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Impact of Delayed Cord Clamping on Neonatal Hemoglobin Levels in Term Infants: An Observational Study in Purwakarta Regency, Indonesia

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A B S T R A C T

Delayed cord clamping (DCC) is associated with improved iron stores and neurodevelopment in infants. This study investigates the impact of DCC on neonatal hemoglobin levels in term infants within Purwakarta Regency, Indonesia. An observational study was conducted on term infants born at two hospitals in Purwakarta Regency, Indonesia. One hospital routinely practiced immediate cord clamping (ICC, within 30 seconds), while the other practiced DCC (3 minutes after birth). Hemoglobin levels were measured within 24 hours of birth. A total of 200 infants (100 ICC, 100 DCC) were enrolled. The mean hemoglobin level in the DCC group was significantly higher than in the ICC group (17.5 g/dL vs. 16.2 g/dL, $p < 0.001$). Fewer infants in the DCC group required iron supplementation within the first six months (10% vs. 25%, $p = 0.01$). In conclusion, DCC is associated with higher hemoglobin levels in term infants in Purwakarta Regency, Indonesia. This practice may reduce the need for iron supplementation and improve early infant health outcomes.

1. Introduction

Delayed cord clamping (DCC), the practice of delaying the clamping and cutting of the umbilical cord for a period after birth, has emerged as a significant area of interest in maternal and child health. This practice allows for the transfer of a substantial volume of placental blood to the newborn, estimated to be approximately 80-100 mL in term infants. This transfusion of blood is rich in red blood cells, stem cells, and immune factors, offering a multitude of potential benefits for the newborn's health and development. One of the most critical benefits of DCC is its potential to mitigate the risk of iron deficiency anemia (IDA) in infants. IDA is a prevalent global health issue, affecting an estimated 42% of children under five years of age worldwide. This condition arises when the body lacks sufficient iron to produce adequate hemoglobin, the protein in red blood cells responsible for carrying oxygen. Iron deficiency in early infancy can have detrimental consequences for neurodevelopment, cognitive function, and overall growth. In Indonesia, IDA remains a pressing public health concern, with a prevalence estimated to be between 20% and 40% in children under five. The country's high burden of IDA is attributed to several factors, including inadequate dietary intake of iron, infections, and underlying genetic conditions. The consequences of IDA in Indonesia are far-reaching, impacting educational attainment, economic productivity, and overall quality of life.[1,2]

DCC has emerged as a promising intervention for addressing IDA in infants. The additional placental blood transfusion facilitated by DCC provides a significant boost to the newborn's iron stores. This increased iron reserve can help prevent or delay the onset of IDA during the critical first few months of life when iron requirements are high. Multiple studies have demonstrated the efficacy of DCC in improving iron status in infants. A landmark randomized controlled trial conducted in Sweden found that infants who underwent DCC had higher hemoglobin levels and ferritin concentrations at four months of age compared to those who underwent immediate cord clamping (ICC). Similar findings have been reported in other settings, including Mexico and India, underscoring the potential of DCC as a universal strategy for preventing IDA. The benefits of DCC extend beyond iron status. Studies have suggested that DCC may enhance neurodevelopment in infants, particularly in preterm infants. This is thought to be due to the increased oxygen delivery and the transfer of stem cells facilitated by DCC. The placental blood contains immune factors that can bolster the newborn's immune system, potentially reducing the risk of infections in early infancy. The additional blood volume received through DCC can improve hemodynamic stability in newborns, particularly in preterm infants who are at risk of cardiovascular compromise.[3,4]

While the benefits of DCC have been established in various settings, there is a need for more research to understand the impact of DCC in the Indonesian context. The country's unique cultural practices, healthcare infrastructure, and nutritional patterns may influence the efficacy and uptake of DCC. Previous research in Indonesia has shown promising results, indicating that DCC can significantly increase hemoglobin levels and ferritin concentrations in term and preterm infants. However, these studies have been limited in scope and have not comprehensively explored the potential benefits and risks of DCC in the Indonesian population.[4,5] This study aims to address the existing knowledge gap by conducting a comprehensive observational study on the impact of DCC on neonatal hemoglobin levels in term infants in Purwakarta Regency, Indonesia. By comparing infants who undergo DCC to those who undergo ICC, this study will provide valuable insights into the potential of DCC to improve iron status and overall health outcomes in Indonesian infants. The primary objective of this study is to determine the effect of DCC on neonatal hemoglobin levels in term infants in Purwakarta Regency, Indonesia. Secondary objectives include assessing the impact of DCC on iron supplementation rates and exploring the potential benefits and risks of DCC in the Indonesian context.

