Improving Delayed Cord Clamping Across Tennessee Through a Statewide Quality Collaborative

Scott O. Guthrie, MD,[1,2,3] Howard E. Herrell, MD,[1,4] Patricia A. Scott, DNP,[1,5] Bonnie J. Miller, MSN,[1,6] Sharon Wadley, BSN, RN, CLS, CCRP,[1] Brenda Barker, MEd, MBA[1]

abstract

OBJECTIVE: The objective of this initiative was to increase the proportion of infants born in participating hospitals receiving the benefits of delayed cord clamping (DCC) for at least 60 seconds to a minimum of 90% for each facility.

METHODS: In January 2022, a quality improvement (QI) initiative was launched across 5 pilot hospitals, later expanding to 22 additional hospitals in May 2022. The goal of the initiative was to ensure that all newborns at each facility experienced a delay of at least 60 seconds before umbilical cord clamping. Monthly data collection continued through June 2023, tracking the number of live births, the number of infants whose cords were clamped after 60 seconds, and race/ethnicity. Balancing measures, including the number of infants with a 5-minute appearance, pulse, grimace, activity, and respiration (Apgar) score of up to 3 and hypothermia (temperature of <36.5 °C), were recorded monthly. Structure and process measures critical for improving DCC rates were also identified and monitored.

RESULTS: At project completion, 61 642 out of 74 241 (83%) infants received a delay of at least 60 seconds in cord clamping. The aggregate baseline mean for DCC was 76%. Special cause variation (a favorable shift) was observed, resulting in an adjusted mean rate of 87% for DCC. The impact was consistent across both level I/II and level III/IV facilities.

CONCLUSIONS: This report highlights the successful implementation of DCC practices through the state's perinatal QI collaborative. Evidence-based QI initiatives can significantly enhance uptake of recommended practices and improve infant care during birth.

INTRODUCTION

For the term and late preterm infant (≥34 weeks), deferring umbilical cord clamping for at least 60 seconds can increase blood volume, improving cardiovascular stability and enhancing the transition to extrauterine life.[1] Delayed cord clamping (DCC) has been shown to increase hemoglobin and hematocrit levels, reducing the risk of iron deficiency anemia and, in doing so, potentially improving neurodevelopmental outcomes.[2] A meta-analysis of available data suggests DCC in the preterm infant can decrease this population's mortality rates.[3]

Despite recommendations of the World Health Organization, the American College of Obstetricians and Gynecologists (ACOG), and the American Academy of Pediatrics (AAP), the practice of DCC is inconsistent.[4–7] Recognizing this inconsistency within our state, the Tennessee Initiative for Perinatal Quality Care (TIPQC), a multidisciplinary, quality improvement (QI) collaborative, designed a project to implement DCC statewide. Our aim was to increase the percentage of

[1]*Tennessee Initiative for Perinatal Quality Care, Nashville, Tennessee;* [2]*School of Medicine, Vanderbilt University, Nashville, Tennessee;* [3]*Jackson-Madison County General Hospital, Jackson, Tennessee;* [4]*Ballad Health, Greeneville, Tennessee;* [5]*School of Nursing, Vanderbilt University, Nashville, Tennessee; and* [6]*Regional One Health, Memphis, Tennessee*

Address correspondence to: Scott Guthrie, MD, Department of Pediatrics, Division of Neonatology, Monroe Carell, Jr. Children's Hospital at Vanderbilt, 2200 Children's Way, 11101 Doctor's Office Tower, Nashville, TN 37232. scott.o.guthrie@vumc.org

Dr Guthrie conceptualized and designed the project, drafted the initial manuscript, and critically reviewed and revised the manuscript. Drs Herrell and Scott and Ms Miller conceptualized and designed the project and critically reviewed and revised the manuscript. Ms Wadley carried out the data analyses and critically reviewed and revised the manuscript. Ms Barker conceptualized and designed the project, coordinated, and supervised data collection and critically reviewed and revised the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

CONFLICT OF INTEREST DISCLOSURES: Dr Guthrie is a paid consultant for ONY Biotech and Infant Bacterial Therapeutics. The other authors have no conflicts of interest to disclose.

FUNDING: The Tennessee Initiative for Perinatal Quality Care receives funding through the Tennessee Department of Health. The Tennessee Department of Health had no role in the design and conduct of the project.

Accepted for Publication Date: November 27, 2024

https://doi.org/10.1542/peds.2024-066158

To cite: Guthrie SO, Herrell HE, Scott PA, et al. Improving Delayed Cord Clamping Across Tennessee Through a Statewide Quality Collaborative. *Pediatrics.* 2025;155(5):e2024066158

infants born in participating Tennessee delivering facilities who had their umbilical cord clamped at least 60 seconds after birth to 90% by June 2023. Race/ethnicity data are collected as part of TIPQC's projects at the request of the Tennessee Department of Health, and our secondary goal was to evaluate for racial disparities in DCC rates.

METHODS

Context

Since 2008, TIPQC has engaged with birthing hospitals throughout Tennessee to improve maternal and infant outcomes. TIPQC collaborates with a wide range of stakeholders including health care providers, nurses, clinical professionals, patients and their families, community partners, and public health leaders. Tennessee currently has 57 birthing hospitals encompassing all maternal and neonatal levels of care as defined by the Tennessee Department of Health.[8] Data from 2021 indicated 81 717 live births in Tennessee (population of 7 million). Race/ethnicity of the birthparent was documented as 65.3% Non-Hispanic white (NH-w), 18.6% Non-Hispanic Black (NH-B), 11.6% Hispanic (any race), and 2.3% classified as American Indian, Alaskan Native, Asian, Native Hawaiian or other Pacific Islander.[9]

Planning the Intervention

A comprehensive literature review was performed around the topic, which included previously published QI toolkits.[10] After our review, we decided to target cord clamping at 60 seconds after delivery and sought to achieve this in over 90% of live births in each facility. Our approach to DCC was confirmed with the publication of the International Federation of Gynecology and Obstetrics' PremPrep-5 initiative.[11]

A statewide, multidisciplinary QI team was formed consisting of an obstetrician from the eastern part of the state, a neonatologist from the western part of the state, obstetric and neonatal QI specialists, a statistician, and the TIPQC executive director. This group identified primary and secondary key drivers (Figure 1) and developed an "Optimal Cord Clamping Project" toolkit with intervention strategies and best practices that would be distributed to each participating facility.[12] The toolkit was shared with providers statewide to gather feedback and generate enthusiasm for the project. The QI initiative was approved by the

