Variation in Cesarean Birth Rates by Labor and Delivery Nurses

Joyce K. Edmonds, Michele O’Hara, Sean P. Clarke, and Neel T. Shah

ABSTRACT

Objective: To examine variation in the cesarean birth rates of women cared for by labor and delivery nurses.

Design: Retrospective cohort study.

Setting: One high-volume labor and delivery unit at an academic medical center in a major metropolitan area.

Participants: Labor and delivery nurses who cared for nulliparous women who gave birth to term, singleton fetuses in vertex presentation.

Methods: Data were extracted from electronic hospital birth records from January 1, 2013 through June 30, 2015. Cesarean rates for individual nurses were calculated based on the number of women they attended who gave birth by cesarean. Nurses were grouped into quartiles by their cesarean rates, and the effect of these rates on the likelihood of cesarean birth was estimated by a logit regression model adjusting for patient-level characteristics and clustering of births within nurses.

Results: Seventy-two nurses attended 3,031 births. The mean nurse cesarean rate was 26% (95% confidence interval [23.9, 28.1]) and ranged from 8.3% to 48%. The adjusted odds of cesarean for births attended by nurses in the highest quartile was nearly 3 times (odds ratio = 2.73, 95% confidence interval [2.3, 3.3]) greater than for births attended by nurses in the lowest quartile.

Conclusion: The labor and delivery nurse assigned to a woman may influence the likelihood of cesarean birth. Nurse-level cesarean birth data could be used to design practice improvement initiatives to improve nurse performance. More precise measurement of the relative influence of nurses on mode of birth is needed.

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Cesarean is the most common major surgery in U.S. hospitals (Pluntner, Wier, & Stocks, 2013) and accounts for 1 in 3 births in the United States. Substantial variation (15-fold) in cesarean rates by hospital among women at low risk for the procedure is contributory to perinatal morbidity and an estimated $5 billion in excess spending annually (MacDorman, Menacker, & Declercq, 2008; Zhang et al., 2010). Hospital-level variation in the cesarean rate is not fully explained by patient risk factors or preferences and is instead widely believed to be driven by differences in clinician practices (Barber et al., 2011; Caceres et al., 2013; Spong, Berghella, Wenstrom, Mercer, & Saade, 2012). To measure and understand variability in clinician practices is therefore a focus of quality improvement efforts to reduce cesarean rates (The Joint Commission, 2015). However, despite extensive involvement of physicians and nurses in the direct clinical care of women in labor, only the variation across physicians attending births on cesarean rates has been extensively studied. This is due, in part, to lack of validated metrics with demonstrated sensitivity to intrapartum nursing interventions and information systems to capture nursing observations and interventions. With advances in electronic hospital information systems, it is now possible in more hospitals to link each nurse caring for each patient with clinical and outcome data. Therefore, our study aim was to measure variation in the cesarean birth rates of women cared for by nurses at a single, high-volume academic labor and delivery unit using information from the electronic health record. Our study was informed by the structure, process, outcome paradigm for health care quality (Donabedian, 2005) and by questions about the ability to measure and analyze the extent and source of clinical variation in nursing practice to pinpoint potential opportunities for improvement.

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Measuring nurse-specific cesarean birth rates is a first step toward understanding how individual nurses influence mode of birth and, more broadly, how they affect the care and outcomes of women and newborns during childbirth (Edmonds, Hacker, Golen, & Shah, 2016). Although accountability for intrapartum outcomes is shared, nurses are key members of the team who are constantly present throughout labor and birth and provide much of the direct patient care during the intrapartum period. Cesarean rates in low-risk women are a potentially valid nurse-level performance measure that might have important implications for practice development and management.

**Literature Review**

Labor and delivery nurses attend nearly all of the four million U.S. hospital-based births (Bingham & Ruhl, 2015) and provide care (Gennaro, Mayberry, & Kafulafula, 2007; Simpson, 2005) that can influence mode of birth (Ballit, Dierker, Blanchard, & Mercer, 2005; Sharma et al., 2009; Zhang et al., 2010). Nurses are also known to affect the clinical behaviors and labor management decisions of physicians (Edmonds & Jones, 2012; Flamm, Berwick, & Kabcenell, 1998; Simpson, James, & Knox, 2006). Nurses, for example, may communicate and negotiate with physicians strategically to allow more time for women to labor and discuss clinical opinions about fetal assessment and oxytocin administration with physicians. Previous researchers showed that the number of nurses who care for a woman (Gagnon, Meier, & Waghorn, 2007), a nurse’s cognitive frame or attitudes about birth (Regan & Liaschenko, 2007), and the time a nurse spends in the provision of labor support (Hodnett, Gates, Hofmeyr, & Sakala, 2007, 2013) might influence mode of birth. For example, an increased number of nurses managing a woman in labor, nurse beliefs that birth is a risky process, and less time spent providing direct nursing care and support at the bedside might increase the risk for cesarean.

