

# Society for Maternal-Fetal Medicine (SMFM) Special Report: Comparing variation in hospital rates of cesarean delivery among low-risk women using 3 different measures

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## Measurement of the low-risk cesarean delivery rate

Lowering the low-risk cesarean delivery rate has been a recent public health focus.<sup>1-3</sup> Two risk-adjusted or low-risk cesarean delivery rate measures developed by the Joint Commission (JC) and the Agency for Healthcare Research and Quality (AHRQ) are currently used for hospital reporting.<sup>4,5</sup> Both define “low risk” as term, singleton, live birth deliveries in the vertex presentation. The JC measure applies only to nulliparous patients. The AHRQ measure captures women with no prior cesareans. Both measures identify additional medical factors that classify the delivery as high risk for cesarean delivery and thus exclude those deliveries from measurement (Table 1). The medical factors identified for exclusion are similar, but not identical, between the 2 measures. Further, these lists are not exhaustive, omitting some well-accepted contraindications to vaginal birth such as placenta previa as well as conditions that are likely to lead to cesarean delivery such as HIV infection. Although these risk factors have low prevalence at a population level, if they are not excluded

This report describes the development of a measure of low-risk cesarean delivery by the Society for Maternal-Fetal Medicine (SMFM). Safely lowering the cesarean delivery rate is a priority for maternity care clinicians and health care delivery systems. Therefore, hospital quality assurance programs are increasingly tracking cesarean delivery rates among low-risk pregnancies. Two commonly used definitions of “low risk” are available, the Joint Commission (JC) and the Agency for Healthcare Research and Quality (AHRQ) measures, but these measures are not clinically comprehensive. We sought to refine the definition of the low-risk cesarean delivery rate to enhance the validity of the metric for quality measurement. We created this refined definition—called the SMFM definition—and compared it to the JC and AHRQ measures using claims-based data from the 2011 Nationwide Inpatient Sample of >863,000 births in 612 hospitals. Using these definitions, we calculated means and interquartile ranges (25th–75th percentile range) for hospital low-risk cesarean delivery rates, stratified by hospital size, teaching status, urban/rural location, and payer mix. Across all hospitals, the mean low-risk cesarean delivery rate was lowest for the SMFM definition (12.65%), but not substantially different from the JC and AHRQ measures (13.12% and 13.29%, respectively). We empirically examined the SMFM definition to ensure its validity and utility. This refined definition performs similarly to existing measures and has the added advantage of clinical perspective, enhanced face validity, and ease of use.



**Key words:** cesarean delivery rate variation, hospital variation, low-risk cesarean delivery rate, quality measurement, Society for Maternal-Fetal Medicine

in a low-risk cesarean delivery rate definition, the face validity of the measure for practicing physicians and hospitals is decreased. Further, this creates

skepticism about the measure, particularly among hospitals that disproportionately care for women with some of these conditions. More concerning from

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TABLE 1

**ICD-9 codes indicating medical exclusion conditions for cesarean rate calculations according to 3 definitions**

ICD9 Diagnosis Code	ICD9 Diagnosis Code Short Description	Risk Factor Classification	SMFM	JC	AHRQ
042	HUMAN IMMUNO VIRUS DIS	Maternal factors	x		
641.01	PLACENTA PREVIA-DELIVER	Maternal factors	x		
641.11	PLACENTA PREV HEM-DELIV	Maternal factors	x		
642.6	ECLAMPSIA	Maternal factors	x		
642.60	ECLAMPSIA-UNSPECIFIED	Maternal factors	x		
642.61	ECLAMPSIA-DELIVERED	Maternal factors	x		
642.62	ECLAMPSIA-DELIV W P/P	Maternal factors	x		
642.63	ECLAMPSIA-ANTEPARTUM	Maternal factors	x		
644.2	EARLY ONSET OF DELIVERY	Preterm birth	x		
644.20	EARLY ONSET DELIV-UNSPEC	Preterm birth	x		X
644.21	EARLY ONSET DELIVERY-DEL	Preterm birth	x	x	x
646	PAPYRACEOUS FETUS	Stillborn	x		
646.0	PAPYRACEOUS FETUS	Stillborn	x		
646.00	PAPYRACEOUS FETUS-UNSPEC	Stillborn	x		
646.01	PAPYRACEOUS FETUS-DELIV	Stillborn	x		
646.03	PAPYRACEOUS FET-ANTEPAR	Stillborn	x		
648.51	CONGEN CV DIS-DELIVERED	Maternal factors	x		
648.52	CONGEN CV DIS-DEL W P/P	Maternal factors	x		
648.53	CONGEN CV DIS-ANTEPARTUM	Maternal factors	x		
648.54	CONGEN CV DIS-POSTPARTUM	Maternal factors	x		
648.6	OTHER CARDIOVASCULAR DISEASE	Maternal factors	x		
648.60	CV DIS NEC PREG-UNSPEC	Maternal factors	x		
648.61	CV DIS NEC PREG-DELIVER	Maternal factors	x		
648.62	CV DIS NEC-DELIVER W P/P	Maternal factors	x		
648.63	CV DIS NEC-ANTEPARTUM	Maternal factors	x		
648.64	CV DIS NEC-POSTPARTUM	Maternal factors	x		
651	TWIN PREGNANCY	Multiple gestation	x		
651.0	TWIN PREGNANCY	Multiple gestation	x		
651.00	TWIN PREGNANCY-UNSPEC	Multiple gestation	x		x
651.01	TWIN PREGNANCY-DELIVERED	Multiple gestation	x	x	x
651.03	TWIN PREGNANCY-ANTEPART	Multiple gestation	x		x
651.1	TRIPLER PREGNANCY	Multiple gestation	x		
651.10	TRIPLER PREGNANCY-UNSPEC	Multiple gestation	x		x
651.11	TRIPLER PREGNANCY-DELIV	Multiple gestation	x	x	x
651.13	TRIPLER PREG-ANTEPARTUM	Multiple gestation	x		x
651.2	QUADRUPLET PREGNANCY	Multiple gestation	x		
651.20	QUADRUPLET PREG-UNSPEC	Multiple gestation	x		x

Armstrong. Hospital rates of cesarean delivery among low-risk women. *Am J Obstet Gynecol* 2016. (continued)

a policy perspective is the potential of limiting access to care to women with high-risk conditions that are not excluded from the low-risk cesarean delivery definition as a strategy to reduce the low-risk cesarean delivery rate. An additional challenge with the JC measure is that it is labor intensive and requires hospital resources for chart abstraction.