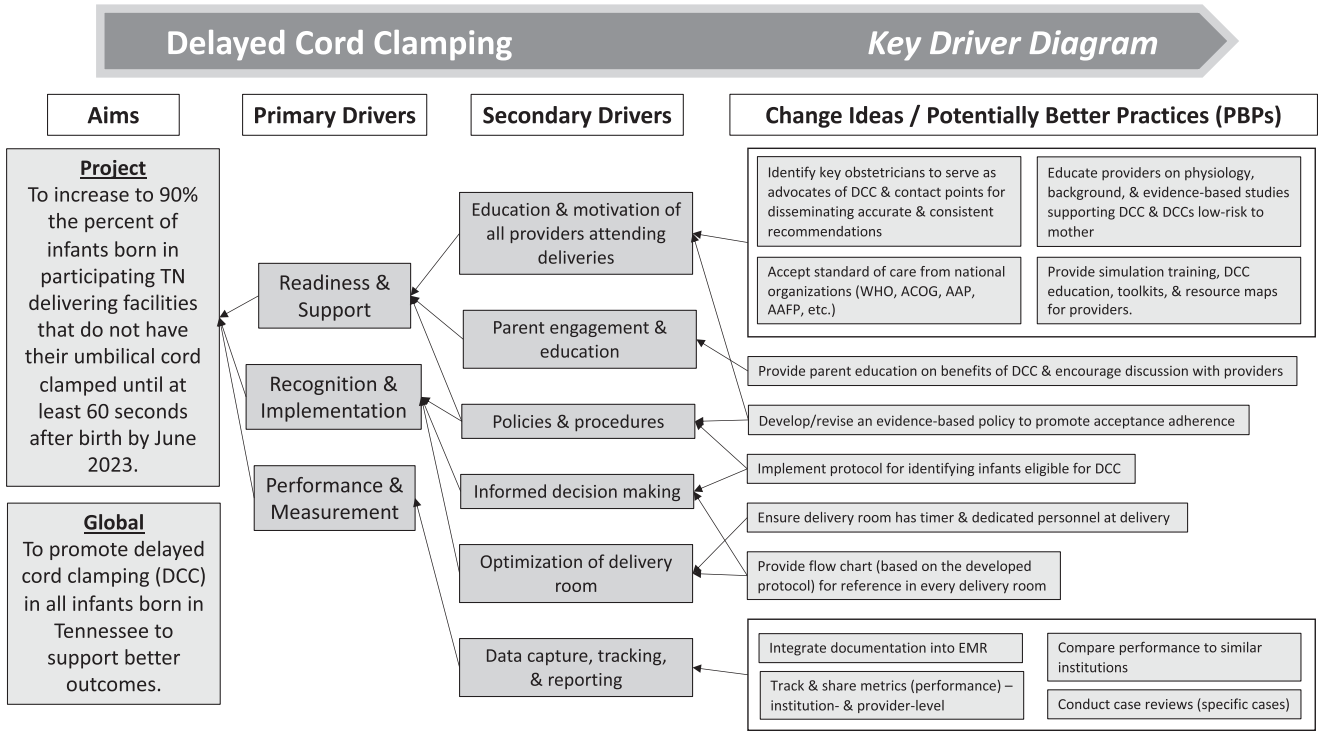

FIGURE 1.
Key driver diagram showing the specific, measurable, applicable, realistic, and timely aim; global aim; primary and secondary drivers; and change ideas/potentially better practices.
Abbreviations: AAFP, American Academy of Family Physicians; AAP, American Academy of Pediatrics; ACOG, American College of Obstetricians and Gynecologists; DCC, delayed cord clamping; EMR, electronic medical record; PBPs, potentially better practices; TN, Tennessee; WHO, World Health Organization.

Institutional Review Board of the Tennessee Department of Health.

Intervention

All live born infants at each participating facility were to have the umbilical cord clamped at least 60 seconds after delivery. Recommendations were to initially target a 30-second delay while assessing need for immediate neonatal resuscitation. If, after 30 seconds, the infant did not need resuscitation, placental transfusion would continue for the full 60 seconds. The only absolute contraindication to a delay in clamping was the need for maternal resuscitation after cardiovascular collapse or trauma to the cord vessels resulting in hemorrhage (eg, velamentous insertion, cord avulsion, etc). It was recommended that other concerns such as fetal hydrops, recipient twin in twin-to-twin transfusion syndrome, and selected congenital malformations be discussed by the obstetric and neonatal team members prior to the delivery. Umbilical cord milking was discouraged due to concerns in the preterm infant population and to keep the practice consistent among all gestational age deliveries.[13,14]

The initiative started in January 2022 with 5 pilot hospitals conducting plan-do-study-act cycles focused on the intervention and data collection processes through April 2022. The pilot hospitals, all providing maternal level of care III or IV, had volunteered to participate. Monthly videoconference meetings were held with facility leaders to address challenges, discuss implementation strategies, and suggest potential toolkit and data collection changes. The project was publicly announced and thoroughly discussed at the TIPQC Annual Meeting in March 2022. In May 2022, the project expanded to include 22 additional hospitals, bringing the total to 27. Before beginning the intervention, teams were surveyed on their local cord management practices.

All participating hospitals received a comprehensive toolkit that included QI education, data collection tools, content education from nationally recognized experts, infographics for patients and providers, and a detailed implementation road map.[12] Educational materials were aligned with TIPQC's "Wait A Minute" project theme and encompassed a range or resources such as videos, podcasts, and presentations for health care staff and parents.[12] Monthly huddles and quarterly learning sessions provided forums discussing implementation challenges with the most common barrier identified as physician behavior and engagement. Teams shared solutions including the use of the TIPQC podcasts to educate providers on DCC and collecting physician-specific adherence to address outliers. Additional resources to improve staff engagement and patient education were also distributed throughout the collaborative. Learning sessions emphasized overcoming implementation challenges through expert presentations, hospital spotlights, guidance from ACOG on cesarean delivery and hemorrhage, and the use of QI tools. These sessions also provided computer coding for electronic medical record (EMR) integration.

Teams received individual coaching calls from TIPQC faculty to assist each facility in tailoring the materials to their unique setting and to review their data. If any racial disparities in DCC were noted, these were examined, allowing each hospital to develop targeted strategies to address them. In recognition of their effort, all hospitals were awarded an achievement banner. TIPQC also issued press releases to local news outlets, and the Tennessee Hospital Association acknowledged the high performing teams.

Measures and Definitions

Clinical data were collected prospectively by hospital personnel using standardized definitions as outlined in the TIPQC toolkit.[12] Data collection and management were conducted using REDCap (Vanderbilt University) hosted by the Tennessee Department of Health.[15,16]

The primary outcome was the percentage of infants receiving DCC among all live births. DCC was defined as cord clamping at least 60 seconds after delivery. Live births were defined as the total number of births for which active resuscitation was attempted.

The outcome data were stratified by the self-reported birthparent's race/ethnicity, specifically among NH-w, NH-B, and Hispanic populations. Race/ethnicity data were not collected for any other populations. Data with missing race/ethnicity data were included in aggregate analysis.

The project collected monthly balancing measures to monitor the proportion of infants with 5-minute Apgar scores of up to 3 and hypothermia (defined as a body temperature of <36.5 °C) among the total number of live births. Process measures were collected quarterly and comprised education for staff and providers as well as the percentage of newborns with documented DCC in the medical record. Structure measures included parent engagement and education, implementation of a DCC policy and procedure, use of a DCC flowchart, and EMR integration of DCC documentation. Further details on project measures are provided in Table 1.