Clinical observations on any given obstetric unit indicate that there are certain nurses who appear to consistently have low intervention rates, low cesarean rates, and good maternal and neonatal outcomes, irrespective of patient risk levels or the physician involved. However, only one group of researchers has addressed this topic to date. Radin, Harmon, and Hanson (1993) found that the unadjusted cesarean rates by quintile for 14 nurses who attended 216 births varied from 4.9% for nurses in the lowest group to 19% for nurses in the highest group. No further studies of this type have been conducted.

Measurement of the cesarean rate among nulliparous women with term, singleton fetuses in vertex presentation (NTSV) may help identify the contribution of individual nurses to perinatal outcomes. First, this rate is a widely endorsed perinatal quality measure at the physician, hospital, and national levels, and as a result most hospitals collect the requisite data elements for its calculation. Second, the use of specific nursing practices may reduce the likelihood of cesarean birth in women having their first newborns, including limiting admissions in early labor, making standard assessments of fetal heart rate and labor progression, supporting non-pharmacologic approaches to relieve labor pain, assisting in position changes, encouraging pushing in second-stage labor, and providing continuous labor support. Providing feedback to nurses on their cesarean rates in NTSV births as part of an audit and feedback intervention could be used to engage them to explore and ultimately standardize practices.

**Methods**

**Setting and Sample**

This retrospective cohort study was conducted with data from an obstetric unit in an academic medical center with a volume of 3,500 births per year. The hospital’s institutional review board approved the study. The obstetric unit comprises 12 private labor, delivery, and recovery rooms; two operating rooms; and a triage area. Primary nursing supports a patient care delivery model in which the registered nurse (RN) labor and delivery staff are cross-trained and circulate to the operating room as needed. The hospital is designated by the American Nurses Credentialing Center as a Magnet facility, a recognized marker of high-quality management of nursing services. Nurse-patient assignments are made independently of women’s risks for cesarean birth, and intrapartum management is based on the managing providers’ interpretation of case presentation and clinical judgment, informed by professional standards of care and the perspectives of nurses and patients. In general, nursing assignments on this unit, particularly of low-risk women with NTSV pregnancies, are made without regard to

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factors that can increase or decrease the potential for cesarean, with rotational patient assignment of new admissions. During the study period, there were no new RN hires. All managing providers are members of the hospital’s obstetric service run by a single collaborative practice of 36 obstetricians and 22 midwives. The cesarean rate among women with NTSV pregnancies at this hospital in 2015 was 24.3%. At the time of the study, 72 RNs (54 full-time equivalents) were employed on the unit. With few exceptions, the RNs work 12-hour shifts between 24 and 40 hours per week on the day shift (7 a.m. to 6:59 p.m.) or night shift (7 p.m. to 6:59 a.m.). During the study period, all RNs were permanent staff; there were no float team or temporary staff. Criterion for RN inclusion in the analysis was attendance at 15 or more NTSV births during the study period, which all 72 nurses on the unit met.

Data Collection and Analysis Procedures

Data from January 1, 2013 through June 30, 2015 were extracted from the electronic health records consisting of data entered by obstetric providers at the point of care. Births to nulliparous women with single, vertex fetuses at term (36.7–41.5 weeks) were identified. Births by scheduled cesarean for medical or elective reasons were excluded. Each eligible birth was attributed to the primary RN present. Cesarean rates were calculated for each nurse present at more than 15 of the eligible births during the study period. Each nurse’s cesarean rate was calculated by dividing the number of NTSV cesarean births attributed to each nurse by the total number of NTSV births attended by that individual nurse. Nurses were then divided into four groups or quartiles based on the distribution of their calculated cesarean birth rates. Quartiles were selected to explore the patterns of spread of the normally distributed data. Collapsing the data into fewer categories would have masked the extent of the variation observed.

