

# Quality Strategies Initiative for the Improvement of Delayed Cord Clamping Among Preterm Neonates: A Quality Improvement Study in Saudi Arabia

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**Background:** Delayed cord clamping (DCC) has significant impact on health and well-being of preterm and term infants locally and worldwide. Effect of autotransfusion from delayed cord clamping has demonstrated significant beneficial effects in decreasing neonatal morbidity and mortality. However, this implementation has not been routinely established in clinical practice.

**Aim:** To improve the percentage of eligible infants who receive DCC among preterm newborns at tertiary hospital in Riyadh, Saudi Arabia.

**Methods:** The study was conducted between June 2023 and June 2024 at tertiary hospital, Prince Sultan Military Medical City (PSMMC), Riyadh, Saudi Arabia. We applied Plan-Do-Study-Act (PDSA) as a structured approach. The study population was defined as preterm infants aged <35 weeks. Interventions that were used included: workforce education, improving standardized procedures, monitoring and evaluation, and resources management. The DCC compliance rate was measured, in addition to employee training attendance and documentation methods.

**Results:** At the beginning of this study, the rate of DCC procedure was very low, and accounted only for 0% to 3%. After the interventions (Education and training, policy development, process monitoring and audits, and resource allocation) were applied, the rate of DCC increased to 92%, and this prevalence remained above the benchmark (60%), plateauing at above 90%. There were no reported maternal or neonatal adverse events.

**Conclusion:** This study confirmed that the rate of DCC increased after using the appropriate organized interventions. Applying the same or similar approach in other medical settings may be a valuable contributor in improving neonatal outcomes in addition to improve the standards related to DCC practices.

**Keywords:** delayed cord clamping, preterm infants, neonatal care, quality improvement

## Introduction

Delayed cord clamping (DCC) is a procedure that is performed for newborns, whether born preterm or term. It consists of few simple steps where umbilical cord is not clamped immediately after the baby is born, but rather, it is cut thirty seconds following neonatal birth. It has been showed that this practice has positive impact on newborns where it enhances blood transfer from placenta to the neonate and consequently does contribute to favorable neonatal outcomes, especially for preterm infants.<sup>1</sup> Delayed cord clamping has multiple benefits for preterm and term infants. In preterm

infants, DCC decrease the rates of intraventricular hemorrhage and necrotizing enterocolitis, and decrease the need for transfusion among newborn.<sup>2</sup> In term infants, DCC increases hemoglobin levels at birth and improves iron stores, which have favorable developmental outcomes.<sup>2</sup> In preterm infants, despite that DCC may delay timely resuscitation efforts, if needed, because the placenta continues to perform gas exchange after delivery, preterm infants are likely to benefit most from blood derived from continued placental transfusion. Another concern related to DCC implementation is that it could increase the potential for excessive placental transfusion.<sup>2</sup> Moreover, DCC supports the physiological transition from fetal to neonatal circulation.<sup>3</sup> DCC helps in maintaining the placental circulation during the onset of ventilation.<sup>3</sup> This enhances pulmonary blood flow; which stabilizes cardiac output and avoids sudden venous return reduction.<sup>3</sup> In recent years, many researches encouraged implementation of DCC as practice guideline in newborn care, especially if the delivery is expected at preterm period, prior thirty-seven weeks of gestation.<sup>4</sup>

A large body of literature has demonstrated positive impact of DCC on in infants' health. A previous meta-analysis that involved 48 randomized controlled trials (RCTs) found that DCC decreased the odds of death before discharge by 32% compared with immediate cord clamping (ICC).<sup>5</sup> The mortality rate was 30% lower among preterm infants who underwent DCC compared to those who received ICC.<sup>6</sup> Another meta-analysis that included 56 RCTs identified that DCC reduced the odds of other complications compared to ICC. The odds of intraventricular hemorrhage (IVH) are decreased by 30% and the odds of red blood cell transfusion by more than 50%.<sup>6</sup> In addition to its effect on reducing the mortality rate, it is also associated with decreasing the complications that may occur in prenatal infants such as neurological damage.<sup>7</sup> Furthermore, a retrospective study compared between DCC and ICC and found that the infants who received ICC were more susceptible to lower APGAR score and requirement for longer resuscitation compared to those who received DCC. However, it should be noted that there is a continuity of change in practices between these two procedures.<sup>8</sup>

The American College of Obstetricians and Gynecologists (ACOG) recommended to follow the DCC guidelines in infants' whether if they are born preterm or term. The recommendation includes applying DCC and cutting for thirty to sixty seconds unless the new-born requires rapid resuscitation.<sup>9</sup> The mechanism of how DCC work can explain why this organization seeks to promote this recommendation, as DCC can help in increasing the iron levels and prevent anemia, which in result can reduce morbidity among infants. A Cochrane Review further assists the benefits of DCC procedure on mortality, but further studies are needed to detect the proper time of clamping.<sup>4</sup>