Analysis

The data analysis included the overall rate of DCC during project implementation, DCC rates stratified by race/ethnicity, a performance comparison between the highest and lowest performing teams, a comparison of hospitals by maternal level of care, and data patterns of the balancing measures (hypothermia and 5-minute Apgar rates).

Data were analyzed using statistical process control charts (Laney P charts) created in Microsoft Excel with the QI-macros add-in (KnowWare International, Inc.) or

TABLE 1. Measures

Measure Type	Measure Name	Measure Calculation	Project Goal	Data Source	Collection Frequency
Outcome measure	Percent of DCC	Numerator: among the denominator, No. of infants who had their umbilical cord clamped ≥60 s after birth	≥90% of infants receive DCC	EMR, delivery log	Monthly
		Denominator: total No. of live births (all viable babies for which active resuscitation attempted) in the mo			
		[a]Data disaggregated by mother's race/ethnicity			
Balancing measures	Percent of 5-min Apgar score of ≤3	Numerator = among the denominator, No. of infants with 5-min Apgar score of ≤3	N/A: monitor data patterns for negative impact to system changes	EMR, delivery log	Monthly
		Denominator = total No. of live births in the mo			
	Percent of hypothermia on first temperature	Numerator = among the denominator, No. of infants with first temp <97.7°F/ 36.5°C	N/A: monitor data patterns for negative impact to system changes	EMR	Monthly
		Denominator = total No. of live births in the mo			
Process measures	Provider education[a]	Description (calculation N/A) report in 10% increments the cumulative proportion of infant care providers completing an education program (within the last 2 y) on DCC that includes the unit-standard protocols	90%–100% completion	Team self-reported	Quarterly
	Nurse education[a]	Description (calculation N/A) report in 10% increments the cumulative proportion of infant care providers completing an education program (within the last 2 y) on DCC that includes the unit-standard protocols	90%–100% completion	Team self-reported	Quarterly
	Percent of infants with cord clamping documentation in the EMR[b]	Numerator = among the denominator, No. of infants with complete DCC data in the EMR	≥95% of infants have cord clamping documentation in the EMR	EMR	Quarterly (report after EMR integration structure measure)
		Denominator = total No. of live births			
Structure measures	Parent engagement and education	Description (calculation N/A): hospital develop and use parent education material on the benefits of DCC and encourage discussion with providers	Report as completed	Team self-reported	Completion date
	Policy and procedure	Description (calculation N/A): hospital develop, use, and/or review DCC policy	Report as completed	Team self-reported	Completion date
	DCC flowchart	Description (calculation N/A): develop/implement a DCC best practice flow chart for reference in every delivery room	Report as completed	Team self-reported	Completion date
	EMR integration	Description (calculation N/A): EMR integration of DCC documentation	Report as completed	Team self-reported	Completion date
	Reporting of DCC metrics	Description (calculation N/A): hospital track and share DCC metrics as part of facility QI activities	Report as completed	Team self-reported	Completion date

Abbreviations: Apgar, appearance, pulse, grimace, activity, and respiration (test); DCC, delayed cord clamping; EMR, electronic medical record; N/A, not applicable; QI, quality improvement.

[a] Supplemental Figure 1 for graphic representation of improvement over time.

[b] Supplemental Figure 2 for graphic representation of improvement over time.

with the QI-charts add-in (Process Improvement Products). The center line was adjusted when sustained special cause variation (eg, 8 values above or below the center line) was established. To identify potential disparities in DCC among different racial/ethnic populations, a χ^2 analysis was performed with statistical significance determined at a P value of less than 0.05.

RESULTS

Twenty-seven teams collaborated, including 11 of Tennessee's maternal level of care III and IV facilities and 16 maternal level of care I and II hospitals. A preintervention query found that 21 out of the 27 participating centers reported performing DCC. Of these, 20 used a target of 30 seconds and 1 used a target of 60 seconds. Only 2 centers

TABLE 2. Participating and Nonparticipating Hospital Characteristics				
	Participating Hospitals (n = 27)		Nonparticipating Hospitals (n = 30)	
Characteristics	Maternal Level of Care I and II	Maternal Level of Care III and IV	Maternal Level of Care I and II	Maternal Level of Care III and IV
No. of hospitals	16 (1 birthing center)	11	30 (1 birthing center)	0
Average annual delivery vol	911 deliveries	3728 deliveries	829 deliveries	0
West Tennessee region	3	4	5	0
Middle Tennessee region	1	4	19	0
East Tennessee region	12	3	6	0

actively tracked DCC rates in the EMR. Table 2 and Supplemental Table 1 contain more detailed data such as hospital characteristics and specifics on DCC practices.

Outcome Measures

A total of 61 642 (83%) infants received at least a 60-second delay in clamping the umbilical cord out of 74 241 live births that occurred at participating hospitals during this project. Figure 2 illustrates the impact of this project with meaningful milestones annotated. During the first 9 months of the project, the mean DCC rate was 76%. A favorable shift was noted beginning October 2022, and the mean rate was adjusted to 87% and sustained throughout the project.

Characteristics of the highest performing and lowest performing hospitals are noted in Table 3. Figure 3 demonstrates their improvement over time. The highest performing centers were all maternal level of care I and II and had a mean DCC rate of 95% for the duration of the project, while the lowest performing centers demonstrated special cause variation and ended the project with a mean DCC rate of 81%.

Figure 4 compares the maternal level of care I and II hospitals with the maternal level of care III and IV hospitals. Both groups demonstrated special cause variation with the mean rate of DCC resetting at 87% and 86%, respectively, by the end of the project.

Among the analyzed racial/ethnic groups, all the groups exhibited favorable special cause variation. As shown in Figure 5A, the mean DCC rate for the NH-w population (n = 46 731, 63% of total) increased from 78% to 87%. Figure 5B shows a similar increase for the NH-B population (n = 13 672, 18% of total) from 75% to 85%. Figure 5C demonstrates that the Hispanic population (n = 8203, 11% of total) also experienced an increase in the mean DCC rate, rising from 82% to 89%. Race/ethnicity data were not reported, or data were missing for 8% of infants (n = 5662). During the project, race/ethnicity data were reviewed monthly by individual hospital and across the state, revealing that no observable difference in the receipt of a delay in cord clamping by race/ethnicity was occurring. The DCC rate for each racial group was monitored over the 18-month duration of the project. At the conclusion of the

