Title: Reduction in cesarean delivery rates associated with a state quality collaborative in Maryland

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Short title: Reduction in cesarean rate in Maryland

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Precis (max 25 words, current 25):

The Maryland perinatal quality collaborative reduced statewide cesarean delivery rates by 5.6% for nulliparous term singleton vertex (NTSV) births and by 13.2% for NTSV inductions.

Abstract

Objective: To assess the extent to which hospitals participating in Maryland's perinatal quality collaborative (MDPQC) to reduce primary cesarean deliveries adopted policy and practice changes and the impact of the collaborative on state-level cesarean delivery rates.

Methods: This prospective evaluation of the MDPQC includes 31 (97%) of the birthing hospitals in the state, which all voluntarily participated in the 30-month collaborative. Hospital teams agreed to implement practices from the "Safe Reduction of Primary Cesarean Births" patient safety bundle, developed by the Council on Patient Safety in Women's Health Care. Each hospital's implementation of practices in the bundle was measured through surveys of team leaders at 12 and 30 months. Half-yearly cesarean delivery rates were calculated from aggregate birth certificate data for each hospital and differences in rates between the 6 months prior to the collaborative (baseline) and the 6 months afterwards (endline) were tested for statistical significance.

Results: Among the 26 bundle practices that were assessed, participating hospitals reported having a median of 7 practices (range: 0-23) already in place prior to the collaborative and implementing a median of 4 (range: 0-17) new practices during the collaborative. The cesarean delivery rates decreased by 1.6 percentage points ($p=0.011$) for all nulliparous term singleton vertex (NTSV) births and 4.8 percentage points ($p<0.001$) for NTSV inductions across the collaborative. While 5 hospitals had a statistically significant decrease in NTSV cesarean delivery rates, four hospitals had a significant increase. NTSV cesarean delivery rates were

significantly lower across hospitals that implemented more practices in the "Response" domain of the bundle.

Conclusions: The MDPQC successfully reduced statewide cesarean delivery rates, particularly for NTSV inductions, but not all hospitals made improvements. Determining the best ways to support hospitals to implement practice changes is essential for maximizing the impact of perinatal quality improvement collaboratives.

Introduction

Although cesarean delivery can be a lifesaving intervention when needed, evidence suggests that there is no benefit to maternal health when national cesarean rates are above 20 per 100 live births.[1] In the United States, the cesarean delivery rate underwent what has been characterized as an "epidemic" increase[2] from 20.7% in 1996 to a peak of 32.9% in 2006,[3] with only slight decrease to 31.7% by 2019.[4] Women with a first cesarean are at increased risk for serious complications that can lead to the need for blood transfusion, intensive care unit admission, or unplanned hysterectomy,[5,6] and the risks of several maternal morbidities, such as placenta accreta and hysterectomy, increase with each subsequent cesarean delivery.[7,8]

The Department of Health and Human Services,[9] the Joint Commission,[2] the American College of Obstetrics and Gynecologists (ACOG), and the Society for Maternal-Fetal Medicine (SMFM)[10] have all prioritized reducing cesarean delivery among nulliparous term singleton vertex (NTSV) pregnancies. Wide variation in NTSV rates exists between states and hospitals, even when controlling for differences in patient case mix,[11] suggesting that standardizing care might substantially impact cesarean rates. To this end, the Council on Patient Safety in Women's Health Care (the Council) compiled evidence-based practices in the obstetric patient safety bundle, "Safe Reduction of Primary Cesarean Births" (the cesarean bundle).[12] Practices in the cesarean bundle are grouped by type into the four domains: "Readiness," "Recognition and Prevention," "Response," and "Reporting and Systems Learning."[13]

California is the first state to report results of a quality collaborative to reduce primary cesarean rates. Through three cohorts between 2016 and 2018, California's collaborative successfully

reduced NTSV cesarean delivery rates by 3.2 percentage points.[14] A corresponding assessment of the safety of the collaborate reported no adverse effects on maternal or neonatal outcomes.[15] It is not yet known whether other state perinatal collaboratives will have similar success when implementing the cesarean bundle. Birthing hospitals in Maryland undertook a similar quality collaborative to implement the cesarean bundle in 2016, when the state's NTSV cesarean rate was 28.5%, 3 percentage points above the national average.[16] The primary aim of this paper is to evaluate the impact of Maryland's collaborative on state-level NTSV cesarean rates. The secondary aims are to assess the extent to which hospitals participating in Maryland's collaborative adopted policy and practice changes in the cesarean bundle, and whether adoption of more practices was associated with lower cesarean delivery rates.

Materials and Methods

Context and Intervention

Maryland has 32 birthing hospitals where about 70,000 deliveries occur every year.[4] The Maryland Perinatal Quality Improvement Collaborative (MDPQC) was initiated in 2009 and completed one prior collaborative to reduce early elective deliveries between 2009 and 2013. In 2016, under the coordination of the Maryland Patient Safety Center, the MDPQC recruited hospitals to voluntarily participate in a collaborative to reduce NTSV cesareans. The MDPQC selected the Council's cesarean bundle as the focus of the collaborative. A letter from the Governor was sent to hospital administrators, encouraging their participation, and 31 hospitals signed a participation agreement.