Despite the clinical evidence that encourages and supports the use of DCC, its clinical practice remains inconsistent. In France, a previous study examined the adaptation of DCC among midwives, only 34.3% of them notified that they are using this procedure always or sometimes for at least one minute after childbirth.<sup>10</sup> In consistency concerning DCC implementation arise from multiple factors; which include the lack of standardized protocol, limited institutional support, suboptimal knowledge concerning DCC among healthcare providers, and concerns regarding neonatal resuscitation. This can be evidence to encourage the development and increase the education about the adoption of DCC in health institutions. Additionally, a quality improvement study demonstrated that 98% of the risk reduction in early cord clamping (ECC) was achieved by adhering to specific instructions in the delivery room. This implies that the use of certain mobile resuscitation instruments will increase the prevalence of DCC.<sup>11</sup> A previous study by Jegatheesan et al highlighted quality improvement efforts directed at optimal umbilical cord management. Quality improvement strategies that demonstrated successful implementation of DCC included development of theory for change, multidisciplinary team collaboration, creation of a unit-specific evidence-based protocol for cord management, and mapping of the current and ideal process and workflow for cord management.<sup>12</sup>

Significant efforts had been taken to explore the long-term impacts of DCC, particularly effect on neurological development. A study by Belling-Dierks et al analyzed survival rate and neurological development after they received DCC for 120 seconds at two years corrected age. This study reported a decrease in the compound measure of mortality or adverse neurodevelopmental outcome in the DCC group, however, the results were not statistically significant, in consequence this emphasise the need of more research to support the role of DCC among preterm infants.<sup>13</sup> DCC has not been routinely established in clinical practice in Saudi Arabia. Implementing DCC could provide an opportunity to enhance neonatal care safety and efficacy. The main aim of this quality improvement study is to increase the percentage of eligible infants who receive DCC among preterm newborns whose gestational age at birth is less than thirty-five weeks

to rate at least 60% by using a structured quality improvement approach. Specifically, this study examined the impact of education and training, policy development, process monitoring and audits, and resource allocation on enhancing DCC practices. These interventions cover system, process, and providers-related barriers that restricted the implementation of DCC based on previous literature.

## Methods

### Context

#### Study Design

The study employed a quality improvement (QI) strategy using the Plan-Do-Study-Act (PDSA) cycle in order to improve the DCC rate among preterm infants who were delivered in maternity ward and operating room in our hospital. The study was carried out for 12 months, from June 2023 to June 2024, and included multiple interventions aiming to provide staff with adequate education, enhanced the structured protocols, and continuously follow-up the compliance and impacts. The total number of infants included in this study was 503 infants; of which 131 infants delivered via SVD.

First PDSA cycle started in January 2024 second PDSA started in March 2024 for 6 months and interventions included:

- A. Policy creation and implementation
- B. Staff training
- C. Electronic system update and monitoring of documentation
- D. Equipment and supply optimization
- E. Regular audit and feedback meetings.

#### Study Settings

The study was conducted in Prince Sultan Military Medical City (PSMMC) in a tertiary-level hospital in Riyadh, Saudi Arabia. The target areas included the delivery ward and operating rooms, where most preterm deliveries occur. The study group also included the neonatal intensive care unit (NICU) staff, most responsible for giving an immediate care to infants after birth.

#### Participants

The participants in this study included all medical caregivers involved in the delivery of preterm infants, including obstetricians, midwives, nurses, and neonatologists. All preterm neonates (defined as infants born at or less than 35 weeks during the study timeframe) and delivered at PSMMC hospital were included in the study. Each delivery is attended by a pediatrician (registrar or resident), a neonatal nurse and respiratory therapist.

## Interventions

### Education and Training

#### Initial Training Sessions

Educational sessions were conducted for all eligible healthcare providers. These sessions focused on the positive outcomes of DCC, the specific protocol involved, and the evidence encouraging its use in preterm infants. Training included both theoretical workshops and interactive sessions. Training was conducted at the beginning for all staff then training for each team separately was conducted frequently: For pediatrician it was on monthly basis as new trainees are rotating every month. For obstetricians and midwives, it was every 3 months.

#### Advanced Medical Education

Refresher programs were held quarterly, with a focus on consequences encountered during the primary implementation phase. Educational instructions were provided to all medical staff to maintain the key messages.

### Policy Development

#### Protocols and Guidelines

New standards were provided to support use of DCC among infants and these were enhanced by the current findings and

best clinical guidelines.<sup>2</sup> These guidelines contain detailed protocols related to various pathways in management delivery of preterm infants in addition to appropriate time related to each of vaginal and caesarean birth.

### Protocol Implementation

The newly developed guidelines were implemented across the labor ward and operating theatre. Staff were required to follow these protocols during every delivery involving a preterm infant, with specific roles and responsibilities clearly outlined. During cesarean section and after delivery of the baby the obstetrician is the one who is doing stimulation and suctioning if needed under observation from the pediatrician if the baby is still flat or not breathing/crying then the pediatrician asks the obstetrician to cut the cord immediately. For vaginal deliveries, the midwife is doing DCC while the pediatrician or the neonatal nurse is assessing stimulating and suctioning the airway.

### Guideline's Implementation

The protocols and instructions in the guidelines were implemented in hospital departments which are specified in this study. Health caregivers were responsible to follow the protocols for each preterm birth.

### Process Monitoring and Audits

#### Electronic Health Record (EHR) Integration

To enhance the documentation process, additional section was added to EHR system to record the time and method of DCC. This step is vital due to its impact on giving clear records about any future audits.

#### Regular Audits

Audits were performed monthly to ensure the compliance with guidelines related to DCC procedure. The audits allow evaluating EHR entries, assessing the birth records, and discussing with medical staff any deviations from the guidelines. The aim of audits is to acknowledge the feedback to the caregivers and make immediate modifications if they are necessary.