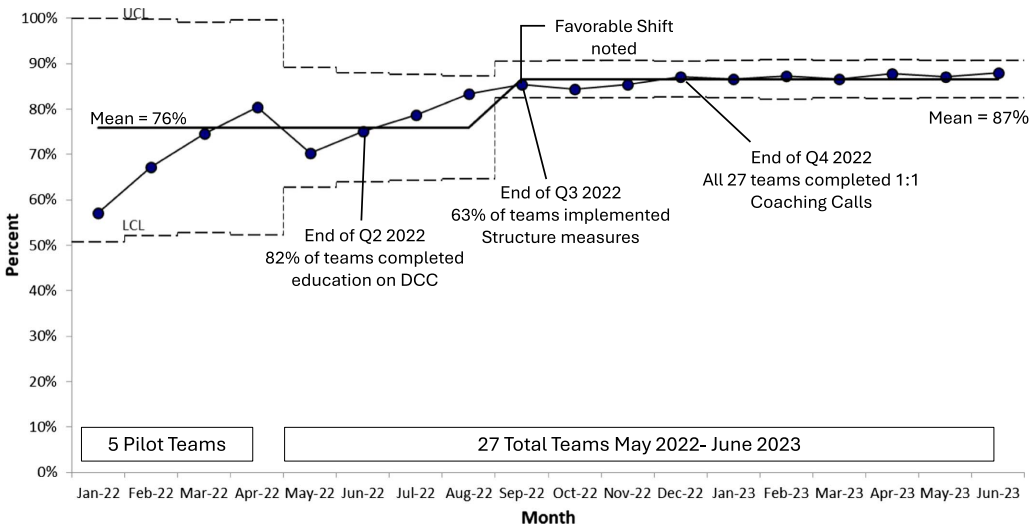

FIGURE 2.
Percent of infants receiving DCC. SPC-chart (Laney P) showing the aggregate rate of DCC in the 27 participating hospitals. Annotations include meaningful milestones and interventions. A favorable shift is noted in October 2022 when the mean DCC rate shifted from 76% to 87%.
Abbreviations: CL, center line (mean); DCC, delayed cord clamping; LCL, lower control limit; Q, quarter; SPC, statistical process control; UCL, upper control limit.

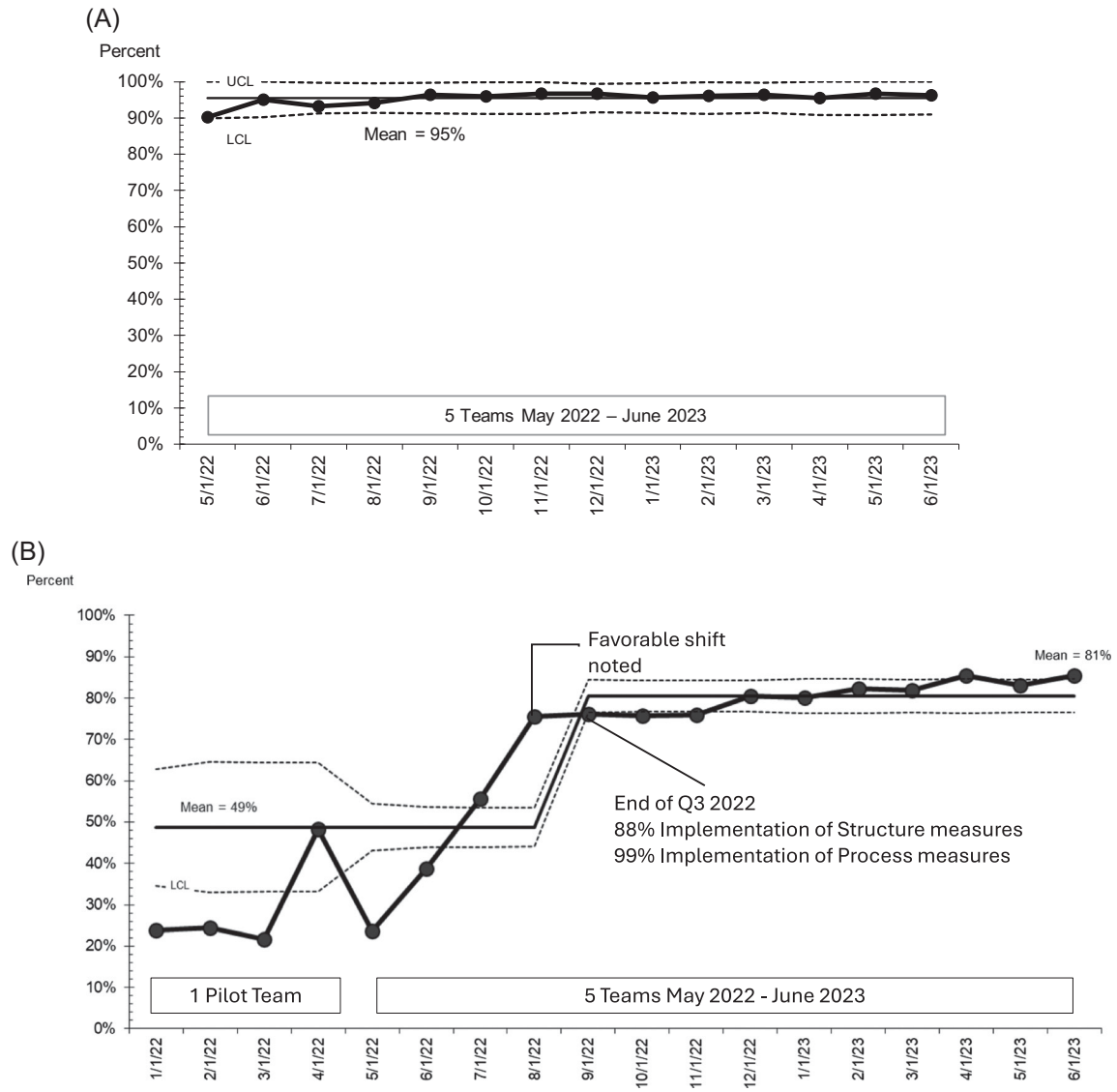

FIGURE 3.

Percent DCC in highest vs lowest performing centers. (A) SPC-chart showing the rate of DCC in the 5 highest performing hospitals with a mean rate of 95%. (B) SPC-chart showing the rate of DCC in the 5 lowest performing hospitals with an initial mean rate of 49%. A special cause variation was noted from August 2022, and the rate of DCC went to 81%. Meaningful milestones are noted.

Abbreviations: DCC, delayed cord clamping; LCL, lower control limit; Q, quarter; SPC, statistical process control; UCL, upper control limit.

project, we analyzed the mean DCC rates for each racial population (NH-w mean = 84, SD = 10; NH-B mean = 83, SD = 7; Hispanic mean = 86, SD = 8). A χ^2 test (χ^2 (2, 18) = 2.2, $P = 0.33$) was conducted, which showed no statistically significant association between race/ethnicity and the receipt of DCC.

Balancing Measures

Figure 6A shows that the average percentage of infants with a low 5-minute Apgar score (≤3) was 0.53%. Figure 6B indicates that the average percentage of infants experiencing hypothermia (<36.5 °C) was 7.0%. Throughout the project, the rates of these adverse events remained stable with no significant fluctuations.

