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# Implications for delayed versus immediate umbilical cord clamping

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# IMPLICATIONS FOR DELAYED VERSUS IMMEDIATE UMBILICAL CORD CLAMPING

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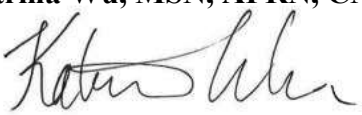
**Second Reader Signature:** 

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## Abstract

**Purpose:** The purpose of the critical review of literature was to identify and analyze benefits of delayed umbilical cord clamping in full term and preterm infants with a focus on iron stores, hemoglobin, hematocrit, and hyperbilirubinemia.

**Methods:** Twenty-two articles were included in the critical literature review with the purpose of determining whether delayed umbilical cord clamping caused increases in iron stores, hemoglobin and hematocrit, or had no clinical significant increases in hyperbilirubinemia causing neonatal jaundice and the need for phototherapy treatment.

**Results/Conclusion:** Delayed umbilical cord clamping is a low risk, cost effective intervention that is safe and has many benefits to both preterm and full term infants. Furthermore, delayed umbilical cord clamping should be the standard of care within all birth settings.

**Implications for Research and Practice:** Nurse-midwives should implement delayed umbilical cord clamping in every birth since it has been proven to have many benefits including decreasing iron deficiency anemia in the newborn for up to six months of life, increasing hemoglobin and hematocrit without any significant rates of hyperbilirubinemia, decreasing rates of intraventricular hemorrhage, late onset sepsis, and necrotizing enterocolitis in the preterm infant. Nurse-midwives must be visionary leaders in implementing change within organizations for the practice of delayed umbilical cord clamping for all births.


**Keywords:** delayed, immediate, and early umbilical cord clamping

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## Chapter One: Introduction

Delayed cord clamping is a beneficial, cost effective intervention used in obstetrics. The practice of umbilical cord clamping is controversial and varies significantly among birth settings (Buder, 2015). Initially, clamping and cutting of umbilical cords was introduced in the 17th century to reduce the amount of blood that would spill onto the birth beds and onto birth clothes and the practice continues to this day with no indications to timing (Gruneberg & Crozier, 2015). In the 18 th and 19 th century, Erasmus Darwin, an English physician, recognized that umbilical cords should be left alone until they ceased pulsation because the blood belonged to the child and was necessary for life. If this action were not done, according to Darwin, the child would be much weaker (Bechard, 2015). Along with the invention and use of chloroform in the 1950s came immediate cord clamping due to neonatal respiratory depression at birth and the immediate need for resuscitation (Bayer, 2016).

The benefits of delayed cord clamping have been well researched and established, yet there are still providers who do not do or offer this to their patients. A study conducted by Buder found more than 95% of obstetricians and midwives in the United Kingdom immediately clamp and cut umbilical cords in their practices (Buder, 2015). Delayed cord clamping has been shown to increase the infant's blood volume by 30% or 80-100 ml, which gives the infant valuable blood rich in red blood cells (containing iron), oxygen, and stem cells (Gruneberg & Crozier, 2015). This is especially important in the compromised infant having difficulties transitioning to extra-uterine life.

**Statement of Purpose**

The purpose of this critical review of the literature is to determine if the timing of umbilical cord clamping, delayed or immediate, in newborn infants is associated with differences in hemoglobin, hematocrit, and hyperbilirubinemia.

**Evidence Demonstrating Need**

Iron deficiency anemia affects children both in the Unites States and globally. In the United States, the rate of anemia is 35% to 47%, and globally the prevalence of anemia is 25% (McAdams, 2014). Inadequate iron stores in infancy can cause irreversible damage on the developing brain even in the context of administration of iron supplementation (Anup, Rich, & Finer, 2016). The Family Health Survey III suggested that in India childhood anemia occurs in 80% of the children between six and 26 months (Yadav et al., 2015). Eighty percent of childhood anemia worldwide is due to iron deficiency (Yadav et al., 2015). Iron deficiency anemia and iron deficiency in infancy are associated with poor cognitive, motor, social emotional, and neurophysiologic outcomes (Leslie, 2015). Andersson et al. (2015) found that using delayed umbilical cord clamping versus immediate umbilical cord clamping improved fine motor skills and social domains in children up to four years of age, which could optimize neurodevelopment in high income countries. In underserved countries where there are few resources rich in iron, delayed cord clamping could be a significant method to prevent childhood anemia.

In preterm infants, delaying cord clamping versus immediately clamping the cord can be beneficial and has been shown to improve hemodynamic stability (Sommers et al., 2012). Immediate cord clamping in the preterm infant deprives the infant of valuable additional blood volume (10%-15%), which has beneficial effects during the extra-

uterine transition to life (Sommers et al., 2012). Also, in the preterm infants where delayed cord clamping was done, a decrease of 50% was noted in the occurrences in intraventricular hemorrhage, necrotizing enterocolitis, and the need for more blood transfusions (Chiruvolu et al., 2015).

**Significance to Nurse-Midwifery**

Many professional organizations have supported and highly recommended implementation of delayed cord clamping in the context of both full term and preterm births. In 2012, the World Health Organization (WHO) recommended that delayed cord clamping (not earlier than one minute after birth) be implemented to improve maternal and infant health and nutrition outcomes. In its recommendations, WHO also included the need for delayed cord clamping during basic newborn resuscitations and in the event of the need for initial positive pressure ventilation. In the event of asphyxia, the umbilical cord should be cut immediately for resuscitation. The WHO also recommended that delayed cord clamping of at least one to three minutes be done if the mother is HIV positive. The recommendation was given because the benefits of delayed cord clamping strongly outweigh the risks of HIV transmission in the context of appropriate antiviral therapy given to decrease the transmission of HIV (WHO, 2012). The American College of Nurse-Midwives (ACNM) position statement on delayed cord clamping stated that delayed cord clamping should be the standard of care in all birth settings for both term and preterm newborns. In the event resuscitation is needed, ACNM suggested umbilical cord milking. The position statement stated that the benefits of delayed cord clamping result in placental transfusion of blood to the newborn, facilitating extra uterine life by increasing blood volume, birth weight, increasing hemoglobin concentration, and

therefore increasing infant iron stores. Also, it states that there was no increased risk of developing tachypnea, clinical jaundice, or symptomatic polycythemia. In pre-term births, delaying the umbilical cord clamping for at least 30-60 seconds shows a significant reduction in intraventricular hemorrhage and the need for blood transfusions (ACNM, 2014). The American Academy of Pediatrics (AAP), in 2012, endorsed American College of Obstetrics and Gynecologist's (ACOG) opinion on timing of the umbilical cord clamping after birth, which was updated in 2016 to include the recommendation that umbilical cord clamping should be delayed for all healthy infants (both full term and preterm infants) after at least 30 to 60 seconds have elapsed after the birth (ACOG, 2016). ACOG's opinion stated that in the preterm infant, delaying cord clamping can result in benefits such as improved transitional circulation, better establishment of red blood cell volume, decreased need for blood transfusions, a lowered incidence of intraventricular hemorrhage, and necrotizing enterocolitis. ACOG mentioned there is a small increase in the rates of jaundice requiring phototherapy in term infants (ACOG, 2016), and thus, it was suggested that providers ensure that proper mechanisms are in place to monitor and treat jaundice.

**Theoretical Framework**

Change is often seen as an obstacle in healthcare organizations. Implementing change can be a large task and can require support from many of the stakeholders for the change to be an integral part of the organization. Change is crucial for organizations to continue to grow and also to offer evidence-based interventions to patients that are proven to benefit them (Hussain, Akram, Haider, Hussain, & Ali, 2016). Many providers are complacent, remain confident in the status quo, and resist functional changes.

Change management within hospitals requires continual forward progress with evidence based practices based on the needs and benefits to patients (Cummings, Bridgman, & Brown, 2016). Barriers to change include anxiety, fear of the unknown, lack of education, and complacency, which is often seen with providers who do not practice delayed cord clamping in the births they attend. Many providers may be unaware or uninformed about the benefits of delayed cord clamping and do not want to embrace change.

Kurt Lewin, the founding father of change management, created a fundamental theory of approaching change and managing change (Cummings, Bridgman, & Brown, 2016). His theory was based on the premise that for change to be created, one must utilize a three step process: 1) unfreezing the change process; 2) moving toward the change through transition; and 3) refreezing of the change process in its new form (McGarry, Cashin, & Fowler, 2012). Lewin believed that one must create an environment for change, transition to the change implemented, and maintain the process of change.