### Resource Allocation

#### Equipment Provision

Necessary medical apparatus such as bulb syringes, plastic bags, and wall clocks was provided in all delivery rooms and operating rooms. The availability and function of supplies were of high importance in verification that all materials related to DCC are readily available for use insuring excellent efficacy within the standards.

#### Environmental Settings Adjustment

To make the DCC successful process, the delivery and operation rooms were reviewed physically and necessary adjustments were done. Among the items that were consciously inspected are resuscitation equipment with optimization of the space for the mother and her newly born baby during the DCC.

### Diagrams and Visual Aids

#### Fishbone Diagram

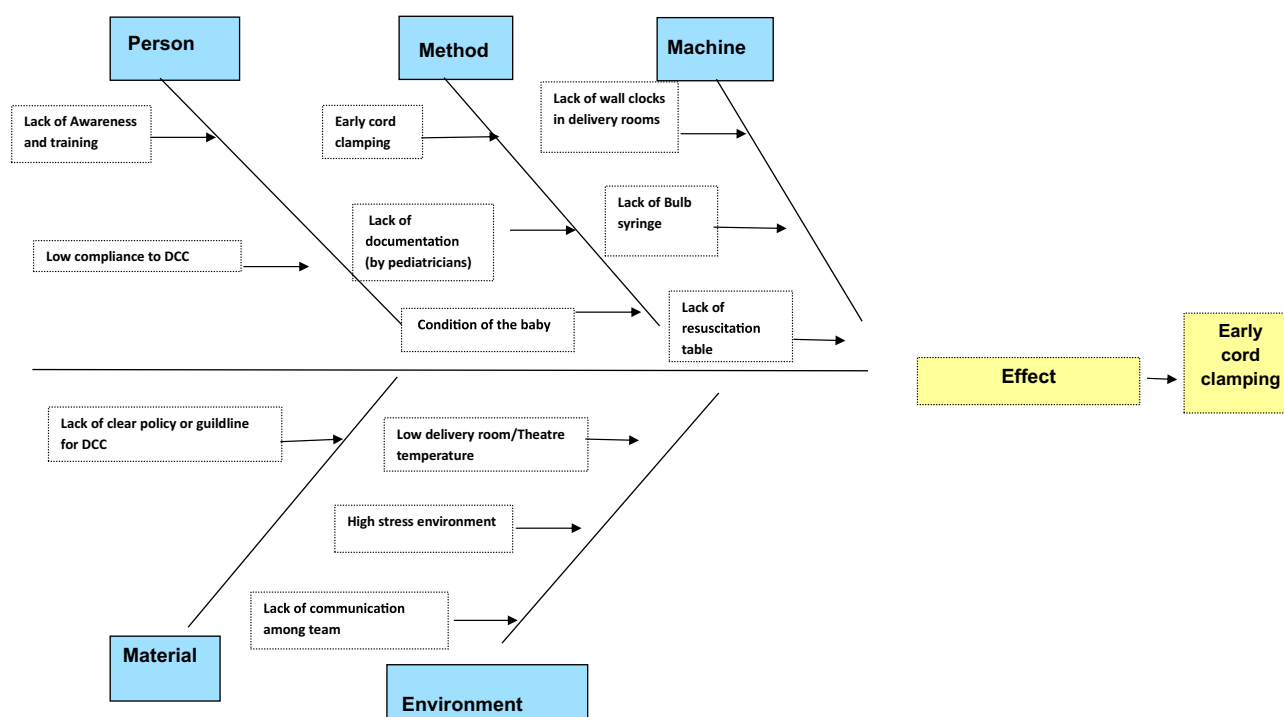
A Fishbone Diagram (Cause and Effect Diagram) aimed to determine potential barriers to the implementation of DCC. (Figure 1) This diagram classified the barriers into different domains, including lack of awareness, insufficient training, inadequate resources, and environmental barriers. The diagram was used during staff interviewing to discuss and address possible barriers systematically, Figure 1.

#### Aim Statement Diagram

An Aim Statement Diagram was developed to outline the primary and secondary drivers aimed at increasing DCC rates. (Figure 2) This visual aid was displayed in staff areas to keep the team focused on the project's objectives and to track progress.

#### Process Flow Diagram

A Process Flow Diagram was created to illustrate the steps involved in the DCC process, from birth to documentation in



**Figure 1** Cause and Effect Fishbone diagram.

the EHR (Figure 3). This diagram was used in training sessions and displayed in delivery rooms to ensure that all staff members were familiar with the correct procedures.

## Measures

The outcome measure was the rate of DCC among preterm infants ( $\leq 35$  weeks gestational age). Additional measures included staff compliance with the DCC protocols, accuracy of EHR documentation, and percentage of staff attending teaching activities about the project. Process measure included protocol compliance; which was defined as appropriate implementation of DCC in clinically eligible infants and avoiding the implementation of DCC in contraindicated cases. The balancing outcome was the number of reported adverse events related to quality and safety of baby due DCC in labor ward or operating theatre, including hypothermia and conducting DCC in contraindicated cases such as non vigorous baby that is not responding to suctioning and stimulation, fetal growth restriction (FGR), abnormal Doppler, abnormal placenta, and multiple gestations. The main outcome measures were: A. percentage of Staff Attendance in DCC Educational Sessions. B. compliance Rate of DCC documentation in electronic system HER.