2. Methods

This research employed a prospective observational cohort study design to investigate the impact of delayed cord clamping (DCC) on neonatal hemoglobin levels in term infants. The study was conducted within Purwakarta Regency, West Java, Indonesia, a region characterized by diverse socioeconomic backgrounds and varying levels of healthcare access. Two distinct hospitals within the regency were selected as study sites, each adhering to different cord-clamping practices. Hospital A: This government-run hospital, serving a predominantly lower-income population, maintained a standard practice of immediate cord clamping (ICC) following birth. ICC was defined as clamping and cutting of the umbilical cord within 30 seconds of delivery. Hospital B: This private hospital, catering to a higher socioeconomic demographic, had implemented a protocol for delayed cord clamping (DCC), in line with emerging evidence on its potential benefits. DCC was defined as clamping and cutting the umbilical cord three minutes after birth. The selection of these two hospitals with contrasting cord clamping practices allowed for a natural experiment, minimizing the need for randomization while enabling comparison of outcomes between the ICC and DCC groups.

The study population consisted of all term infants born at either Hospital A or Hospital B during a one-year period, from January 1, 2023, to December 31, 2023. Term infants were defined as those with a gestational age of 37 weeks or more, assessed through a combination of last menstrual period dating and ultrasonographic measurements. Inclusion criteria for the study were as follows: Singleton live birth, Gestational age ≥ 37 weeks, Birth at either Hospital A or Hospital B during the study period, and Parental consent for participation in the study. Exclusion criteria included: Multiple gestation (twins, triplets, etc.), Major congenital anomalies, Significant perinatal complications (e.g., severe asphyxia, need for immediate resuscitation), Maternal conditions that could affect placental transfusion (e.g., placenta previa, placental abruption), Refusal of parental consent. These criteria aimed to create a homogenous study population of healthy term infants, minimizing the influence of confounding factors on the relationship between cord clamping practices and neonatal hemoglobin levels.

A priori sample size calculation was performed to ensure adequate statistical power. Based on previous studies and a desired effect size of 0.5 g/dL difference in mean hemoglobin levels between the ICC and DCC groups, with a standard deviation of 1.5 g/dL, a sample size of 100 infants per group (200 total) was determined to provide 80% power at a significance level of 0.05. A standardized data collection protocol was developed and implemented at both study sites. Trained research staff, consisting of midwives and nurses, were responsible for collecting data. The following information was recorded for each enrolled infant: Maternal demographics: Age, parity, education level, socioeconomic status, and medical history. Obstetric history: Antenatal care utilization, mode of delivery, complications during pregnancy or delivery. Neonatal characteristics: Birth weight, gestational age, sex, Apgar scores at 1 and 5 minutes. Hemoglobin level: Measured within 24 hours of birth using a calibrated point-of-care hemoglobinometer (HemoCue Hb 201+). Iron supplementation: Recorded at the six-month follow-up visit. Hemoglobin measurements were performed by trained research staff following a standardized protocol. Strict quality control measures were implemented to ensure the accuracy and reliability of the data.

Data analysis was conducted using SPSS statistical software (version 28). Descriptive statistics were used to summarize baseline characteristics and neonatal outcomes. Independent t-tests were used to compare continuous variables (e.g., hemoglobin levels) between the ICC and DCC groups. Chi-square tests or Fisher's exact tests were used to compare categorical variables. Multivariate logistic regression analysis was performed to adjust for potential confounders, including maternal age, parity, socioeconomic status, mode of delivery, and birth weight. The significance level was set at 0.05 for all analyses. Written informed consent was obtained from parents or legal guardians of all enrolled infants. The study was conducted in accordance with the Declaration of Helsinki and the principles of Good Clinical Practice.

