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Delayed Cord Clamping Impact on Transitional Outcomes of the Newborn

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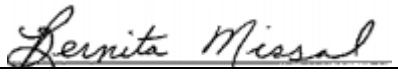
Project Advisor Signature:	
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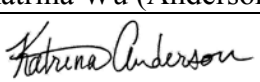
Second Reader Signature:	
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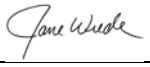
Director of Graduate Nursing Program Signature:	

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Abstract

Background: Currently in the United States, after a baby is born, the umbilical cord is immediately clamped; this is a routine obstetric procedure despite lack of evidence supporting this practice (Elchenbaum-Pikser, 2009). The practice of cord clamping varies with each provider from immediate cord clamping, to delayed cord clamping (which can vary from 1 to 5 minutes) to cord clamping after pulsation of the cord ceases. The procedure of cord clamping is a practice choice made by each medical provider and is based largely on personal preference, not evidence.

Purpose: The purpose of this review and synthesis of literature is to examine studies focused on the impact of delayed cord clamping versus immediate cord clamping, both with full-term and preterm infants: *Does delayed cord clamping impact transitional outcomes of the newborn?*

Results: While utilizing Imogene King's Theory on Goal Attainment, twenty articles were found for appraisal and review using the John Hopkins Research Evidence Appraisal Tool. The key findings of the appraised research include the following: benefits of delayed cord clamping, effects of delayed cord clamping on third stage of labor, and practice differences.

Conclusion: Delayed cord clamping requires only a small change in practice and is free while offering significant benefits to the newborn and maternal outcomes. Nurse-Midwives have the capability to change immediate cord clamping practice by educating other providers, staff, and parents.

Implications for Research and Practice: Implications for research include more studies on preterm babies and keeping the cord intact during resuscitation, delayed cord

clamping with Cesarean deliveries, as well as delayed cord clamping with high-risk pregnancy and/or high-risk infants. Even though there is more research that needs to be conducted on delayed cord clamping, current practice needs to be changed. The conclusions of this review support delayed cord clamping by all providers. Nurse-Midwives have the power to promote change in provider practices by providing education on the advantages of delayed cord clamping. Nurse-Midwives can provide evidence-based research to recommend and implement change in personal preferences on delayed cord clamping by implementing protocols to unite all providers' practices.

Keywords: delayed cord clamping, immediate cord clamping, early cord clamping, preterm infants, term infants, neonatal outcomes, maternal outcomes, and pregnancy.

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Chapter One: Introduction

As soon as an infant is delivered, the newborn stays linked to the mother by the placenta and umbilical cord. During this time a placental transfusion is occurring from which the blood is transferred from the placenta to the infant. Placental transfusions can add between one-quarter and one-third of the total blood volume of the newborn (80-85 ml/kg) and delayed cord clamping (DCC) can reduce the hypovolemic damage, several long term difficulties and even disability associated with early cord clamping (ECC) (Holvey, 2014). For nearly sixty years, immediate umibillical cord clamping was initiated as part of several interventions in the third stage of labor to prevent postpartum hemorrhage, along with routine administration of prophylactic uterotonic drugs and controlled cord traction. Presently, cord clamping immediately after birth is the typical obstetric practice in the United States despite limited supportive evidence verifying its benefits (Elchenbaum-Pikser, 2009). The current practice of delayed cord clamping varies by provider from clamping and cutting the cord immediately after birth to delayed clamping and cutting of the cord based on the medical providers' preference of one to five minutes or waiting until pulsation ceases. The amount of time between birth and cord clamping is a personal choice in practice that is made by each individual medical provider.

Need for Critical Review of a Nursing Problem

Even though ideal timing has been discussed for more than 60 years, present-day practice in the United States is to clamp the cord right after delivery (ACNM, 2014). Also, there is no firm description of what defines early cord clamping versus late or delayed cord clamping (ACNM, 2014). According to the American College of

Obstetricians and Gynecologists (2012), presently, there is a lack of evidence that supports or disproves the advantages of delayed umbilical cord clamping for term newborns that are born in the United States. This lack of a firm description and limited evidence to support or disprove delayed cord clamping goes against the World Health Organization (WHO) recommendations of "late cord clamping (performed after one to three minutes after birth)" for all newborns (WHO, 2014). Appropriate evidence demonstrates that there is a need for this critical review due to limited research to defend or invalidate the practice, no firm definition of delayed cord clamping differing views of practitioners and different practices by practitioners on the timing of clamping cord after delivery. These views and practices include immediate clamping of the cord, delayed clamping of the cord ranging in a specific timeframe, to lastly, clamping the cord after pulsation ceases. The high prevalence of immediate cord clamping or differing variations of cord clamping and potential harm with no benefits of this practice necessitate a critical review of the literature.

Delayed Cord Clamping

For better maternal and newborn health and nutrition outcomes, delayed umbilical cord clamping is recommended no earlier than one minute after delivery (WHO, 2014). One of the first interventions in the birth process is clamping and cutting of the umbilical cord after birth. While the precise time frame of when to clamp the cord had been studied and disputed for over six decades, current practice in the United States still consists of immediate cord clamping after birth. Placental transfusion is the time period after delivery where the infant is still attached to the umbilical cord and placenta. Throughout this timeframe if the cord is not clamped immediately, the infant is receiving

a transfusion of blood from the placenta until the cord is clamped or the cord stops pulsating. Placental transfusion can contribute between one-quarter and one-third of the total blood volume of the newborn (80-85 ml/kg) and delayed cord clamping (DCC), can reduce the hypovolemic damage, long term difficulties and even disability associated with early cord clamping (ECC) (Holvey, 2014). Although providers delivering babies have the unique ability to promote placental transfusion and all the benefits of delayed cord clamping, this has been avoided in deliveries. Reasons for this include concerns of not being able to adequately resuscitate the newborn, effects on management of the mother and third stage of labor, effects on management of the delivery, and possibly negative effects on the newborn. In the United States after birth in most deliveries, the cord is immediately clamped and cut, and the newborn is taken to the warmer for further assessment, drying, vital signs, and weight. Delayed cord clamping increases both the mean Hct and the mean ferritin levels (Ranjit et al., 2015). A study by Gyorkos et al. (2012) assessed the efficiency of a DCC hospital policy change on newborn anemia and hemoglobin (Hgb) level at four and eight months of age. The study found that the DCC mean infant Hgb levels increased and anemia decreased.

Effects on the Third Stage of Labor

To avoid postpartum hemorrhage, active management of the third stage of labor is recommended. This includes the administration of Pitocin immediately after birth, late cord clamping and cutting, and controlled cord traction (WHO, 2014). Despite the WHO's statement on active management of the third stage of labor, immediate cord clamping practice still continues. A study by Andersson et al. (2013) indicated that delayed cord clamping did not have a considerable effect on maternal postpartum

hemorrhage or on the proportion of valid blood gas samples. The American College of Nurse-Midwives position statement on delayed cord clamping states that the practice of delayed cord clamping has not been related to an increase in maternal hemorrhage and should not delay the administration of oxytocic drugs to the mother as needed (ACNM, 2014). Delayed cord clamping provides many benefits to the newborn and mother and does not increase the risk of postpartum hemorrhage.

Practice Differences

Currently, there is no established definition of delayed cord clamping. The exactness of 'delay' is individualized and can range in timeframe from 30 seconds to three minutes, once cord pulsation has ceased or after the third stage of labor is complete (Cord Clamping.com, n.d.). The American College of Obstetricians and Gynecologists (ACOG) states there is a lack of evidence to support or disprove the advantages of delayed cord clamping. ACOG supports delayed cord clamping in preterm infants and suggests neonatal advantages of delayed cord clamping in term infants for only 30 to 60 seconds below the level of the placenta. Recommendations from improved infant and maternal health and nutrition outcomes by the World Health Organization is that delayed umbilical cord clamping is not preformed before 60 seconds after birth for all gestational ages in infants that do not require positive pressure ventilation (WHO, 2014). For all births cord clamping one to three minutes after birth is recommended while also starting neonatal cares (WHO, 2014). According to The American College of Nurse-Midwives, delayed cord clamping is recommended for five minutes when the term newborn is placed skin-to-skin or two minutes if the newborn is placed below the level of the introitus (ACNM, 2014). In preterm newborns ACNM recommends delayed cord

clamping for 30 to 60 seconds (ACNM, 2014). The American Academy of Pediatrics (AAP) supports ACOGs statement of delayed cord clamping in preterm infants of 30 to 60 seconds (The American Academy of Pediatrics (AAP), 2013). The AAP does not sanction delayed cord clamping for term newborns or those requiring resuscitation (AAP, 2013).

The benefits to the newborn necessitate consideration of practicing delayed cord clamping of both term and preterm infants that do not require resuscitation. This patience in practice after birth is more than a change in training but offers both physiological and psychological benefits to both the newborn and the mother. It is the responsibility of all providers caring for women and newborns during the birth process to provide evidence-based care.