## Study of the Interventions

### Data Collection

Data were collected prospectively throughout the study period. EHR entries were reviewed to gather information on the timing of cord clamping and neonatal outcomes. Additionally, data from the monthly audits were compiled to assess compliance with the protocols and to identify areas for improvement.

## Analysis

Data were analyzed using descriptive statistics to determine the overall rates of DCC and compliance with the protocols. The Fishbone Diagram and other visual aids were used to identify trends and to guide further interventions.

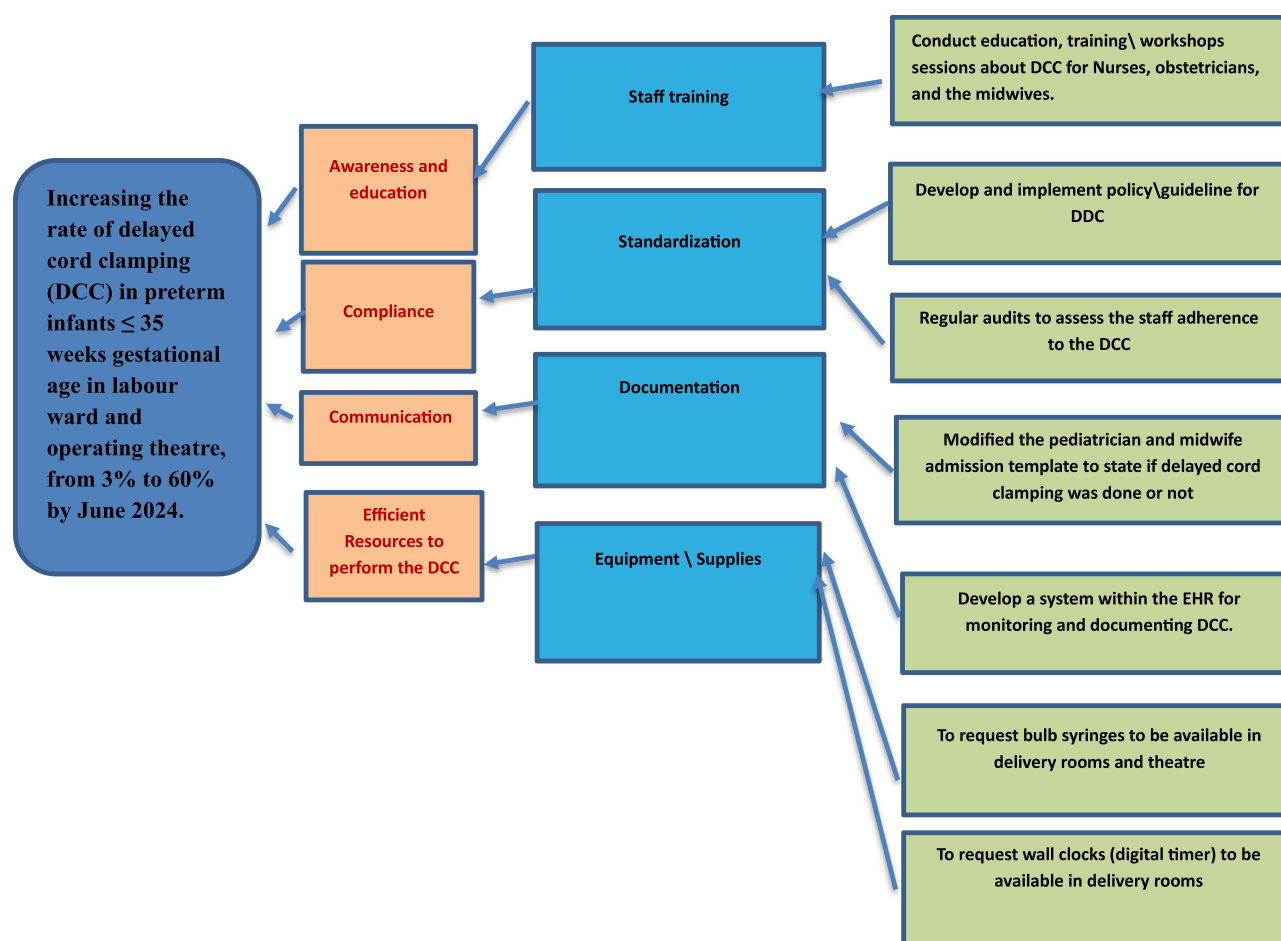


Figure 2 Aim Statement Diagram.