To determine if significant differences existed in the population of women attended by the four groups of nurses, characteristics (maternal age, gestational age, birth weight, Apgar scores, and time of birth) of the women and neonates they attended were compared using one-way analysis of variance. Gestational age was based on best dates for estimated date of birth as evaluated by the clinician. Birth weight in grams and Apgar scores at 1 and 5 minutes were extracted from the electronic health record. Times of birth were categorized into day and night based on when they occurred relative to day and night nursing shifts. A chi-square test of goodness of fit was performed to determine whether there were differences in the proportion of night births by nurse quartile. We further computed a Pearson’s r to assess the relationship between the case count of NTSV births attended per nurse and nurse NTSV cesarean rates. Finally, a robust logit regression model that accounted for clustering of births within nurses was estimated to evaluate the effect of nurse quartiles on cesarean births adjusting for maternal age, gestational age, birth weight, and time of birth. Analyses were conducted in Stata 14 (StataCorp, 2015), and statistical significance was set at $p < .05$.

Results

The data analyzed related to 3,031 NTSV births and 72 RNs. Figure 1 illustrates the distribution of the individual nurse NTSV cesarean rates, which ranged from 8.3% to 48.0%, with a mean of 26.0% (95% confidence interval [CI] [23.9, 28.1]). The distribution of nurse case counts and NTSV cesarean rates are summarized by quartiles (see Table 1). Mean nurse NTSV cesarean rates varied from 15.7% for Quartile 1 to 37.6% for Quartile 4, and case counts ranged from 15 to 90 (mean $= 42.1 \pm 16.7$). For births that occurred during day shifts ($n = 1,535$) the mean nurse NTSV cesarean rate was 27.8% (95% CI [27.4, 28.1]) and for births that occurred during night shifts ($n = 1,496$) the mean nurse NTSV cesarean rate was 23.8% (95% CI [23.4, 24.2]). There was no correlation between nurse-level NTSV case

![Figure 1](http://jognn.org)
counts and NTSV cesarean rates, $r(72) = -0.05$, $p = .68$.

Characteristics of the women and newborns cared for by the nurses in each quartile are summarized in Table 2. There were no significant differences in the distribution of gestational age, birth weight, or Apgar scores by nurse quartile. There were, however, significant differences in maternal age ($p = .01$) and time of birth ($p < .001$) by nurse quartiles. A post hoc comparison using the Tukey HSD test indicated an approximate 1-year (0.92) difference in maternal age between Quartiles 2 and 4. Nurses with lower cesarean rates (Quartiles 1 and 2) attended a greater proportion of night births than nurses with higher cesarean rates (Quartiles 3 and 4), $\chi^2(1, n = 1,496) = 136.57$. After adjusting for maternal age, gestational age, birth weight, and time of birth, the effect of nurse quartiles on the likelihood of cesarean remained significant. The adjusted odds for cesarean among births attended by nurses in the highest quartile were nearly three times (odds ratio = 2.73, 95% CI [2.3, 3.3]) greater than births attended by nurses in the lowest quartile (see Table 3).

### Discussion

This study showed significant variations in the NTSV cesarean birth rates for labor and delivery registered nurses at a single tertiary center. Moreover, this variation was not associated with the NTSV case count (a measure of volume, or number of total eligible births attended by each nurse). All of the women were from a population

### Table 1: Descriptive Data on Nurse-Level NTSV Cesarean Rates

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Quartile 1 (Lowest)</th>
<th>Quartile 2</th>
<th>Quartile 3</th>
<th>Quartile 4 (Highest)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>NTSV births, N</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>72</td>
</tr>
<tr>
<td>NTSV case count within quartile, M (SD)</td>
<td>765 (19.3)</td>
<td>840 (20.2)</td>
<td>694 (15.8)</td>
<td>732 (15.5)</td>
<td>3,031</td>
</tr>
<tr>
<td>Nurse-level NTSV cesarean rate within quartile, M (SD)</td>
<td>15.7 (3.8)</td>
<td>23.4 (1.4)</td>
<td>27.4 (1.3)</td>
<td>37.6 (6.1)</td>
<td>26.0 (8.8)</td>
</tr>
<tr>
<td>Highest nurse-level NTSV cesarean rate within quartile</td>
<td>21.5</td>
<td>25.6</td>
<td>29.6</td>
<td>48.0</td>
<td>48.0</td>
</tr>
<tr>
<td>Lowest nurse-level NTSV cesarean rate within quartile</td>
<td>8.3</td>
<td>21.6</td>
<td>26.0</td>
<td>30.2</td>
<td>8.3</td>
</tr>
</tbody>
</table>

Note. M = mean; NTSV = nulliparous, term, singleton, and vertex; SD = standard deviation.