Significance to Midwifery

Delayed cord clamping (DCC) is significant to the practice of midwifery because patients are requesting this procedure; it provides benefits to the newborn and a better maternal birth experience for the mother overall. Nurse-midwives have the ability to change cord clamping practices by advocating for delayed cord clamping and by providing education related to all the benefits to newborns. The influence of nurse-midwives to provide improved newborn outcomes contributes to guiding a multidisciplinary, collaborative approach to implement this practice. This modification in practice contributes to physiological and psychological change for both the newborn and the mother. This change in practice is free while producing healthier newborns and more satisfied mothers. Midwifery has an obligation and the opportunity to improve

newborn and maternal outcomes by implementing and educating other providers, delivery teams, patients and their families about delayed cord clamping.

Theoretical Framework

In the 1960's Imogene King's Theory of Goal Attainment was first presented. The rudimentary idea of the theory is that the nurse-midwife and patient convey knowledge, establish goals with one another, and then undertake actions to attain those goals (Nursing Theory, 2015). It explains an interpersonal relationship that permits an individual to blossom and grow in order to achieve particular lifetime goals (Nursing Theory, 2015). The three interrelating classifications in her theory include the personal system, the interpersonal system, and the social system. The interpersonal system centers on interaction, communication, transaction, role and stress, which extrapolate to the midwives role in educating parents on DCC and discussing it for their birth plan. The social system concept of the theory is based on organization, authority, power, status, and decision-making; this system allows the midwife to individualize and change her practice and initiate delayed cord clamping. Also, it encourages educating the organization, such as other providers and nurses on the benefits of delayed cord clamping for newborns and mothers.

King's theory describes nursing as course of action, response and interaction. A midwife and patient can communicate information about their view on labor and the birth process and delayed cord clamping. According to King's theory, the midwife focuses on the treatment of the patient, and the goal of the health care of patient, which is implementation of delayed cord clamping.

Statement of Purpose

The purpose of this review and synthesis of literature is to examine studies focused on the question of delayed cord clamping versus immediate cord clamping in term and preterm infants improve maternal and neonatal outcomes: *Does delayed clamping, impact transitional outcomes of the newborn?*

Summary

Midwives are the leaders in delayed cord clamping and are in a crucial position to enhance the benefits to the newborn and maternal outcomes at birth. Practicing, advocating, and promoting delayed cord clamping will improve patient outcomes to both the neonate and the mother. Holistically caring for the mother newborn dyad through integration of Imogene King's Theory of Goal Attainment and implementation of delayed cord clamping will improve transitional outcomes of the newborn and the maternal birth experience.

Chapter Two: Methods

This chapter will examine the method utilized in the critical appraisal of the literature. Studies associated with delayed cord clamping and their effects on birth outcomes were included. Exploration tactics of research studies that respond to the research question will be reviewed. In addition, inclusion and exclusion conditions for the research studies and the types and numbers of studies obtained in the searches will be explained. Lastly, the appraisal method for deciding the quality and level of evidence will be expounded upon.

Search Strategies Used to Identify Research Studies

The purpose of this critical appraisal of the literature is to determine if delayed cord clamping impact transitional outcomes for the newborn and maternal experience. A primary search was done using the Cumulative Index to Nursing and Allied Health Literature (CINAHL) database entering the key words, "delayed cord clamping" and "neonatal and maternal outcomes." This search revealed eight items, published between 2006 and 2015. A second search with Ovid database using the same key words retrieved no articles. A third search, again using Ovid database, found fourteen items published between 2009 and 2015 when entering the key phrase "delayed cord clamping". Other databases used to conduct the literature synthesis from published research papers included Pub Med and Google Scholar. Keywords included: "delayed cord clamping," "immediate cord clamping," "preterm infants," "term infants," "neonatal outcomes," "maternal outcomes," and "pregnancy." Ninety-three articles were identified through the search and 20 were assessed. The references within the research studies were examined producing additional information for study. Inclusion criteria included term newborns

and preterm newborns starting at 24 weeks, vaginal and Cesarean deliveries, international studies, adequate sample size, randomized control trials, quantitative studies, and literature reviews (Mercer, 2001) wrote most of the literature reviews that were appraised and chosen because of her expertise in maternal child nursing; she is respected and well known in the midwifery profession. Exclusion criteria included infants that needed resuscitation, high- risk pregnancies and low quality studies.

The John Hopkins Nursing Evidence-Based Practice Model and Guidelines were used to evaluate the research studies in this literature review (Dearhorlt & Dang, 2012). Based on this model, studies were evaluated according to level and quality of evidence. Level I research studies consist of experimental studies, which are either randomized control trials (RCT), or systematic reviews of RCTs with or without a meta-analysis (Dearholt & Dang, 2012). Level II research studies consist of quasi-experimental studies, which are a mixture of RCTs and quasi-experimental studies with or without meta-analysis (Dearholt & Dang, 2012). Level III research studies consist of non-experimental studies, qualitative studies, or a mixture of RCTs, quasi-experimental and non-experimental studies with or without meta-analysis (Dearholt & Dang, 2012). Level IV studies are thoughts, clinical practice guidelines, or consensus panels (Dearholt & Dang, 2012).

Research studies are measured as high quality if the outcomes are simplified and if they have an adequate subject size, design, suitable control, and a final conclusion. Research studies are measured as good quality if there are moderately reliable outcomes, if they have a suitable sample size, design, a little control, and moderately final conclusions. Research studies are considered low quality if there is minimal evidence

with varying results, inadequate sample size for the study, and a closing argument cannot be determined (Dearholt & Dang, 2012).

The research was examined based on the purpose of the study, literature review, research designed, data collection, setting, sample size, results, conclusions as well as recommendations. In addition, the studies were reviewed to decide if they sufficiently addressed the research question. To verify the quality of evidence, the studies had to meet certain requirements such as reliable results, an adequate sample size, sufficient control, and final conclusions and the studies could not be outdated. Also, included from the literature review are reliable suggestions for delayed cord clamping (Dearholt & Dang, 2012).

Criteria for Including or Excluding Research Studies

Random controlled trials, observational study, and cohort study research studies of high and good quality were incorporated into the matrix. Although it was hard to find high and good quality review articles that related to the purpose of this review, articles that addressed the effects of delayed cord clamping were included into this review. Also, the research studies of various practices regarding the timing of delayed cord clamping were included. Both, high quality or good quality qualitative studies were included. Articles relating to delayed cord clamping; as well as expert opinions in maternal child health were included in the review.

Number and Types of Studies Selected

Ninety-three articles correlated to delayed cord clamping, timing of cord clamping, preterm versus term cord clamping, risk of postpartum hemorrhage related to delayed cord clamping, and the impact on the newborn. Twenty out of ninety-three

articles were selected based on the design of the study using mostly randomized control trails and qualitative studies.

Criteria for Evaluating Research Studies

Each study was reviewed and organized based on the type of research design, meta-analysis, literature review, and expert opinion in maternal child health. Studies were omitted if they were of low quality or did not pertain to the review question. Based on the results from the search, all studies were reviewed for an association between delayed cord clamping and newborn and maternal outcomes. Of the articles 20 included in the critical review, six were random controlled trials, two were quasi- experimental, one was non-experimental, two were observational study, one cohort study, one qualitative, and seven literature reviews.

Studies that were included in the final review are shown in Table 1. The matrix was used as an organizational tool for the literature for this critical appraisal. The headings included in the final matrix were as follows: citation, purpose, sample, design, measurement, results/conclusions, recommendations, level and quality.

Summary

The inclusion of 20 studies for the final matrix provided detailed appraisal of the research. This chapter explained the search and evaluation tactics used for this critical appraisal of the literature. Inclusion and exclusion criteria were reviewed, as well as the procedure used to select studies for the matrix.

Chapter III: Literature Review and Analysis

This chapter synthesizes the major findings of the literature to identify and analyze the impact of delayed clamping and its effects on transitional outcomes of the newborn. This synthesis will offer a summary and review of significant findings of delayed cord clamping benefits, its effects on the third stage of labor, and its lack of generalized practice guidelines. The strengths and weaknesses of the investigations will be discussed.

The Matrix

To organize the research studies and analyze trends, the matrix format was used. Factors leading to benefits for the newborn were reviewed. Twenty studies were arranged into a matrix using the following titles: citation, purpose, sample, design, measurement, results/conclusions, recommendations, level and quality. The matrix organized the studies in alphabetical order by author(s).

After reviewing each study, results were synthesized and suggestions for practice were distinguished. The matrix is represented by Table 1.