The MDPQC followed an adapted "Breakthrough Series" model for the cesarean collaborative (Appendix 1). As a requirement of participation, hospital teams sent at least one team member to each collaborative event. Activities included a June 2016 half-day, in-person kick off meeting for two to three representatives from each hospital to familiarize them with the cesarean bundle and the requirements of participation, followed by conference calls that occurred every month in the first year and every two months in the second year. Additional in-person meetings for all hospital teams took place at 12 months and at the end of the collaborative (November 2018); nine webinars on related clinical topics were presented throughout the 30-month period (Appendix 1, Table 1). The collaborative director provided facilitation support to site teams through calls and visits when requested by the site team or when site participation lapsed.

ACOG's Alliance for Innovation in Maternal Health (AIM) program, that supports implementation of all of the Council's patient safety bundles nationally, provided a data portal for monitoring implementation and outcomes across the collaborative. Each hospital's NTSV and overall cesarean rates, as well as severe maternal morbidity rates, were entered on behalf of hospitals by the collaborative management and Maryland Department of Health epidemiologists. The portal displayed each hospital's NTSV and overall cesarean delivery rates benchmarked anonymously against other hospitals in the collaborative. Hospital teams also self-reported process and structure measures on a quarterly basis to the data portal. The required measures track a limited set of practices recommended in the bundle, including provider training, policies on freedom of movement in labor, protocols for responding to labor challenges, establishment of internal case reviews, and bundle compliance as assessed through case reviews (see Appendix 2 for process and structure measure definitions at the time of Maryland's collaborative). In order to

incentivize greater adoption of practice changes during the second year, the MDPQC also offered a banner of excellence to hospitals that completed 7 of 8 practice changes that could be documented by policy documents (Appendix 1, Panel 1). Hospitals that qualified received a printed banner in a ceremony at their facility.

Data Sources and Measurement

This evaluation assesses both implementation and health outcomes[18] of the Maryland cesarean collaborative and was approved by the Institutional Review Board of the University of Maryland, Baltimore County. Implementation of practices from the cesarean bundle was assessed through web-based surveys in Qualtrics at 12 months and 30 months after the start of the collaborative. An email invitation to complete the survey was sent to the hospital-designated lead of collaborative activities at each participating hospital. The survey expanded on the limited set of process and structure measures in the portal, to include 26 discrete clinical practices, policies, and strategies recommended in the bundle (see Appendix 3 for the list of practices assessed). For each practice, the survey asked respondents to characterize their hospital's implementation progress as follows: not started, in the planning phase, partially implemented, fully implemented during the collaborative, or fully implemented before the collaborative. The surveys were first distributed in September 2018, and hospital leads were asked to respond within two months, with up to five e-mail reminders sent to encourage participation. All respondents provided informed consent and were offered a $50 incentive for completion of the survey. Follow up queries were sent to survey respondents to correct missing or discrepant data.

We supplemented data on hospital characteristics from secondary sources including the American Hospital Association hospital profiles[19] (for-profit status, teaching status, and annual number of births), the Maryland Hospital Community Benefit Report (percentage of patients covered by Medicaid),[20] the Office of Rural Health Policy (rural status),[21] and the Maryland Department of Health (ACOG/SMFM level of maternal care[22]). We also extracted data on training coverage of providers from the AIM data portal, which hospital teams were required to enter quarterly from the 2nd quarter of 2016 through the 2nd quarter of 2018. The indicator definition provided by the AIM program (Appendix 2) asked hospital teams to estimate, in 10% increments, the proportion of nurses and physicians who received training on the latest ACOG/SMFM guidelines on labor management and support for intended vaginal birth in the past two years. The Maryland Vital Statistics Agency provided quarterly aggregate birth data by hospital, extracted from the medical portion of each birth certificate, for 30 hospitals that signed a supplemental data use agreement. These data included the number of births (denominator) and number of cesarean births (numerator) overall, for all NTSV births, and NTSV inductions. Of note, one Level II hospital responded to the implementation survey but declined to provide vital statistics and portal data for this evaluation.

Analysis

We calculated descriptive statistics for hospitals and survey respondents, the implementation status of each of the 26 practices in the cesarean bundle, and the coverage of physician and nurse training. Half-year rates were calculated for three outcomes: cesarean deliveries among all births and among NTSV births, and cesarean deliveries among NTSV births that were induced. The first six-months of 2016 were considered the baseline period (prior to collaborative activities)

and the first half of 2019 was considered the endline period. The statistical significance of differences in baseline and endline rates was assessed using the chi-squared test for state-level rates and the one-sided Fisher's exact test for hospital-level rates, with $p<0.05$ as the threshold for statistical significance. To assess whether greater adoption of bundle practices was associated with NTSV cesarean rates at endline, we calculated the relative risk of cesarean delivery for births at hospitals that had implemented the median number or more practices for each bundle domain, compared with births at hospitals that had implemented fewer practices. All analyses were conducted in Stata/SE, version 15.1 (StataCorp LLC).

Results

Each of the 31 hospitals in the Maryland cesarean collaborative completed the endline implementation survey (100% response rate; Table 1). Survey respondents were most commonly nurses (27; 87%), including nursing directors/managers (19; 61%), and safety/quality managers (4; 13%). A physician completed the survey at 3 hospitals (9.7%) and a midwife at 1 hospital (3%). The majority of respondents (77%) were responsible for leading collaborative activities at their hospital, while 23% were implementation team members. All but one of the respondents were female (30; 97%), and the median number of years working in labor and delivery among respondents was 20 (range: 5-45). The hospitals in the collaborative included 6 Level I hospitals (19%), 11 Level II hospitals (35%); and 14 Level III/IV hospitals (45%). The majority of hospitals were members of a larger health system at the time of the survey (22; 71%), were teaching hospitals (22; 71%), and located in a non-rural county (29; 93.6%). One-third of hospitals reported fewer than 10 obstetricians and the same proportion reported no midwives.