The availability of a published, risk-adjusted cesarean delivery rate measure based on a comprehensive list of clinically valid diagnoses that are easily identified in administrative data is therefore needed to facilitate adoption by the clinical community and allow comparisons of quality and variation among hospitals. We sought to extend the efforts of the Society for Maternal-Fetal Medicine (SMFM) in this arena and to refine the definition of the low-risk cesarean delivery rate by building on the 2 previous measures and excluding additional clinically relevant risk factors. We then compared the performance of this refined definition to the JC and AHRQ measures in a nationally representative sample of US hospitals. The new definition was developed with the assistance of maternal-fetal medicine specialists and is supported by the SMFM Coding and Health Policy Committees giving it additional credibility among practicing clinicians.

### Development and testing of a refined definition

Hospital discharge data were used in a retrospective analysis of hospital cesarean rates, based on 3 different measures, 2 established measures (JC and AHRQ) compared with a newly proposed measure based on a more comprehensive inclusion of clinical risk factors and developed by the SMFM. This measure will be referred to as the SMFM measure for the remainder of the article.

### Data and study population

Data from the 2011 Nationwide Inpatient Sample (NIS), Healthcare Cost and Utilization Project, AHRQ were analyzed. The NIS is an all-payer inpatient claims database designed to

approximate a 20% stratified sample of US hospitals.<sup>6,7</sup> While it contains only administrative data, not clinical information, it is one of the most comprehensive national sources of information on hospital-based care in the United States. Hospitals represented in the NIS data include all US hospitals (nonfederal, short-term, general, and other specialty hospitals, including obstetrics gynecology, ear-nose-throat, orthopedic, and pediatric institutions). This includes both public hospitals and academic medical centers. Detailed information on the NIS data set, methodology, and variables is publicly available.<sup>8</sup> Our analyses focused on hospitals that reported discharges with neonatal and/or maternal diagnoses and procedures. From these hospitals, we used a validated methodology to identify hospital discharge records for obstetric deliveries in 2011.<sup>9</sup> We excluded hospitals with <100 births, consistent with prior research, to ensure enough sample for cross-hospital comparisons.<sup>10</sup> Our final data set included 863,346 births in 612 hospitals in 46 states.

### Medical exclusions for refined cesarean rate calculations

A refined measure of the risk-adjusted cesarean delivery rate, or low-risk definition was created. It included all term, singleton, vertex, live birth deliveries without prior cesarean and without high-risk diagnoses. Women with prior cesarean deliveries were excluded given the practice variation in trial of labor after cesarean delivery and the impact of patient choice on this decision. Initially, each diagnosis code was reviewed and classified independently by 2 authors (S.K.S. and J.C.A.) for inclusion in the measure. This was performed through systematic review and classification of all diagnoses codes in the *International Classification of Diseases, Ninth Revision (ICD-9)* in the maternity code range of 641.00 through 669.6, V22 through V28.9, and V91.00 through V91.99.<sup>11</sup> In our classification, we followed the practice guidelines of the American Congress of Obstetricians and Gynecologists (ACOG) or the SMFM as much as

TABLE 1

**ICD-9 codes indicating medical exclusion conditions for cesarean rate calculations according to 3 definitions** (continued)

ICD9 Diagnosis Code	ICD9 Diagnosis Code Short Description	Risk Factor Classification	SMFM	JC	AHRQ
651.21	QUADRUPLT PREG-DELIVER	Multiple gestation	x	x	x
651.23	QUADRUPLT PREG-ANTEPART	Multiple gestation	x		x
651.3	TWIN PREGNANCY WITH FETAL LO	Multiple gestation	x		
651.30	TWINS W FETAL LOSS-UNSP	Multiple gestation	x		x
651.31	TWINS W FETAL LOSS-DEL	Multiple gestation	x	x	x
651.33	TWINS W FETAL LOSS-ANTE	Multiple gestation	x		x
651.4	TRIPLT PREGNANCY WITH FETAL	Multiple gestation	x		
651.40	TRIPLETS W FET LOSS-UNSP	Multiple gestation	x		x
651.41	TRIPLETS W FET LOSS-DEL	Multiple gestation	x	x	x
651.43	TRIPLETS W FET LOSS-ANTE	Multiple gestation	x		x
651.5	QUADRUPLT PREGNANCY WITH FE	Multiple gestation	x		
651.50	QUADS W FETAL LOSS-UNSP	Multiple gestation	x		x
651.51	QUADS W FETAL LOSS-DEL	Multiple gestation	x	x	x
651.53	QUADS W FETAL LOSS-ANTE	Multiple gestation	x		x
651.6	OTHER MULTIPLE PREGNANCY WIT	Multiple gestation	x		
651.60	MULT GES W FET LOSS-UNSP	Multiple gestation	x		x
651.61	MULT GES W FET LOSS-DEL	Multiple gestation	x	x	x
651.63	MULT GES W FET LOSS-ANTE	Multiple gestation	x		x
651.7	MULTIPLE GESTATION	Multiple gestation	x		
651.70	MUL GEST-FET REDUCT UNSP	Multiple gestation	x		
651.71	MULT GEST-FET REDUCT DEL	Multiple gestation	x		
651.73	MUL GEST-FET REDUCT ANTE	Multiple gestation	x		
651.8	OTHER SPECIFIED MULTIPLE GES	Multiple gestation	x		
651.80	MULTI GESTAT NEC-UNSPEC	Multiple gestation	x		x
651.81	MULTI GESTAT NEC-DELIVER	Multiple gestation	x	x	x
651.83	MULTI GEST NEC-ANTEPART	Multiple gestation	x		x
651.9	UNSPECIFIED MULTIPLE GESTATI	Multiple gestation	x		
651.90	MULTI GESTAT NOS-UNSPEC	Multiple gestation	x		x
651.91	MULT GESTATION NOS-DELIV	Multiple gestation	x	x	x
651.93	MULTI GEST NOS-ANTEPART	Multiple gestation	x		x
652.20	BREECH PRESENTAT-UNSPEC	Malpresentation			x
652.21	BREECH PRESENTAT-DELIVER	Malpresentation	x	x	x
652.23	BREECH PRESENT-ANTEPART	Malpresentation			x
652.30	TRANSV/OBLIQ LIE-UNSPEC	Malpresentation			x
652.31	TRANSVER/OBLIQ LIE-DELIV	Malpresentation	x	x	x
652.33	TRANSV/OBLIQ LIE-ANTEPAR	Malpresentation			x