Advantages of Delayed Cord Clamping

There are several advantages to delayed cord clamping which include the following: better short and long-term anemia status and hematological values; improved ventricular functions; higher blood pressure at four hours of age; lower arterial O2 saturation at four hours of age; no significant difference in jaundice; a decreased need for mechanical ventilation and surfactant in preterm newborns; improved oxygenation; and a lower incidence of necrotizing enterocolitis (Baenziger et al., 2007; Grajeda et al., 1997; Gyorkos et al, 2012; Kugelman et al., 2007; Ranjit et al., 2015, Yigit et al., 2015). If the

umbilical cord is clamped three minutes after birth of a term infant or after pulsation ceases with the newborn held beneath the level of the placenta the newborn will obtain roughly 20 to 35 ml/kg more blood than with immediate cord clamping (Yao et al., 1968). An observational study of umbilical cord clamping practice of maternity care providers in a tertiary care center found that if immediate intervention is not preformed, a substantial quantity of fetal blood from the placental will transfer to the infant after birth, a process defined as "placental transfusion" (Hutton et al., 2013). In a study conducted by Aziz et al. (2012) it was reported that babies (24-33 weeks) who were in the experimental group of delayed cord clamping (DCC) were less likely to have problems with thermoregulation of a temperature less than 36.3 C, had an increased hemoglobin level, and experienced decreased rates of necrotizing enterocolitis (NEC). A study by Gyorkos et al. (2012) assessed the efficiency of a DCC hospital policy modification on infant anemia and hemoglobin (Hgb) level at four and eight months of age. The study investigated a pre/post hospital policy change to DCC by following a group of Peruvian mothers and infants until eight months postpartum. The study found that implementation of DCC resulted in an improvement of newborn mean Hgb levels by 0.89 gdl-1 and a reduction in anemia at eight months of age.

A randomized control trial conducted by Grajeda et al. (1997) examined ways to develop cost-effective interventions, such as delayed cord clamping to increase hematologic status in children. In this study, 69 Guatemalan infants were indiscriminately allocated into one of the three groups at the birth: immediate cord clamping at delivery, cord clamping when pulsation ceased horizontally to the placenta, and clamping of the cord after pulsation ceased with the newborn beneath the level of the

placenta. Both maternal and newborn hemoglobin levels were drawn at delivery and two months postpartum. At delivery, the infants in all groups had similar hemoglobin levels. However, at two months post birth, newborns in both delayed cord clamping groups had considerably higher hematocrit and hemoglobin levels compared to those in the immediate cord clamping group. The percentage of hematocrit (Hct) values <0.33 was 88% in the control group compared with 42% in-group two (cord clamping when pulsation ceased horizontally to the placenta), and 55% in-group three (clamping of the cord after pulsation ceased with the newborn beneath the level of the placenta) (P=0.01) (Grajeda et al., 1997). A study was preformed on preterm infants six weeks after birth by Ranjit et al. (2015) using a randomized control trial to compare hematocrit and serum ferritin levels using early cord clamping (ECC) versus delayed cord clamping (DCC) practices. The study showed that at six weeks of age the infants in the DCC group had significantly higher mean Hct (27.3 $\pm$ 3.8% vs. 31.8 $\pm$3.5%, p value 0.00) and mean serum ferritin (136.9 $\pm$ 83.8 ng/mL vs. 178.9 $\pm$ 92.8 ng/mL, p value 0.037) (Ranjit et al., 2015). At day one the Hct was considerably increased in the DCC group (50.8 $\pm$ 5.2% vs. 58.5$\pm$ 5.1 %, p value of 0.00) (Ranjit et al., 2015).

A study by Baenziger et al. (2007) researched the effects of placentofetal transfusion on cerebral oxygenation in preterm infants by near-infrared spectroscopy. Thirty-nine preterm infants at 30 weeks 4 days gestational age were randomly assigned to the control group of conventional deliveries with no delayed cord clamping or the experimental group where mothers received Oxytocin, the newborn was positioned 15 cm beneath the placenta, and delayed cord clamping for 60 to 90 seconds was preformed. At four and 24 hours after birth with the use of a near-infracted spectroscopy cerebral

hemoglobin concentrations, cerebral blood volume, and regional oxygenation were assessed. At four hours of age (6.1 vs. 5.8 ml/100 g of tissue) or 24 hours of age (6.2 vs. 6.2 ml/100g of tissue) there was no difference in cerebral blood volume between the two groups (Baenziger et. al., 2007). In the experimental group cerebral tissue oxygenation was higher at four hours (69.9% compared to 65.5% in the control group) and at 24 hours (71.3% compared to 68.1% in the control group). A sample size of 35 preterm neonates was used in a prospective masked, randomized controlled study conducted by Kugelman et al. (2007). This study examined whether delayed cord clamping (30 to 45 seconds) or immediate cord clamping (five to ten seconds) would result in higher hematocrit (Hct) and blood pressure levels in neonates less than 35 weeks gestation. The results concluded that DCC was associated with higher diastolic blood pressure, higher initial Hct, and a decreased need for surfactant and mechanical ventilation in neonates less than 1500 grams compared to the immediate cord clamping (ICC) group. A study by Yigit et al. (2015) constructed a physiologically accurate and detailed lumped parameter model (LPM) of the transition from fetal-to-neonatal circulation at birth to compare DDC versus ICC as well as the impact on hemodynamics and respiration in the transitioning circulation of a term infant. The results showed that the placental transfusion volume was 31.3 ml in the DCC group, which improved neonatal blood volume by 11.7%; however, in the ICC group, placental flow suddenly stopped and no placental transfusion was found (Yigit et al., 2015). Generally, the DCC group had increased arterial blood pressures by 20% compared to the ICC group. Also, there was 20% higher cardiac output with the DCC group compared to the ICC group (Yigit et al., 2015). The study

found that DCC improves the oxygen saturation during the early transitional period when lungs are not yet fully active.

The results were similar in multiple appraised articles (Conner, & Macones, 2014; Garofalo, & Abenhaim, 2012; Holvey, 2014; Rabe et al., 2012). These studies support the practice that delayed cord clamping is not harmful to the newborn.

The articles included in the matrix that focused on the advantages of delayed cord clamping and its effects on newborn outcomes were all level I to level V; in addition, these sources received high to good quality appraisal using the John Hopkins Research Evidence Appraisal Tool. Identified strengths of the reviewed articles include three randomized control trails, randomization of sample groups, a level of high statistical analysis, well-defined limitations and needs for future research, as well as detailed literature reviews. Inclusion criteria were also used which included: high and good quality studies; review articles that addressed the effects of DCC and various timing of DCC; and quality and expert opinions. Four out of twelve articles were level V strength of evidence due to being literature reviews and finding limited research on this topic. Other limitations of the eight remaining articles that were not literature reviews include small samples sizes, inconsistencies in data collection due to human factors, limited sites used for data collection, and a homozygous sample causing it to be hard to generalize data.

Effects on the Third Stage of Labor

Postpartum hemorrhage remains a major complication worldwide (Khan et al., 2006). To prevent postpartum hemorrhage, active management of the third stage is

recommended which includes administration of Pitocin right after birth, late cord clamping and cutting, and controlled cord traction (WHO, 2014). A randomized control trial by Andersson et al. (2013) studied the effects of cord clamping on the length of the third stage of labor, maternal postpartum hemorrhage (PPH), and umbilical cord blood gas sampling. This study was conducted in a Swedish county hospital where 382 term deliveries from low-risk pregnancies were randomized to either the DCC group (≥180 seconds, n = 193) or the ECC group (≤10 seconds, n = 189) (Andersson et al., 2013). The estimated blood loss was determined by the midwife and cord gas samples were taken from both the DCC and ECC groups. The results of the study found that DCC, compared with ECC, did not have a considerable effect on length of the third stage of labor, maternal postpartum hemorrhage or on cord blood gas sample results.

This particular study by Andersson et al. (2013) was of good quality and was a Level I in strength. These researchers strengthened their study by providing using healthy, pregnant women who were non-smokers with an uncomplicated, singleton pregnancy and an expected vaginal delivery of an at term fetus with a cephalic presentation; in addition, these women could understand Swedish. A weakness of this study is that the sample size was small and not powered to show a difference in PPH. The midwife who estimated the blood loss was not blinded and this could cause bias. The study also has limited power to find a small difference in the proportion of valid blood gases. Another weakness in the current study, as well as in other studies investigating PPH, is that it is impossible to accurately measure maternal bleeding.

There are limited research studies available on delayed cord clamping and the effects on the third stage of labor. Only one article by Andersson et al. (2013) focused on

the effects of delayed cord clamping during the third stage of labor. It was deemed high quality based on the John Hopkins Research Appraisal Tool. Strengths of this study included: inclusion criteria for consistency; statistically significant results; and quality literature reviews. Limitations to this study include the staff was not blinded collecting the data, inconsistencies in measurement, and scarcity of data concerning maternal outcomes.