Step one involves unfreezing the change process. In this step, the stakeholders recognize the process needing change and old behaviors that need to be discarded or unlearned so that new evidence based interventions can be utilized (McGarry, Cashin, & Fowler, 2012). This process is difficult due to the anxiety felt by providers and the staff that is caused by significant organizational change. As with the implementation of delayed cord clamping rather than immediate cord clamping, the prospect of learning something new causes anxiety often because of lack of education and incompetence of the stakeholders (McGarry, Cashin, & Fowler, 2012). The benefits are often overlooked due to lack of education and complacency. To create the change, the stakeholders must have buy in and support the change. Step two involves transitioning or moving the

change process. Lewin noted that this step may involve trial and error and does not ensure its sustainability. Lastly, the third step involves refreezing the change. This refers to creating a new state of status quo with the new learned behavior. In this step, policies and procedures should be implemented to maintain the change (McGarry, Cashin, & Fowler, 2012).

**Implementation of Delayed Cord Clamping into Practice**

Over the last decade, the WHO, ACOG, AAP, and ACNM supported delayed cord clamping and no longer recommended immediate cord clamping within the active third stage of labor, but yet changes in the practice are still questioned, in spite of the evidence to the contrary, and hospital policies and protocols are rare (Malqvist, Rana, Ranneberg, & Andersson, 2016). By using Lewin's steps to implement change, delayed cord clamping could become current practice in facilities that are not practicing it (McGarry, Cashin, & Fowler, 2012).

Step one, unfreezing the change process, will require educating providers, including hospital staff nurses, nursery nurses, OB-GYN's, and pediatricians, on the benefits of delayed cord clamping. Barriers and resistance will likely be seen in this stage. Overcoming these barriers will only occur when there is buy in from stakeholders as a result of increased education through the study of evidence based research on benefits of delayed cord clamping for the newborn. Step two, the transitional stage, will include the movement from immediate cord clamping in the third stage to delayed cord clamping. This will include changes of thoughts, personal feelings, and behaviors that can move forward the implementation of the intervention. In this step, fears and anxiety will have to be controlled so implementation succeeds. In the third and last step,

refreezing the new change, delayed umbilical cord clamping for every delivery will be the norm and become a new habit followed by providers and supported by the staff. New policies and procedures supporting delayed cord clamping will be implemented within the hospital. Change is often perceived as difficult and painful, and many barriers must be overcome. With the use of Lewin's change theory and three-step process, delayed cord clamping could become normal practice with providers that are currently clamping the cord immediately.

## Summary

Nurse-midwives and obstetrical providers have the ability to delay umbilical cord clamping in every birth setting benefitting the newborn to receive iron rich blood, yet many still do not practice this. Because of the large rates of childhood anemia in the United States and globally, this practice is imperative. Educating both the providers and the mothers could help increase the rates of delayed umbilical cord clamping worldwide. Chapter two will review the methods used to examine scholarly literature on the benefits of delayed umbilical cord clamping such as increased iron stores, increased hemoglobin and hematocrit, and occurrences of hyperbilirubinemia and polycythemia. Chapter three will include a synthesis of the literature reviewed with recommendations for further research.

## Chapter Two: Methods

The purpose of this chapter is to review the methods used in the critical appraisal of the literature. Scholarly literature that was included in the appraisal will show the effects of delayed umbilical cord clamping and early umbilical cord clamping on term neonates, preterm neonates, iron, hemoglobin and hematocrit, and polycythemia with regard to the need for phototherapy for the treatment of hyperbilirubinemia. Strategies and data bases, inclusion and exclusion criteria for the final 22 research articles, and the level and quality of the articles will be reviewed.

### Search Strategies

The intent of the critical literature appraisal is to show the benefits of delayed umbilical cord clamping in newborns. The review of literature includes research studies dated between 2006 and 2015. Articles dated in the years prior to 2012 were used in the literature search where the research question was relevant. An initial search was conducted using the Cumulative Index to Nursing and Allied Health Literature (CINAHL) database entering the following key words: delayed, immediate, and early umbilical cord clamping. This search retrieved 2,657 items. A second search was completed using the Science Direct Journal database entering the same key words. This search retrieved 318 items. Abstracts of the articles were reviewed. Literature that included umbilical cord milking or items that were not included in the research question were excluded. After searching the literature, the following subject terms occurred most frequently: delayed, late, and early umbilical cord clamping, hemoglobin, hematocrit, ferritin, iron, newborn anemia, polycythemia, hyperbilirubinemia, neonatal jaundice, phototherapy in the newborn, placental transfusion, as well as term and preterm infants.

**Criteria for Inclusion and Exclusion**

Experimental, quasi experimental, and non experimental research articles that are of high, good, and low quality were included in the matrix. Articles included in this review used early or immediate and late or delayed umbilical cord clamping on term and preterm infants with detailed follow up on the incidences of hyperbilirubinemia, polycythemia, anemia, serum ferritin levels, hemoglobin, and hematocrit. Articles were also reviewed and excluded then from the literature appraisal on the basis that the content did not relate to the purpose of this review. Studies conducting reviews of literature, expert opinions, surveys, case studies, and meta analysis on delayed versus immediate umbilical cord clamping were included in the initial search so that additional references could be reviewed in a search for additional information. None of these studies was used in the final matrix.

**Summaries of Selected Articles**

A total of 180 studies related to delayed or immediate umbilical cord clamping was included in the initial review appraisal. Studies were then sorted according to original research, literature reviews, meta-analysis, case studies, surveys, and expert opinions. Only studies that included mothers who positioned newborns on their abdomens during delaying of clamping of the umbilical cord were included in the matrix. Since placental transfusion differed with the neonate placed in different positions other than on the mother's abdomen during delayed cord clamping, consistency in positioning was important for comparison purposes. Therefore, any studies with different positioning or unclear positioning were excluded.

Next, the articles were sorted according to types of research: experimental, quasi-experimental, and non experimental. The studies were then reviewed for the research question content. The research was completed throughout the United States, as well as in India, Ireland, and Japan. Randomized control clinical trials, quasi experimental studies, retrospective studies, prospective studies, historical studies, observational studies, descriptive studies, and a correlational study were all used in the final 22 articles included in the appraisal of literature for the matrix (see Appendix 1).

Table 1 shows the studies that were included in the final review of literature. The matrix was used to organize the literature. Headings included on the final matrix are as follows: citation, purpose, sample, design, measurement, results, conclusions, recommendations, as well as level and quality of the research.

**Criteria for Evaluating Research Studies**

The John Hopkins Nursing Evidence Based Practice Model and Guidelines were used in the evaluation of the literature in the appraisal (Dearholt & Dang, 2012). The model used a rating scale which differentiates the strengths, weaknesses, and quality within the research articles listed as levels I through IV with quality ratings of high, good, and low. The literature appraisal in the 22 articles in the matrix used levels I through IV with quality classified at high, good, and low. Level I studies included randomized control trials, experimental studies, and systematic review of randomized control trials, with or without meta-analysis (Dearholt & Dang, 2012). Level II studies included quasi-experimental studies, systematic reviews of a combination of random controlled trials, and quasi experimental or mixed quasi experimental studies, with or without meta-analysis. In level III, there are non-experimental studies, systematic reviews of

combination randomized control trials, and mixed quasi experimental and non experimental studies, with or without meta analysis and qualitative studies. Expert opinions, nationally recognized committees, and consensus panels based on scientific evidence (which also may include clinical practice guidelines) were all included in level IV studies (Dearholt & Dang, 2012).

The quality of the level was also determined by the John Hopkins Appraisal Tool. High quality reviews included consistent results, sufficient sample size, adequate control, definite conclusions, and recommendations that were based on the literature review with reference to evidence (Dearholt & Dang, 2012). Good quality article reviews included reasonably consistent results, sufficient sample size for the sample group, fairly definitive conclusions, and reasonably consistent recommendations based on the literature review that included some reference to evidence. Lastly, low quality reviews had little evidence, inconsistent results, insufficient sample size, and conclusions that could not be deciphered.

Table 1

Quality of Evidence

| | High | Good | Low |
|---|---|---|---|
| Experimental | 10 | 3 | 1 |
| Quasi Experimental | 1 | 0 | 0 |
| Non Experimental | 4 | 2 | 1 |

## Summary

Delayed versus immediate umbilical cord clamping has been researched and practiced for many years and has yielded many articles for the review. Articles were chosen through inclusion and exclusion criteria and, in the end, 22 articles were included in the matrix. The various levels and strengths were then applied to the articles for the critical appraisal through the John Hopkins Research Appraisal Tool. Chapter three will include the literature review and analysis.

## Chapter III: Literature Review and Analysis

### Synthesis of Matrix

The matrix includes thirteen randomized control trials, three prospective case control studies, three historical studies, one descriptive study, one quasi experimental study, and one observational study. Using the John Hopkins Research Evidence Tool, the levels and quality of the literature were obtained and applied (Dearholt & Dang, 2012). The matrix includes the purpose of the study, sample, study design, measurement, results and conclusions, recommendations from the authors, and the level and quality of each piece of literature. The matrix lists the literature in the order of highest level to lowest level, organized in alphabetical order according to the author within each level. Chapter three will discuss the findings from the critical literature review.