Armstrong. Hospital rates of cesarean delivery among low-risk women. *Am J Obstet Gynecol* 2016. (continued)

TABLE 1

**ICD-9 codes indicating medical exclusion conditions for cesarean rate calculations according to 3 definitions** (continued)

ICD9 Diagnosis Code	ICD9 Diagnosis Code Short Description	Risk Factor Classification	SMFM	JC	AHRQ
652.40	FACE/BROW PRESENT-UNSPEC	Malpresentation			x
652.41	FACE/BROW PRESENT-DELIV	Malpresentation	x	x	x
652.43	FACE/BROW PRES-ANTEPART	Malpresentation			x
652.6	MULTIPLE GESTATION, MALPRESE	Multiple gestation	x		
652.60	MULT GEST MALPRESEN-UNSP	Multiple gestation	x		x
652.61	MULT GEST MALPRES-DELIV	Multiple gestation	x	x	x
652.63	MULT GES MALPRES-ANTEPAR	Multiple gestation	x		x
652.70	PROLAPSED ARM-UNSPEC	Malpresentation	x		
652.71	PROLAPSED ARM-DELIVERED	Malpresentation	x		
652.81	MALPOSITION NEC-DELIVER	Malpresentation		x	
653.6	HYDROCEPHALIC FETUS CAUSING	Fetal factors	x		
653.60	HYDROCEPHAL FETUS-UNSPEC	Fetal factors	x		
653.61	HYDROCEPH FETUS-DELIVER	Fetal factors	x		
653.63	HYDROCEPH FETUS-ANTEPART	Fetal factors	x		
653.71	OTH ABN FET DISPRO-DELIV	Fetal factors	x		
654.2	UTERINE SCAR FROM PREVIOUS S	Uterine/placental factors	x		
654.20	PREV C-DELIVERY UNSPEC	Uterine/placental factors	x		x
654.21	PREV C-DELIVERY-DELIVRD	Uterine/placental factors	x	x	x
654.23	PREV C-DELIVERY-ANTEPART	Uterine/placental factors	x		x
654.3	RETROVERTED AND INCARCERATED	Uterine/placental factors	x		
654.30	RETROVERT UTERUS-UNSPEC	Uterine/placental factors	x		
654.31	RETROVERT UTERUS-DELIVER	Uterine/placental factors	x		
654.32	RETROVERT UTER-DEL W P/P	Uterine/placental factors	x		
654.33	RETROVERT UTER-ANTEPART	Uterine/placental factors	x		
654.34	RETROVERT UTER-POSTPART	Uterine/placental factors	x		
655.01	FETAL CNS MALFORM-DELIV	Fetal factors	x		
656.4	INTRAUTERINE DEATH COMPLICAT	Stillborn	x		
656.40	INTRAUTERINE DEATH-UNSP	Stillborn	x	x	x
656.41	INTRAUTER DEATH-DELIVER	Stillborn	x	x	x
656.43	INTRAUTER DEATH-ANTEPART	Stillborn	x		

Armstrong. Hospital rates of cesarean delivery among low-risk women. *Am J Obstet Gynecol* 2016. (continued)

possible.<sup>3,12,13</sup> In the absence of a practice guideline, clinical expertise was used to determine conditions to be excluded from the low-risk definition based on the following principles: obstetric risk factors had to be present prior to delivery or in the intrapartum course (not a postpartum occurrence); maternal conditions where vaginal delivery may be relatively contraindicated (eg, maternal cardiac disease); obstetric clinical factors where there is a contraindication to vaginal delivery or broad professional acceptance of cesarean delivery (eg, umbilical cord prolapse). Of note, most progress of labor disorders (with some exceptions) are not classified as high risk due to the discretionary/subjective nature of labor management. The clinical conditions classified as high risk and thus excluded from the SMFM measure were in addition to those already excluded in the JC and AHRQ measures. In no case was a clinical condition identified as high risk in the JC and AHRQ measures reclassified as low risk in the SMFM measure. The final code list (Table 1) was reviewed and supported by the coding committee of the SMFM.