The median number of annual births was 1312 (range: 238-9597), and the median proportion of patients covered by Medicaid was 23.5% (range: 8.7-48.4).

Among the 26 bundle practices that we assessed, participating hospitals reported having a median of 7 practices (range: 0-23) already in place prior to the collaborative (Table 2). During the collaborative, hospitals implemented a median of 4 new practices (range: 0-17). Although some hospitals did not fully implement any bundle practice, all hospitals reported at least planning to implement or partially implementing one or more practices (Appendix 3).

The practices that were implemented by at least two-thirds of hospitals by the end of the collaborative were standardized assessment and documentation of fetal heart rate (25, 81%), standardized induction scheduling (25, 81%), in-house maternity care provider or alternative coverage for response to labor problems (23, 74%), establishment of a provider team to lead the bundle implementation (23, 74%), comfort measures for labor dysfunction (21, 68%), and tracking provider-level cesarean rates (21, 68%). The clinical practices most commonly implemented during the collaborative were policies and protocols to encourage freedom of movement in labor (10, 32%), staff training on labor support (9, 29%), and use of standard criteria for diagnosis and treatment of labor dystocia, arrest disorders, and failed induction (9, 29%). Hospitals also commonly reported establishing case reviews (14, 45%) and starting to track provider-level cesarean rates (10, 32%) during the collaborative. The practices with the lowest overall adoption include implementing a policy to integrate doulas in the birth care team (3, 10%) and integrating new tools or guidelines in the electronic health record system (4, 13%).

Provider training on labor and support techniques per ACOG/SMFM guidelines was a key process indicator tracked on the AIM portal. Although 23 hospitals reported complete or partial implementation of provider training, the training coverage was not high at all hospitals. Training coverage across the collaborative increased gradually over time and was slightly higher for nurses (Figure 1) than physicians (Figure 2). Seventeen (57%) hospitals reported 60% training coverage or higher for nurses by Q2 2018, and 16 (53%) reported that level for physicians and midwives (Appendix 4).

Figure 3 charts the collaborative-wide half-yearly cesarean rates for NTSV births, NTSV induced births, and all births from Q1-Q2 2016 through Q1-Q2 2019. The largest change in cesarean rates was seen for NTSV induced births, which decreased by five percentage points from 36.1% to 31.3% ($p<0.001$; see Appendix 5). Cesarean rates for all NTSV births decreased from 28.5% to 26.9% ($p=0.011$) and for all births from 33.6% to 32.7% ($p=0.012$).

The change in individual hospital cesarean delivery rates for NTSV births and NTSV inductions demonstrates that although rates decreased from baseline to endline for the collaborative as a whole, the results were not consistent between hospitals. For NTSV births (Figure 4), 17 hospitals had a decrease in cesarean delivery rates (range: 0.1 to 11.9 percentage points lower) while 13 hospitals had an increase (range: 0.2 to 16.2 percentage points higher). For NTSV inductions (Figure 5), 19 hospitals had a decrease in cesarean delivery rates (range: 0.7 to 20.6 percentage points lower) and 11 hospitals had an increase (range: 2.8 to 31.1 percentage points higher). Decreases in rates were statistically significant at 5 hospitals for NTSV births and 8

hospitals for NTSV inductions. Statistically significant increases in cesarean delivery rates only occurred at Level I/II hospitals.

We also assessed whether the strength of implementation of the bundle was associated with lower cesarean delivery rates. Table 3 compares Q1-Q2 2019 cesarean rates for hospitals that implemented the median number of bundle practices or more versus fewer for each domain of the bundle. Implementation strength was associated with reduced cesarean delivery rates for only one of the four domains—Response. Across hospitals that implemented at least the median number of practices in the Response domain, the relative risk of cesarean delivery was 0.91 (95% CI: 0.85—0.97) for all NTSV births and 0.82 (95% CI: 0.75—0.91) for induced NTSV births. For all NTSV births, the risk of cesarean delivery was also lower across hospitals that implemented at least the median number of practices in the Readiness and Recognition and Prevention domains, but these differences did not reach statistical significance.

Discussion

This study is the second evaluation of a state perinatal quality improvement collaborative to reduce NTSV cesarean delivery rates. Most hospitals in Maryland's primary cesarean collaborative reported implementing multiple practice changes during their participation. As a result, the statewide NTSV cesarean delivery rate decreased by 1.6 percentage points in Maryland, a significant but smaller change than the corresponding 3.2 percentage point reduction reported by California's collaborative.[14] Maryland's collaborative also led to a larger 4.8 percentage point reduction in the cesarean delivery rate for NTSV births following induction. Overall, the reduction in cesarean delivery rates appears to be driven primarily by improvements

at Level III/IV hospitals with larger delivery volumes. It's worth noting that at the end of the collaborative, Maryland's NTSV cesarean delivery rate of 26.9% was still above the national average of 25.9% and well above the recently set national goal of 19.4%.[23]