### Synthesis of Major Findings

Within the matrix, there are 22 articles that were appraised and reviewed, 21 of which supported delayed umbilical cord clamping with positive implications on both preterm and full term infants. One article included did not support delayed umbilical cord clamping due to the severity of neonatal jaundice in infants born in Japan. Included in the synthesis are studies that focused on preterm and full term births and the implications of delayed versus immediate umbilical cord clamping. Also included are data gathered based on primary outcomes of iron stores, hemoglobin and hematocrit, and hyperbilirubinemia, which were based on the research question. Secondary outcomes reported within the matrix are incidences of postpartum hemorrhage and intraventricular hemorrhage with the use of delayed versus early umbilical cord clamping. Excluded from the review were articles that included umbilical cord milking.

**Preterm Births with Immediate Versus Delayed Umbilical Cord Clamping**

The critical literature review includes immediate versus delayed umbilical cord clamping in preterm births. Five articles are included in the review that focused on preterm births that used both early and delayed umbilical cord clamping and have results focused on the effects of iron stores, hemoglobin and hematocrit, and hyperbilirubinemia and secondary outcomes such as intraventricular hemorrhage, late onset sepsis, and necrotizing enterocolitis.

**Iron Stores**

Iron deficiency anemia has been studied and delayed cord clamping has been listed as a strategy to counteract the anemia in preterm infants (Ranjit et al., 2015). Mean serum ferritin levels were significantly higher in the delayed cord clamping groups versus the early clamped group ($p= 0.037$), in infants 30 to 36 weeks' gestation when measured at birth and then again at six weeks of life (Ranjit et al., 2015).

**Hemoglobin and Hematocrit**

Increasing the hemoglobin and hematocrit in the preterm neonate has led to a decrease in the need for post delivery blood transfusions (88.5 % in the immediate clamped group versus 38.1% in the delayed clamped group) and a more hemodynamically stable infant, as noted with post delivery higher vena cava blood flow, greater right ventricular output, and higher right ventricular stroke volumes at 48 hours, with delayed umbilical cord clamping (Chiruvolu et al., 2015; Sommers et al., 2012). Serum hematocrit levels in delayed umbilical cord clamping were significantly higher at six hours' afterbirth (>65%) versus the immediate umbilical cord clamping (<45%) with no harmful effects (Cernadas et al., 2015).

**Hyperbilirubinemia**

Ranjit et al. (2015) found that the delayed umbilical cord clamping group required longer phototherapy and had higher incidences of polycythemia resulting in hyperbilirubinemia in the preterm neonates (p= 016), whereas Nevill and Meyer (2015) proved that the need for phototherapy due to polycythemia was not significantly higher in either the delayed or early clamped group (p= 0.01). Hyperbilirubinemia requiring phototherapy occurred rarely in neonates who had delayed umbilical cord clamping; therefore, the advantages and benefits of delayed umbilical cord clamping outweighed the small occurrences of hyperbilirubinemia (Malhi, Kakar, & Jaffar, 2015).

**Intraventricular Hemorrhage, Late Onset Sepsis, and Necrotizing Enterocolitis**

Preterm infants have many health disparities to overcome and intraventricular hemorrhage, late onset sepsis, and necrotizing enterocolitis are three of the worst problems they face. Delayed cord clamping has been shown to decrease the rate of necrotizing enterocolitis on preterm infants (Chiruvolu et al., 2015; Ranjit et al., 2015) and on very preterm infants the rate of necrotizing enterocolitis was 3.2%, versus 11% in the immediate clamped group (Nevill & Meyer, 2015). Delayed cord clamping with preterm infants was also shown to have a decreased rate of intraventricular hemorrhage (Chiruvolu et al., 2015; Ranjit et al., 2015). Lastly, Ranjit et al. (2015) found that delayed cord clamping led to a decreased rate of late onset sepsis in the preterm infant.

**Full-Term Births with Immediate Versus Delayed Umbilical Cord Clamping**

Full term births with immediate umbilical cord clamping versus delayed umbilical cord clamping were also included in the critical review of literature. The articles focused on full term births that used both early and delayed umbilical cord

clamping and had results focused on the effects of iron stores, hemoglobin and hematocrit, and hyperbilirubinemia, along with secondary outcomes such as postpartum hemorrhage, neonatal distress with or without resuscitation.

**Iron Stores**

Research on delayed cord clamping indicated infants show improved ferritin levels up to the age of four months (Andersson et al., 2011) and show no significant increases at the age of twelve months when delayed cord clamping was used, compared to early umbilical cord clamping (Andersson, Domellof, Andersson, & Hellstrom-Westas, 2014). There were no significant differences in the two groups (n=100) with the serum ferritin levels at birth and at 48 hours of life (p= 0.08) in the neonates (Shirvani et al., 2010). Delayed umbilical cord clamping can increase valuable serum ferritin levels in children lasting until four to six months of age, optimizing brain development (Andersson, Domellof, Andersson, & Hellstrom-Westas, 2014).

**Hemoglobin and Hematocrit**

Serum hemoglobin and hematocrit showed significant increases at 48 hours (n=242) after birth in the delayed umbilical cord groups versus the immediate umbilical cord clamped groups (Rincon et al., 2014). Serum hematocrit was noted to be higher in the delayed clamped group within the first 72 hours of birth (p= 0.02), and this was correlated to the group that did not require as many blood transfusions in the hospital (Backes et al., 2015).

Begum, Zaman, and Khan (2012) found that the hemoglobin levels in the delayed cord clamping group at the seventh day were significantly higher than the immediate clamped group.

**Hyperbilirubinemia**

Many providers are concerned with using delayed umbilical cord clamping because they feel that the increase in red blood cells will cause polycythemia and result in hyperbilirubinemia that requires phototherapy for neonatal jaundice. Numerous studies in the critical review of literature supported the observation that there were no increases in the rate of hyperbilirubinemia requiring the necessity of phototherapy (Andersson et al., 2011; Begum et al., 2012; Cernadas et al., 2015; El-Moneim et al., 2015; Jahazi, Kordi, Mirbehbahani, & Mazloom, 2008; Mansaray, Yetman, & Berens, 2015; and Shirvani et al., 2010). When polycythemia was diagnosed in a newborn who had delayed umbilical cord clamping, no treatments were needed for hyperbilirubinemia with phototherapy (Rincon et al., 2014). Delayed cord clamping should not be done or suggested because of the increased risk of neonatal jaundice in Japan (Nakagawa et al., 2015). However, the study was of low quality and level (n=28 in phototherapy group). Increased hematocrit levels (>65%) were noted in the delayed umbilical cord clamping group with no polycythemia and no partial exchange transfusions required (Cernadas et al., 2015).

**Post-Partum Hemorrhage**

Included in the critical literature review are secondary outcomes to delayed cord clamping in reference to postpartum hemorrhage. Delayed cord clamping brought no significant differences to maternal hemorrhage (400 ml in delayed versus 350 ml in immediate) (Andersson, Hellstrom-Westas, Andersson, Clausen, & Domellof, 2013). In regard to maternal outcomes, there were no differences observed among groups that had delayed umbilical cord clamping versus immediate umbilical cord clamping with any increased postpartum blood loss, postpartum hemorrhage, retained placenta, or need for

maternal blood transfusions (Andersson et al., 2013; Begum et al., 2012; Cernadas et al., 2006).

**Summary**

The critical review of literature included 22 articles, which studied delayed versus immediate cord clamping on both preterm and full term infants. The majority of the articles included in the critical literature review were randomized control trials that were level I high quality according to the John Hopkins Appraisal Tool. Benefits of delayed umbilical cord clamping included improved iron stores that persist to six months into infancy, increased hemoglobin and hematocrit up to 72 hours of life that decreased the need for many blood transfusions, and fewer instances of increased rates of hyperbilirubinemia requiring phototherapy for jaundice. Also, in preterm infants, delaying umbilical cord clamping was proven to decrease the instances of intraventricular hemorrhage, late onset sepsis, and necrotizing enterocolitis.

Chapter four will address implications for nurse-midwifery practice, explore recommendations for future research to further study the practice question, and additional discussion of Lewin's change theory.

## Chapter Four: Discussion, Implications, and Conclusions

The purpose of this review is to reveal whether the timing of umbilical cord clamping would show differences in the newborns' iron stores, hemoglobin, hematocrit, or increased instances of hyperbilirubinemia. In this chapter, several topics will be discussed, including the literature synthesis, current trends and gaps in the literature, implications for nurse-midwifery practice, recommendations for future research, and integration and application of the theoretical framework. The information that will be discussed is based on the critical review of the studies shown in the matrix. Understanding the implications of immediate versus delayed umbilical cord clamping can better equip the nurse-midwife with the knowledge needed to implement this into practice.