**Variable measurement**

We identified cesarean delivery using ICD-9 procedure codes (740X, 741X, 742X, 744X, 7499) as well as Diagnosis Related Group payment codes (370, 371), consistent with validated methods and prior research using the NIS data.<sup>9</sup> We calculated each hospital's cesarean delivery rate as the percentage of cesareans among obstetric deliveries to all women who met the criteria for low risk according to each of the 3 definitions: the JC perinatal care core measure PC-02, AHRQ inpatient quality indicator no. 33, and the newly defined measure by SMFM described above.

The JC measure is defined based on the Specifications Manual for JC National Quality Measures (v2015A1, Appendix A).<sup>4</sup> Contraindications for vaginal delivery included complications related to preterm labor or multiple gestation, long or obstructed labor with multiple gestation, malpresentation (eg, breech), complications from prior cesareans, and other serious fetal or



placental problems. Parity is not specified by ICD-9 codes and is therefore not distinguished in the JC measure as specified in the definition of PC-02 cesarean delivery, however women with prior cesarean deliveries are excluded. The AHRQ measure is defined based on the specifications outlined in the National Quality Measures Clearinghouse and excludes deliveries with complications including abnormal presentation, preterm delivery, fetal death, multiple gestation diagnosis, or breech presentation.<sup>5</sup> Women are excluded from the denominators of these risk-adjusted or low-risk hospital cesarean rate measures on the basis of the ICD-9 diagnosis and procedure codes described in these measures and listed in Table 1. All patient-level measures are based on administrative records, ICD-9 diagnosis and procedure codes, and Clinical Classification Software (Healthcare Cost and Utilization Project, Rockville, MD) codes, developed for use with ICD-9 codes.

We used a unique hospital identification code to group deliveries by hospital. We also used hospital-specific data on bed size, teaching status, birth volume (100-500, 501-1000, and  $\geq 1000$ ), and rural vs urban location. Bed size was defined as small, medium, or large based on AHRQ methodology.<sup>14</sup> Hospital teaching status was based on information from the American Hospital Association's Annual Survey of Hospitals. Classification of hospitals as either urban or rural was based on core-based statistical area codes from Census 2000 data. Based on patient-level information on primary payer (private insurance, Medicare, Medicaid, self-pay/uninsured, or other), we also created a measure of a hospital's payer mix, which was categorized as predominantly commercial if  $>50\%$  of a hospital's 2011 births had private insurance listed as the primary payer and predominantly public if private insurance financed fewer than half of births in that hospital.

### Analysis

We report descriptive statistics and calculated hospital rates of cesarean delivery, according to 2 established and 1

TABLE 1

ICD-9 codes indicating medical exclusion conditions for cesarean rate calculations according to 3 definitions (continued)

ICD9 Diagnosis Code	ICD9 Diagnosis Code Short Description	Risk Factor Classification	SMFM	JC	AHRQ
660.3	DEEP TRANSVERSE ARREST, PERS	Malpresentation	x		
660.30	DEEP TRANS ARR AND PERSIST OP-UNSP	Malpresentation	x		
660.31	DEEP TRANS ARR AND PERSIST OP -DELIV	Malpresentation	x		
660.5	LOCKED TWINS COMPLICATING PR	Multiple gestation	x		
660.50	LOCKED TWINS-UNSPECIFIED	Multiple gestation	x		x
660.51	LOCKED TWINS-DELIVERED	Multiple gestation	x	x	x
660.53	LOCKED TWINS-ANTEPARTUM	Multiple gestation	x		x
660.7	FAILED FORCEPS OR VACUUM EXT	Conduct of labor	x		
660.70	FAILED FORCEP NOS-UNSPEC	Conduct of labor	x		
660.71	FAILED FORCEPS NOS-DELIV	Conduct of labor	x		
660.73	FAIL FORCEPS NOS-ANTEPAR	Conduct of labor	x		
662.3	DELAYED DELIVERY SECOND TWIN	Multiple gestation	x		
662.30	DELAY DEL 2ND TWIN-UNSP	Multiple gestation	x		x
662.31	DELAY DEL 2ND TWIN-DELIV	Multiple gestation	x	x	x
662.33	DELAY DEL 2 TWIN-ANTEPAR	Multiple gestation	x		x
663	PROLAPSE OF UMBILICAL CORD C	Uterine/placental factors	x		
663.0	PROLAPSE OF UMBILICAL CORD C	Uterine/placental factors	x		
663.00	CORD PROLAPSE-UNSPEC	Uterine/placental factors	x		
663.01	CORD PROLAPSE-DELIVERED	Uterine/placental factors	x		
663.03	CORD PROLAPSE-ANTEPARTUM	Uterine/placental factors	x		
663.5	VASA PREVIA COMPLICATING PRE	Uterine/placental factors	x		
663.50	VASA PREVIA-UNSPECIFIED	Uterine/placental factors	x		
663.51	VASA PREVIA-DELIVERED	Uterine/placental factors	x		
663.53	VASA PREVIA-ANTEPARTUM	Uterine/placental factors	x		
665	RUPTURE UTERUS BEFORE ONSET	Uterine/placental factors	x		
665.0	RUPTURE UTERUS BEFORE ONSET	Uterine/placental factors	x		
665.00	PRELABOR RUPT UTER-UNSP	Uterine/placental factors	x		

Armstrong. Hospital rates of cesarean delivery among low-risk women. Am J Obstet Gynecol 2016. (continued)

TABLE 1

**ICD-9 codes indicating medical exclusion conditions for cesarean rate calculations according to 3 definitions** (continued)