The large number of practices in the cesarean bundle and the variability in practice adoption patterns between hospitals—both before and during the collaborative—limits the ability to identify individual practices that independently reduce the cesarean rate. We, therefore, compared NTSV rates by implementation strength for each of the four bundle domains. In this analysis, adopting more practices was only associated with lower rates for the Response domain. The Response domain has the largest number of practices that standardize clinical care, including induction scheduling, diagnosis and treatment of labor dystocia and failed induction, and interpretation of fetal heart rate patterns. The important role of standardizing care is consistent with a Cochrane review finding moderately strong evidence that implementation of clinical practice guidelines, alongside feedback to clinicians (e.g., second opinions, audit and feedback of rates), can reduce cesarean delivery.[24] Indeed, multiple reports have highlighted variability in cesarean rates between hospitals[11,25] and physicians,[26] suggesting that differences in clinical practice play a key role in cesarean rate patterns over time.

The majority of the implementation of practices in the Response domain at Maryland hospitals took place prior to the collaborative. The limited progress in the Response domain during the collaborative may help explain why the reduction in cesarean rates was smaller than that observed in California.[14] California hospitals were also required to reduce NTSV cesarean rates to the Healthy People 2020 goal of 24% in order to participate in health insurance exchange

plans,[14,27] an additional external incentive not present in Maryland. It should also be noted that the results of the ARRIVE trial, which concluded that labor induction at 39 completed weeks resulted in lower cesarean delivery rates, were published in late 2018,[28] towards the end of both Maryland and California's collaboratives. It is unclear if the results of the ARRIVE trial will have an impact on routine scheduling of labor induction or cesarean sections rates going forward.

The Readiness and Recognition and Prevention domains of the bundle include multiple practices to improve labor support and pain management, which have also been shown to reduce cesarean rates in some studies.[29–31] Although training on labor management and support did take place at most hospitals in the collaborative, only half of hospitals trained the majority (>60%) of physicians and nurses, and training coverage increased at some hospitals only towards the end of the collaborative. Delayed implementation of labor support practices may have prevented us from observing an association with cesarean rates during the study period. Another labor support practice associated with lower cesarean delivery rates, integration of doulas into birth care teams,[32,33] had very low adoption among participating hospitals.

An important finding from this study is the variability in implementation progress and cesarean rates between hospitals. On average, hospitals had implemented half of the practices in the bundle by the end of the collaborative, with some implementing more and others far fewer. Other evaluations of perinatal quality improvement collaboratives have also found that some hospitals get left behind in these efforts, without making considerable progress and improving outcomes.[15,34,35] Indeed, quality improvement collaboratives in other clinical areas are not always

successful at all sites. The quality improvement capacity and motivation at individual sites are likely important determinant of success.[37] For example, labor and delivery units that have experienced interdisciplinary quality improvement teams, support from hospital-wide quality improvement offices, and strong patient safety cultures[27] are likely better prepared to implement maternal safety bundles. In the MDPQC, hospitals that used implementation strategies engaging clinicians made greater progress implementing early practice changes.[38] Given that work by state PQCs represents a primary national strategy for reducing maternal morbidity and mortality,[39] it is critically important to conduct further implementation research to identify determinants of success and strategies to support all participating hospitals to make improvements.

This evaluation study has strengths and limitations. The study includes 94% of birthing hospitals in the state that provided complete data. Although the before-and-after design limits our ability to examine causal associations, we have assessed intermediate outcomes—self-reported changes in clinical practices—at 2 time points in order to limit recall bias and strengthen the plausibility of the findings.[40] Bundle practice implementation was self-reported by hospital respondents, and we were not able to independently verify practice implementation or the degree to which individual providers adhered to new practices and policies. Further studies are needed to assess the effectiveness of the individual practices in the cesarean bundle that are not already well studied.

The limited data available for this evaluation precluded some analyses. Outcome data were only available in aggregate, preventing patient-level analyses and adjustments for patient population characteristics or assessment of outcomes by such characteristics. In Maryland and many other

states, stronger maternal data systems that link hospital discharge data with birth certificates are needed to accurately assess maternal morbidity among NTSV births. While California's cesarean collaborative reported no change in some maternal morbidities (e.g., transfusion, 3rd and 4th degree lacerations), strengthening the ability of all states to monitor maternal morbidities is important for ensuring maternal safety while working to reduce cesarean delivery rates.

Conclusion

Reducing cesarean delivery rates will continue to be a national priority for low-risk births, as was reaffirmed by the U.S. Department of Health and Human Services' recent "Action Plan to Improve Maternal Health in America."[23] The Maryland PQC reduced NTSV cesarean rates through implementation of the cesarean bundle, but to a lesser extent than California,[15] and not for all hospitals that participated in the quality collaborative. Determining the best ways to support hospitals to implement practice changes is essential for maximizing the impact of perinatal quality improvement collaboratives.