### Literature Synthesis

The research question that guided this study is as follows: In newborn infants, is the timing of the umbilical cord clamping (delayed versus immediate) associated with differences in iron stores, hemoglobin, hematocrit, and hyperbilirubinemia? Through the literature synthesis, secondary outcomes were found, such as intraventricular hemorrhage, late onset sepsis, and necrotizing enterocolitis in the preterm infants and postpartum hemorrhage.

### Current Trends

**Iron stores.** Iron deficiency and iron deficiency anemia are global problems in children worldwide, especially in low resource settings (Andersson et al., 2011). Iron deficiency and iron deficiency anemia are associated with poor neurodevelopment and are associated with altered affective responding, impaired motor development, behavioral

abilities, and cognitive delays. Iron in small children, including neonates, is essential for brain growth and development. There are more than three million people in the world who are iron deficient the majority of which are women of reproductive age and children under the age of five years (Raju & Singhal, 2012). Iron deficiency and iron deficiency anemia are prevalent in both low income and middle income countries. Current treatment for iron deficiency is supplementation. This is easily available in industrialized countries but is not easily obtained in low resource or low income countries. Also, low income parents may not have the resources or available governmental assistance to appropriately treat their children who may have iron deficiency anemia. A large-scale Cochrane review by McDonald, Middleton, Dowswell, and Morris (2013) reported that iron stores seem to persist to the age of three to six months in the delayed clamping group, whereas the early clamped group was likely to be iron deficient at three to six months. Delayed cord clamping is a noninvasive and cost effective method to treat this condition and therefore should be considered as a preventive measure implemented at all births.

**Hemoglobin and hematocrit.** In both full term and preterm infants, delayed umbilical cord clamping showed a significant increase in the serum hemoglobin and hematocrit (Backes et al., 2015; Elimian et al., 2013; Nevill & Meyer 2015; Ranjit et al., 2015) without any serious medical complications observed (Ertekin et al., 2015). This increase in circulating hemoglobin, hematocrit, and blood volume was most important in instances where there was maternal hemorrhage causing neonatal hypovolemia. Neonatal hypovolemia could lead to hypovolemic shock, with subsequent ischemia and hypoxic tissue inflammation. In preterm infants, where delayed cord clamping was used, there was a decrease in the amount of blood transfusions (Nevill & Meyer, 2015). Risk with

blood transfusions, though small currently, do come with serious risk, such as transmission of infections (bacterial and viral), blood transfusion reactions, and acute volume overload. Delayed cord clamping was noted to be safe and feasible in the presence of congenital heart defects (Backes et al., 2015).

**Hyperbilirubinemia**. When delayed umbilical cord clamping was performed, there was an increase in the amount of red blood cells the newborn received via the placental transfusion. Many providers were concerned with polycythemia leading to the risk of hyperbilirubinemia and the need for phototherapy when implementing delayed versus immediate umbilical cord clamping. Although polycythemia was noted in infants that had delayed umbilical cord clamping implemented at birth, there were no significant differences in the need for phototherapy between the delayed group and the immediate clamped group (Begum, Zaman, & Khan, 2012; Cernadas et al., 2016; Ertekin et al., 2015; Jahazi, Kordi, Mirbehbahani, & Mazloom, 2008; Malhi, Kakar, & Jaffar, 2015). A large scale Cochrane review found that there was a slight increase in neonatal jaundice requiring phototherapy in the delayed clamping group (4.36%) versus the early clamped group (2.74%) and recommended delayed cord clamping as long as phototherapy was readily available (McDonald, Middleton, Dowswell, & Morris, 2013). Nakagawa et al., (2015) recommended that in low resource settings, the possible risks versus benefits of delayed umbilical cord clamping should be considered since the availability of readily accessible phototherapy may not be present; however, this study was low level and low quality. Furthermore, Nakagawa et al. (2015) concluded that there may be higher rates of neonatal jaundice requiring phototherapy in the Japanese race (10-14 mg/dl) compared to the African-American race (5-6 mg/dl) at 72-120 hours after birth, which made this

research difficult to generalize to the population as a whole. Given the fact that delayed umbilical cord clamping provided increased iron stores and increased vital red blood cells, delayed cord clamping should be implemented in all resource settings.

**Postpartum hemorrhage.** Postpartum hemorrhage is one of the most common causes of maternal deaths (World Health Organization, 2012). Because providers are aware of this, many professionals feel that by delaying umbilical cord clamping, the third stage is prolonged, resulting in hemorrhage (Buder, 2015). This has been found to be incorrect. According to McDonald et al. (2013) and WHO (2012), neither controlled cord traction nor the timing of the umbilical cord clamping have been determining factors in decreasing postpartum hemorrhage. In regard to maternal outcomes, Cernadas et al. (2006) also found that there were no differences in postpartum blood loss, postpartum hemorrhage, or maternal hematocrit levels when delayed cord clamping was implemented. Therefore, the concern over postpartum hemorrhage should not be a barrier for implementing delayed cord clamping into a provider's practice based on the current evidence.

**Intraventricular hemorrhage, late onset sepsis, and necrotizing enterocolitis.** Preterm infants can also benefit from delayed umbilical cord clamping versus early umbilical cord clamping. McAdams (2014) noted that by implementing delayed umbilical cord clamping, intraventricular hemorrhage can be decreased by 50%. By decreasing this rate by 50% annually, implementing delayed umbilical cord clamping could prevent 3,795 cases of intraventricular hemorrhages in the United States. Also, improvement in the tissue perfusion related to the increase blood volume with delayed umbilical cord clamping has been shown to decrease the amount of necrotizing

enterocolitis. Necrotizing enterocolitis is a serious condition that effects mostly premature infants. The length of stay in the neonatal intensive care unit for infants with necrotizing enterocolitis was 17 to 106 days. The estimated cost for treatment was $28,912 (hospital costs) and $6,754 (physician costs), without surgical interventions. Placental transfusion by delayed umbilical cord clamping improved the hemodynamic stability of the preterm newborn decreasing the incidences of intraventricular hemorrhage, necrotizing enterocolitis, and late onset sepsis (Chiruvolu et al., 2015; Nevill & Meyer, 2015), and should be implemented by all providers at every birth.

**Gaps in The Literature**

In the critical review of the literature, differences were noted on the length of delay for umbilical cord clamping in both preterm and full term infants. Many professional organizations offered suggestions as to the exact timing of the delay in the clamping, but those suggestions differed. In the preterm infant, many providers chose to delay the umbilical cord clamping by either 15 to 35 seconds or two to six minutes. With full term infant's delays were noted at one to five minutes, though were inconsistences noted with both preterm and full term infants. Because of the noted differences, future studies should include a definitive length of time for delayed umbilical cord clamping for both full term and preterm newborns. Further studies need to be compiled to determine if certain preexisting conditions of the mother, such as iron deficiency anemia prior to the pregnancy and iron deficiency anemia of pregnancy, impact maternal and newborn outcomes when delayed cord clamping is used. Little research has been compiled on the effects of delayed cord clamping on neonates who were born to women of different cultures, or who live in different climates or altitudes. Nakagawa et al. (2015) did note

that there were increased rates in the occurrences of jaundice in neonates born to women in Japan; therefore, more research is needed on the impact of delayed cord clamping among other ethnic groups.

**Implications for Practice**

Midwives strive to keep birth sacred and to partner with the women under their care. They are leaders in change and protect their roles as leaders in change. The care a midwife gives is cost effective, low risk, high quality, and evidenced based. Organizational change to support delayed umbilical cord clamping will require shifting the perspectives of many members of the obstetrical team. Creating an environment of physiological normalcy for the care of women that goes against the status quo is a challenge that midwives can overcome. The midwives' noninterventionist backgrounds will help create the change that is needed to implement delayed umbilical cord clamping in an organization that uses immediate umbilical cord clamping. Nurse-midwives have a duty to act in the best interest of the women and children they care for through evidenced based practices that include the benefits and healthful outcomes of delayed umbilical cord clamping.

**Recommendations for Future Research**

Future research is necessary on delayed versus early umbilical cord clamping and its implications on the newborn. In preterm infants, when delayed cord clamping has occurred, more studies are needed on longer duration in clamping (i.e., until the cease of pulsations) and its effects. Also, larger studies are needed to follow up on neurodevelopmental outcomes in preterm infants with delayed cord clamping

implementation (Chiruvolu et al., 2015). Current research only includes neurodevelopmental outcomes of term newborns.

When a depressed infant is delivered, most providers immediately clamp and cut the umbilical cord and initiate neonatal resuscitation or have a team available to do so. Cutting the cord cuts of valuable oxygen that the depressed newborn needs. If the cord were to remain intact, the depressed newborn would continue to receive oxygenated blood. More research is needed on transition to spontaneous respirations of preterm neonates with an intact umbilical cord.