ICD9 Diagnosis Code	ICD9 Diagnosis Code Short Description	Risk Factor Classification	SMFM	JC	AHRQ
665.01	PRELABOR RUPT UTERUS-DEL	Uterine/placental factors	x		
665.03	PRELAB RUPT UTER-ANTEPAR	Uterine/placental factors	x		
665.1	RUPTURE UTERUS DURING/AFTER	Uterine/placental factors	x		
665.10	RUPTURE UTERUS NOS-UNSP	Uterine/placental factors	x		
665.11	RUPTURE UTERUS NOS-DELIV	Uterine/placental factors	x		
665.12	RUPTURE UTERUS DURING/AFTER	Uterine/placental factors	x		
665.14	RUPTURE UTERUS DURING/AFTER	Uterine/placental factors	x		
669.6	BREECH EXTRACTION WITHOUT ME	Malpresentation	x		
669.60	BREECH EXTR NOS-UNSPEC	Malpresentation	x		x
669.61	BREECH EXTR NOS-DELIVER	Malpresentation	x	x	x
678.10	FETAL CONJOIN TWINS-UNSP	Fetal factors	x		x
678.11	FETAL CONJOIN TWINS-DEL	Fetal factors	x		x
678.13	FETAL CONJOIN TWINS-ANTE	Fetal factors	x		x
761.5	MULT PREGNANCY AFF NB	Multiple gestation	x	x	x
V08	ASYMP HIV INFECTN STATUS	Maternal factors	x		
V27.1	DELIVER-SINGLE STILLBORN	Stillborn	x	x	x
V27.2	DELIVER-TWINS, BOTH LIVE	Multiple gestation	x	x	x
V27.3	DEL-TWINS, 1 NB, 1 SB	Stillborn	x	x	x
V27.4	DELIVER-TWINS, BOTH SB	Stillborn	x	x	x
V27.5	DEL-MULT BIRTH, ALL LIVE	Multiple gestation	x	x	x
V27.6	DEL-MULT BRTH, SOME LIVE	Multiple gestation	x	x	x
V27.7	DEL-MULT BIRTH, ALL SB	Stillborn	x	x	x
V91.00	TWIN GEST-PLAC/SAC NOS	Multiple gestation	x		
V91.01	TWIN GEST-MONOCHR/MONOAM	Multiple gestation	x		
V91.02	TWIN GEST-MONOCHR/DIAMNI	Multiple gestation	x		
V91.03	TWIN GEST-DICH/DIAMNIOTC	Multiple gestation	x		
V91.09	TWIN GEST-PLAC/SAC UNDET	Multiple gestation	x		
V91.10	TRIPL GEST-PLAC/SAC NOS	Multiple gestation	x		
V91.11	TRIPLET GEST 2+ MONOCHOR	Multiple gestation	x		
V91.12	TRIPLET GEST 2+ MONOAMN	Multiple gestation	x		
V91.19	TRIPL GEST-PLAC/SAC UND	Multiple gestation	x		
V91.20	QUAD GEST-PLAC/SAC NOS	Multiple gestation	x		

Armstrong. Hospital rates of cesarean delivery among low-risk women. *Am J Obstet Gynecol* 2016. (continued)

new measure for cesarean delivery rates for all hospitals and stratified by hospital bed size, teaching status, geographic location, and payer mix. For each stratum, we calculated the minimum, maximum, and mean number of deliveries as well as the interquartile ranges (IQRs) (the difference between the 25th and 75th percentiles). The IQR provides a measure of the variability of hospital rates across facilities within that stratum. Higher IQRs indicate greater variability.

In addition, we assessed cesarean rates across the 3 measures for each individual hospital and calculated the percentage of hospitals for which low-risk cesarean rates were lower using the SMFM measure, compared with both the JC and AHRQ measures. We also calculated comparisons for 3 subgroups of hospitals: (1) all large, urban, teaching hospitals with primarily public payers; (2) all large, urban, nonteaching hospitals with primarily private payers; and (3) all medium, rural, nonteaching hospitals with primarily public payers. Finally, we plotted cesarean rates, based on measures comparisons. Data for this analysis were deidentified, and as such, the study was granted exemption from review by the University of Minnesota Institutional Review Board (study number 1011E92980).

### Performance and comparison of the SMFM definition

As can be seen in Table 1, many conditions that are likely to lead to cesarean delivery were not included in the low-risk exclusion for the JC and AHRQ definitions. Characteristics of the hospitals in the sample are shown in Table 2. The mean number of births among the 612 hospitals was 1410, and the median number was 851. A quarter of the hospitals were urban teaching hospitals, and 43% were urban nonteaching hospitals, while 32% were rural nonteaching hospitals. Nearly half of the hospitals were large or had >1000 births annually (46% and 44%, respectively). Almost 40% of hospitals had a predominantly commercial payer mix, with the remaining 61% of

hospitals having more than half of births financed by public programs or individual payers.

The mean and range of hospital birth volume varied by hospital size, teaching status, and rural/urban location, but not payer mix (Table 3). Across all hospitals, the mean hospital low-risk cesarean rate was lowest for the SMFM measure (12.65%), but very similar for both the JC and AHRQ measures (13.12% and 13.29%, respectively). Average rates varied slightly across hospital strata, with rates being higher, in general, for teaching hospitals (16.24%, 16.58%, 16.71%) and lower, in general, for rural hospitals (10.86%, 11.41%, 11.58%). However, the average rates were similar across measures within each strata. The magnitude of the variability of cesarean rates across strata (as measured by the IQR) is similar for all 3 cesarean rate measures.

Among all 612 hospitals in the sample, 484 (79.1%) had a lower rate of cesarean delivery in low-risk women based on the SMFM measure compared with the JC measure (Table 4). More than 90% ( $n = 563$ ) of hospitals had a lower rate using the SMFM measure compared with the AHRQ measure. Results were similar when looking at specific subgroups of hospitals. Among large, urban teaching hospitals with primarily noncommercial payers ( $n = 41$ ), 78.0% and 90.2% had lower low-risk cesarean rates with the SMFM measure compared with the JC and AHRQ measures, respectively. Similarly, all 49 large, urban nonteaching hospitals with primarily private payers had lower low-risk cesarean delivery rates using the SMFM compared with the AHRQ measure, and 81.6% had a lower rate compared with the JC measure. Finally, among medium, rural, nonteaching hospitals with primarily noncommercial payers, >75% of hospitals had a lower rate under SMFM than JC and AHRQ measures.