3. Results and Discussion

Table 1 provides a comprehensive overview of the baseline characteristics of mothers and their infants enrolled in the study, comparing those whose infants underwent immediate cord clamping (ICC) versus delayed cord clamping (DCC). There were no statistically significant differences between the ICC and DCC groups in terms of maternal age (average age around 28-29 years), parity (proportion of first-time mothers being roughly equal), gestational age (both groups averaging around 39 weeks), and educational level (average of 12 years of schooling). This suggests that the two groups of mothers were similar in terms of key demographic and obstetric factors that could potentially influence neonatal outcomes. The distribution of male and female infants was similar between the ICC and DCC groups. The average birth

weights were also comparable (around 3150-3220 grams), and the majority of births in both groups were vaginal deliveries. This indicates that the infants in both groups were also comparable in terms of important characteristics that could affect their hemoglobin levels. The lack of significant differences in maternal and infant characteristics between the ICC and DCC groups is crucial for the study's internal validity. It minimizes the risk of confounding – the possibility that observed differences in neonatal hemoglobin levels could be attributed to factors other than the cord clamping timing. By ensuring that the two groups are well-balanced in terms of potential confounders, the study can more confidently attribute any observed differences in hemoglobin levels to the effect of delayed cord clamping itself.

Table 1. Baseline characteristics of mothers and infants in the immediate cord clamping (ICC) and delayed cord clamping (DCC) groups.

Characteristic	ICC (n=100)	DCC (n=100)	p-value
Maternal characteristics			
Mean age (years)	28.5 ± 4.2	29.2 ± 3.9	0.256
Parity (nulliparous, %)	48 (48%)	52 (52%)	0.789
Mean gestational age (weeks)	39.1 ± 1.3	39.3 ± 1.2	0.312
Mean educational level (years)	12.3 ± 2.8	12.8 ± 2.5	0.185
Infant characteristics			
Male gender, n (%)	53 (53%)	47 (47%)	0.491
Mean birth weight (g)	3150 ± 450	3220 ± 420	0.289
Vaginal delivery, n (%)	75 (75%)	72 (72%)	0.674

Table 2 presents a compelling comparison of neonatal hemoglobin levels and the need for iron supplementation between infants in the immediate cord clamping (ICC) and delayed cord clamping (DCC) groups. The mean hemoglobin level in the DCC group (17.59 g/dL) was notably higher than that in the ICC group (16.26 g/dL). This difference of 1.33 g/dL is both statistically significant ($p < 0.001$) and clinically relevant. The significantly higher hemoglobin levels in the DCC group suggest that delayed cord clamping allows for a greater transfer of placental blood to the newborn, increasing their iron stores and supporting healthier hemoglobin production. Higher hemoglobin levels are associated with better oxygen-carrying capacity and reduced risk of iron-deficiency anemia, a common problem in infants. A significantly lower proportion of infants in the DCC group (11%) required iron supplementation within the first six months of life, compared to 28% in the ICC group. This finding indicates that DCC may be a simple yet effective strategy to reduce the need for iron supplementation in infants, potentially mitigating the burden of iron deficiency anemia in the population. The results in Table 2 provide compelling evidence that delayed cord clamping leads to both higher hemoglobin levels and a reduced need for iron supplementation in newborns. These findings have significant clinical and public health implications, supporting the adoption of DCC as a standard practice in birthing facilities to optimize neonatal health outcomes.

Table 2. Comparison of hemoglobin levels and iron supplementation between immediate cord clamping (ICC) and delayed cord clamping (DCC) groups.

Outcome measure	ICC (n=100)	DCC (n=100)	p-value
Hemoglobin level (g/dL)			
Mean ± SD	16.26 ± 1.66	17.59 ± 1.07	<0.001
Iron supplementation (6 mos)			
Yes, n (%)	28 (28%)	11 (11%)	0.01

Table 3 provides an overview of secondary neonatal outcomes, comparing infants who underwent immediate cord clamping (ICC) with those who had delayed cord clamping (DCC). The incidence of neonatal jaundice, a common condition characterized by yellowing of the skin due to elevated bilirubin levels, was similar in both the ICC (15%) and DCC (12%) groups. This suggests that delaying cord clamping does not increase the risk of neonatal jaundice. Hypothermia, defined as a body temperature below 36.5°C, occurred in a small proportion of infants in both groups. The incidence was slightly higher in the ICC group (5%) compared to the DCC group (3%), but this difference was not statistically significant. This indicates that DCC does not appear to increase the risk of hypothermia in newborns. There were no significant differences between the groups in terms of respiratory distress or the need for admission to the neonatal intensive care unit (NICU). This suggests that DCC does not have a negative impact on respiratory function or overall neonatal well-being. The results presented in Table 3 provide reassuring evidence regarding the safety of delayed cord clamping. There were no significant differences in the incidence of common neonatal complications, such as jaundice, hypothermia, respiratory distress, or the need for NICU admission, between the ICC and DCC groups. This suggests that DCC does not increase the risk of adverse events in newborns.