## Ethics

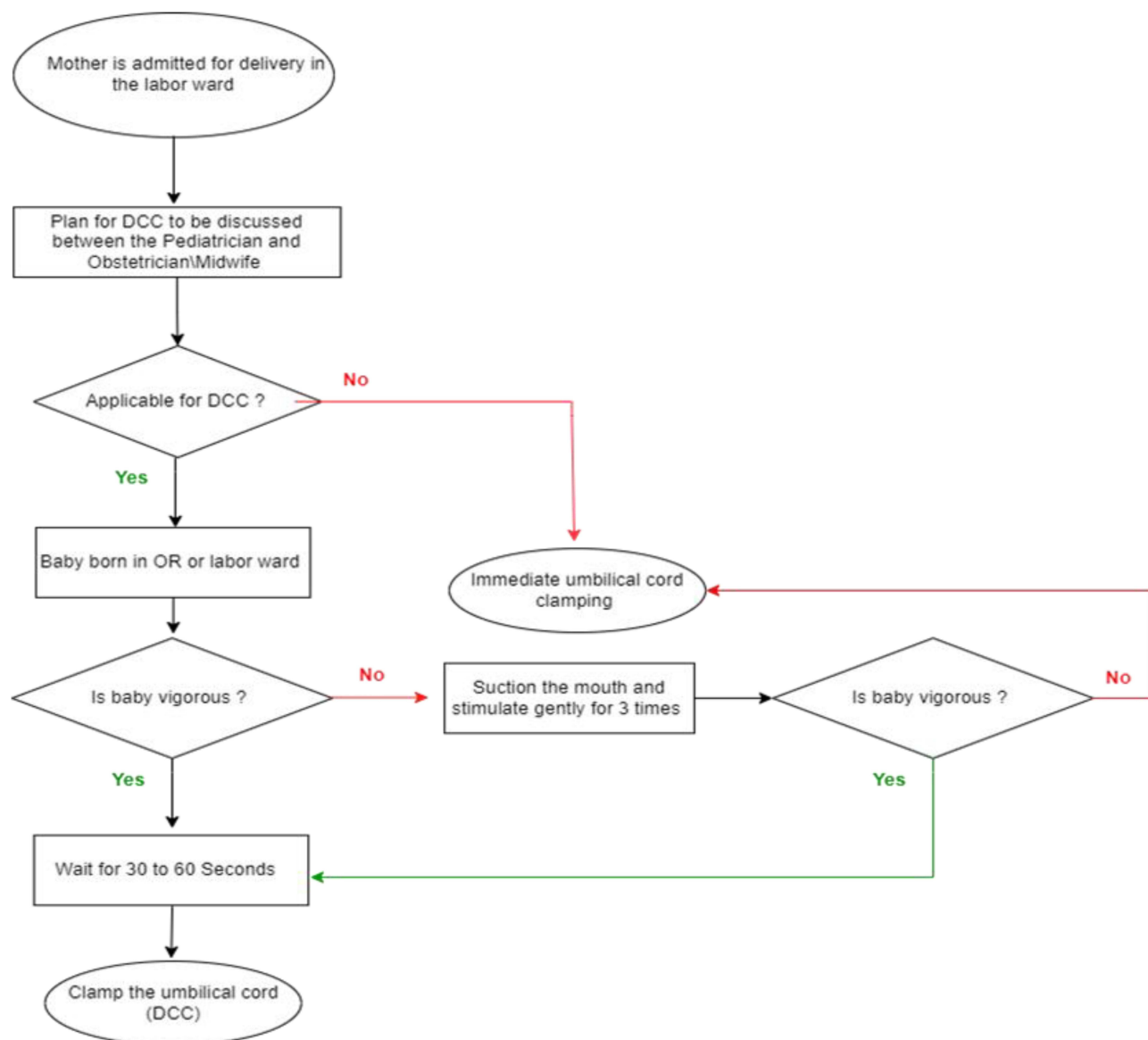
This study was approved by the Institutional Review Board at Prince Sultan Military Medical City (E-2474). This study was conducted in accordance with the Declaration of Helsinki.

## Results

### Rate of Delayed Cord Clamping (DCC) in Preterm Infants

The Root Cause Analysis shown in Figure 1 identified multiple barriers towards the implementation of DCC. Identified barriers included environmental constraints, lack of awareness, absence of DCC policy, equipment limitations, and poor documentation. Therefore, the implemented interventions in this research were designed to address these identified causes. The baseline rate of delayed cord clamping (DCC) among preterm infants ≤ 35 weeks gestational age was initially between 0% and 3%, measured from June 2023 to December 2023. Following the introduction of evidence-based guidelines, comprehensive training programs, and continuous monitoring, a significant increase in DCC rates was observed. The rate of DCC was observed in January 2024 and it was found that it rose to 92% (Figure 4). Our study period was 12 months, and during this period the rate was above the bench mark (>60%). This highlights that the interventions were sustainable.

- PDSA Cycle 1 (Jan-2024): Focused on staff education and system standardization, including DCC policy development, Staff training and education sessions, and provision of necessary devices.
- PDSA Cycle 2 (Mar-2024): Involved the development and implementation of DCC documentation within the HER allowing for the formal measurement of actual compliance, along with continuous staff training.