Structure and Process Measures

The reporting frequency of process and structure measures varied with teams collecting data quarterly and providing dates of completion. Upon completion of the project, 88% of facilities completed provider education, and 92% completed nurse education at the goal level of 90%. By June 2023, 26 out of 27 (96%) of teams reported integration of DCC documentation into the EMR. Table 4 provides a summary of the progress made by the teams in implementing

TABLE 3. Characteristics of the Highest and Lowest Performing Hospitals		
Hospital Characteristics	**Highest Performing Hospitals (n = 5)**	**Lowest Performing Hospitals (n = 5)**
Maternal level of care I or II	5	2
Maternal level of care III or IV	0	3
Average annual delivery vol	490 deliveries	2282 deliveries
Urban setting	1	5
Rural setting	4	0
Teaching hospital	1	4
Nonteaching hospital	4	1
For profit hospital	1	1
Nonprofit hospital	4	4

the recommended practices at the end of the project. Supplemental Figures 1 and 2 demonstrate improvement in the process measures over time.

DISCUSSION

We have detailed the implementation of DCC led by Tennessee's Perinatal Quality Collaborative (PQC) across a wide range of health care systems and facilities statewide. By the end of the project, 87% of live births received DCC, approaching our target of 90%. In total, 61 642 births across Tennessee benefitted from TIPQC's initiative. This QI effort highlights the ability of a PQC to effectively lead large-scale implementation of evidence-based practices, serving as a model for other PQCs. The project also achieved one of the highest voluntary participation rates in the TIPQC history, including several hospitals that had never previously participated in a TIPQC project. These new participants were primarily level I and II facilities and many demonstrated their capability to implement and sustain a QI project with 5 becoming high performing centers.

By collecting racial/ethnicity data, a first for a TIPQC maternal and infant project, we evaluated whether our QI effort provided equitable care for all birthparents and infants.[17] A previous report indicated racial disparities related to DCC existed due to gaps in obstetric provider knowledge of the AAP and ACOG recommendations.[18] Asking hospitals to collect these data and reviewing them monthly allowed us to evaluate for disparities and knowledge gaps. The coaching calls allowed us to work with each facility, help them address any disparities that were being noted, and recommend interventions. These interventions included implicit bias training and the sharing of the center's data with staff during monthly huddles. The project's participants reflected the state's racial and ethnic demographics. At the project's conclusion, all racial and ethnic groups demonstrated similar improvements in receiving DCC, and there were no racial or ethnic disparities in the rate of DCC receipt statewide.

To address concerns about the infant's ability to tolerate 60 seconds of DCC, we selected Apgar scores and hypothermia as balancing measures because providers expressed apprehension despite previous literature having shown no impact on Apgar scores or hypothermia.[19] This was also true in this large QI project because a very small percentage of infants were noted to have an Apgar score of up to 3 (0.53%). Hypothermia (<36.5 °C) was noted at 7.0%, which is below the level targeted in 1 recent QI project.[20] Data reviews identified and addressed isolated cases of hypothermia in some facilities. High adherence with process and structure measures suggests the project's ease of implementation and staff enthusiasm, boding well for long-term sustainability.

The characteristics and performance of participating teams are of specific note. All maternal level of care III and IV hospitals in Tennessee participated in this project, and 35% (16/46) of maternal level care I and II facilities joined the effort in May 2022. Both groups demonstrated special cause variation, and both groups demonstrated improvement over the duration of the project.

The preproject query allowed us to estimate a baseline rate of at least 60 seconds DCC in the cohort at 5% because only 1 of the surveyed hospitals reported this as routine and were documenting this in the EMR. When the official data collection started, we noted that both groups began at a high rate relative to this estimated baseline. Anecdotally, we were aware that facilities had already begun to adopt the recommended practice and integrate it into their system-wide EMRs before the project officially began. This is an example of how the Hawthorne effect (a change in behavior when observation occurs) can have a positive impact on QI projects,[21] which has been noted in previous QI work.[22–24] Because many of the level I and II facilities are in the same health care system as the larger facilities and share some of the same obstetric and pediatric providers, infants born at these facilities were receiving the benefits of this QI project before data collection at these facilities started. The educational materials and teaching for this project were also widely distributed by TIPQC before the nonpilot hospitals were able to participate, and several of these facilities had already implemented at least 60 seconds of DCC before the project officially started. A more comprehensive preintervention data collection could have helped better

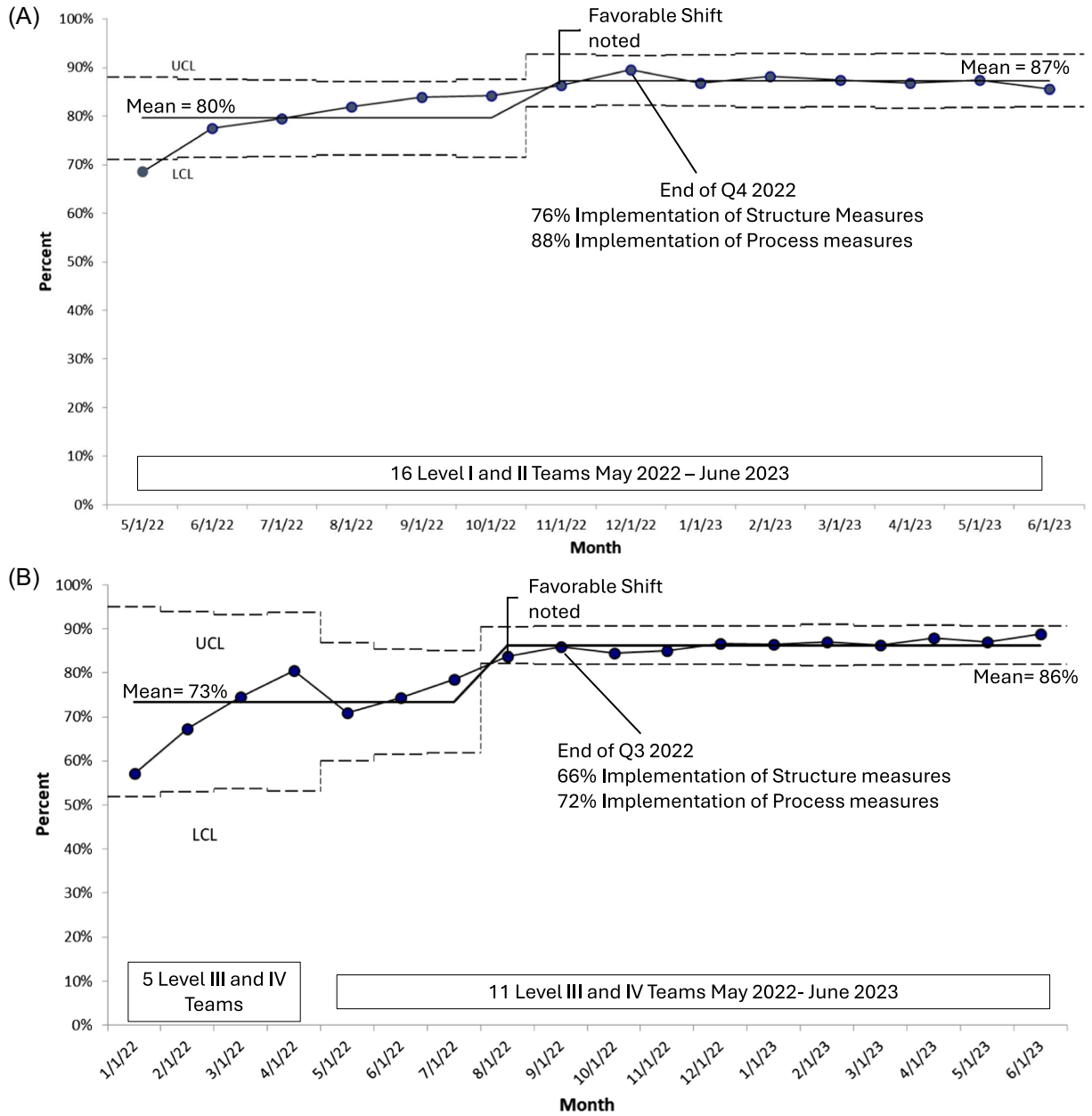

FIGURE 4.