Practice Differences

Research supports delayed cord clamping in both term and preterm infants (Coggins & Mercer, 2009). Evidence supports DCC if the situation allows, which means waiting about three minutes until pulsations cease before clamping the cord. Research supports the benefits of DCC in preterm infants below the level of the placenta, and/or milking the cord for 30 to 45 seconds after birth (Coggins & Mercer, 2009). In a study by Aziz et al. (2012), delayed cord clamping practice was implemented after a staff orientation. A policy of DCC (45 seconds) was instituted for all eligible newborns born at a gestational age of 24-33 weeks. When the newborn was born, the NICU team was responsible to report both at the time of birth and at 45 seconds post birth to facilitate delayed cord clamping. Meanwhile the delivering provider wrapped the newborn in a warm, sterile towel and positioned the baby 20 cm below the introitus for a vaginal birth or on the mother's lap during a Caesarean section. Results of the study concluded that delayed cord clamping in preterm newborns is safe, applicable, practical and has minimal negative impact on early neonatal outcomes (Aziz et al., 2012).

The study by Aziz et al. (2012) was appraised to be of good quality and is considered a Level III in terms of strength of evidence. The researchers strengthened

their work by using delayed cord clamping protocol and choosing outcome measures that were based on practices of present randomized controlled trials in preterm infants. DCC was not performed for high-risk pregnancies or fetal intolerance to labor, such as an antepartum hemorrhage, fetal compromise in a multiple gestation pregnancy, cord prolapse, or any obstetrical concern before or during delivery. Staff education was provided on DCC and a protocol of DCC for 45 seconds for all eligible newborns born between 23 and 32 weeks 6 days gestational age was put into place. An algorithm was also created to help with clarification. Limitations of the study included no randomization, even though the patients who were eligible for DCC were of similar birth weights and gestational ages, ranging from 23 to 32 weeks 6 days. Also, the rates of compliance were measured only for deliveries that met the qualifications for DCC and not to meet the change in policy. Other limitations included human, clinical, and administrative influences. Also, if the neonatal team missed a precipitous delivery or lacked documentation, the birth was coded as noncompliant. During the study, DCC was applied to more mature newborns, largely to alleviate anxiety of delivering extremely preterm neonates. The study evolved as the delivering team became more comfortable with DCC and less likely to abandon the protocol. The study also supported a consideration of a "hands-off," gentler approach to facilitating transition in very premature babies.

A study by Gyorkos et al. (2012) assessed the value of a hospital policy change toward DCC on infant anemia and hemoglobin (Hgb) level at four and eight months of age. Results from implemented hospital policy change resulted in a delay of clamping

the cord from a mean (±SD) of 57s (± 32) preintervention to a mean (±SD) of 170s (±87) postintervention (Gyorkos et al., 2012).

A qualitative study by Oddie et al. (2014) interviewed providers on the variety of practices employed by units preforming DDC at very preterm births. Four main themes emerged which included inconsistency in guidelines, assessing suitability for DCC, opposing urgencies, and nervousness about timing of DCC. The study found differences in nature and application of placental transfusion techniques used at very preterm births.

An observational study by Hutton et al. (2013) used a stopwatch to time the interval when the newborn was born to the umbilicus until the umbilical cord was clamped. The study found that most newborns had their umbilical cord clamped right after birth, with more than half being clamped at or before 15 seconds of birth; the average umbilical cord clamping time was 12 seconds. It was also noted during this study that the obstetricians were more likely to preform immediate cord clamping compared to family practice doctors and midwives. The average clamping time was 12 seconds for obstetricians, 19 seconds for family practice doctors, and 81 seconds for midwives (Hutton et al., 2013). It was noted that the average clamping time was longer with natural, spontaneous births without interventions on a low-risk unit.

A questionnaire was used by Mercer et al. (2000) to study the current cord clamping practices and beliefs of American nurse-midwives. The questionnaire was composed of nine multiple choice questions asking about cord clamping practices of normal babies and distress babies, placement of the newborn right after birth, management of a nuchal cord, meconium stained amniotic fluid, practice examples of distress infants, and references or resources on rationale for practice. Of 157

respondents, the results found ECC were preformed when the infant appeared distressed (89%), while only 6.4% chose intermediate cord clamping and 4.5 % chose late cord clamping. In addition, 87% of the providers placed the newborn on the mother's abdomen after birth. When asked to provide resources for decisions on practice, 78% of the respondents provided no references for how they practice.

A study by Ononeze et al. (2009) was preformed to determine obstetricians' attitudes towards delayed cord clamping. A questionnaire composed of two questions explored obstetricians' practice of delayed cord clamping in preterm deliveries to determine whether or not they preformed DCC. This survey was given to obstetricians from 43 different units in various countries including the United Kingdom and other European countries, the United States, Canada, and Australia. The results of the questionnaire indicated that 9.3% of respondents practice DCC all of the time, 53.4% practiced DCC sometimes and 37.2% had never practice DCC (Ononeze et al., 2009). The main reason for not preforming delayed cord clamping, according to the study, was difficulties encountered with implementation in clinical practice.

A randomized control study by Vain et al. (2014) assessed if gravity affects the volume of a placental transfusion. After birth vigorous babies were randomly assigned to be held for two minutes before cord clamping at the introitus or the mother's abdomen. In each group, the babies were weighted immediately after birth and then two minutes following birth after the cord was clamped. Also, venous bilirubin and hematocrit concentrations were obtained at 36 and 38 hours. The study results found that the volume of placental transfusion was not affected by the position of the newborn baby before cord clamping (Vain et al., 2014).

The articles included in this critical appraisal that addressed practice differences in delayed cord clamping are of high or good quality. The appraised articles provided strengths in inclusion criteria, a high level of statistical analysis, and sample randomization. Limitations include only one randomized control trial, small samples, limited generalizability, altered practice because of knowledge of the study being undertaken, inconsistencies in data collection and limited studies on delayed cord clamping and maternal outcomes.

Summary

The matrix contains 20 critically appraised articles that examine delayed cord clamping advantages, the effects on the third stage of labor, and the differences in practice. The John Hopkins Research Evidence Appraisal Tool was utilized to assess the level of evidence and the quality of each article. All articles met the standards to be appraised as high to good quality literature. Recommendations for midwifery have been acknowledged in the matrix as well. The main focus of the appraised literature is the benefits of delayed cord clamping. Delayed cord clamping is free, requires minimal training, and carries significant benefits to both the newborn and to the mother-infant dyad concerning transitioning from intrauterine to extrauterine life and to facilitating bonding. The major findings of the reviewed literature show that delayed cord clamping has multiple physiological benefits to the newborn, has no effect in the change of active management during the third stage of labor, and shows major differences in practices of cord clamping. Their needs to be more research on delayed cord clamping, but one area that needs further research is focusing on delayed cord clamping and maternal satisfaction of her birthing experience.

Table 1

Citation	Purpose	Sample	Design	Measurement	Results/Conclusions	Recommendations	Level & Quality
Andersson, O., Hellström-Westas, L., Andersson, D., Clausen, J., Domellöf, M. (2013). Effects of delayed compared with early umbilical cord clamping on maternal postpartum hemorrhage and cord blood gas sampling: A randomized trial. *Acta Obstetricia et Gynecologica Scandinavica*. W*22*(5), 567. doi:10.1111/j.1600-0412.2012.01530.x	To investigate the effect of delayed cord clamping (DCC) compared with early cord clamping (ECC) on maternal postpartum hemorrhage (PPH) and umbilical cord blood gas sampling.	382 term deliveries after a low-risk pregnancy in a Swedish county hospital	Secondary analysis of a parallel-group, single-center, randomized controlled trial	PPH & proportion valid blood gas samples. Maternal EBL by midwife. Samples-blood gas taken from 1 umbilical artery & umbilical vein, pulsating unclamped cord in DCC group & double-CC in ECC. Valid arterial–venous difference −0.02 or less for pH & 0.5 kPa or more for pCO2.	Differences of DCC & ECC groups to PPH (1.2%, p = 0.8) and severe PPH (−2.7%, p = 0.3) small & non-significant. Proportion valid blood gas samples similar between DCC (67%, n = 130) & ECC (74%, n = 139) groups, with 6% (95% confidence interval: −4%−16%, p = 0.2) fewer valid samples after DCC. DCC vs. ECC did not have a significant effect on maternal postpartum hemorrhage or on the proportion of valid blood gas samples.	Delayed cord clamping is a feasible method from an obstetric perspective.	Level I, Quality B (good)

Citation	Purpose	Sample	Design	Measurement	Results/Conclusions	Recommendations	Level & Quality
Aziz, K., Chinnery, H., & Lacaze-Masmonteil, T. (2012). A single-center experience of implementing delayed cord clamping in babies born at less than 33 weeks' gestational age. *National Association of Neonatal Nurses 12*(6): 371-376: doi: 10.1097/ANC.0b013e3182761246	To describe the implementation and outcomes of DCC in preterm babies.	Eligible babies born between 28 and 32 weeks gestational age, and later to all those younger than 33 wks.	Observational study, Quantitative	Compliance was logged by NICU staff. Audit process for chart review. "Plan, Do, Study, Act" cycles. Algorithm was developed. Once the baby was expelled the NICU team was responsible for announcing 45 secs after birth for DCC.	Implementing DCC for preterm deliveries is complex, involves obstetric & neonatal team training, & requires modification of timing of resuscitation interventions to timing of CC. DCC in eligible babies less than 33 wks gestation 68% compliance. DCC in preterm babies appears practical, safe, and applicable, and has minimal impact on early neonatal outcomes.	Longer evaluation of morbidity & mortality is needed. Consider extended DCC to 60 secs in babies up to 36 weeks gestational age. Need a RCT to confirm conclusions and inferences due to gestation of eligible for DCC.	Level III, Quality B (good)