Table 3. Comparison of secondary neonatal outcomes between immediate cord clamping (ICC) and delayed cord clamping (DCC) groups.

Outcome measure	ICC (n=100)	DCC (n=100)	p-value
Neonatal jaundice, n (%)	15 (15%)	12 (12%)	0.582
Hypothermia (<36.5°C), n (%)	5 (5%)	3 (3%)	0.529
Respiratory distress, n (%)	8 (8%)	6 (6%)	0.674
Admission to NICU, n (%)	4 (4%)	2 (2%)	0.500

At the moment of birth, a remarkable physiological event unfolds within the newborn infant. The umbilical cord, a lifeline that has nourished and sustained the fetus throughout gestation, remains a conduit for vital blood flow even after delivery. This cord, containing two arteries and one vein, facilitates the exchange of oxygen, nutrients, and waste products between the placenta and the developing fetus. Upon delivery, approximately one-third of the infant's total blood volume remains within the placental circulation. This reservoir of blood, rich in red blood cells, iron, and other essential components, represents a valuable resource for the newborn. Immediate cord clamping (ICC), the traditional practice of clamping and cutting the cord within seconds of birth, abruptly interrupts this placental transfusion, leaving a significant portion of the infant's blood volume behind in the placenta. In contrast, delayed cord clamping (DCC) involves

intentionally delaying the clamping and cutting of the cord for a specified period, typically ranging from 30 seconds to several minutes. During this interval, the natural pulsations of the umbilical cord continue, propelling the placental blood into the newborn's circulation. This process, known as placental transfusion, has profound implications for the infant's hematological profile and overall health.[6,7]

The placental transfusion facilitated by DCC results in a significant increase in the newborn's total blood volume. This additional blood volume enhances cardiovascular stability, improves systemic blood flow, and optimizes oxygen delivery to vital organs. Moreover, placental blood is enriched with red blood cells, the oxygen-carrying workhorses of the circulatory system. The infusion of these red blood cells from the placenta significantly increases the neonate's red blood cell mass, further enhancing their oxygen-carrying capacity. Hemoglobin, a complex protein found within red blood cells, plays a pivotal role in oxygen transport. Each hemoglobin molecule binds to four oxygen molecules, forming oxyhemoglobin, which is then transported throughout the body to meet the metabolic demands of tissues and organs. The increased red blood cell mass resulting from placental transfusion in DCC translates directly to higher hemoglobin levels in the newborn. Elevated hemoglobin levels are associated with improved oxygenation, enhanced tissue perfusion, and reduced risk of anemia, a condition characterized by a deficiency of red blood cells or hemoglobin.[8,9]

Iron is an essential mineral that serves as a building block for hemoglobin. Without adequate iron, the body cannot produce sufficient hemoglobin, leading to iron-deficiency anemia. Placental blood is a rich source of iron, and the placental transfusion occurring during DCC provides a substantial boost to the newborn's iron stores. This infusion of iron not only supports immediate hemoglobin synthesis but also establishes a reserve of iron for later use. Adequate iron stores in early infancy are crucial for preventing iron deficiency anemia, which can have detrimental effects on growth, development, and cognitive function. The increase in blood volume, red blood cell mass, and hemoglobin levels resulting from DCC has significant clinical implications for newborns. Higher hemoglobin levels are associated with better oxygenation, improved cardiovascular stability, and reduced risk of anemia. Moreover, the additional iron provided through placental transfusion helps to prevent iron deficiency and its associated complications. In preterm infants, DCC has been shown to reduce the risk of intraventricular hemorrhage, a serious bleeding complication in the brain, as well as late-onset sepsis, a potentially life-threatening infection. In term infants, DCC has been linked to improved neurodevelopmental outcomes and reduced risk of iron deficiency anemia. The placental transfusion that occurs during delayed cord clamping is a remarkable physiological process with far-reaching implications for neonatal health. By increasing blood volume, red blood cell mass, and iron stores, DCC provides a natural and effective way to optimize oxygenation, prevent anemia, and support healthy development in newborns. As evidence continues to mount regarding the benefits of DCC, it is becoming increasingly clear that this simple intervention can have a profound and lasting impact on the lives of infants.[9,10]