Figures 1 and 2 represent the plot for each hospital's low-risk cesarean rate according to the SMFM definition (y-axis) vs either the JC definition (x-axis, Figure 1) or AHRQ definition (x-axis, Figure 2). Each point represents

TABLE 1

### ICD-9 codes indicating medical exclusion conditions for cesarean rate calculations according to 3 definitions (continued)

ICD9 Diagnosis Code	ICD9 Diagnosis Code Short Description	Risk Factor Classification	SMFM	JC	AHRQ
V91.21	QUAD GEST 2+ MONOCHORION	Multiple gestation	x		
V91.22	QUAD GEST 2+ MONOAMNIOTC	Multiple gestation	x		
V91.29	QUAD GEST-PLAC/SAC UNDET	Multiple gestation	x		
V91.90	MULT GEST-PLAC/SAC NOS	Multiple gestation	x		
V91.91	MULT GEST 2+ MONOCHR NEC	Multiple gestation	x		
V91.92	MULT GEST 2+ MONOAMN NEC	Multiple gestation	x		
V91.99	MULT GEST-PLAC/SAC UNDET	Multiple gestation	x		

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1 hospital, and points located below or to the right of the diagonal line represent a hospital with a lower cesarean rate, when

measured using the SMFM definition, compared with the other 2 definitions. Consistent with results reported in

TABLE 2

### Hospital Characteristics

Number of hospitals with over 100 births	612
Total deliveries	8,63,346
Mean number births per hospital	1410
Median number of births per hospital	851
<i>Teaching status and location<sup>a</sup></i>	
Teaching (urban <sup>b</sup> )	152 (25%)
Non-teaching (urban)	259 (43%)
Non-teaching (rural)	194 (32%)
<i>Bed size<sup>c</sup></i>	
Small	136 (22%)
Medium	192 (32%)
Large	277 (46%)
<i>Birth volume</i>	
100-500 deliveries annually	215 (35%)
501 – 1000 deliveries annually	127 (21%)
1001+ deliveries annually	270 (44%)
<i>Payer mix</i>	
Predominantly private payers (>50% of deliveries)	239 (39%)
Predominantly non-private (public or individual) payers (>50 % of deliveries)	373 (61%)

<sup>a</sup> Hospital teaching status was obtained by HCUP from the AHA Annual Survey of Hospitals; <sup>b</sup> Classification of urban or rural hospital location used Core Based Statistical Area (CBSA) codes based on 2000 Census data; prior to 2004 Metropolitan Statistical Area (MSA) was used. Hospitals residing in counties with a CBSA or MSA type of metropolitan were considered urban, while hospitals with a CBSA or MSA type of micropolitan or non-core were classified as rural; <sup>c</sup> Hospital bed size categories are defined by the Healthcare Cost and Utilization Project (HCUP), based on number of short-term acute hospital beds, and are specific to the hospital's U.S. region, rural-urban designation, and teaching status. Thirteen hospitals are missing information for bed size.

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TABLE 3

**Mean values and range of low-risk cesarean rates in U.S. hospitals with >100 births in 2011, overall and stratified by size, teaching status, and location (N = 612)**

	All hospitals N = 612	Small hospitals <sup>c</sup> N = 136	Medium hospitals <sup>c</sup> N = 192	Large hospitals <sup>c</sup> N = 277	Teaching hospitals <sup>d</sup> N = 159	Non-teaching hospitals <sup>d</sup> N = 446	Rural hospitals <sup>e</sup> n = 194	Urban hospitals <sup>e</sup> n = 411	Predominantly public or individual payers (>50% of births) n = 373	Predominantly private payers (>50% births) n = 239
Number of obstetric deliveries										
Mean	1410	667	1,104	1,977	2,620	973	455	1854	1214	1718
Min	101	101	107	110	107	101	102	101	102	101
Max	13,999	4,414	8,849	13,999	13,999	6,197	1,981	13,999	13,999	13,657
IQR <sup>a</sup>	1,530	811	1,127	2,104	2,164	912	369	1,828	1,171	1,840
% of low-risk women (SMFM definition) with cesarean delivery <sup>b</sup>										
Mean	12.651	13.149	13.199	12.085	16.243	11.406	10.864	13.534	12.693	12.587
IQR <sup>a</sup>	5.959	7.285	6.287	5.342	6.962	5.93	6.619	6.031	5.946	5.752
% of low-risk women (Joint Commission) with cesarean delivery <sup>b</sup>										
Mean	13.123	13.757	13.733	12.452	16.577	11.931	11.407	13.975	13.117	13.133
IQR <sup>a</sup>	6.075	6.774	6.937	5.19	6.583	5.957	6.096	6.034	6.097	6.004
% of low-risk women (AHRQ definition) with cesarean delivery <sup>b</sup>										
Mean	13.294	13.911	13.913	12.622	16.713	12.112	11.583	14.142	13.3	13.285
IQR <sup>a</sup>	6.007	7.093	6.798	5.438	6.815	5.818	6.065	6.194	6.28	5.76

<sup>a</sup> IQR is the interquartile range, a measure of variability, calculated as the difference between the 75th and 25th percentiles. Larger numbers indicate greater variability across hospitals within a column; <sup>b</sup> The low-risk cesarean rate is calculated as the percentage of cesarean deliveries among women with term, singleton, vertex pregnancies and no prior history of cesarean section; <sup>c</sup> Hospital bed size categories are defined by the Healthcare Cost and Utilization Project (HCUP), based on number of short-term acute hospital beds, and are specific to the hospital's U.S. region, rural-urban designation, and teaching status. Thirteen hospitals are missing information for bed size; <sup>d</sup> Hospital teaching status was obtained by HCUP from the AHA Annual Survey of Hospitals; <sup>e</sup> Classification of urban or rural hospital location used Core Based Statistical Area (CBSA) codes based on 2000 Census data; prior to 2004 Metropolitan Statistical Area (MSA) was used. Hospitals residing in counties with a CBSA or MSA type of metropolitan were considered urban, while hospitals with a CBSA or MSA type of micropolitan or non-core were classified as rural.