Citation	Purpose	Sample	Design	Measurement	Results/Conclusions	Recommendations	Level & Quality
Baenziger, O., Stolkin, F., Keel, M., Von Siebenthal, K., Fauchere, J., DasKundu, S., Dietz, V., Bucher, H., Wolf, M. (2007). The influence of the timing of cord clamping on postnatal cerebral oxygenation in preterm neonates: a randomized, controlled trial. *Pediatrics. 119*(3).	To investigate the effect of placentofetal transfusion (PFT) on cerebral oxygenation in preterm infants by near-infrared spectroscopy.	39 preterm infants with a median gestational age of 30.4 weeks, randomly assigned to an experiment group or control group.	A randomized, controlled trials	Ages 4, 24, & 72 hrs, cerebral O2 measured by deoxyhemoglobin, Oxyhemoglobin, sum of the total Hgb, & regional tissue O2 saturation by NIRS. Using tHb & hct cerebral blood volume calculated. HR, arterial blood pressure, hct, arterial oxygen saturation were recorded. Oxygenation index=mean airway pressure x fraction of inspired oxygen x 100.	Hct higher infants in experiment group vs. control group 4, 24, & 72 hours of age. Mean arterial BP higher in experimental group vs. control group at 4 hrs. No difference at 24 & 72 hrs. Arterial O2 sat. lower in infants experimental group at 4 hrs., but not older infants. No difference experimental group vs. control group HR. 6 infants experiment group & 12 infants control group needed mechanical ventilation. O2 index did not differ.	Recommend practicing PFT to reduce the need for transfusion of packed RBC. Use of a larger, multicenter trial.	Level I, Quality B (good)

Citation	Purpose	Sample	Design	Measurement	Results/Conclusions	Recommendations	Level & Quality
Coggins, M., Mercer, J. (2009). Delayed Cord Clamping Advantages for Infants. *Association of Women's Health, Obstetric, and Neonatal Nurses (AWHONN) 13*(2): 132-138.	Reviews the current theory used to explain why delayed cord clamping offers and advantage to infants, examines the recent evidence and provides clinical recommendations for nursing practice for labor and delivery nurses.	Term and preterm newborn infants at birth. A meta-analysis of 15 controlled trials (both randomized & non-randomized).	Literature Review	Most citations are from randomized-control trails (RCTs) and meta-analyses.	Evidence supports delayed cord clamping at birth in both term and preterm infants. If circumstances permit waiting until pulsations cease before clamping (about 3 minutes). Preterm infants benefit from a delay of at least 30 to 45 secs, if held below the level of the placenta, and/or cord milking.	No evidence-based recommendations SGA term infants & term infants born mothers DM or HTN. Discuss with colleagues about evidence of DCC to help challenge commonly held beliefs. Practicing logistics where to put infant for DCC providers & nurses, maybe skin-to-skin on the maternal abdomen. OB or neonatal RNs in unique spot to facilitate change. Discuss DCC RNs & providers	Level V, Quality B (good)

Citation	Purpose	Sample	Design	Measurement	Results/Conclusions	Recommendations	Level & Quality
Conner, S. N., & Macones, G. A. (2014). Delayed umbilical cord clamping. *Contemporary OB/GYN, 59*(6), 46.	To confirm or refute the potential for benefits from delayed umbilical cord clamping in term infants, especially in settings with rich resources.	Eligible Term and Preterm infants. 11 trials of 2,989 women & infants. 10 trials of ECC vs. DCC clamping in 454 preterm infants (at less than 37 weeks of gestation). Another review analyzed the results from 15 eligible studies (738 premature infants).	Systematic Review, 36 studies.	A 2008 Cochrane review assessed the effect of umbilical cord clamping in term infants on maternal and fetal outcomes.	DCC preterm infants 30–60 secs below placenta = neonatal benefits. Improved transitional circulation, better rbc volume, and decreased risk blood transfusion. Insufficient evidence exists to support or to refute the benefits from DCC in term infants that are born in settings with rich resources. Limited studies on maternal outcomes & incidence of postpartum hemorrhage is r similar between ICC groups and LCC groups.	Research on evaluating optimal timing of umbilical cord clamping, the management of the third stage of labor in relation to umbilical cord clamping, and the timing of umbilical cord clamping in relation to the initiation of voluntary or assisted ventilation in the neonate.	Level V, Quality B (good)

Citation	Purpose	Sample	Design	Measurement	Results/Conclusions	Recommendations	Level & Quality
Garofalo, M., Abenhaim, H. (2012). Early Versus Delayed Cord Clamping in Term and Pretem Births: A Review. *Journal of Obstetrics and Gynecology Canada (JOGC)* 34(6): 525-531	A Review of early versus delayed cord clamping in term and preterm births.	Term and preterm births. Searching multiple databases	Literature Review	Selected systematic reviews and randomized controlled trails. Search terms used were "cord clamping", "timing of cord clamping", "delayed vs. early cord clamping," placental transfusion," "umbilical cord blood banking," and "PH cord clamping."	Benefits of delaying cord clamping (DCC) in the term baby seen to outweigh the risks of adverse outcomes, including neonatal jaundice requiring phototherapy. DCC in preterm infants by at least 30 secs, or possibly even milking the cord in these babies, is beneficial and should be considered whenever possible. Insufficient evidence to date to support a recommendation to delay cord clamping in non-vigorous infants requiring resuscitation.	The definition of timing for ECC and DCC varies in the studies. The position of the baby at the time of cord clamping and the use of uterotonics are not described in many studies, making it difficult to assess their role in placenta transfusion. Benefits of delayed cord clamping in term infants outweigh risks in both areas where iron deficiency is endemic and in high income countries.	Level V, Quality B (good)

Citation	Purpose	Sample	Design	Measurement	Results/Conclusions	Recommendations	Level & Quality
Grajeda, R., Perez-Escamilla, R., Dewey, K. G. (1997). Delayed clamping of the umbilical cord improves hematologic status of Guatemalan infants at 2 mo. of age. *American Journal for Clinical Nutrition.* 65(2):425-431.	Report results RCT effect DCC of the umbilical cord on infant iron status was examined. Hypotheses tested in this study were as follows: 1) DCC will enhance hematologic status during early infancy, and 2) placing the newborn below the level of the placenta, in addition to DCC, will enhance even further the hematologic status of infants.	88 Low-income Guatemalan women & infants. Group 1 ICC (control, n = 29); group 2, clamping cord stopped pulsating, infant placed at the level of placenta (n = 30); or group 3, clamping when cord stopped pulsating, with the newborn placed below the level of the placenta (n 29).	Randomized Control trial	Stopwatch recorded time elapsed before clamping the umbilical cord relative to head crowning & appearance of newborn's shoulders. 2 blood samples collected moms- 1 h before birth & 2 mo later. Blood infants 2-mo & Last 41 infants in study, blood collected 24 h after Hct.	Time between birth & CC significantly shorter (by 1 mm) in control group vs. 2 experimental groups. Hct values infants-all groups no difference 24 h & clinical assessment (including jaundice) revealed no significant difference in newborn health status across groups. Polycythemia (% HCT value > 0.65) more likely to occur in DCC group & placement newborn below the level of the placenta 2 groups. Infants DCC higher Hct at 2 mo. after delivery vs. control group.	Urge providers to DCC until it stops pulsating & to clamp the cord while the newborn is at the level of the placenta. easy, low-cost intervention could result in a significant decrease in of anemia in vulnerable populations.	Level I, Quality B (good)