**Figure 3** Process Flow Diagram.

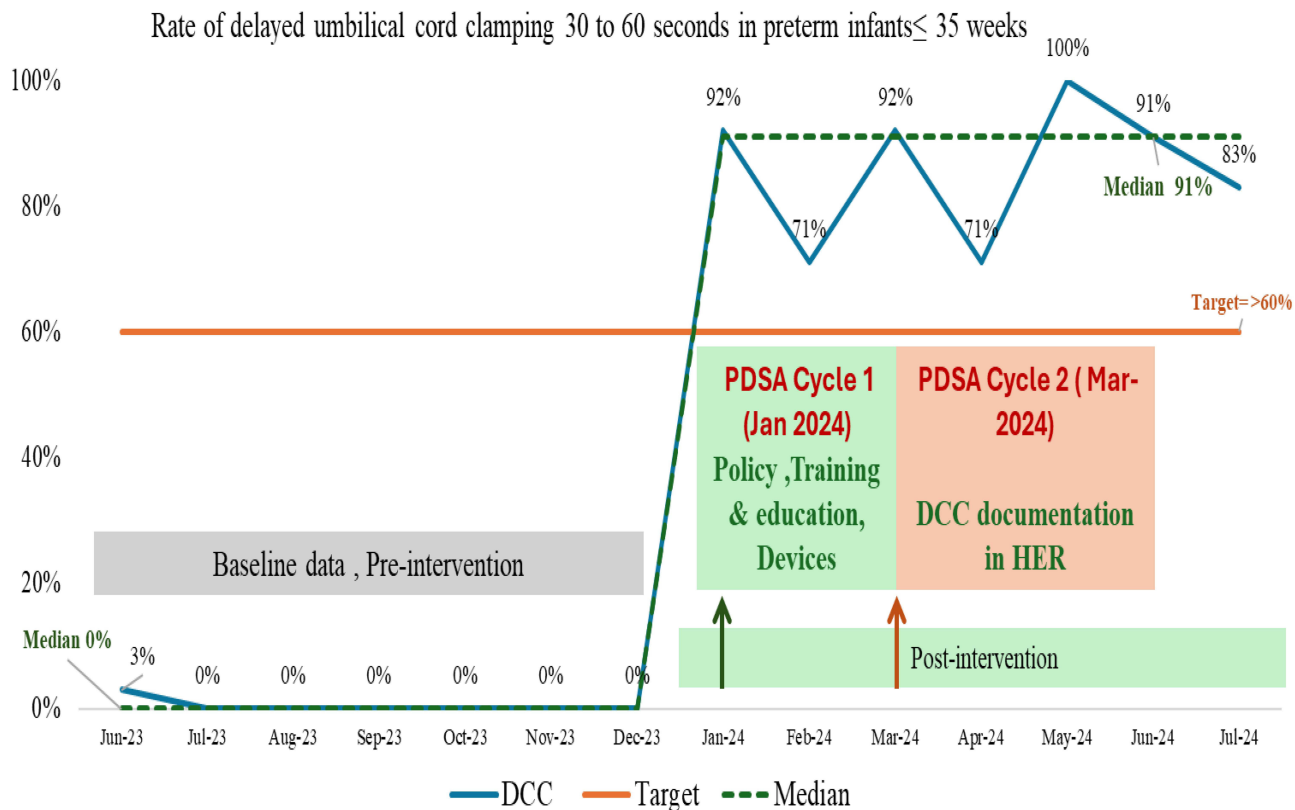
Following the implementation of study interventions, clear improvement in DCC compliance was observed, with sustained shift in performance. Two median lines are displayed, One representing the baseline data (pre-interventions), and a second representing the shifted median after Jan 2024 (Post intervention).

As illustrated in [Figure 4](#), PDSA Cycle 1, implemented in January 2024, focused on staff education and training, policy implementation, and system preparation. Following this intervention, the DCC rate reached 92% by January 2024, exceeding the project's target of 60%, and remained above the target throughout the study period.

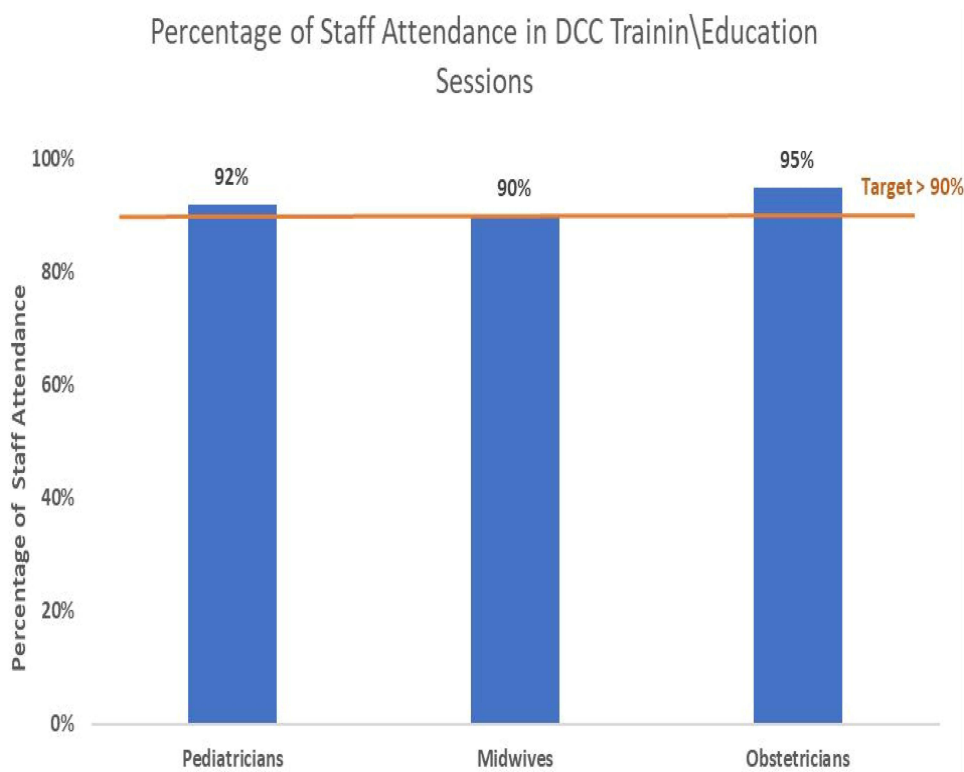
Subsequently, PDSA Cycle 2, implemented in March 2024, introduced structured DCC documentation and continuous monitoring through the electronic health record, which supported the sustainability of the improvement observed over time. The success of the systematic program refers to the interventions that were adopted, including training of healthcare providers, adherence to standardized policies, and ongoing observation and monitoring.