In term infants, future research in delayed cord clamping versus early umbilical clamping is also necessary. Children in the studies included in the critical literature review were at the ages of four months, twelve months, and four years (Andersson et al., 2011; Andersson et al., 2014; Andersson et al., 2015). Future studies should research development in later ages and assess long term effects of delayed cord clamping on iron status in areas that have high and low resources (Andersson et al., 2015).

Lastly, fetal blood contains large numbers of activated hematopoietic stem cells which play a role in organ development of the central nervous system, respiratory cardiovascular, hematologic, immunologic, and endocrine systems (Mercer et al., 2016). Stem cells are also known for treating a variety of hemoglobinopathies, metabolic and hematologic disorders, immune deficiencies, and cancers. Longitudinal studies should be compiled on cancer rates in children who had delayed umbilical cord clamping versus children who had immediate cord clamping.

**Integration and Application of Theoretical Framework**

Change is difficult and painful for many people and also within many organizations. The majority of providers in obstetrics desire to do what is best for their patients. Sometimes complacency interferes with doing the right thing. The old way of doing things is easy and requires no new learned information or interventions. Continuing to learn and care for patients with evidenced-based practices always benefits women and children. In the theory developed by Lewin (1947) on change, he noted that to facilitate change, a change agent is needed to serve as the organizer to create and monitor the exerted effort. The change agent can be one member of the organization that ensures the change is implemented and becomes best practice within the organization. With organizations that do not practice delayed umbilical cord clamping, initiation of evidenced based information will be required to achieve buy in from the personnel. There are many different members of the birth team who will need education, such as nurses, nurse-midwives, obstetricians, gynecologists, and pediatricians. The patient is also an integral member of the team, and throughout her pregnancy she is most often involved in the education relating to benefits of delayed cord clamping.

Implementation of this change in practice can be done utilizing Lewin's three-step change theory (Mercer et al., 2016). Unfreezing the status quo is in the first step. During this time, the organizer must initiate the initial push for a change in practice from early umbilical cord clamping to delayed cord clamping. Understanding the benefits, education can be disbursed to the providers. In this step, the organizer can expect to have small setbacks, such as negative comments or refusal to buy in. The organizer can enlist the help of other leaders to distribute and discuss evidenced based information and the positive benefits of delayed versus early umbilical cord clamping on the newborn infants

(Mercer et al., 2016). At the end of step one, the organizer will need the support of the chief of obstetrics to begin implementing a proposal for the adoption of delayed umbilical cord clamping for both term and preterm infants as a best practice policy.

The second step in Lewin's change theory is change adoption and adaptation to delayed cord clamping in all births. Through this phase, the organizer must introduce the practice and monitor its progress. Also during this time, a new policy for delayed umbilical cord clamping should be reviewed with all stakeholders to determine any true contraindications to this practice.

The third and final step includes refreezing the practice of delayed umbilical cord clamping for all births as a standard practice with all providers within the organization (Mercer et al., 2016). During this step, acceptance and use of the new policy must be integrated into the new culture of the organization such that it becomes the best practice of the providers. This begins the new status quo of the organization with regard to delaying umbilical cord clamping for all births.

**Conclusion**

The decision to delay umbilical cord clamping or implement early umbilical cord clamping lies in the hands of the nurse-midwife or other providers. The value of this critical literature review lies in the information that showed great benefits to delayed umbilical cord clamping versus early umbilical cord clamping, such as increased iron stores (often lasting to late in infancy), and increased hemoglobin and hematocrit (leading to an increased blood volume with no maternal suboptimal outcomes). In reference to hyperbilirubinemia and polycythemia causing neonatal jaundice, the review found little to no significant cases, but the review revealed that readily accessible phototherapy is

warranted. In preterm infants, this critical review of literature also found that delayed versus early umbilical cord clamping showed a decrease in the need for blood transfusions and in the occurrence of intraventricular hemorrhage, late onset sepsis, and necrotizing enterocolitis.

Failure to adopt easy and beneficial evidenced based practices does not allow all newborns to reap the many benefits of delayed umbilical cord clamping. Delayed cord clamping does not impose any financial burden to either the nurse-midwife or to the parents of the newborn. Change in practice is often difficult as providers will have to shift their own perspectives. Delaying the clamping of the umbilical cord using evidenced based information should be implemented into best practices for all providers.

| Citation | Purpose | Sample | Design | Measurement | Results/Conclusions | Recommendations | Level & Quality |
|---|---|---|---|---|---|---|---|
| Andersson, O., Westas-Hellstrom, L., Andersson, D., & Domellof, M. (2011). Effect of delayed vs. early umbilical cord clamping on neonatal outcomes and iron status at 4 months: A randomized controlled trial. *British Medical Journal , 343*, 1-12. doi:10.1136/bmj.d7157 | Delayed cord clamping was compared to early cord clamping with regard to iron statuses at 4 months of age in a European hospital. | 382 newborn full term infants born to mothers who had a low risk pregnancy were randomized into delayed cord clamping (> or equal to 180 seconds) and early cord clamping (< or equal to 10 seconds) after the delivery (Andersson, Westas-Hellstrom, Andersson, & Domellof, 2011). | Randomized controlled trial | Venous and arterial blood samples were drawn on the sample newborns to assess acid base status at 30 seconds from unclamping the cord in the delayed group and 10 minutes with the early group. At 4 months, venous samples were then reevaluated. | Delayed cord clamping resulted in improved ferritin levels and reduced levels of iron deficiencies at 4 months, and there were no incidences of respiratory difficulties, polycythemia, or hyperbilirubinemia that required phototherapy. | Further research: Examine the long-term outcomes of delayed versus early cord clamping. | Level I, High Quality |

| Citation | Purpose | Sample | Design | Measurement | Results/Conclusions | Recommendations | Level & Quality |
|---|---|---|---|---|---|---|---|
| Andersson, O., Domellof, M., Andersson, D., & Hellstrom-Westas, L. (2014). Effect of delayed vs early umbilical cord clamping on iron status and neurodevelopment at age 12 months: A randomized clinical trial. *JAMA, 160*(6), 547-554. doi:10.1001/jamapediatrics.2013.4639 | The purpose of the study was to research the effects of delayed cord clamping and early clamping on an infant's iron status and neurodevelopment at age 12 months. | 382 full-term infants with delayed cord clamping (>180 seconds after delivery) and early cord clamping (<10 seconds after delivery). | Randomized controlled trial | Follow up evaluations at 12 months of ferritin level, transferrin saturation, transferrin receptor level, reticulocyte hemoglobin level, and mean cell volume with a parental assessment of neurodevelopment by the Ages and Stages Questionnaire. | **Results** The delayed cord clamping group did not show a significant difference in the iron status or neurodevelopment at age 12 months. In both outcomes boys scored lower results. **Conclusions** Delayed cord clamping did not change the results of iron stores or neurodevelopment at 12 months. One's sex may influence the effects on an infant's development after delayed cord clamping. | Further research should be on the neurodevelopment at later ages and on the effects of delayed cord clamping on iron status and neurodevelopment in areas with higher rates of iron deficiency and anemia. | Level I, High Quality |

| Citation | Purpose | Sample | Design | Measurement | Results/Conclusions | Recommendations | Level & Quality |
|---|---|---|---|---|---|---|---|
| Andersson , O., Lindquist, B., Lindgren, M., Stjernqvist, K., Domellof, M., & Hellstrom-Westas, L. (2015). Effect of delayed cord clamping on neurodevelopment at 4 years of age: A randomized clinical trial. *JAMA Pediatrics, 169*(7), 631-638. doi: 10.1001/jamapediatrics.2015.0358 | The purpose of the study was to investigate the effects of delayed cord clamping with neurodevelopment at 4 years of age. | 382 full-term infants with delayed cord clamping (>180 seconds after delivery) and early cord clamping (<10 seconds after delivery). 263 children at the 4-year mark. | Randomized controlled trial | Parents of the selected groups were contacted 4 years after original study and were asked to record their child's development using the Ages and Stages Questionnaire and behavior using the Strengths and Difficulties Questionnaire. | Both delayed and early clamping improved the children's scores in fine motor and social domain at 4 years of age. | Future research should look at studying development at later ages and assess long-term effects of delayed cord clamping on iron status in areas that have a higher rate of iron deficiency and anemia. | Level I, High Quality |

| Citation | Purpose | Sample | Design | Measurement | Results/Conclusions | Recommendations | Level & Quality |
|---|---|---|---|---|---|---|---|
| Andersson, O., Hellstrom-Westas, L., Andersson, D., Clausen, J., & Domellof, M. (2013). Effects of delayed compared with early umbilical cord clamping on maternal postpartum hemorrhage and cord gas sampling: A randomized trial. *Obstetricia Et Gynecologica, 92,* 567-574. doi:10.1111/j.1600-0412.2012.01530.x | The purpose of the study was to investigate the effects of delayed cord clamping compared to early cord clamping on postpartum hemorrhage and umbilical cord blood sampling. | 382 term deliveries that were low risk were randomized to a delayed cord clamp group (>180 seconds, n=193) or early cord clamping group (<10 seconds, n=189). | Randomized control trial | After the birth, the midwives estimated the blood loss in both the delayed cord clamping group and the early cord clamping group. | Results: The incidence of postpartum hemorrhage between both groups was small to non-significant. Conclusions: No significant effect on maternal postpartum hemorrhage was seen with regard to delayed cord clamping versus early cord clamping. | Future meta-analysis may be beneficial looking at postpartum hemorrhage. | Level I, High Quality |