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507 **Table 1. Characteristics of survey respondents and hospitals (n=31)**
508

Characteristic	Number (%)
Respondents	
Position	
Nursing director or manager	19 (61)
Nurse, other	4 (13)
Safety or quality manager	4 (13)
Medical director	3 (10)
Midwife	1 (3)
Gender	
Female	30 (97)
Male	1 (3)
Years of experience working in labor & delivery (median; range)	20 (5-45)
Years of experience at index hospital (median; range)*	11.5 (0-43)
Respondent was leading collaborative activities at hospital	
Yes	24 (77)
No	7 (23)
Hospitals	
Type	
Not-for-profit	31 (100)
Level of maternity care	
I	6 (19)
II	11 (35)
III/IV	14 (45)
Health system membership	
Yes	22 (71)
No	9 (29)
Location	
Rural county	2 (6)
Nonrural county	29 (94)
Teaching status[† ‡]	
Major	3 (10)
Minor	19 (63)
Nonteaching	8 (27)
Continuous availability of in-hospital anesthesia care	
Yes	25 (81)
No	6 (19)
No. of obstetricians delivering at hospital[‡ §]	
1-9	10 (33)
10-19	7 (23)

20-29	7 (23)
30-59	4 (13)
60 or more	2 (7)
No. of nurses or midwives delivering at hospital	
0	10 (32)
1-4	11 (35)
5-9	7 (23)
10 or more	3 (10)
Annual no. of births (median; range)	1312 (238-9597)
Proportion of patients covered by Medicaid (median; range)	23.5 (8.7-48.4)

Notes: *Information missing for 3 hospitals. †Major teaching hospitals are members of the Council of Teaching Hospitals; minor teaching hospitals have an accredited residency program but are not members. ‡Information missing for 1 hospital. §Includes all attending, fellows, and resident physicians, as reported by hospitals.

Table 2. Hospital implementation of cesarean bundle practices by domain (n=31)

Bundle Domain	No. practices assessed	Median No. Practices Fully Implemented Before Collaborative (Range)	Median No. Practices Fully Implemented During Collaborative (Range)	Median Total No. Practices Fully Implemented (Range)
R1: Readiness	5	0 (0-4)*	1 (0-5)	2 (0-5)
R2: Recognition and Prevention	8	3 (0-8)	1 (0-8)	5 (0-8)
R3: Response	7	3 (0-6)	0 (0-5)	4 (0-7)
R4: Reporting and Systems Learning	6	0 (0-6)	1 (0-5)	3 (0-6)
All Domains	26	7 (0-23)	4 (0-17)	13 (0-24)

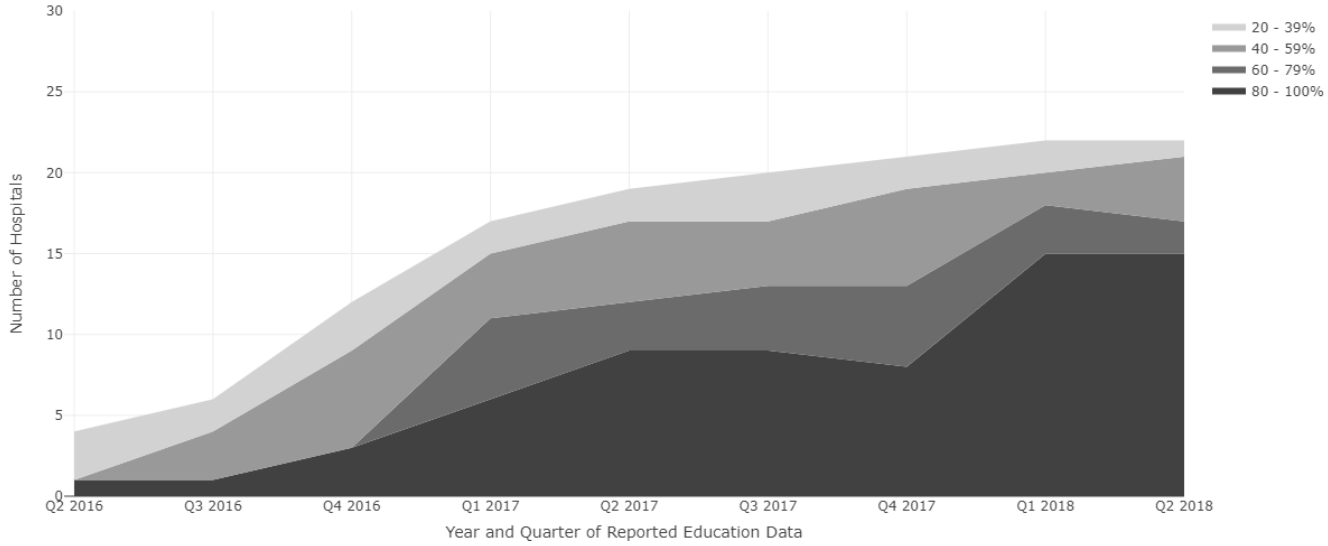
Notes: *Only four of five readiness practices were assessed before the collaborative. The creation of a team to lead bundle implementation (R1.1 in Appendix 3) was not assessed before the collaborative.