### Table 2: Birth Characteristics by Nurse Quartile

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total</th>
<th>Quartile 1 (Lowest)</th>
<th>Quartile 2</th>
<th>Quartile 3</th>
<th>Quartile 4 (Highest)</th>
<th>p, Difference Between Quartiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal age in years, M (SD)</td>
<td>30.87 (5.5)</td>
<td>30.79 (5.4)</td>
<td>30.47 (5.6)</td>
<td>30.91 (5.7)</td>
<td>31.39 (5.3)</td>
<td>.01</td>
</tr>
<tr>
<td>Gestational age in weeks, M (SD)</td>
<td>39.3 (1.3)</td>
<td>39.4 (1.3)</td>
<td>39.3 (1.3)</td>
<td>39.4 (1.2)</td>
<td>39.32 (1.4)</td>
<td>.77</td>
</tr>
<tr>
<td>Birth weight in g, M (SD)</td>
<td>3,363 (472)</td>
<td>3,356 (467)</td>
<td>3,354 (484)</td>
<td>3,377 (465)</td>
<td>3,367 (468)</td>
<td>.60</td>
</tr>
<tr>
<td>Apgar score, M (SD)</td>
<td>7.88 (1.6)</td>
<td>7.98 (1.5)</td>
<td>7.89 (1.7)</td>
<td>7.81 (1.7)</td>
<td>7.84 (1.7)</td>
<td>.23</td>
</tr>
<tr>
<td>Births at night, %</td>
<td>49.4</td>
<td>64.7</td>
<td>57.0</td>
<td>37.5</td>
<td>35.8</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Note. M = mean; SD = standard deviation.
The findings are consistent with those of studies of variation in physician cesarean rates (Berkowitz, Fiarman, Mojica, Bauman, & de Regt, 1989; DeMott & Sandmire, 1990; Goyert, Bottoms, Treadwell, & Nehra, 1989; Segal, Blatman, Doble, & Datta, 1999) in which researchers used the term **physician factor** to describe the influence of the obstetrician who attends the birth on the risk of cesarean. Recently, Metz et al. (2016) found that the primary cesarean rates of individual physicians in a laborist practice model varied from 12.5% to 35.9%. Similarly, based on our data we suggest that there is a potential **nursing factor** as well. Although most nurses had rates similar to the hospital’s overall rate, we observed a near 40% difference between the nurse with the highest and the nurse with the lowest rate (range = 8.3%–48%), similar to the 37.5% difference (range = 0%–37.5%) reported by Radin et al. (1993) more than 20 years ago. Other potential explanations for the observed variations in cesarean rates across RNs, beyond practice difference, include differences in staffing patterns or other unit conditions, maternal preferences, and/or differences in labor patterns among subgroups of women assigned to these nurses, which seem unlikely but cannot be ruled out. Nurse-level NTSV cesarean rates may need to be adjusted for additional patient characteristics to be meaningful, given that some nurses may consistently be assigned to care for women with more complex needs. Published risk adjustment models have identified factors important for calculation and comparison of hospital- and physician-level primary cesarean rates (Bailit, 2007; Bailit & Garrett, 2003; Bailit & Love, 2008; Luthy, Malmgren, Zingheim, & Leininger, 2003; Tang et al., 2006), but models for labor and delivery nurses have not yet been developed.

The main potential explanations relate to differences between individual nurses. Education level, obstetric skills, intrapartum nursing experience, and cognitive traits such as beliefs about practice are plausible factors that might be associated with the care provided by nurses and might be used to explain the observed variation. For example, it could be that nurses with more intrapartum nursing experience and beliefs supportive of physiologic labor will consistently have lower NTSV cesarean rates than their counterparts with less experience and a practice based on a set of risk-based beliefs about childbirth. Our finding that births on night versus day shift have lower NTSV cesarean is potentially significant in the context of organizational factors such as provider availability. However, at the study site, there are the same number of obstetric providers and ratio of nursing staff on the night shift as on the day shift following the same standards of care. Further research is needed to identify and explain the factors that distinguish the relative ranking of nurses by mode of birth outcomes of women in their care in different practice settings.