DCC by maternal level of care. (A) SPC-chart showing the rate of DCC in the maternal level of care I and II hospitals with a baseline mean rate of 80%. A favorable shift is noted in November 2022, and the mean rate of DCC increased to 87%. Meaningful milestones are noted. (B) SPC-chart showing the rate of DCC in the maternal level of care III and IV hospitals with a baseline mean rate of 73%. A favorable shift is noted in August 2022, and the mean rate of DCC went to 86%. Meaningful milestones are noted.

Abbreviations: CL, center line (mean); DCC, delayed cord clamping; LCL, lower control limit; Q, quarter; SPC, statistical process control; UCL, upper control limit.

measure this effect but was not possible with this pragmatic statewide QI project.

All 5 of Tennessee's regional perinatal centers and 11 of the 12 level III or IV neonatal intensive care units (NICUs) in the state participated in this project. One impetus for this project was to begin to implement potentially better practices that are targeted toward improving care for preterm infants to decrease Tennessee's high infant mortality rate. Deaths among infants who are of an extremely low birth weight and/or gestational age have been implicated as the primary contributor to infant mortality rates.[25] Very preterm births, defined as less than 32 weeks and birth weight of less than 1500 g, represented 33% of all infant deaths in 1 report.[26] Rabe et al[19] and Quinn et al[27] have both reported

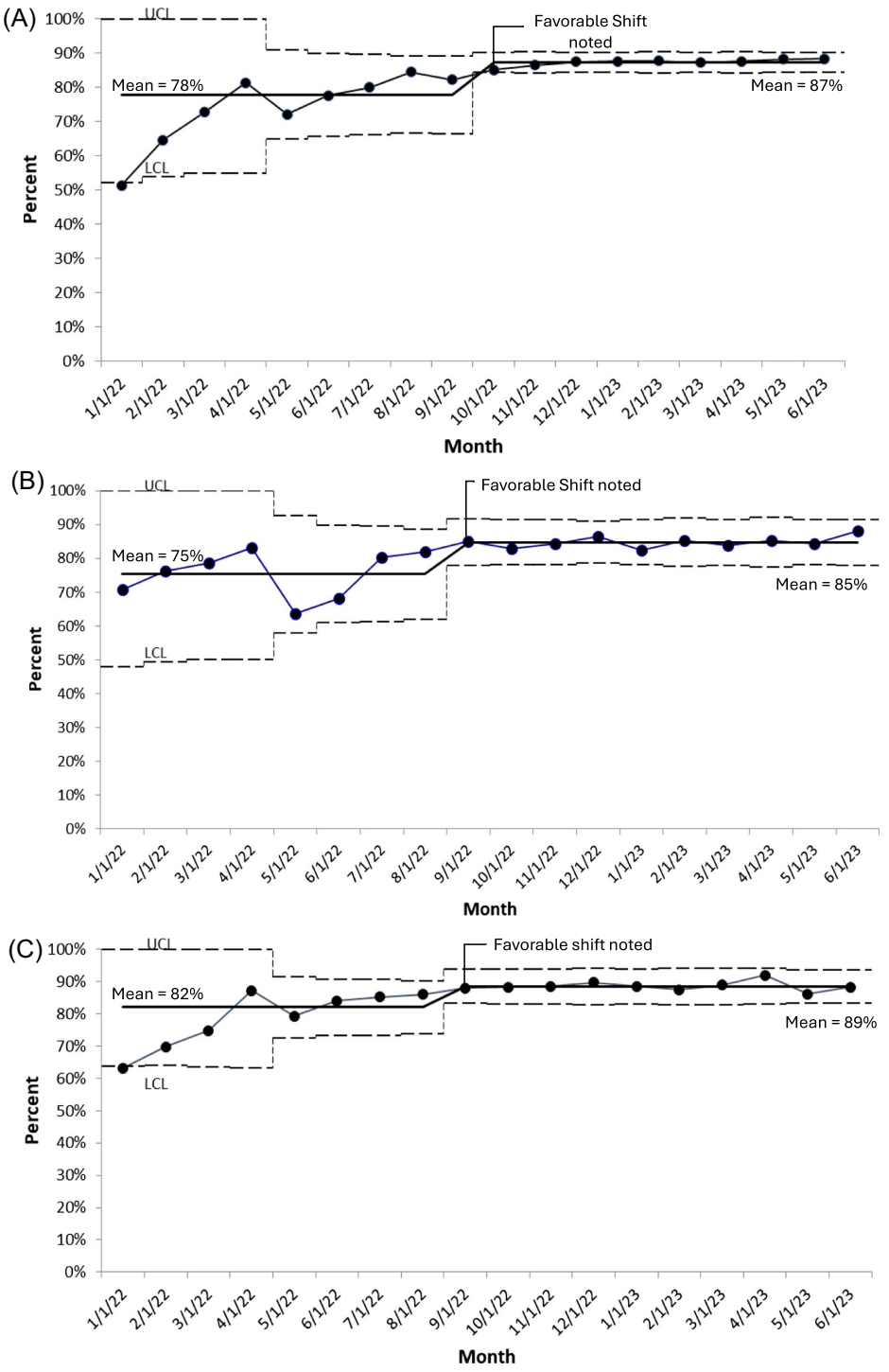

FIGURE 5.
SPC charts (Laney P) showing the rate of DCC by race for NH-w, NH-B, and Hispanic. (A) SPC-chart (Laney P) showing the rate of DCC for the (NH-w) population. A favorable shift is noted in October 2022 when the mean DCC rate shifted from 78% to 87%. (B) SPC-chart (Laney P) showing the rate of DCC for the NH-B population. A favorable shift is noted in September 2022 when the mean DCC rate shifted from 75% to 85%. (C) SPC-chart (Laney P) showing the rate of DCC for the Hispanic population. A favorable shift is noted in September 2022 when the mean DCC rate shifted from 82% to 89%. Abbreviations: CL, center line (mean); DCC, delayed cord clamping; LCL, lower control limit; NH-B, Non-Hispanic Black; NH-w, Non-Hispanic white; SPC, statistical process control; UCL, upper control limit.