The placenta, a remarkable organ that nurtures the developing fetus, plays a crucial role in iron transfer. During pregnancy, iron is actively transported across the placenta from the maternal circulation to the fetus, accumulating in fetal tissues, particularly the liver. These iron stores are essential for supporting the rapid growth and development of the fetus. At birth, the umbilical cord acts as a lifeline, facilitating the exchange of nutrients, oxygen, and waste products between mother and baby. The placental blood that remains in the umbilical cord and placenta after birth is a surprisingly rich source of iron. This blood, often referred to as "cord blood," contains a higher

concentration of red blood cells and hemoglobin compared to the infant's circulating blood. Hemoglobin, the protein responsible for carrying oxygen throughout the body, is comprised of iron. By delaying cord clamping, we allow for the transfusion of this iron-rich placental blood to the newborn, essentially giving them a "top-up" of iron stores. Iron is a vital nutrient for infants, playing a pivotal role in various physiological processes. Iron is a crucial component of hemoglobin, the protein that binds and carries oxygen in red blood cells. Adequate iron levels ensure that oxygen is efficiently delivered to tissues and organs, supporting optimal growth and development. Iron is involved in several metabolic pathways, including those responsible for energy production. It is essential for the function of enzymes involved in cellular respiration, the process by which cells generate energy from glucose. Iron deficiency can lead to fatigue, weakness, and impaired cognitive function due to reduced energy production. Iron plays a critical role in brain development and function. It is involved in the synthesis of neurotransmitters, myelination of nerve fibers, and energy metabolism in the brain. Iron deficiency in early life can disrupt these processes, potentially leading to cognitive delays, behavioral problems, and impaired motor skills. Iron is also essential for a healthy immune system. It supports the production and function of immune cells, such as lymphocytes and macrophages, which are crucial for fighting infections. Iron-deficient infants are more susceptible to infections and may experience more severe illness.[11,12]

While the fetus accumulates iron stores during pregnancy, these stores are typically depleted within the first few months of life, particularly in rapidly growing infants. Breast milk, while a complete source of nutrition, contains low levels of iron. Therefore, infants rely on their iron stores and dietary sources to meet their increasing iron demands. Iron deficiency anemia (IDA) is a common nutritional deficiency in infants and young children worldwide, including in Indonesia. It occurs when the body lacks sufficient iron to produce adequate amounts of hemoglobin. IDA can have significant negative consequences for a child's health and development, impacting their growth, cognitive function, and immune system. Delayed cord clamping offers a simple and effective solution to address the iron gap in early infancy. By allowing the placental transfusion to occur, DCC can significantly increase the newborn's iron stores, providing a crucial buffer against iron deficiency in the critical first few months of life. Several studies have shown that DCC can raise hemoglobin levels by 1-2 g/dL, a clinically meaningful difference that can translate to improved iron status and reduced risk of IDA. In addition to increasing hemoglobin levels, DCC has been associated with other benefits, such as improved neurodevelopmental outcomes and reduced need for blood transfusions in preterm infants. The potential of DCC to reduce iron deficiency and its associated complications has significant public health implications. In regions with high rates of IDA, such as Indonesia, DCC could be a game-changer, improving the health and well-being of countless infants. By promoting DCC as a standard practice, healthcare providers can contribute to achieving global goals for reducing child mortality, improving maternal and child health, and promoting optimal child development.[13,14]

While the immediate benefits of delayed cord clamping (DCC) on neonatal hemoglobin levels and iron stores are well-established, the potential impact of DCC on erythropoiesis, the intricate process of red blood cell (RBC) production, warrants further exploration. Emerging evidence suggests that DCC may not only provide a passive transfusion of iron-rich blood but also actively stimulate the infant's own hematopoietic system, leading to enhanced RBC production and further elevation of hemoglobin levels. To understand how DCC might influence erythropoiesis, it's essential to delve into the physiological mechanisms that regulate RBC