Table 3. Association between practice adoption by cesarean bundle domain and endline cesarean delivery rates among NTSV births (n=30)*

		NTSV Births			Induced NTSV Births		
Implementation Strength	**No. hospitals (%)**	**Cesareans/ Births**	**Cesarean Rate**	**Risk Ratio (95% CI)**	**Cesareans/ Births**	**Cesarean Rate**	**Risk Ratio (95% CI)**
R1. Readiness							
≥ median no. practices	17 (57)	1490/5647	26.4%	0.96 (0.90-1.03)	587/1891	31.0%	0.99 (0.90-1.08)
< median no. practices (ref)	13 (43)	1153/4195	27.5%		581/1845	31.5%	
R2. Recognition and Prevention							
≥ median no. practices	17 (57)	1245/4736	26.3%	0.96 (0.90-1.02)	590/1844	32.0%	1.05 (0.95-1.15)
< median no. practices (ref)	13 (43)	1398/5106	27.4%		578/1892	30.5%	
R3. Response							
≥ median no. practices	16 (53)	1526/5913	25.8%	0.91 (0.85-0.97)	598/2092	28.6%	0.82 (0.75-0.91)
< median no. practices (ref)	14 (47)	1117/3929	28.4%		570/1644	34.7%	
R4. Reporting and Systems Learning							
≥ median no. practices	16 (53)	1127/4125	27.3%	1.03 (0.96-1.10)	489/1509	32.4%	1.06 (0.97-1.17)
< median no. practices (ref)	14 (47)	1516/5717	26.5%		679/2227	30.5%	

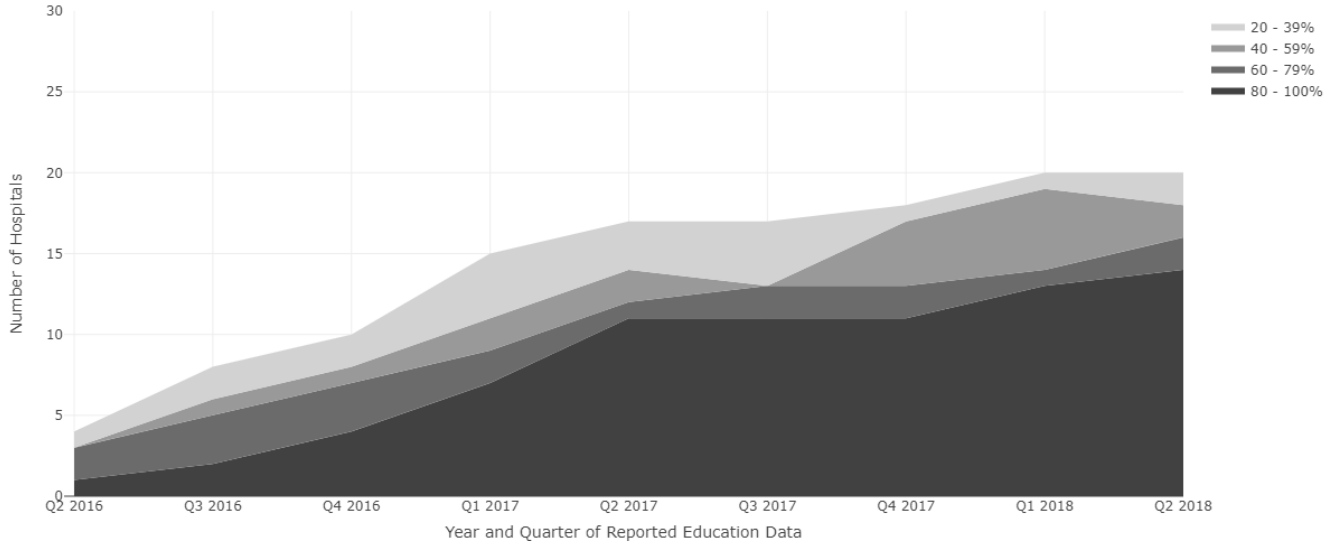
Notes: *Includes 30 out of 31 hospitals participating in the collaborative; vital statistics data not available for one hospital. The median number of practices adopted for R1=2 practices, R2=5 practices, R3=4 practices, R4=3 practices.

Figure 1. Change over time in the cumulative proportion of nurses that completed education on ACOG/SMFM labor management guidelines at hospitals participating in the collaborative (n=30)*



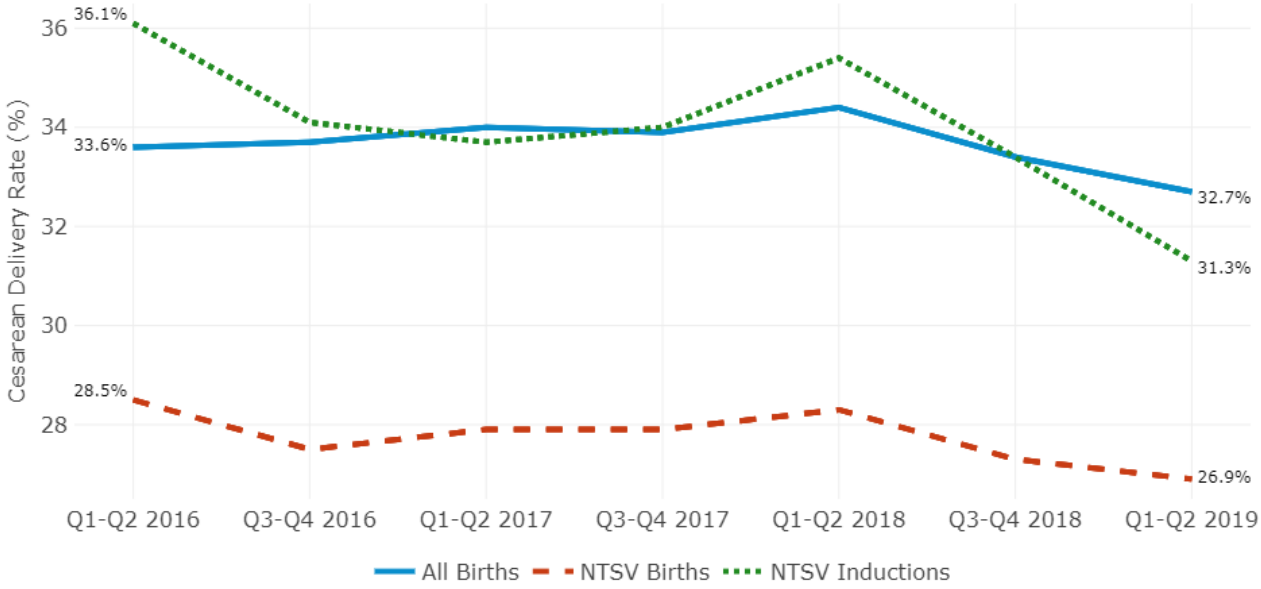
Notes: *Includes 30 out of 31 hospitals participating in the collaborative; training data not available for one hospital.