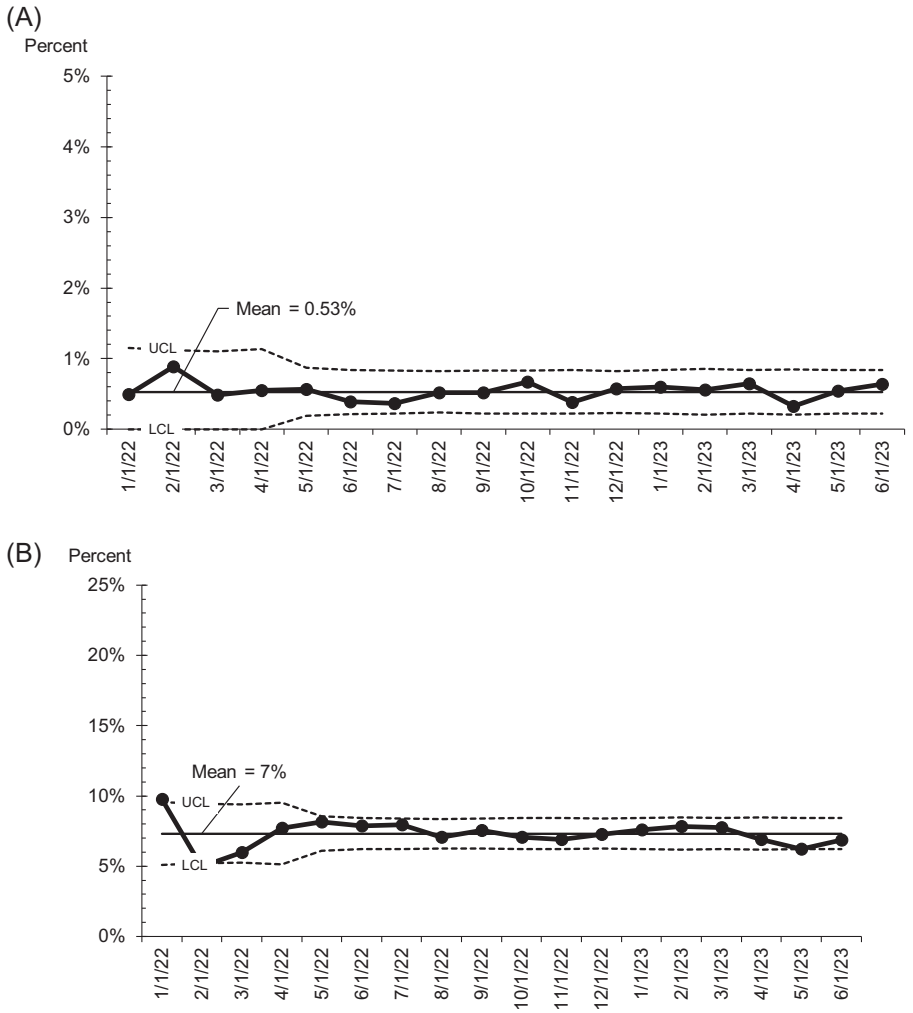

FIGURE 6.
Balancing measures. (A) SPC-chart showing the incidence of 5-minute Apgar score of up to 3 with a mean rate of 0.53%. (B) SPC-chart showing the incidence of hypothermia with a mean rate of 7.0%.
Abbreviations: Apgar, appearance, pulse, grimace, activity, and respiration (test); LCL, lower control limit; SPC, statistical process control; UCL, upper control limit.

TABLE 4. Summary of Process and Structure Measures

Process Measures	**Percent of Teams Reporting Implementation at Project Completion (n = 27)**
Provider education on DCC	88
Nurse education on DCC	92
Audit of cord clamping documentation in the EMR	92
Structure Measures	**Percent of Teams Reporting Completion Date at Project Completion (n = 27)**
Parent education and engagement	85
DCC policy and procedure	67
DCC flowchart	67
EMR integration of DCC documentation	96
Multidisciplinary case reviews with DCC metrics	96

Abbreviations: DCC, delayed cord clamping; EMR, electronic medical record.

that a factor as simple as delaying the clamping of the umbilical cord can decrease the mortality rate of these infants. We are hopeful that improvement will occur if the increased rates of DCC we have seen with this project are sustained. While this project was not designed to measure the impact on infant mortality rates, TIPQC is building upon this project with "Tennessee's Tiniest Babies," in which targeted DCC along with other potentially better practices will be implemented in all 12 of the state's level III and IV NICUs in an effort to impact our state's high infant mortality rate.[28] This statewide effort to improve care for our most vulnerable infants holds promise for reducing Tennessee's high infant mortality rate.

In conclusion, we have reported the largest QI project to date, the purpose or which was the "de-implementation of the nonevidence-based practice of immediate or early

clamping of the umbilical cord"[29] and to replace it with the recommended and physiologic-based practice of an at least 60-second delay in clamping of the umbilical cord. Our "Wait A Minute" strategy led to high participation and significant uptake of this evidence-based practice around the state of Tennessee. Based on the positive effects of DCC documented in the literature, we can expect these benefits to impact newborns in our state. The project's large scale demonstrates replicability across hospitals and health care systems. All project resources are available for adaptation and use.[12]

ACKNOWLEDGMENTS

The Tennessee Initiative for Perinatal Quality Care would like to thank the faculty and staff who worked tirelessly on this project. Without your leadership, we would not be able to improve health care in our state. In addition, the hospital teams who tirelessly worked on this project deserve the enormous credit for improving local care practices. Many thanks to Steven Compton, JD, Tanika Edwards, BSN, Ajay Talati, MD, and Dupree Hatch, MD who reviewed the manuscript drafts and made wonderful suggestions, along with Sue Butts-Dion, MA Institute for Healthcare Improvement advisor for her guidance.

ABBREVIATIONS

AAFP: American Academy of Family Physicians
AAP: American Academy of Pediatrics
ACOG: American College of Obstetricians and Gynecologists
Apgar: appearance, pulse, grimace, activity, and respiration (test)
CL: center line (mean)
DCC: delayed cord clamping
EMR: electronic medical record
LCL: lower control limit
NH-B: Non-Hispanic Black
NH-w: Non-Hispanic white
NICU: neonatal intensive care unit
PBP: potentially better practice
PQC: perinatal quality collaborative
QI: quality improvement
SPC: statistical process control
TIPQC: Tennessee Initiative for Perinatal Quality Care
UCL: upper control limit
WHO: World Health Organization