### Staff Attendance in Educational Sessions

Due to the sufficient educational resources that were given to medical staff including obstetricians, midwives, and pediatricians, the compliance of the them was improved. They were attended to the educational workshops and this attendance rate reached 90% concurrently with the project target ([Figure 5](#)). These training sessions were crucial in



**Figure 4** Run Chart Showing the Rate of Delayed Cord Clamping (DCC) for Preterm Infants  $\leq 35$  Weeks Gestational Age (June 2023–July 2024).



**Figure 5** Bar Chart of Staff Attendance in DCC Educational Sessions.

assessing the adherence of the staff with new instructions and protocols to ensure the maximum compliance during the study. Figure 5 illustrates the percentage of pediatricians, midwives, and obstetricians attending training sessions, consistently surpassing the 90% target.

## Compliance with DCC Documentation

An essential part of the project involved improving documentation practices in the electronic health record (EHR). Initially, DCC documentation was almost nonexistent. However, following the modification of admission templates for midwives and pediatricians and the introduction of regular audits, compliance increased steadily. By June 2024, the documentation compliance rate had reached 100% (Figure 6), ensuring the accurate tracking of DCC implementation and facilitating ongoing quality monitoring. Figure 6 shows the gradual improvement in documentation compliance, reaching 100% by June 2024. PDSA Cycle 2 implemented in March 2024 introduced a structured DCC documentation in the HER along with continuous staff education and training. Baseline data is not available as DCC documentation was not there yet, so data points after this cycle reflect post-intervention compliance to HER documentation from March onwards.

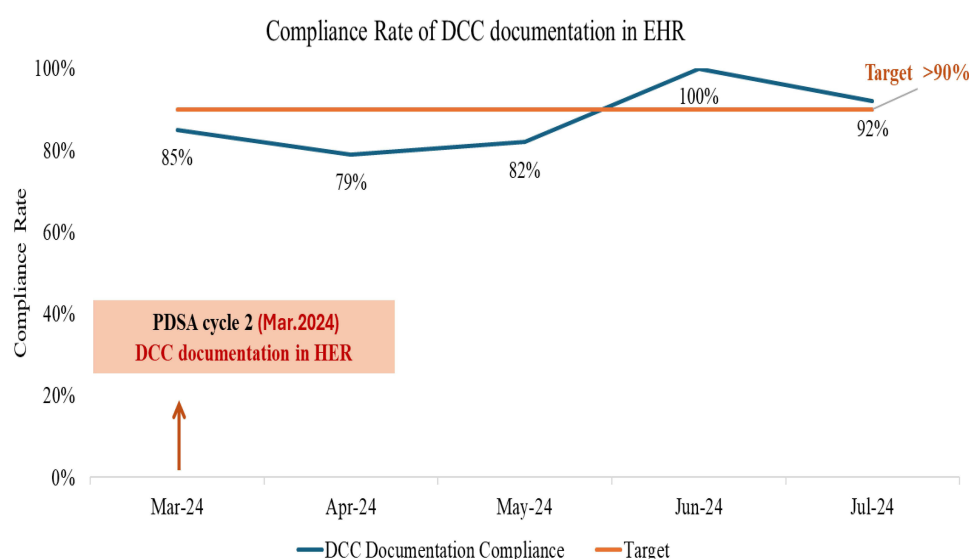
## Adverse Events

During the course of the project, DCC was performed in three cases where it was contraindicated (eg, multiple gestations with separate placentas). These three cases were reviewed as compliance with protocol. However, no significant adverse events were reported, and the newborns remained stable. These incidents were discussed with the respective teams, and the DCC guidelines were reviewed to prevent future occurrences (Figure 7). Figure 7 highlights the number of adverse events reported for preterm infants  $\leq 35$  weeks during the project period, including the three instances of DCC performed despite contraindications. The adverse events that were measured were hypothermia and DCC done while its contraindicated.

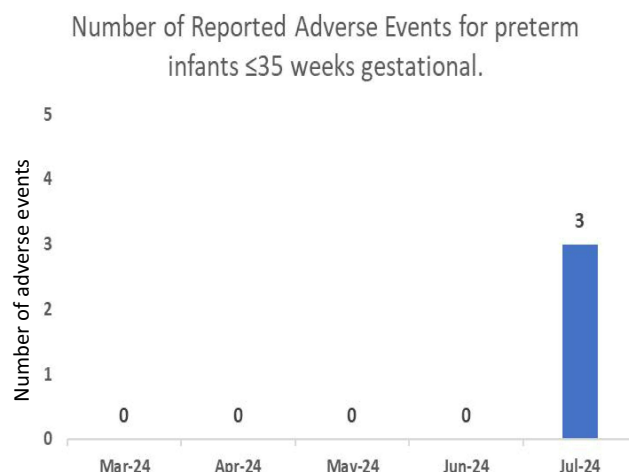
## Discussion

The aim of this study was to improve the incidence of DCC among preterm newborns at tertiary hospital in Riyadh, Saudi Arabia. The key findings of this study were: 1) the rate of DCC procedure implementation after the interventions were applied increased to 92%. There were no reported maternal or neonatal adverse events.