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Table 4, Figures 1 and 2 indicate that risk adjustment using the SMFM measure resulted in lower low-risk cesarean rates at the hospital level, in general and for the vast majority of individual hospitals, compared with other established measures.

### The value of the SMFM definition in quality measurement

After a persistent rise in the total cesarean delivery rate over the past decades, there is now broad interest in safely lowering the rate. Multiple factors have contributed to the rise in the cesarean delivery rate, including nonmedical factors, labor management and induction practices, changes in the prevalence of medical risk factors, and medicolegal concerns. A number of discretionary practice behaviors that unintentionally contributed to the increase in the rate have been the focus of policy changes at the hospital and/or professional college level. For example, the practice of eliminating elective deliveries <39 weeks' gestation has enjoyed broad physician support with dramatic reductions in the practice over a few years.<sup>15</sup> More recently, ACOG and SMFM have issued obstetric care consensus guidelines on labor arrest management with an aim to safely reduce the primary cesarean delivery rate.<sup>2,3</sup> This is an opportunity to lower the rate in view of the emerging data suggesting that the majority of the increase in the rate is attributed to relatively subjective clinical risk factors such as nonreassuring fetal status and labor arrest disorders than to more objective risk factors such as maternal and fetal medical risk factors.<sup>16</sup>

Although changes in the prevalence of maternal and fetal medical risk factors are not the dominant driver of the increase in the cesarean delivery trend, they are important contributors to the rate and must be carefully evaluated in the definition of a low-risk cesarean delivery rate. A low-risk cesarean delivery rate definition that has enhanced face validity, is more comprehensive, and is accepted by clinicians could help move the momentum forward toward achieving the Healthy People 2020 goals of reducing cesarean births among low-

	Lower cesarean rate with SMFM measure, compared with Joint Commission measure N (%)	Lower cesarean rate with SMFM measure, compared with AHRQ measure N (%)
All hospitals (N=612)	484 (79.1)	563 (92.0)
All large, urban, teaching hospitals with primarily public payers (N=41)	32 (78.0)	37 (90.2)
All large, urban, non-teaching hospitals with primarily private payers (N=49)	40 (81.6)	49 (100.0)
All medium, rural, non-teaching hospitals with primarily public payers (N=42)	31 (73.8)	37 (88.1)

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risk (full-term, singleton, and vertex presentation) women.<sup>1</sup> A more clinically robust definition of low risk is also important when evaluating hospital-level variation and obtaining hospital buy-in of measurement. Low-frequency, high-risk diagnoses that are maintained in the definition could overstate the cesarean delivery rate and skew hospital comparison in the same geographic area. This ultimately undermines physician buy-in. At worst, it could result in perceived disincentives for clinicians to care for women with these complications if the quality measures for the care these patients receive does not appropriately account for their disproportionate risks.

We have created a definition to identify women at low risk for cesarean delivery. The definition is claims based, is relatively easy to program, and does not require additional hospital resources for data abstraction. Not surprisingly, we observed that this refined definition applied to a nationally representative sample of US hospitals providing obstetric delivery services resulted in lower risk-adjusted cesarean delivery rates than the JC or AHRQ measure for all hospitals strata (hospital

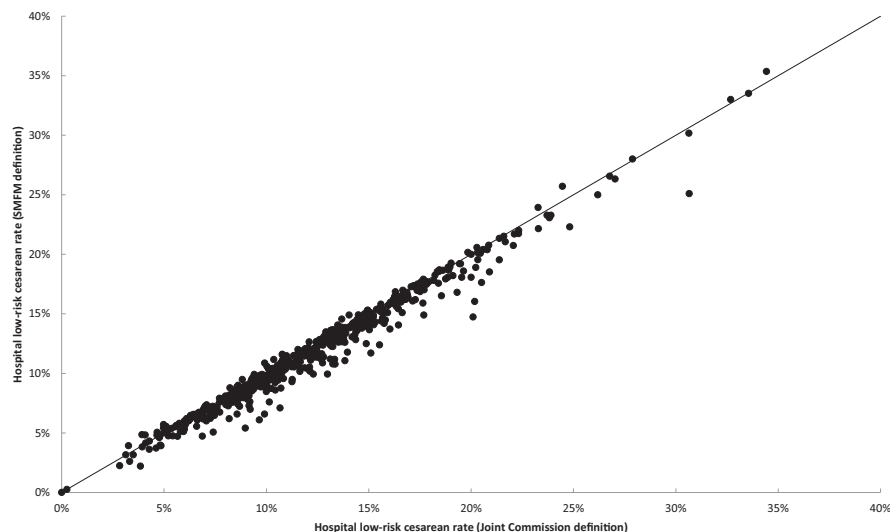
size, geography, teaching status, and payer type).

Importantly, a single, consistent accepted measure is necessary to track national progress in safely lowering the cesarean delivery rate. The SMFM measure achieves all measurement goals while also addressing previous clinician concerns. Engagement of frontline clinicians is essential in working toward achieving Healthy People 2020.