| Citation | Purpose | Sample | Design | Measurement | Results/Conclusions | Recommendations | Level & Quality |
|---|---|---|---|---|---|---|---|
| Backes, C., Huang, H., Cua, C., Garg, V., Smith, C., Yin, H., . . . Hoffman, T. (2015). Early versus delayed cord clamping in infants with congenital heart disease: A pilot, randomized, controlled trial. *Journal of Perinatology, 35*(10), 826-831. doi:10.1038/jp.2015.89 | The purpose of the study was to establish safety and feasibility with delayed cord clamping in neonates with congenital heart disease. | 188 mother / infant pairs >37 weeks' gestation were included in the randomized study. | Randomized controlled trial | Women included in the study were enrolled in the delayed and early cord clamping groups randomly. In the early cord clamping group, the obstetrician clamped the umbilical cord immediately following the birth (<10 seconds) and in the delayed cord clamping group the obstetrician clamped the cord 110-130 seconds after the birth of the infant. At 72 hours of birth, a hematocrit was obtained on both groups. | **Results**<br>A higher peak serum bilirubin trend was noted with the delayed versus the early cord clamping group. Similar bilirubin serum trends were noted later in both groups. Hematocrit levels were higher in the delayed cord clamping group versus the early clamped group within the first 72 hours of life. The proportion of infants who did not receive blood transfusions in the hospital were included in the delayed cord clamping group compared to the early clamped group.<br><br>**Conclusion**<br>Delayed cord clamping with infants born with congenital heart disease is both safe and feasible. Infants with delayed cord clamping were exposed to fewer blood transfusions. | Further research should include consideration of maternal outcomes (hemorrhage) with delayed versus early cord clamping. | Level I, High Quality |

| Citation | Purpose | Sample | Design | Measurement | Results/Conclusions | Recommendations | Level & Quality |
|---|---|---|---|---|---|---|---|
| Begum, F., Zaman, T., & Khan, R. (2012). Effcet of early and delayed umbilical cord clamping of term infants on mothers and neonates. *International Journal of Gynecology & Obstetrics, 119,* 295. doi: 10.1016/S0020-7292(12)60527-X | The purpose of the study was to compare maternal and neonatal effects of early (within 1 minute) and delayed cord clamping (2 minutes after delivery) in term infants (Begum, Zaman, & Khan, 2012). | 200 infants were randomly grouped into the early clamped and delayed clamped groups. | Randomized controlled trial | Group one was clamped and cut within one minute. Group two infants were immediately dried and wrapped and handed to the mother to initiate breastfeeding with the cord being cut at two minutes. The mothers were asked to return in seven days to obtain hemoglobin and ferritin levels. The results were then compared in the two groups. Secondary outcomes were occurrences of postpartum hemorrhage, retained placenta, need for maternal blood transfusions, clinical jaundice, and need for phototherapy. | **Results** In the delayed cord clamping group, the newborns' hemoglobin and ferritin levels at the seventh day were significantly higher. No significant differences were found in both groups with postpartum hemorrhage, retained placenta, need for maternal blood transfusions, clinical jaundice, or need for phototherapy. **Conclusions** Delayed cord clamping may be beneficial to areas that have increased incidences of anemia, such as in Bangladesh or other developing countries. | No recommendations were given. | Level I, High Quality |

| Citation | Purpose | Sample | Design | Measurement | Results/Conclusions | Recommendations | Level & Quality |
|---|---|---|---|---|---|---|---|
| Cernadas, J., Carroli, G., Pellegrini, L., Otano, L., Ferreira, M., Ricci, C., et al. (2015). The effect of timing of cord clamping on neonatal venous hematocrit values and clinical outcome at term: A randomized, controlled trial. *Pediatrics, 117* (4), 779-785. doi:10.1542/peds.2005-1156 | The purpose of the study was to determine if in healthy newborns delayed cord blood clamping would increase hematocrit levels with no undue physiological harmful effects. | 276 newborns born (recruited in pregnancy) assigned to 3 groups:<br>1.Early cord clamping<br>2.Delayed 1 minute<br>3.Delayed 3 minutes | Randomized controlled study | The three groups were clamped at different interval times; then venous samples were obtained (for hematocrit values) from the newborns at 6 hours of birth. Secondary measurements were to draw venous samples from the newborn at 24 & 48 hours of life to evaluate hematocrit and bilirubin levels. | No physiological adverse effects were noted with delayed cord blood clamping in the sample and a decrease in neonatal anemia was noted. | More follow up controlled studies are needed focusing on the relationship between delayed cord clamping and the presence of anemia and iron levels in infants. | Level I, High Quality |

| Citation | Purpose | Sample | Design | Measurement | Results/Conclusions | Recommendations | Level & Quality |
|---|---|---|---|---|---|---|---|
| Elimian, A., Goodman, J., Escobedo, M., Nightingale, L., Knudtson, E., & Williams, M. (2013). A randomized controlled trial of immediate versus delayed cord clamping in the preterm neonate. *American Journal Of Obstetrics & Gynecology, 124*, 1075-1079. Retrieved from http://dx.doi.org/10.1016/j.ajog.2012.10.209 | The purpose of the study was to determine short term effects of delayed cord clamping in preterm infants. | 200 preterm infants were randomized (24-34 weeks). 99 were assigned to the delayed group (30-35 seconds) and 101 were assigned to the early group (5 seconds). | Randomized control study | The two groups were compared for various outcomes including initial hematocrit, need for blood transfusion, number and volume of blood transfusions, respiratory distress, intraventricular hemorrhage, necrotizing enterocolitis, and neonatal mortality. | **Results** The initial hemoglobin and hematocrit were significantly higher in the delayed group versus the early clamped group. **Conclusion** Delayed cord clamping (30 seconds) in the preterm infant increases the initial hemoglobin/hematocrit. No decrease in adverse perinatal outcomes were noted. | Studies in which an increased duration of delay in clamping the cord is needed. | Level I, High Quality |

| Citation | Purpose | Sample | Design | Measurement | Results/Conclusions | Recommendations | Level & Quality |
|---|---|---|---|---|---|---|---|
| Ertekin, A., Ozdemir, N., Sahinoglu, Z., Gursoy, T., Erbil, N., & Kaya, E. (2015). Term babies with delayed cord clamping: An approach in preventing anemia. *The Journal of Maternal-Fetal and Neonatal Medicine*, 1-4. doi:10.3109/1467058.2015.1105951 | The purpose of the study was to analyze the effects of delayed and early cord clamping and its hematological status on the neonate. | 150 neonates were included in the study. Two groups were formed. Group one was the early clamping (30 seconds) and group two was delayed (90-120 seconds). | Prospective case control study | After the birth, blood was drawn (venous) on both groups analyzing hemoglobin, hematocrit, ferritin and iron.<br>Two months after the births, the same serum samples were drawn in both groups. | Delayed cord clamping in term babies had no effect on hematologic status at birth; improved hemoglobin, hematocrit and iron levels at second month without serious complications (Ertekin, Ozdemire, Sahinglu, Gursoy, Erbil, & Kaya, 2015)<br>There was a small increase in phototherapy use in the delayed clamping group | The authors recommend long-term follow up to evaluate the effects of higher iron levels on the neurocognitive outcomes. | Level I, High Quality |

| Citation | Purpose | Sample | Design | Measurement | Results/Conclusions | Recommendations | Level & Quality |
|---|---|---|---|---|---|---|---|
| Jahazi, A., Kordi, M., Mirbehbahani, N., & Mazloom, S. (2008). The effect of early and late umbilical cord clamping on neonatal hematocrit. *Journal of Perinatology, 28*, 523-525. doi:0.1038/jp.2008.55 | The purpose of the study was to compare the effect of early and delayed cord clamping on the newborn's hematocrit at 2 hours and at 18 hours after the birth (Jahazi, Kordi, Mirbehbahani, & Mazloom, 2008). | 64 healthy term vaginally born neonates were broken into groups of early and delayed cord clamping. | Randomized control trial | One group was early cord clamping (30 seconds) and delayed clamping (3 minutes). Prior to clamping the cord in both groups, the newborns were held supine at the level of the introitus. The newborn's venous hemoglobin and hematocrit was evaluated at 2 hours after birth and 18 hours after birth in both groups. | **Result** The hematocrit in both groups in the interval times were not significantly different, nor was polycythemia was noticed. There was an increase in the estimated neonatal blood volume in the delayed cord clamping group. **Conclusion** Delayed cord clamping does not lead to an increase in the neonate's hematocrit or raises the chance for polycythemia. | More trials are needed to evaluate more positions the neonate is held in after the birth to determine if this would result in more significant results and a longer time of delaying the cord clamping (Jahazi, Kordi, Mirbehbahani, & Mazloom, 2008). | Level I, High Quality |