This study has several limitations. First, no data on the nurses themselves other than their coded identities were available for analysis, and therefore it is unclear what nurse attributes, if any, could be used to explain the variation we see. Second, it is possible that the variation observed is influenced by unmeasured factors, such as clinical details and delivery provider, that were not captured in our record abstraction. Third, our method of attributing births to nurses does not capture the complexity of patterns and intensity of nursing care during the course of a woman’s

### Table 3: Adjusted Odds Ratios of NTSV Cesarean Births for Women Cared for by Nurses in Different Quartiles of NTSV Cesarean Rates

<table>
<thead>
<tr>
<th>Nurse Quartile</th>
<th>Mean Nurse-Level NTSV Cesarean %</th>
<th>AOR*</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15.7</td>
<td>1.00</td>
<td>Reference</td>
</tr>
<tr>
<td>2</td>
<td>23.4</td>
<td>1.55</td>
<td>[1.34, 1.80]</td>
</tr>
<tr>
<td>3</td>
<td>27.4</td>
<td>1.81</td>
<td>[1.58, 2.08]</td>
</tr>
<tr>
<td>4</td>
<td>37.6</td>
<td>2.73</td>
<td>[2.29, 3.26]</td>
</tr>
</tbody>
</table>

*Note. AOR = adjusted odds ratio; CI = confidence interval; NTSV = nulliparous, term, singleton, and vertex.

**Odds ratios for NTSV cesarean births were calculated from robust regression models adjusted for maternal age, gestational age, birth weight, and time of birth.**
labor. The nurse attributed to a birth may not be the nurse who most influenced the outcome. In our future work, we plan to explore attribution methods to take into account the contributions of multiple nurses to the outcomes of women with longer labors and/or those whose births take place during nursing shift changes. Despite the limitations, our approach and findings show clear patterns that are consistent with previous research and analogous research conducted with physicians.

We believe that the need for further research on the influence of individual nurses on mode of birth is supported by our data. It is recommended that future research in this area address several major issues involved: conceptualization of performance of intrapartum nursing care, electronic data availability and quality, choice of attribution method, formulation of statistical analyses, and development of approaches to report results of analyses to clinicians. Furthermore, how the structure of labor and delivery units influence the provision of intrapartum nursing care needs to be examined, because organizational contexts of units differ considerably.

Practice Implications
One of the most fundamental principles in quality improvement is that the elimination of unwarranted practice variation can lead to better outcomes and more efficient uses of resources (Clark, Belfort, Hankins, Meyers, & Houser, 2007; Wennberg, 2011). Seminal work in maternal quality and safety, focused on the reduction of cesareans, made intensive use of comparative outcome data to reduce variation in physician practice patterns (Main, 1999). Providing individualized feedback to physicians about the cesarean rates of women under their care has been proven to be an effective strategy to initiate practice changes that can safely reduce cesarean rates (Chaillet & Dumont, 2007; Hartmann et al., 2012; Ivers et al., 2012). When included as part of a multifaceted strategy, the use of audit and feedback aims to improve outcomes by prompting health care professionals to modify their practice when given formal and informal feedback about their performance and how it compares with explicit criteria. Measuring the cesarean rates of individual labor and delivery nurses may inform a more effective audit and feedback intervention to help reduce rates and improve maternal and newborn outcomes by prompting nurses to take more ownership of the population outcomes they are responsible for shaping. Identifying the practices consistently used by nurses in the first quartile, those with lower NTSV cesarean rates, can help pinpoint best practices used to achieve desired physiologic labor and birth outcomes. Including nurse-level data profiles alongside those of obstetricians and nurse-midwives might support a more collaborative approach to implementing evidence-based management of labor and birth. This approach to examining individual nurse data could also serve as a basis for examining the sensitivity of other nursing measures, including those developed by the Association of Women's Health, Obstetric and Neonatal Nurses.

Conclusions
The data from our study have future implications for health care practice, management, and policy. However, for this type of data to be used in analytic-based quality improvement activities, performance evaluations, and national benchmarking of nursing performance, valid nurse–patient level measures that treat each nurse as a unique provider of care are needed. Accordingly, this research is relevant to current policy considerations such as the national voluntary consensus standards endorsed by the National Quality Forum (2004), the Interdisciplinary Nursing Quality Research Initiative (Naylor et al., 2013), and the national nursing efforts to measure the value of nursing care using big data (Welton & Harper, 2016).

Examination of the relative effects of clinicians on the prevention of primary cesarean birth is a current focus of hospital-based performance improvement strategies in the United States. Our findings provide current evidence of a nearly threefold variation in the NTSV cesarean birth rates across labor and delivery nurses at the same institution. These findings highlight the potential influence of the individual nurse practice on mode of birth outcomes. Further refinement of this nurse-level outcome measure and examination of how individual nursing practice might be modified to improve birth outcomes are needed.


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