Citation	Purpose	Sample	Design	Measurement	Results/Conclusions	Recommendations	Level & Quality
Gyorkos, T., Maheu-Giroux, M., Blouin, B., Creed-Kanashiro, H., Casapia, M., Aguilar, E., Silva, H., Joseph, S., Penny, M. (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.	To assess the effectiveness of a hospital policy change toward delayed cord clamping (DCC) on infant hemoglobin (Hb) levels and anemia status at 4 and 8 months postpartum.	Cohort of Peruvian mothers, 224 mother-infant pairs provided complete baseline hospital data. Final study 207 mother-infant pairs at 4 months and 184 mother-infant pairs at 8 months.	Cohort Studies	Questionnaire L & D at hospital NM. In labor moms Hb levels measured finger-prick blood using HemoCue. NM observed & recorded delivery 1st shoulder & CC with digital chronometer. 4 & 8 mo. PP questionnaire health services, infant health & feeding, wt, and HB checked with HemoCue machine.	DCC from mean (±SD) 57s (±32) pre mean (±SD) 170s (±87) post. 4 mo pre & post mean Hb level 10.4 gdl. Infant anemia same. 8 mo. pre mean Hb 9.9 gdl & 79.1 anemic. Post Hb 10.7gdl (±0.9) & proportion anemic infants 63.4% No changes Hb level or anemia status at 4mo & 8mo. Infants in post group adjusted mean Hb level 0.89 gdl higher & improved anemia status vs. pre group. No Maternal anemia & intervention 4 mo. or 8 mo. Anemia 8 mo. infants due to change in policy 22.4%.	DCC is effective in improving Hb levels and anemia status at infants at 8 mo. Implementation of DCC will yield benefits. 22% reduction of infant anemia at 8 mo. of age is associated with cost-free intervention. More research is needed on the benefits of DCC extending into late infancy/early childhood.	Level III, Quality B (good)

Citation	Purpose	Sample	Design	Measurement	Results/Conclusions	Recommendations	Level & Quality
Holvey, N. (2014). The imperative of implementing delayed cord clamping to improve maternal and neonatal outcomes. *British Journal of Midwifery*. 22(9): 651-6 56.	Implementing delayed cord clamping (DCC) to improve maternal and neonatal outcomes into clinical practice.	Newborn and maternal outcomes on term infants.	Literature Review	Selected systematic reviews and randomized controlled trails	DCC improves short & long-term HCT, Hgb & Fe status newborn, improve neurological & cognitive development. DCC easy inexpensive method to reduce anemia. DCC full placental transfusion, supporting transition, from intrauterine to extra-uterine life, reducing hypovolemic damage and its related effects. DCC can be done with skin-to-skin contact with the mother, enabling bonding, breastfeeding, and thermoregulation of newborn.	Midwives should practice DCC due to the evidence. Patient's should be informed and given the choice of DCC. A review of local and national protocols should be preformed. DCC should become part or routine practice.	Level V, Quality B (good)

Citation	Purpose	Sample	Design	Measurement	Results/Conclusions	Recommendations	Level & Quality
Hutchon, D.J. (2012). Immediate or early cord clamping vs. delayed clamping. *Journal of Obstetrics and Gynecology*. (32): 724-729	Describes how the need for early cord clamping can be avoided in practically all clinical complications of birth.	Term and preterm infants at birth.	Literature Review	Selected systematic reviews, observational reviews, and randomized controlled trails	Intervention of ICC which is shown to cause even minor short-term harm and no benefit should be removed from practice until ongoing research shows clear evidence of its benefit.	On-going studies on preterm babies where the cord is left intact and the fragile babies are cared for close to their mothers.	Level V, Quality B (good)

Citation	Purpose	Sample	Design	Measurement	Results/Conclusions	Recommendations	Level & Quality
Hutton, E., Stoll, K., Taha, N. (2013). An observational study of umbilical cord clamping practice of maternity care providers in a tertiary care center. *Birth: Issues in Perinatal Care. 40*(1): 39-45. doi: 10.1111/birt.12027.	To investigate actual cord clamping time and circumstances at a large tertiary care center.	Women in active labor, likely to deliver during the period of time the research assistant was present, planned a vaginal birth & were under the care of a practitioner who had agreed to be observed in the study. 101 practitioners. 96 singleton births & 2 sets of twins.	Observational study, Quantitative	A stopwatch watch to time the interval from the time the infant was born as far as the umbilicus until the time the umbilical cord was clamped before cutting	The study highlighted actual time of the umbilical cord and found that almost one-half of infants observed had their umbilical cord clamped within 15 seconds. Midwives and family physicians were more likely to delay clamping the umbilical cord compared to obstetricians.	Since this study delayed umbilical cord clamping for the healthy term newborn has become a part of recommended management of third stage of labor and resuscitation guidelines. It would be informative to repeat a study like this one to determine compliance with the current standards of care.	Level III, Quality B (good)

Citation	Purpose	Sample	Design	Measurement	Results/Conclusions	Recommendations	Level & Quality
Kugelman, A., Borenstein-Levin, L., Riskin, A., Chistyakov, I., Ohel, G., Gonen, R., Bader, D. (2007). Immediate versus Delayed Umbilical Cord Clamping in Premature Neonates Born < 35 Weeks. : A Prospective, Randomized, Controlled Study. *American Journal of Perinatology*. *24*(5): 307-315: doi 10.1055/s-2007-981434.	The purpose of this study was to test whether delayed versus immediate cord clamping would result in higher blood pressure (BP) and hematocrit (Hct), and to assess its clinical effects on the neonatal course in premature neonates (< 35 weeks).	Prior to delivery, 35 neonates were randomly assigned to immediate cord clamping (ICC) at 5 to 10 seconds, and a comparable group of 30 neonates were randomly assigned to delayed cord clamping (DCC) at 30 to 45 seconds	Prospective, masked, randomized, controlled study	Mean BP & initial Hct as the primary outcome variables and an expected 10 to 15% increase by DCC (a ¼ 0.05; power 80%)	DCC compared with ICC in premature neonates was associated with a tendency for higher diastolic blood pressure and initial Hct (especially in vaginal deliveries). DCC resulted in decreased need for mechanical ventilation and surfactant in neonates < 1500 g.	DCC seems to be safe in premature neonates, and may be beneficial when compared with ICC. The differences between the two methods were modest and the clinical relevance needs to be assessed further by larger studies or a meta-analysis of current data.	Level I, Quality B (good)

Citation	Purpose	Sample	Design	Measurement	Results/Conclusions	Recommendations	Level & Quality
Mercer, J. S. (2001). Current best evidence: A review of the literature on umbilical cord clamping. *Journal of Midwifery & Women's Health*: 46(6) 402-414.	The purpose of this article is to evaluate the literature on cord-clamping practices published between 1980 and 2001 to provide the best possible foundation for clinical practice.	RCT term and preterm infants & well-designed controlled trials were included in the summaries found in Appendices A and B. Other studies, review articles, expert committee reports, & case studies are referred to as appropriate throughout the text.	Literature Review	DCC for preterm infants, term "delayed" meant no longer than 30 to 45 seconds Term infants, "delay" ranges from 3 min to cessation of pulsations in cord or up to 10 min. ECC ranged from immediate to before 1 min. for term infants. For preterm infants, most studies defined ECC as immediate, 2 studies immediate =20sec delay.	The literature contains many unsubstantiated references to the fact that delaying cord clamping leads to a variety of harmful effects. Currently, the belief that delayed cord clamping causes polycythemia is so prevalent that one often finds it stated in the literature as an accepted fact not needing scientific references (10–12,76).	There is no evidence that early cord clamping is better, and evidence is lacking regarding long-term harm from immediate or delayed cord clamping. Until we have sufficient appropriate evidence showing otherwise, it is better to mimic nature than to interfere with the intricate, complex, and only partially understood design of the physiologic neonatal transition.	Level V, Quality B (good)

Citation	Purpose	Sample	Design	Measurement	Results/Conclusions	Recommendations	Level & Quality
Mercer, J. S., Nelson, C. C., Skovgaard, R. L. (2000). Umbilical cord clamping beliefs and practices of American Nurse-Midwives. *Journal of Midwifery & Women's Health*: 45(1) 58-66.	The purpose was to identify and describe the current cord clamping beliefs and practices of American nurse-midwives and to specify the resources they use to provide a rationale for their practice.	ACNM members who returned the questionnaire before the deadline constituted the sample for this study. A simple computer-randomized sample of 303 CNMs was selected from the 4,114 active members of the ACNM in March, 1998.	Questionnaire	9 multiple-choice. 6 clinical questions on CC practice normal babies; CC practices distressed babies, placement of infant immediately after birth, management nuchal cord is present, management meconium-stained amniotic fluid. Distressed infant, pale, no reflexes, HR >100.	Descriptive statistics fairly equal distribution of respondents across 3 CC practices. CC interval when the neonate appeared distressed, EC was the predominate practice (89%). Only 6.4% and 4.5% chose IC and LC, respectively. Beliefs question (87%) place the infant on the mother's abdomen after birth. Last question asked 2 references or resources underlying the respondent's rationale for practice. 78% sited no references.	The controversies and lack of consensus regarding cord clamping recommendations and policies are clearly represented in the responses of these experienced midwives. The nearly equal distribution between early, intermediate, and late cord clamping is a natural ramification of an inadequate scientific knowledge base	Level III, Quality B (good)