Figure 2. Change over time in the cumulative proportion of physicians and midwives that completed education on ACOG/SMFM labor management guidelines at hospitals participating in the collaborative (n=30)*



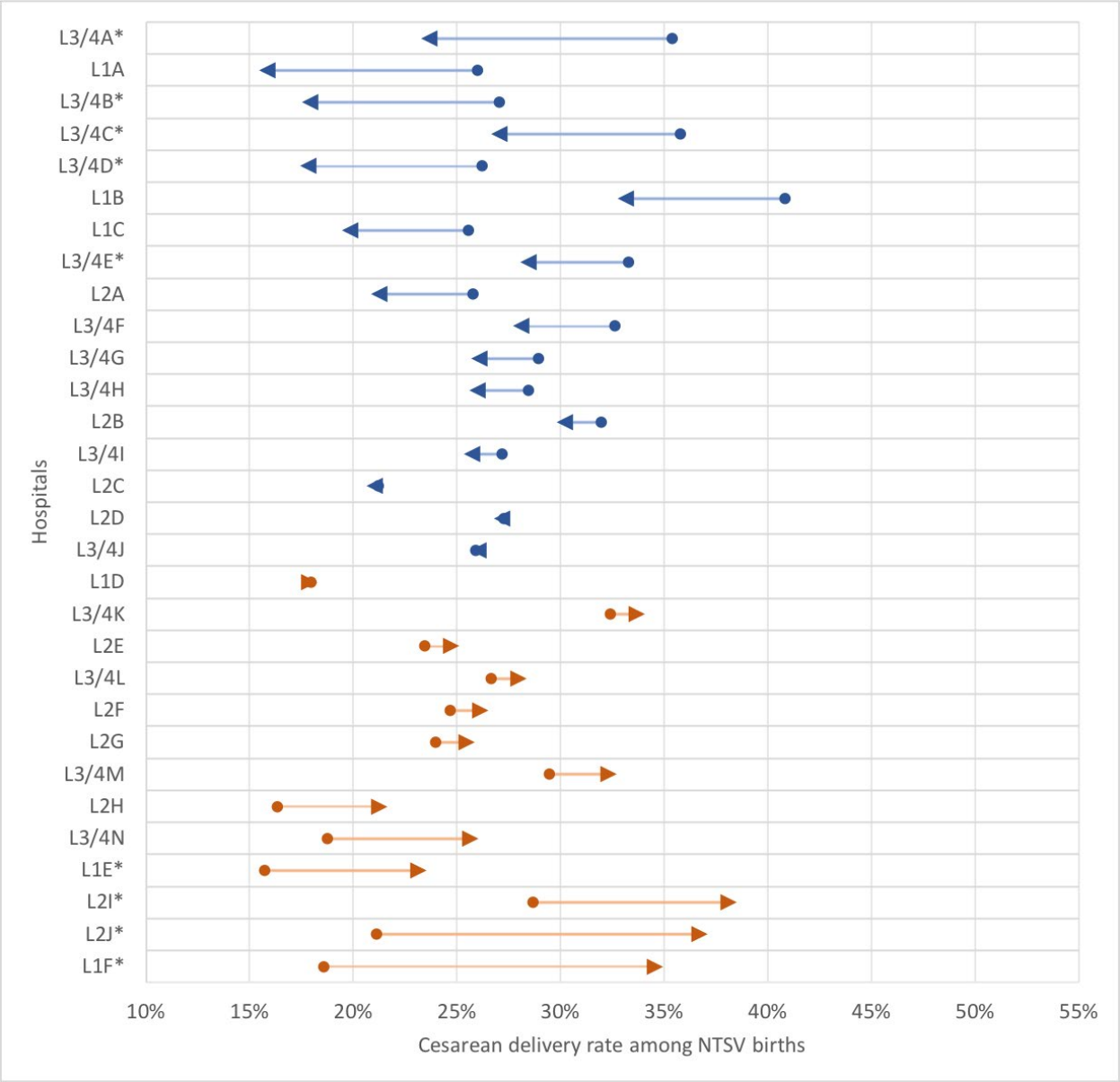
Notes: *Includes 30 out of 31 hospitals participating in the collaborative; training data not available for one hospital.

