduce the term cesarean delivery rate to the lowest level possible while assuring optimal outcomes for mothers and infants.[1] National benchmarks for acceptable cesarean rates have been proposed, including the Healthy People 2020 goal of 23.9% for nulliparous term singleton vertex (NTSV) cesarean delivery.[2] Hospitals and individual providers are increasingly being held accountable for their rates.[3] However, the reasons for between-hospital variation in cesarean rates are not well understood.

In the perinatal quality improvement arena, there is vigorous debate about whether all hospitals can be held to the same benchmark for an acceptable cesarean rate regardless of patient acuity, regional referral patterns, or function as a "safety net" institution. We sought to evaluate the contribution of patient acuity to the primary term singleton vertex (TSV) cesarean rate, also known as Agency for Healthcare Research and Quality (AHRQ) inpatient quality indicator no. 33,[4] among Washington State hospitals. We examined trends in this relationship over a 5-year time interval that included active statewide quality improvement efforts to reduce the cesarean delivery rate. We hypothesized that hospitals with higher patient acuity would have higher TSV cesarean delivery rates and that this relationship would persist despite temporal trends.

Materials and Methods

We conducted a cross-sectional analysis of aggregate administrative hospital-level data for all nonmilitary hospitals in Washington State with a consistent delivery volume of ≥100 deliveries/y during 2010 through 2014. Hospitals that opened or closed during the study interval were included if they had ≥100 deliveries for each year of operation. Hospitals were excluded if they had <100 deliveries/y but were still in operation. The analysis included deidentified

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TABLE 1
Severity-of-illness weights for admission diagnoses and delivery procedure categories

	Severity-of-illness score			
	Minor	Moderate	Major	Extreme
Example diagnoses	Transient hypertension	Hypertension due to renal disease	Severe preeclampsia superimposed on chronic hypertension	Severe preeclampsia with venous thromboembolism and systemic lupus erythematosus
APR-DRG delivery code				
Cesarean delivery (540)	.5185	.6237	.9296	2.8305
Vaginal delivery with sterilization and/or D&C (541)	.4895	.5356	.8539	2.3987
Vaginal delivery with other procedure (542)	.3354	.4327	.9245	4.2739
Vaginal delivery (560)	.3027	.3445	.5115	1.7983

APR-DRG, All Patient Refined Diagnosis Related Groups; *D&C*, dilation and curettage.
Hitti. Severity of illness and cesarean rates. Am J Obstet Gynecol 2017.

data from pregnant women in the TSV population with no history of cesarean delivery (total 287,031 deliveries over 5 years). The University of Washington Institutional Review Board categorized this research as exempt from human subjects review, as it did not include identifiable patient data.

During the study interval, the Washington State Hospital Association championed an effort to reduce the cesarean rate by promoting a bundle of evidence-based best practices for labor management based on published guidelines[1] (Washington State Hospital Association Safe Deliveries Roadmap).[5] This program was initiated in 2012. Participation was voluntary and uptake among hospitals occurred progressively during the study interval, with 84% participation in 2013 and 100% participation in 2014.

Hospital-level data points were determined from analysis of deidentified individual patient data from the Washington State Comprehensive Hospital Abstract Reporting System (CHARS).[6] The CHARS database contains inpatient demographic, diagnosis, procedure, and discharge information derived from hospital billing systems. Patient-level CHARS data including age, admission diagnoses, and procedure codes were converted to patient-level admission severity-of-illness scores using the 3M All Patient Refined Diagnosis Related Groups (APR-DRG) classification system[7] provided through the Hospital Industry Data Institute. The APR-DRG classification is widely used throughout the United States to adjust hospital data for severity of illness, and is utilized by AHRQ[8] and the Centers for Medicare and Medicaid Services.[9,10] The APR-DRG are updated on a federal fiscal calendar (Oct. 1 through Sept. 30), and accordingly this analysis used the appropriate APR-DRG for each federal fiscal year.

The APR-DRG classification system assigns patient-level severity-of-illness scores for admission diagnoses at 4 levels: minor, moderate, major, and extreme. These scores are further weighted by delivery procedure code (delivery APR-DRG 540, 541, 542, 560). The standardized APR-DRG severity-of-illness weights by admission diagnoses and delivery procedure codes are summarized in Table 1, along with examples for each diagnosis category. We used APR-DRG version 31 weights (released in 2014) consistently to normalize patient-level severity-of-illness scores over the study interval. We then determined hospital APR-DRG severity-of-illness scores by calculating the mean patient-level severity-of-illness score at admission for each hospital, for each federal fiscal year.

We calculated hospital primary TSV cesarean rates for each federal fiscal year using CHARS data. We performed linear regression to evaluate the effect of hospital-level admission APR-DRG severity of illness on the primary TSV cesarean delivery rate for each year. We calculated the regression slope and 95% confidence intervals for each year, and evaluated the Pearson correlation between hospital admission APR-DRG severity-of-illness score and the primary TSV cesarean rate. We conducted 2 subset analyses: the first excluded 1 potential outlier hospital with very high acuity to determine whether this hospital significantly influenced the regression lines. A second subset analysis excluded hospitals that opened or closed during the study interval. Analyses were conducted in software (Stata, Version 13; StataCorp, College Station, TX).

Results

In all, 52 nonmilitary hospitals in Washington State met inclusion criteria. One new suburban level-2 hospital [T1] opened in 2012 and 1 rural level-1 hospital closed in 2014, yielding 51 included hospitals for 2010, 2011, and 2014, and 52 hospitals for 2012 and 2013. Hospital characteristics are summarized in Table 2. Hospitals were diverse with [T2] respect to annual delivery volume, neonatal intensive care unit level, and geographic region within the state.

The Figure illustrates the relationship [F1] between hospital aggregate APR-DRG severity-of-illness score at admission and the primary TSV cesarean delivery rate for each federal fiscal year. We noted

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