Citation	Purpose	Sample	Design	Measurement	Results/Conclusions	Recommendations	Level & Quality
Oddie, S., Rhodes, P. (2014). Barriers to deferred cord clamping in preterm infants. *Archives of Disease in Childhood. Fetal Neonatal Edition*. doi: 10.1136/archdischild-2014-305968.	To describe the range of practices employed by units conducting deferred cord clamping at very preterm birth.	7 sites included; 33 practitioners were interviewed: 7 midwives, 7 neonatologists, 2 pediatricians, 6 neonatal nurses, 7 obstetricians and 4 managers.	Qualitative Study.	Semistructured Interviews lasting 20-40 min, digitally recorded and transcribed. Transcripts were anonymous & coded, following a process of constant comparison & using qualitative data software (NVivo10). Common themes were identified between sites, professional groups and individual clinicians.	4 main themes: variability in guidelines; assessing eligibility; competing priorities; anxiety about timing; persisting uncertainty. Study uncovered variation in nature & implementation of placental transfusion techniques at very preterm birth. Application most effective where significant interdisciplinary dialogue (including NM) guideline Development and unit participation.	Ongoing studies need to be done to resolve uncertainties: about optimal form or combination of placental transfusion techniques; case selection; positioning of the baby; duration of delay, and timing of uterontonics. Stabilization with cord intact may promote transitional cardiovascular stability.	Level III, Quality B (good)

Citation	Purpose	Sample	Design	Measurement	Results/Conclusions	Recommendations	Level & Quality
Ononeze, A. O., & Hutchon, D. R. (2009). Attitude of obstetricians towards delayed cord clamping: A questionnaire-based study. *Journal Of Obstetrics & Gynaecology*, 29(3), 223-224. doi: 10.1080/ 01443610802712918.	The purpose of this study therefore was to determine the views and attitudes of obstetricians towards delayed cord clamping (30–120 seconds) in preterm deliveries.	Obstetricians from 43 different units in UK, other EU countries, USA, Canada, Australia etc.	Quantitative non-experimental studies, Questionnaire	A questionnaire comprised of two questions exploring whether or not obstetricians practice delayed cord clamping in preterm delivery.	9.3% of respondents indicated they always adhered to the recommendation on delayed cord clamping, 53.4% adhered to the recommendation on delayed cord clamping, on some occasions and 37.2% never practiced delayed cord clamping.	Obstetricians are reluctant to practice delayed cord clamping in spite of the proven benefits of this simple clinical practice. Difficulty in implementation was the main reason given although in reality this is not the case.	Level III, Quality B (good)

Citation	Purpose	Sample	Design	Measurement	Results/Conclusions	Recommendations	Level & Quality
Rabe, H., Diaz-Rossello, J., Duley, L., Dowell, T. (2012). Effect if timing of umbilical cord clamping and other strategies to influence placental transfusion at preterm birth on maternal and infant outcomes. Cochrane Database System Review. 8:CD003248.	The effect of timing of umbilical cord clamping and other strategies to influence placental transfusion at preterm birth on maternal and infant outcomes	Fifteen studies (738 infants) were eligible for inclusion. Participants were between 24 and 36 weeks' gestation at birth. The maximum delay in cord clamping was 180 seconds.	Literature Review	Randomized controlled trials comparing early with delayed clamping of the umbilical cord and other strategies to influence placental transfusion for births before 37 completed weeks' gestation. Three review authors assessed eligibility and trial quality.	DCC fewer infants requiring transfusions anemia (seven trials, 392 infants; risk ratio (RR) 0.61, 95% confidence interval (CI) 0.46 to 0.81), less intraventricular hemorrhage (US dx all grades) 10 trials, 539 infants (RR 0.59, 95% CI 0.41 to 0.85) & lower risk necrotizing enterocolitis (five trials, 241 infants, RR 0.62, 95% CI 0.43 to 0.90) vs. ICC bilirubin conc. higher infants allocated DCC vs. ICC (seven trials, 320 infants, mean difference 15.01 mmol/L, 95% CI 5.62 to 24.40). No studies on women outcome.	Additional placental blood to preterm baby by DCC 30 to 120 sec, rather than ECC, seems to be asso.with less need for transfusion, better circulatory stability, less intraventricular hemorrhage (all grades) & lower risk for necrotizing enterocolitis. Insufficient data for reliable conclusions about the comparative effects on any of the primary outcomes for this review.	Level V, Quality B (good)

Citation	Purpose	Sample	Design	Measurement	Results/Conclusions	Recommendations	Level & Quality
Ranjit, T., Nesargi, S., Rao, P. N., Sahoo, J., Ashok, C., Chandrakala, B. S., Bhat, S. (2015). Effect of early versus delayed cord clamping on hematological status of preterm infants at 6 wk of age. Indian *Journal of Pediatrics* 82(1): 29-34. doi 10.1007/s12098-013-1329-8.	To compare the effect of early cord clamping (ECC) vs. delayed cord clamping (DCC) on hematocrit and serum ferritin at 6 wk of life in preterm infants.	100 preterm infants born between 30 0/7 and 36 6/7 weeks were randomized to either early or delayed cord clamping groups.	Randomized, controlled trial	In the ECC group cord clamping was immediately after delivery of the baby and in the DCC the cord was clamped after 2 minutes of the delivery. HCT and serum ferritin were drawn at 6 wks.	Mean Hct (27.3± 3.8% vs. 31.8± 3.5%, p value 0.00) & mean serum Fe(136.9±83.8 ng/mL vs. 178.9±92.8 ng/mL, p value 0.037) 6 wk significantly higher infants randomized to DCC group. Hct day 1 was significantly higher in the DCC group (50.8±5.2% vs. 58.5± 5.1%, p value 0.00). DCC also, requires a longer duration of phototherapy and had trends towards higher risk of polycythemia.	DCC by 2 min, significantly improves the Hct value at birth and continues at least 6 wks after birth.	Level I, Quality B (good)

Citation	Purpose	Sample	Design	Measurement	Results/Conclusions	Recommendations	Level & Quality
Vain, N. E., Satragno, D. S., Gorenstein, A. N., Gordillo, J. E., Berazategui, J. P., Alda, M. G., & Prudent, L. M. (2014). Effect of gravity on volume of placental transfusion: A multicenter, randomized, non-inferiority trial. *The Lancet, 384*(9939), 235-40. doi:http://dx.doi.org/10.1016/S0140-6736(14) 60197-5	To assess whether gravity affects the volume of placental transfusion	391 mothers were eligible which included a normal pregnancy, admitted at term, during the first stage of labor and in whom a vaginal uncomplicated delivery.	Randomized control trail	Wt. immediately at birth at level of the vagina with an electronic 1 g precision scale (STW - 6 BB, Electronic Balanzas CAM, Buenos Aires, Argentina) with a coefficient of variation of 0·0006 g. 2 min, CC in newborn babies of both groups, & they wt. again scale. Venous Hct and bilirubin values were obtained at 36-48 h.	77 introitus group & 78 abdomen group ineligible after randomization (eg, C-birth, forceps delivery, short umbilical cord or nuchal cord). Mean wt. 56 g (SD 47, 95% CI 50-63) for 197 babies in the introitus group compared 53 g (45, 46-59) 194 babies in the abdomen group, supporting non-inferiority 2 approaches (difference 3 g, 95% CI -5·8 to 12·8; p=0·45). Position baby before CC does not affect volume placental transfusion.	Mothers could safely be allowed to hold their baby on their abdomen or chest. This change in practice might increase obstetric compliance with the procedure, enhance maternal-infant bonding, and decrease iron deficiency in infancy.	Level I, Quality B (good)

Citation	Purpose	Sample	Design	Measurement	Results/Conclusions	Recommendations	Level & Quality
Yigit, M. B., Kowalski, W. J., Hutchon, D. J., Pekkan, K. (2015). Transition from fetal to neonatal circulation: Modeling the effect of umbilical cord clamping. *Journal of Biomechanics*. 48(9) 1662-1670. doi: 10. 1016/j.jbiomech.2015.02.040	1) construct physiologically accurate & detailed lumped parameter model (LPM) transition from fetal-to-neonatal circulation at birth 2) investigate & compare 2 CC scenarios, DCC & ICC, based on their relative impacts on hemodynamics & respiration in the transitioning circulation of a term infant.	A lumped parameter model (LPM) of the fetal cardio-respiratory system covering the late-gestation to neonatal period. The LPM was validated with *in vivo* clinical data and then used to predict the effects of cord clamping procedures on hemodynamics and vital gases.	Quantitative Quasi-experimental study.	A neonatal and pediatric circulatory LPM framework was constructed and represented a fetal circuit. Compliance (*C*) chambers were used to model major vascular compartments, which were connected with linear resistance (*R*) components that represent the viscous drag.	Placenta transfusion improves ventricular functions and hemodynamic stability. Delayed cord clamping improves oxygenation at birth.	Findings contribute to the literature by demonstrating the link between placental transfusion in DCC and increased cardiorespiratory performance in the term infant.	Level II, Quality B (good)

Chapter IV: Discussion

My research question is: Does delayed cord clamping impact transitional outcomes for the newborn? The John Hopkins Research Evidence Appraisal Tool was used to appraise 20 scholarly articles related to this topic. The results were then reviewed to evaluate trends and gaps in the literature and to identify inferences for change in midwifery practice and future research needs. Imogene King's Theory of Goal Attainment was applied to the concept of delayed cord clamping and the impact on transitional outcomes of the newborn and maternal birth experience. It focuses on the interpersonal system of interaction, communication, transaction, role and stress, which extrapolate to the midwives' role in educating parents on DCC and discussing this option for their birth plan.