Figure 3. Six-month cesarean delivery rates across hospitals participating in the collaborative, 2016-2019 (n=30)*



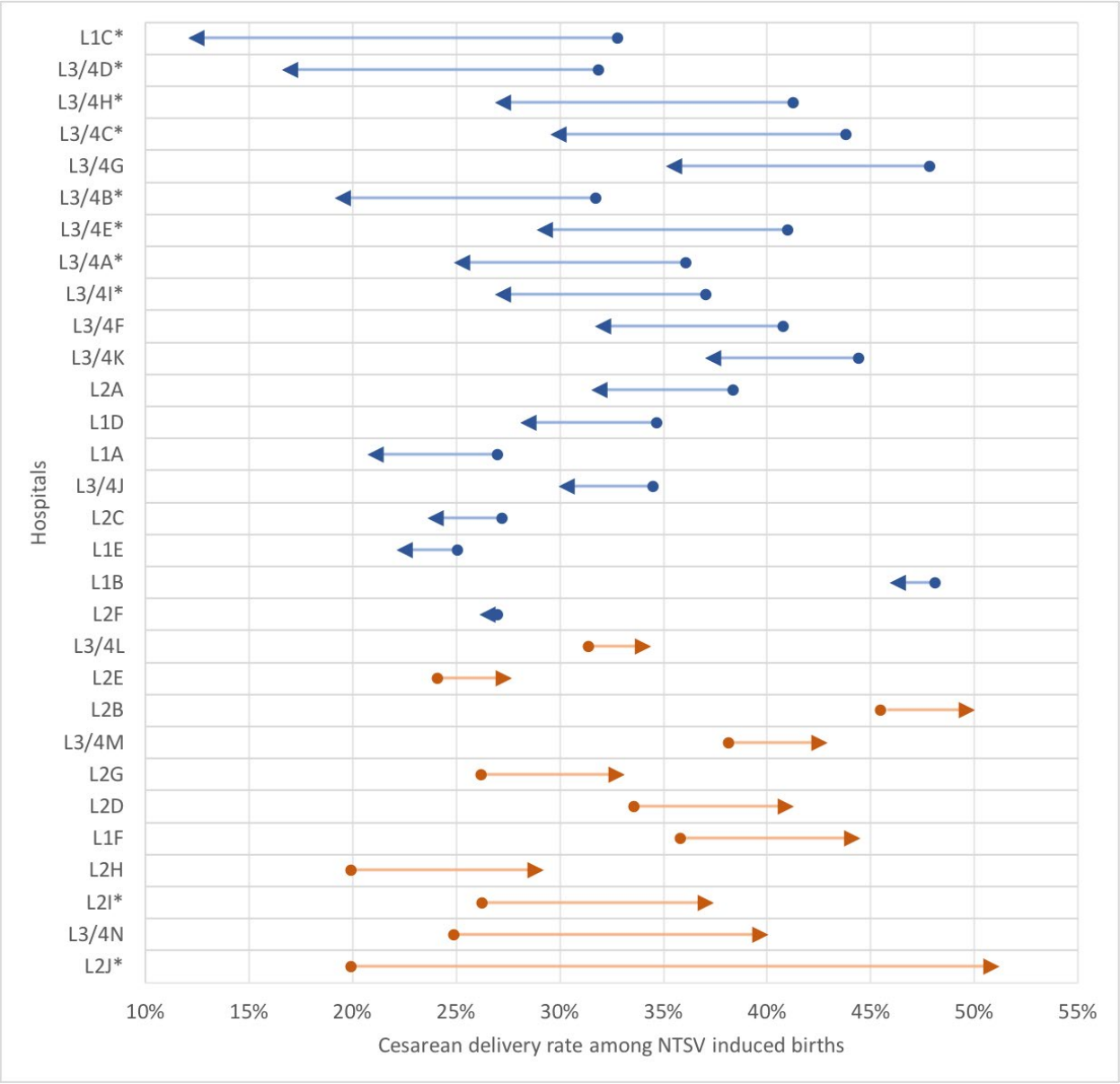
Notes: *Includes 30 out of 31 hospitals participating in the collaborative; vital statistics data not available for one hospital.

Figure 4. Dumbbell plot of baseline and endline cesarean delivery rates for NTSV births, by hospital (n=30)†



Notes: †Hospitals are ordered from greatest decrease in rates to greatest increase in rates between baseline and endline. The baseline cesarean rate is indicated by a dot, and the endline cesarean rate is indicated by an arrowhead. Hospitals with decreasing rates are plotted in blue and hospitals with increasing rates are plotted in orange. Hospital code names reflect the level of care (L1 to L3/4) as well as a code letter. One of the 31 hospitals in the collaborative is not included because vital statistics data were not available. *Denotes statistically significant rate change ($p<0.05$) between baseline and endline cesarean delivery rates.

Figure 5. Dumbbell plot of baseline and endline cesarean delivery rates for NTSV inductions, by hospital (n=30) †



Notes: †Hospitals are ordered from greatest decrease in rates to greatest increase in rates between baseline and endline. The baseline cesarean rate is indicated by a dot, and the endline cesarean rate is indicated by an arrowhead. Hospitals with decreasing rates are plotted in blue and hospitals with increasing rates are plotted in orange. Hospital code names reflect the level of care (L1 to L3/4) as well as a code letter. One of the 31 hospitals in the collaborative is not included because vital statistics data were not available. *Denotes statistically significant rate change ($p<0.05$) between baseline and endline cesarean delivery rates.