| Citation | Purpose | Sample | Design | Measurement | Results/Conclusions | Recommendations | Level & Quality |
|---|---|---|---|---|---|---|---|
| Ranjit, T., Nesargi, S., Rao, S., Sahoo, J., Ashok, C., Chandrakala, B., & Bhat, S. (2015). Effect of early versus delayed cord clamping on hematological status of preterm infants at 6 weeks of age. *Indian Journal Of Pediatrics, 82*(1), 29-34. doi:10.1007/s12098-013-1329-8 | The purpose of the study was to compare the effect of early cord clamping versus delayed cord clamping on hematocrit and serum ferritin at 6 weeks of life in preterm infants (Ranjit, et al., 2015). | 100 preterm infants 30 0/7-36 6/7 weeks were included in the study and placed into groups of delayed and early umbilical cord clamping. | Randomized study | The umbilical cord in the early group was clamped immediately after the birth whereas in the delayed group the cord was clamped beyond 2 minutes after the birth. At the 6 weeks follow up appointment serum ferritin levels and hematocrit levels were obtained in both groups and compared. | **Results** The mean serum hematocrit and serum ferratin levels were significantly higher in the delayed cord clamping groups versus the early cord clamped group. The delayed group required longer phototherapy and had higher rates of polycythemia than the early cord clamped group. **Conclusions** Delayed cord clamping at 2 minutes has shown to improve the hematocrit levels at birth and continued until 2 months of age. | Larger studies are needed to follow up on neurodevelopmental outcomes with delayed cord clamping. | Level I, high Quality |

| Citation | Purpose | Sample | Design | Measurement | Results/Conclusions | Recommendations | Level & Quality |
|---|---|---|---|---|---|---|---|
| EL-Moneim, A., Fawzy, A., Moustafa, A., Kassar, Y., Swelem, M., El-Agwany, A., et al. (2015). Early versus delaye cord clamping of term births in shatby maternity university hospital. *Progresos de Obstetricia Y Ginecologi , 58* (9), 389-392. doi:10.1016/j.pog.2015.05.001 | The purpose of the study was to compare the potential benefits and harms of early cord clamping versus delayed cord clamping assessing Apgar score, hemoglobin, random blood sugar, O2 saturation by pulse oximetry, and bilirubin (EL-Moneim, et al., 2015) | 100 term pregnant women at Shatby Maternity Hospital admitted in labor were included in the study. They were assigned to groups (50 each) of early cord clamping and delayed cord clamping (until the cord ceased pulsation). | Randomized study | After the births of the two groups of newborns, Apgar scores were assigned, hemoglobin levels and random blood sugars were analyzed, and $O_2$ saturations were obtained by a pulse oximeter (no timing was noted on the serum draws). Three days after the birth, bilirubin levels were assessed at the follow up in the pediatrician's office. | In the study, the hemoglobin, Apgar score, and the blood sugar did not differ from one group to the other. The study did show an increase or improvement in the $O_2$ saturation between the two groups when there was delayed cord clamping. In regard to the bilirubin levels, no significant findings toward causation of neonatal jaundice was noticed. | Delayed cord blood clamping is noted to be safe and should be implemented in labor management (EL-Moneim, et al., 2015). | Level I, Good Quality |

| Citation | Purpose | Sample | Design | Measurement | Results/Conclusions | Recommendations | Level & Quality |
|---|---|---|---|---|---|---|---|
| Malhi, K., Kakar, F., & Jaffar, M. (2015). Early versus late clamping of the umbilical cord in full-term neonates. *Pakistan Journal of Medical & Health Sciences, 9*(3), 1083-1085. Retrieved from www.sciencedirect.com/science/article/pii/S1695540330570134X | The purpose of the study was to compare benefits and harms of early versus late cord clamping in term infants. | 100 infants were selected and placed into two groups, which were a delayed cord clamping group and an early cord clamping group. | Randomized control trial | After the birth, serum samples were obtained from both groups to compare hematocrit levels. | **Results**<br>In both groups hematocrit levels were recorded. In the early cord clamping group hematocrit levels were 46.88% compared to the delayed group which were 53.42%.<br>**Conclusions**<br>The benefits of delayed cord clamping outweigh the rare occurrence of jaundice and the need for phototherapy. | No recommendations were given by the authors. | Level I, Good Quality |

| Citation | Purpose | Sample | Design | Measurement | Results/Conclusions | Recommendations | Level & Quality |
|---|---|---|---|---|---|---|---|
| Mansaray, A., Yetman, R., & Berens, P. (2015). Effect of delayed cord clamping above versus below the perineum on neonatal hematocrit: A randomized control trial. *Breastfeeding Medicine, 10* (10), 464-467. doi: 10.1089/bfm.2015.0109 | The purpose of the study was to see if there was a difference in neonatal hematocrit at 24 hours of life in full term infants who had delayed cord clamping above versus below the perineum. | 53 patients completed the study who were >37 weeks' gestation. 27 were assigned to the delayed cord clamping group positioned above the perineum and another group with 26 positioned below the perineum. | Randomized control trial | Group A was delivered and placed on the mother's abdomen, the cord was clamped 60-75 seconds after delivery. In the second group, the infant was delivered, held below the perineum (at least 10 cm below the mother's perineum), and the cord was clamped after 60-75 seconds after birth. Blood samples to assess the hematocrit were obtained at the routine newborn's screening via a heel-stick and at 24 hours of life. Secondary objectives were to determine the need for NICU admission, blood transfusion, and phototherapy. | **Results** The above the perineum group had a mean hematocrit of 52.7% and the below the perineum group had a mean hematocrit of 55.8%. The two were not significant. Also, no significance was shown with the secondary objectives. **Conclusions** When comparing the 2 groups and the results, there are no significant differences in the above and below groups. | Further studies should be conducted with preterm infants. | Level I, Low Quality |

| Citation | Purpose | Sample | Design | Measurement | Results/Conclusions | Recommendations | Level & Quality |
|---|---|---|---|---|---|---|---|
| Blouin, B., Penny, M., Casapia, M., Aguilar, E., Silva, H., Creed-Kanashiro, H., . . . Maheu-Giroux, M. (2013). Timing of umbilical cord-clamping and infant anaemia: The role of maternal anaemia. *Pediatrics and International Child Health, 33*(2), 79-85. doi:10.1179/2046905512Y.0000000036 | The purpose of the study was to determine the effect of maternal anemia at delivery and the association between the timing of umbilical cord clamping and infant anemia at 4 to 8 months of age. | A group of pregnant women (n=224) were recruited for the study where all subjects had delayed cord clamping. | Quasi-experimental study | Maternal hemoglobin levels were obtained prior to delivery, and the time between delivery and cord clamping was obtained and recorded. The mother and infant pairs were followed up on at 4 and 8 months where new samples were drawn and analyzed. | Delayed cord clamping had a greater effect on infants born to anemic versus non-anemic mothers (Blouin, et al., 2013). | Future studies should include the effects of delayed cord clamping on jaundice and polycythemia. | Level II, High Quality |

| Citation | Purpose | Sample | Design | Measurement | Results/Conclusions | Recommendations | Level & Quality |
|---|---|---|---|---|---|---|---|
| Chiruvolu, A., Tolia, V., Qin, H., Stone, G., Rich, D., Conant, R., et al. (2015). Effect of delayed cord clamping on very preterm infants. *American Journal Of Obstetrics & Gynecology, 213*, 676-681. Retrieved from http://dx.org/10.1016/j.ajog.2015.07.016 | The objective of the study was to determine if a departmental protocol (delayed cord clamping in their institution with very preterm infants) would reduce the incidence of intraventricular hemorrhage. | Sample size for retrospective study was 88 infants and 60 in the prospective study. All infants included were >32 weeks' gestation. | Retrospective study and prospective study | Delayed cord clamping was done (45 seconds) to the groups. Neonatal process and their outcomes were documented until discharge. In the historical group, infants born had immediate cord clamping done. Data between both groups were compared. | **Results**<br>There were no differences found between both groups on Apgar scores or admission temperature. A smaller number of infants in the delayed group were intubated in the delivery room, had respiratory distress, received a blood transfusion in the first week of life compared to the historical group. A large reduction was noted in the incidence in intraventricular hemorrhage compared to the historical group.<br>**Conclusion**<br>Delayed cord clamping was associated with a decrease in intraventricular hemorrhage and early blood transfusions. Delayed cord clamping in very early infants has been proven to be safe, feasible, and effective with no adverse outcomes (Chiruvolu, et al., 2015). | Further research is needed for the technique and timing of delayed cord clamping on long-term neurodevelopmental outcomes in very early preterm neonates. | Level III, High Quality |