REFERENCES

1. Niermeyer S, Velaphi S. Promoting physiologic transition at birth: re-examining resuscitation and the timing of cord clamping. *Semin Fetal Neonatal Med.* 2013;18(6):385–392. PubMed doi: 10.1016/j.siny.2013.08.008
2. Seidler AL, Gyte GML, Rabe H, et al; International Liaison Committee on Resuscitation Neonatal Life Support Task Force. Umbilical cord management for newborns <34 weeks' gestation: a meta-analysis. *Pediatrics.* 2021;147(3):e20200576. PubMed doi: 10.1542/peds.2020-0576
3. Seidler AL, Aberoumand M, Hunter KE, et al; iCOMP Collaborators. Deferred cord clamping, cord milking, and immediate cord clamping at preterm birth: a systematic review and individual participant data meta-analysis. *Lancet.* 2023;402(10418):2209–2222. PubMed doi: 10.1016/S0140-6736(23)02468-6
4. World Health Organization. Guideline: delayed umbilical cord clamping for improved maternal and infant health and nutrition outcomes. 2014. Accessed June 6, 2023. https://apps.who.int/iris/handle/10665/148793
5. American College of Obstetricians and Gynecologists' Committee on Obstetric Practice. Delayed umbilical cord clamping after birth: ACOG committee opinion, number 814. *Obstet Gynecol.* 2020;136(6):e100–e106. PubMed doi: 10.1097/AOG.0000000000004167
6. Delayed umbilical cord clamping after birth. *Pediatrics.* 2017;139(6):e20170957. PubMed doi: 10.1542/peds.2017-0957
7. Tran CL, Parucha JM, Jegatheesan P, Lee HC. Delayed cord clamping and umbilical cord milking among infants in California neonatal intensive care units. *Am J Perinatol.* 2020;37(2):151–157. PubMed doi: 10.1055/s-0039-1683876
8. Lee B, Piercey L; Workgroup on Regionalization Guidelines Revision and the Perinatal Advisory Committee. Tennessee perinatal care system guidelines for regionalization, hospital care levels, staffing and facilities. 2020. Accessed August 20, 2024. https://www.tn.gov/content/dam/tn/health/program-areas/reports_and_publications/Regionalization_Guidelines.pdf
9. Osterman MJK, Hamilton BE, Martin JA, Driscoll AK, Claudia P; Division of Vital Statistics. Births: final data for 2021. *Natl Vital Stat Rep.* 2023:72(1). Accessed December 28, 2023. https://www.cdc.gov/nchs/data/nvsr/nvsr72/nvsr72-01.pdf
10. British Association of Perinatal Medicine. Optimal cord management toolkit. Accessed December 28, 2023. https://www.bapm.org/pages/197-optimal-cord-management-toolkit
11. Hall M, Valencia CM, Soma-Pillay P, Luyt K, Jacobsson B, Shennan A; the FIGO Preterm Birth Committee. Effective and simple interventions to improve outcomes for preterm infants worldwide: the FIGO PremPrep-5 initiative. *Int J Gynecol Obstet.* 2024:165:929–935. PubMed doi: 10.1002/ijgo.15269
12. Tennessee Initiative for Perinatal Quality Care. Optimal cord clamping. 2021. Accessed December 28, 2023. https://tipqc.org/occ/
13. Katheria A, Reister F, Essers J, et al. Association of umbilical cord milking vs delayed umbilical cord clamping with death or severe intraventricular hemorrhage among preterm infants. *JAMA.* 2019;322(19):1877–1886. PubMed doi: 10.1001/jama.2019.16004
14. Kumbhat N, Eggleston B, Davis AS, et al; Generic Database Subcommittee of the National Institute of Child Health and Human Development Neonatal Research Network. Umbilical cord milking vs delayed cord clamping and associations with in-hospital outcomes among extremely premature infants. *J Pediatr.* 2021;232:87–94.e4. PubMed doi: 10.1016/j.jpeds.2020.12.072

15. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform.* 2009;42(2): 377–381. PubMed doi: 10.1016/j.jbi.2008.08.010

16. Harris PA, Taylor R, Minor BL, et al; REDCap Consortium. The REDCap consortium: building an international community of software platform partners. *J Biomed Inform.* 2019;95:103208. PubMed doi: 10.1016/j.jbi.2019.103208

17. Gallifant J, Griffin M, Pierce RL, Celi LA. From quality improvement to equality improvement projects: a scoping review and framework. *iScience.* 2023;26(10):107924. PubMed doi: 10.1016/j.isci.2023.107924

18. Uduwana SR, Nemerofsky SL. A questionnaire assessing utilization of delayed cord clamping. *Am J Perinatol.* 2023;40(7): 773–779. PubMed doi: 10.1055/s-0041-1731047

19. Rabe H, Gyte GM, Díaz-Rossello JL, Duley L. Effect of timing of umbilical cord clamping and other strategies to influence placental transfusion at preterm birth on maternal and infant outcomes. *Cochrane Database Syst Rev.* 2019;(9):CD003248. PubMed doi: 10.1002/14651858.CD003248.pub4

20. Sprecher A, Malin K, Finley D, et al. Quality improvement approach to reducing admission hypothermia among preterm and term infants. *Hosp Pediatr.* 2021;11(3):270–276. PubMed doi: 10.1542/hpeds.2020-003269

21. Lied TR, Kazandjian VA. A Hawthorne strategy: implications for performance measurement and improvement. *Clin Perform Qual Health Care.* 1998;6(4):201–204. PubMed

22. Pande A, Ghosh S. The Hawthorne effect: quality and outcomes in neurosurgery. *Acta Neurochir Suppl.* 2023;130:207–216. PubMed doi: 10.1007/978-3-030-12887-6_25

23. Demetriou C, Hu L, Smith TO, Hing CB. Hawthorne effect on surgical studies. *ANZ J Surg.* 2019;89(12):1567–1576. PubMed doi: 10.1111/ans.15475

24. Purssell E, Drey N, Chudleigh J, Creedon S, Gould DJ. The Hawthorne effect on adherence to hand hygiene in patient care. *J Hosp Infect.* 2020;106(2):311–317. PubMed doi: 10.1016/j.jhin.2020.07.028

25. MacDorman MF, Martin JA, Mathews TJ, Hoyert DL, Ventura SJ. Explaining the 2001–02 infant mortality increase: data from the linked birth/infant death data set. *Natl Vital Stat Rep.* 2005; 53(12):1–22. PubMed

26. Callaghan WM, MacDorman MF, Rasmussen SA, Qin C, Lackritz EM. The contribution of preterm birth to infant mortality rates in the United States. *Pediatrics.* 2006;118(4):1566–1573. PubMed doi: 10.1542/peds.2006-0860

27. Quinn MK, Katheria A, Bennett M, Lu T, Lee H. Delayed cord clamping uptake and outcomes for infants born very preterm in California. *Am J Perinatol.* 2024:41(S 01):e981–e987. PubMed doi: 10.1055/a-1975-4607

28. Tennessee Initiative for Perinatal Quality Care. Tennessee's tiniest baby bundle. 2022. Accessed January 2, 2024. https://tipqc.org/ttb/

29. Diaz-Rossello JL, Blasina MF. Care of the newborn infant during the third stage of labor. In: Moreira De Sá RA, Fonseca EBD, eds. *Perinatology.* Springer International Publishing; 2022: 987–1011. doi: 10.1007/978-3-030-83434-0_53