### Limitations

A number of limitations of our analysis merit discussion. The proposed code set to define low risk for cesarean delivery, while comprehensive, does not delineate every clinical scenario. It does not, for example, consider the additive effect of multiple risk factors that individually may not constitute high risk for cesarean delivery but do when combined. Additionally, the classification of risk factors changes as literature and practice guidelines evolve. Thus, our proposed code set represents a starting point to get to a clinically valid definition of low risk. It should be evaluated and updated on a regular basis. To ensure sufficient volume per hospital for comparison, we excluded hospitals with <100 deliveries

FIGURE 1

**Hospital low-risk cesarean rates, comparing SMFM and JC definitions**

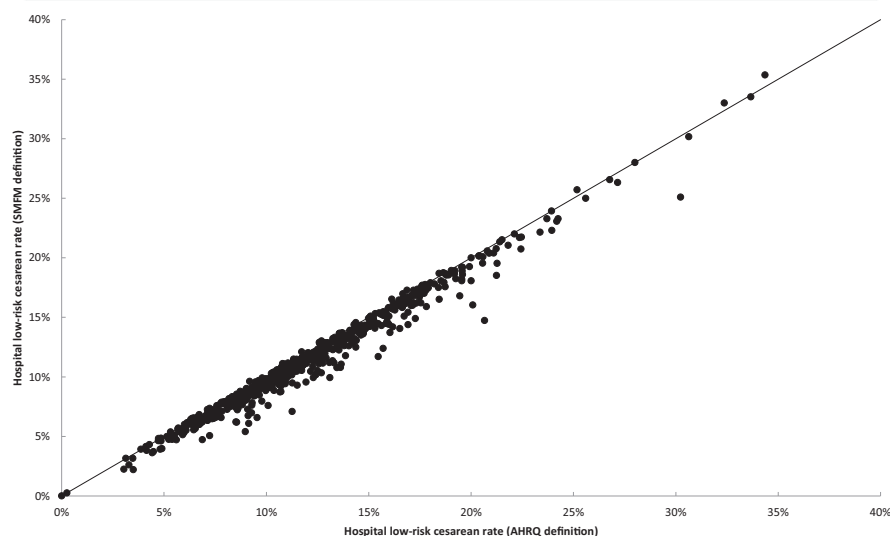
Individual hospital low-risk cesarean rates, Society for Maternal-Fetal Medicine (SMFM) definition compared with Joint Commission definition (all hospitals,  $n = 612$ ).

Armstrong. Hospital rates of cesarean delivery among low-risk women. *Am J Obstet Gynecol* 2016.

in 2011, and thus our findings may not generalize to hospitals with small-volume obstetrical units. While there are no nationally representative data sets in the United States that contain a greater

level of detail on childbirth-related health care services than the data we used in this study, it does not include clinician-level information. Thus cesarean delivery rate differences due to the

FIGURE 2

**Hospital low-risk cesarean rates, comparing SMFM and AHRQ definitions**

Individual hospital low-risk cesarean rates, Society for Maternal-Fetal Medicine (SMFM) definition compared with Agency for Healthcare Research and Quality (AHRQ) definition (all hospitals,  $n = 612$ ).

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specialty training or discipline of the attending clinicians within a hospital (eg, midwifery, family medicine, maternal-fetal medicine) cannot be evaluated. Additionally, our analysis of the risk-adjusted cesarean delivery rate is based on claims data alone and does not allow a review of the clinical reasons for cesarean delivery that chart review would allow. Potential bias may result from clinical differences not identifiable in administrative data or misclassification due to inaccurate recording of complications or comorbidities using claims-based data only.<sup>17,18</sup> It is not expected that this type of bias would affect any 1 definition differently. And while this type of bias could be minimized with supplemental risk adjustment using linked birth or hospital records, the simplicity of using administrative data alone and a code-based measure cannot be overstated. The transition from ICD-9 to *International Statistical Classification of Diseases, 10th Revision* coding will result in the incorporation of greater specificity in the description of clinical services, including obstetrical risk factor description. Efforts to map ICD-9 to *International Statistical Classification of Diseases, 10th Revision* coding are in development and can be used to update this low-risk cesarean rate definition to the new coding set when available. Finally, we did not correlate cesarean delivery rates with neonatal outcomes as this was beyond the scope of this evaluation. Despite these limitations, we believe that we have provided a practical approach to identifying low-risk women with regard to cesarean delivery. No measure is perfect. Since the ultimate goal is to track changes over time and in response to various interventions, any of the 3 definitions can be used, as long as it is used consistently to track cesarean rates over time within a particular health care system.

### Conclusion and future use of the SMFM definition

We have created a low-risk cesarean delivery rate definition using a refined code set of ICD-9 claims-based data. This refined definition sought to maximize face validity by excluding from the

definition of low risk those diagnosis codes that are absolute or relative contraindications to vaginal birth but including in the definition other factors that are known to be discretionary risk factors for cesarean delivery and drivers of the high US cesarean delivery rate. When this refined definition is applied to a nationally representative sample of US hospitals providing obstetric delivery services, it resulted in lower risk-adjusted cesarean delivery rates than the JC or AHRQ measure for all hospitals strata (hospital size, geography, teaching status, and payer type). The greater precision in the definition of low risk increases the clinical accuracy of the definition. Thus, it allows for the identification of the causes of modifiable variation in cesarean delivery rates among hospitals to effectively and safely lower them. The ease of use of the definition and the enhanced face validity of the definition have the potential to empower hospitals and health care providers to keep up the momentum to effectively and safely lower cesarean delivery rates among low-risk women. This enhanced definition should be adopted into ongoing refinement of existing measures with a goal of establishing a single, universally recognized measure. ■

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