At the beginning of this research, the DCC rate among preterm infants was extremely low, ranging between 0% and 3%. This baseline reflects a significant gap in the adoption of DCC practices, particularly for preterm infants. However, after the implementation of DCC guidelines, policies, and standardized processes, the DCC rate improved significantly following the implementation of the PDSA cycle. Nonetheless, after PDSA cycle implementation, DCC implementation



**Figure 6** Compliance Rate of DCC Documentation in the Electronic Health Record (EHR).



**Figure 7** Number of Reported Adverse Events During the DCC Implementation.

showed variability. By January 2024, the rate had reached 92%, well above the project's target of 60%, and remained above the target throughout the study period. This reflects early improvement in DCC rate rather than long-term stability in DCC practices rate. The success of the systematic program refers to the interventions that were adopted such as training of health caregivers, following the policy, and continuous observation and monitoring. These interventions were consistent with interventions that mentioned in Bates et al,<sup>14</sup> where after implantation of specific protocol, the rate of DCC had increased from 12.5% to 89.4% among preterm infants. When immediate resuscitation is not indicated, evidence-based guidelines recommend DCC in preterm infants taking into considerations contraindication criteria. Furthermore, DCC practices implementation should be done through multidisciplinary team collaboration, standardized timing, and mapping of the current and ideal process and workflow for cord management.<sup>2,12</sup> The implementation of these quality improvement initiatives facilitates consistent practices and contributed to improvement in DCC rates.<sup>12</sup>

One of the most important key interventions in this study was the education that was given to medical staff, which had major impact on enhancing the compliance with DCC. Medical staff include midwives, pediatricians, and obstetricians and the educational sessions for them exceed 90%. This highlights the importance of educational workshops in supporting the benefits that associated with DCC. Previous studies demonstrated the importance of education in confirming the improvement study. For example, Payne et al<sup>15</sup> highlight that poor education and training for the staff affect the knowledge about DCC among the staff, thus affect the DCC adaption, particularly in low- and middle-income countries. This clarifies the role of education in increasing the compliance to DCC protocols.

Another focus of this study was improving the documentation of DCC in the EHR. Initially, DCC documentation was nearly nonexistent, but with the introduction of specific documentation fields for midwives and pediatricians, compliance improved steadily. By the end of the study, compliance rates reached over 90%, ensuring accurate and consistent data collection. Regular audits and feedback sessions were key to maintaining this improvement. Another important part of DCC is the documentation section, where this project focuses on developing the documentation process of DCC in EHR. Before starting this study, the documentation had minimal presence, but with the new guidelines and protocols the compliance among medical staff was improved. When the study was finished, it was noted that compliance rate increased to reach approximately 90%, which reflects the accuracy in data collection. This improvement in compliance is related to the continuous feedback sessions and regular assessment.

This mirrors the findings of Chan et al,<sup>16</sup> where a similar quality improvement project led to an increase in DCC documentation, from baseline levels to over 90% compliance by the study's end. Despite the rapid increase in DCC rates, this study did not observe a significant rise in adverse events. While there were three cases where DCC was performed in contraindicated situations (eg, multiple gestations with separate placentas), the infants remained stable. These events were thoroughly reviewed, and the staff was provided with additional guidance to prevent future occurrences. The safety of DCC, even in complex clinical settings, has been well-documented in the literature. According to Rabe et al,<sup>4</sup> DCC is

generally safe and associated with a reduced risk of intraventricular hemorrhage and necrotizing enterocolitis, two major complications in preterm infants. This underscores that, when done under appropriate conditions, DCC can be safely integrated into neonatal care without compromising outcomes.

In this study, the DCC practices improved significantly from 0% to 90% by January 2024. This improvement was due to the protocol and standards that were implemented, as many policies were developed in the field of education, training and education. The findings showed that attendance of medical staff has been increased noticeably. As by the end of this study, the staff compliance was over 90%. These findings can be proven by its consistency with Yunis et al which demonstrate that following well-structured comprehensive approach led to increase the compliance and as a consequence improve the neonatal outcomes.<sup>17</sup>

This quality improvement study has some limitations including the environment adjustments, where there was lack in resuscitation equipment and limited wall clock in delivery operation rooms. This is a single center study that could have limited generalizability. The cross-sectional study design restricted the ability to examine the causality across the study variables. Despite that DCC rate was improved, we still need to more education sessions and training workshops for the medical staff.

## Conclusion

The findings of this study showed an increase in DCC practices by over 90%. The implementation of PDSA cycle as a quality improvement strategy improved DCC rate rapidly. However, in order to maintain adherence to optimal DCC practices, continuous evaluation and monitoring are needed. The rise in the implementation rate was associated with initiating and establishing valuable strategies and instructions that were incorporated in DCC clinical protocol. The protocol consists of various strategic interventions at the level of medical staff education and training, appropriate documentation, along with continuous monitoring and regular audits. These interventions may be used in the same or modified model and applied in other healthcare institutions in purpose of improving overall neonatal outcomes.

## Institutional Review Board Statement

This study was approved by the Institutional Review Board at Prince Sultan Military Medical City (E-2474).

## Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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## Disclosure

The authors declare no conflicts of interest in this work.

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