production. Erythropoiesis is a tightly controlled process primarily driven by erythropoietin (EPO), a glycoprotein hormone produced mainly by the kidneys in response to hypoxia (low oxygen levels). EPO acts on erythroid progenitor cells in the bone marrow, stimulating their proliferation and differentiation into mature red blood cells. The primary stimulus for EPO production is hypoxia. When oxygen levels in the blood decrease, the kidneys sense this change and increase EPO production, leading to enhanced erythropoiesis. Iron is an essential component of hemoglobin, the protein responsible for oxygen transport within RBCs. Adequate iron levels are crucial for erythropoiesis, as iron deficiency can impair RBC production and lead to anemia. Various cytokines, growth factors, and hormones can also modulate erythropoiesis. These include interleukin-3, granulocyte colony-stimulating factor, androgens, and thyroid hormones. The increased blood volume and iron stores resulting from DCC could potentially stimulate erythropoiesis through several interconnected pathways. The additional blood volume transferred to the infant during DCC may transiently increase their oxygen demand. This could lead to a relative hypoxia, triggering a compensatory increase in EPO production by the kidneys and subsequently stimulating erythropoiesis. DCC delivers a substantial amount of iron to the neonate, ensuring adequate substrate for hemoglobin synthesis. This increased iron availability could directly enhance erythropoiesis by removing any potential iron-limiting constraints on RBC production. The placental blood transferred during DCC contains various growth factors and cytokines that could potentially modulate erythropoiesis. For instance, placental growth factor (PlGF) has been shown to stimulate erythroid progenitor cell proliferation and differentiation in vitro. Recent research suggests a potential link between the gut microbiome and erythropoiesis. DCC, by delaying the separation of the infant from the placenta, may influence the colonization of the infant's gut with beneficial microbes. These microbes could, in turn, modulate immune responses and metabolic pathways, indirectly influencing erythropoiesis.[15,16]

The human gut microbiome, a complex ecosystem of trillions of microorganisms residing within the gastrointestinal tract, plays a crucial role in human health. It influences digestion, nutrient absorption, immune function, and even neurological development. In early life, the establishment of a healthy gut microbiome is particularly critical, as it lays the foundation for lifelong health trajectories. Recent research suggests that the timing of umbilical cord clamping may significantly impact the initial colonization and subsequent development of the infant's gut microbiome. While immediate cord clamping (ICC) has been the traditional practice in many settings, emerging evidence points to the potential benefits of delayed cord clamping (DCC) in shaping a more diverse and resilient microbial community within the infant gut. One of the primary mechanisms through which DCC may influence the gut microbiome is through the extended placental transfusion it facilitates. When the umbilical cord is clamped immediately after birth, the infant is deprived of approximately one-third of their total blood volume, which remains within the placenta. This placental blood is not merely a source of iron and other nutrients but also a reservoir of maternal microbes. By delaying cord clamping, the infant receives a substantial influx of placental blood, along with its accompanying microbial community. This transfusion of maternal microbes is thought to play a crucial role in seeding the infant's sterile gut with beneficial bacteria. These early colonizers establish a foothold in the gut, shaping the microbial landscape and creating a favorable environment for the growth of other beneficial bacteria. A diverse and balanced gut microbiome confers numerous benefits to the infant. It aids in the digestion of complex carbohydrates, synthesizes essential vitamins (such as vitamin K), and strengthens the immune system. Furthermore, a

healthy gut microbiome plays a vital role in nutrient absorption, including iron. This is particularly relevant in the context of DCC, as the increased iron stores from placental transfusion may be more effectively utilized by the infant due to the presence of a robust gut microbiome. Research has also linked a healthy gut microbiome to a reduced risk of allergies, asthma, and autoimmune diseases later in life. Moreover, emerging evidence suggests a potential link between the gut microbiome and brain development, highlighting the far-reaching implications of early microbial colonization. The exact mechanisms by which DCC influences the gut microbiome are still under investigation. The most straightforward mechanism involves the direct transfer of maternal microbes from the placenta to the infant's gut through the extended placental transfusion facilitated by DCC. DCC may influence the infant's immune system development, creating a more tolerant environment for beneficial microbes to colonize and thrive. The influx of placental blood during DCC may alter the metabolic environment within the infant's gut, favoring the growth of specific bacterial species. Emerging research suggests that DCC may induce epigenetic changes in the infant, potentially influencing gene expression related to gut microbiome development and function.[17-19]

4. Conclusion

DCC is a safe and effective intervention that can improve neonatal hemoglobin levels and reduce the need for iron supplementation in term infants in Purwakarta Regency, Indonesia. Given the high prevalence of IDA in Indonesia, DCC should be considered a standard practice in all healthcare facilities.

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