| Citation | Purpose | Sample | Design | Measurement | Results/Conclusions | Recommendations | Level & Quality |
|---|---|---|---|---|---|---|---|
| Gyorkos, T., Maheu-Giroux, M., Blouin, B., Creed-Kanashiro, H., Casapia, M., Aguilar, E., et al. (2012). A hospital policy change toward delayed cord clamping is effective in improving hemoglobin levels and anemia status of 8-month-old Peruvian infants. *Journal Of Tropical Pediatrics, 58* (6), 435-440. doi:10.1093/tropej/fms012 | The objective of the study was to assess the effectiveness of an institutional policy change of delayed cord clamping versus early cord clamping on hemoglobin levels and anemia at 4 and 8 months of age. | 224 mother and infant pairs (pre-intervention and post-intervention group) | Historical study | Two groups were created (cord clamping at 57 seconds and 170 seconds). The first group was implemented and tested with both delayed cord clamping and early cord clamping prior to the hospital policy change. The second group was tested after the policy change for both delayed cord clamping and early cord clamping. At ages of 4 and 8 months of age hemoglobin levels were taken. | **Results**<br>With the pre-intervention at the 4 month and 8 month follow up there were similar findings of anemia noted. In the post intervention group at 4 months there were no changes in the prevalence of neonatal anemia. In the 8 month post intervention group higher levels of hemoglobin and lower anemia was noted.<br>**Conclusions**<br>With the post-intervention group at 8 months increasing their hemoglobin levels, the hospital policy change can improve hemoglobin levels and lower anemia. | Further research should be done on the benefits of delayed cord clamping that extend into infancy and early childhood. | Level III, High Quality |

| Citation | Purpose | Sample | Design | Measurement | Results/Conclusions | Recommendations | Level & Quality |
|---|---|---|---|---|---|---|---|
| Nevill, E., & Meyer, M. (2015). Effect of delayed cord clamping (dcc) on breathing and transition at birth on very preterm infants. *Early Human Development,* 91, 407-411. Retrieved from http://dx.doi.org/10.1016/j.earlhumdev.2015.04.013 | The purpose of the study was to review the effects of delayed cord clamping on very preterm infants (condition and breathing effort, resuscitation measures, and their neonatal outcomes). | 124 infants (≤ 20 weeks' gestation) were included in the study. Two groups were formed. Group one (n=62) had delayed cord clamping and group two (n=62) had immediate cord clamping. | Historical study | A chart audit was done viewing historical data. Two groups were created. Group one (n=62) had delayed cord clamping of 40-60 seconds on infants born in group one and immediate cord clamping (n=62) with group two. On day one both groups were reevaluated. | **Results**<br>No significant Apgar scores were noted between the two groups, admission temperatures were no different, the need for phototherapy was not significantly higher in either group, and day one hemoglobin levels were significantly higher in the delayed group.<br>**Conclusions**<br>Delayed cord clamping in very preterm infants is well tolerated (Nevill & Meyer, 2015). | Further research is needed for infants who did not spontaneously breathe during transition and received delayed cord clamping. | Level III, High Quality |

| Citation | Purpose | Sample | Design | Measurement | Results/Conclusions | Recommendations | Level & Quality |
|---|---|---|---|---|---|---|---|
| Rincon, D., Foguet, A., Rojas, M., Segarra, E., Sacristan, E., Teixidor, R., et al. (2014). Time of cord clamping and neonatal complications, a prospective study. *Anales Pediatria, 81*(3), 142-148. Retrieved from http://dx.doi.org/10.1016/j.anpedi.2013.10.051 | The study assessed the effects of early or late cord clamping in term infants and the effects on hemoglobin, hematocrit, and ferritin (Rincon, et al., 2014). | 242 women and their newborn term babies | A descriptive correlational study | Hemoglobin, hematocrit, and ferritin was drawn at 48 hours of birth on the three groups. Group one was clamped early (<60 seconds), group two was intermediately clamped (1 to <2 minutes), and group three was clamped late (2-3 minutes). | **Results**<br>With regards to delayed cord clamping, first group (first test) showed a large increase in the ferratin levels. In the second testing the hemoglobin, hematocrit, and ferratin was significantly higher. In the third group, there was an increased number of newborns with polycythemia.<br>**Conclusions**<br>Late cord clamping has been proven to increase hemoglobin, hematocrit, and ferratin at 48 hours of life. Also, there was an increased number of cases of polycythemia noted. | Clear and safe protocols are needed to establish umbilical cord clamping which takes into consideration any special circumstances. | Level III, High Quality |

| Citation | Purpose | Sample | Design | Measurement | Results/Conclusions | Recommendations | Level & Quality |
|---|---|---|---|---|---|---|---|
| Shirvani, F., Radfar, M., Hashemieh, M., Soltanzadeh, M., Khaledi, H., & Mogadam, M. (2010). Effect of timing of umbilical cord clamp on neborns' iron status and its relation to delivery type. *Archives of Iranian Medicine, 13*(5), 420-425. doi:010135/AIM.0010 | The purpose of the study was to determine the hematological effects on delayed versus early cord clamping in the newborn in term infants delivered and at 48 hours of life (Shirvani, et al., 2010). | 100 newborns were selected | Observational cohort study | Two groups were assigned to the sample. Group one was early at < or = to 15 seconds (n=30) and the second group was late cord clamping > 15 seconds (n=70). Serum hemoglobin, hematocrit, and ferritin levels were obtained from the newborns at the time of birth and also 48 hours after. | **Results:** There was an increase in the hemoglobin and hematocrit (at 48 hrs) in the newborns tested in the late cord clamping group compared to the early group. There were no significant differences in the serum ferritin levels in both groups. Vaginally delivered infants had significantly more delayed cord clamp time. (Shirvani, Radfar, Hashemieh, Soltanzdeh, Khaledi, & Mogadam, 2010) **Conclusions:** Delayed cord clamping increases red cell mass in the newborns in the study and has no differences in the serum ferritin levels. | No recommendations were given by the authors. | Level III, Good Quality |

| Citation | Purpose | Sample | Design | Measurement | Results/Conclusions | Recommendations | Level & Quality |
|---|---|---|---|---|---|---|---|
| Sommers, R., Stonestreet, B., Oh, W., Laptook, A., Yanowitz, T., Ranker, C., et al. (2012). Hemodynamic effects of delayed cord blood clamping in premature infants. *Pediatrics, 129* (3), 667-672. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3356138/ | The purpose of the study was to compare the hemodynamic differences between premature infants in a study using delayed cord clamping or immediate cord clamping (Sommers, et al., 2012). | 51 newborns were included in the study gestational ages of 24-31+6 weeks. | A prospective, descriptive study | 2 groups were created. One group (n=25) was included in the delayed cord clamping group and another group (n=26) was included in the immediate cord clamping group. Serial Doppler studies were performed on the infants in the study at 6, 24, 48, and 108 hours after birth. Measurements included: superior vena cava blood flow, right ventricle output, middle cerebral artery blood flow velocity, superior mesenteric artery blood flow velocity, left ventricle shortening fraction, and presence of a persistent ductus arteriosus (Sommers, et al., 2012). | The results demonstrated significantly higher superior vena cava blood flow, greater right ventricle output and right ventricular stroke volumes at 48 hours with delayed cord clamping with no differences in middle cerebral artery blood flow velocity, mean superior mesenteric artery blood flow velocity, shortening fraction and/or the incidence of a persistent ductus arteriosus | The author did not give any recommendations. | Level III, Good Quality |

| Citation | Purpose | Sample | Design | Measurement | Results/Conclusions | Recommendations | Level & Quality |
|---|---|---|---|---|---|---|---|
| Nakagawa, M., Ishida, Y., Nagaoki, Y., Ohta, H., Shimabukuro, R., Hirata, M., . . . Kusakawa, I. (2015). Correlation between umbilical cord hemoglobin and rate of jaundice requiring phototherapy in healthy newborns. *Pediatrics International, 57,* 626-628. doi:10.1111/ped.12583 | The purpose was to study the relationship between umbilical cord hemoglobin and the rate of jaundice requiring phototherapy (Nakagawa, et al., 2015). | 896 infants were included (28 in the phototherapy group and 868 in the control group). | Qualitative historical study | Infants included in the study had cord hemoglobin drawn and the rate of infants who required phototherapy was obtained from medical records. | **Results**<br>When looking at the infants who received phototherapy and had high hemoglobin levels, most received delayed cord clamping.<br>**Conclusions**<br>The severity of neonatal jaundice differs with race. Since increased hemoglobin levels may cause an increase in neonatal jaundice in newborns in Japan, delayed cord clamping is not suggested. | The author did not give any recommendations. | Level III, Low Quality |

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