Advantages of Delayed Cord Clamping

Delayed cord clamping (DCC) after delivery has been documented as a suitable technique for placental transfusion in both term and preterm births, delivered vaginally or by Cesarean section. Numerous studies included in the matrix reinforce the statement that delayed cord clamping does impact transitional outcomes for the newborn as opposed to immediate cord clamping. The effects of delayed cord clamping include: better short and long-term anemia status and hematological values, improved ventricular functions, higher blood pressure at four hours of age, lower arterial O2 saturation at four hours of age, no significant difference in jaundice, a decreased need for mechanical ventilation and surfactant in preterm newborns, improved oxygenation, and a lower incidence of necrotizing enterocolitis (Baenziger et al., 2007; Grajeda et al., 1997; Gyorkos et al, 2012; Kugelman et al., 2007; Ranjit et al., 2015, Yigit et al., 2015). These

recurring results were reviewed in multiple Level I, II, and III studies of good quality based on the John Hopkins Research Evidence Appraisal Tool. The same conclusion of results provided evidence and support for delayed cord clamping. It does need to be acknowledged that many of the studies used Cesarean sections deliveries, very preterm infants, infants requiring resuscitation, and mothers with high-risk pregnancies as exclusion criteria in evaluating DCC.

Kugelman et al. (2007) piloted a prospective, randomized control study that focused solely on DCC compared with immediate cord clamping in preterm neonates 24 weeks and 34 weeks six days gestation. The researchers found that DCC in preterm neonates, as compared with ICC, was associated with a tendency for higher diastolic blood pressure, higher initial Hct and resulted in decreased need for mechanical ventilation and surfactant in neonates < 1500 g (Kugelman et al., 2007). The study concluded that DCC is feasible and seems to be safe in preterm neonates (Kugelman et al., 2007). These results are similar to other studies with a sample population of preterm infants who had experienced delayed cord clamping (Aziz et al., 2012; Oskar et al., 2007). The lack of literature focusing on very preterm infants needs to be assessed further by larger studies or by a meta-analysis of current data; a longer evaluation on morbidity and mortality is needed.

Effects on the Third Stage of Labor

One recent study was conducted to identify the effects of DCC versus ICC on maternal postpartum hemorrhage and on the proportion of valid blood gas samples (Andersson et al., 2013). The results suggested that DCC did not have a significant effect on maternal postpartum hemorrhage or valid cord gases. Concluding delayed cord

clamping is a proven method backed by evidence from an obstetric perspective and has no negative effect on maternal outcomes or the birth experience. In fact, delayed cord clamping permits the mother and newborn to remain connected which allows for newborn cares to be preformed on the mother enabling skin-to-skin contact, bonding, breastfeeding, and thermoregulation of the newborn. This study was a Level I randomized control trial and was given a good quality rating due to a smaller sample size of 382 term deliveries.

The limited research available on this topic indicates a gap in the literature in evaluating delayed cord-clamping effects on the third stage of labor. Also, studies were excluded in the appraisal of the literature that included delayed cord clamping and the effects on the third stage of labor because either cord traction and/or cord milking was performed after the birth. It would be of interest to further examine the role of delayed cord clamping effects on the third stage of labor now that quantitative blood loss is being measured at births instead of an estimate of blood loss.

Practice Differences

Delayed cord clamping has been recommended as an intervention because of the impact on newborn outcomes, yet there is still no constancy with the exact timeframe for practice which varies from 45 seconds to five minutes in both preterm and term infants. In a study by Aziz et. al. (2012) delayed cord clamping was implemented after a staff orientation on the technique. A policy of DCC for 45 seconds was instituted for all eligible babies born between 24-33 weeks. Results of the study concluded that delayed cord clamping in preterm babies seems safe, applicable, practical and has a very small influence on early neonatal outcomes (Aziz et al., 2012). The study also supported a

consideration of a "hands-off," gentler approach to facilitating transition in very premature babies.

This study by Aziz et al. (2012) was appraised to be of good quality and is considered a Level III in terms of strength of evidence. Limitations of the study included no randomization, even though the patients who were eligible for DCC were similar birth weight and gestation. Also, the rates of compliance were measured only for deliveries that met qualifications for DCC and not measured to meet the protocol. Other limitations included human, clinical, and administrative influences. Also, if the neonatal team missed a precipitous delivery or lack of documentation, it was coded as noncompliant. During the study compliance and protocol also changed as the delivering team evolved regarding reasons for abandoning DCC. An area for further study on this topic would be extending DCC to 60 seconds in preterm babies up to 36 weeks gestational.

A study by Gyorkos et al. (2012) assessed the effectiveness of a hospital policy change toward DCC on infant anemia and hemoglobin (Hgb) level at four and eight months of age. Results from the change in hospital policy resulted in a change in infant Hgb and anemia at four months and at eight months of age. Hemoglobin increased to 10.7 gdl ($\pm$0.9) and the proportion of anemic infants decreased to 63.4% (Gyorkos et al., 2012). Data from long-term follow-up of the cohort indicated a change in hospital policy from early to delayed cord clamping is effective in improving hematological and anemia values at eight months of age. These findings come from a Level III study appraised to be of good quality through the Johns Hopkins Research Appraisal Tool. A limitation of the study was that it was an observational study, and delayed cord clamping was implemented after a policy change. Also, there was limited data obtained on infant diet

and nutrition since birth. A final limitation of this study was the gap in the research regarding how long the impact of delayed cord clamping extends into late infancy/early childhood.

A study by Vain et al. (2014) researched the effect of gravity on the volume of placental transfusion and found identical amounts of placental transfusion if the baby was held at the vaginal introitus or in the mother arms. Vain et al. (2014) recommend that mothers be allowed to hold their newborns while delayed cord clamping is being implemented not only to increase compliance of the procedure, but to also enhance maternal-infant bonding.

Implications for Midwifery Practice

Although there is considerable room for additional research evaluating the impact of delayed cord clamping on newborn and the maternal birth experience, there is significant data to change current practice of cord clamping. The results of this critical appraisal of the literature encourage midwives and all OB providers to practice and promote delayed cord clamping in both preterm and term infants regardless of the delivery method. Midwives have the capability to model, advocate, and promote change in practice by preforming delayed cord clamping at every delivery unless the term or preterm infant requires positive-pressure ventilation; in this case, the cord should be clamped and cut immediately to allow for effective ventilation. The review of the critical appraisal of the literature also encourages midwives to educate all mothers and staff members present at births on the practice of delayed cord clamping. Midwives have a voice in both the development of policies and change in practice based on learned skills and personal preference rather than evidence-based practice. Midwives are in strategic

positions to be able to evaluate the efficacy of current practice and policies to impact positive benefits to the newborn during and after birth.

Recommendations for Nursing Research

Significant research has been focused on preterm and term infants' responses to delayed cord clamping. It is repeatedly cited in the research that newborns will experience a placental transfusion which contains red blood cells and stem cells, an increase in Hgb and Hct, an increase in blood volume, a decrease in newborns with anemia, higher blood pressure, a reduced need for blood transfusion, a reduced incidence of intraventricular hemorrhage, a reduced incidence of necrotizing enterocolitis, and improved cerebral oxygenation. The dearth of studies investigating delayed cord clamping and the physiological responses of infants that need resuscitation necessitates further research. A possible study includes research on very preterm babies whose cord is left intact and the fragile infants are cared for in close proximity to their mothers.

A particular area where more research is needed includes the benefits of delayed cord clamping extending into late infancy/early childhood. Out of all of the studies that were appraised in this review, the longest follow-up time was eight-months post birth. More research needs to be done on the benefits of delayed cord clamping and maternal outcomes such as a better birth experience. Currently, literature on delayed cord clamping and maternal impact on birth has only researched the mothers' response during the third stage of labor. Further work also needs to include mothers with high-risk pregnancies and the timing and initiation of delayed cord clamping.

Integration of Imogene King's Theory of Goal Attainment

Midwifery is providing hands-on, holistic care and support for women and their families before, during, and after birth. The role of the midwife is to listen, provide education and advocate for women during pregnancy, labor and birth. Imogene's King Theory of Goal Attainment is based of the idea that the nurse and patient communicate information, set goals together, and then take actions to achieve those goals (Nursing Theory, 2015). It describes an interpersonal relationship that allows a person to grow and develop in order to attain certain life goals.

Integrating Imogene King's Theory of Goal Attainment into midwifery, birth, and delayed cord clamping is supported in current literature. Communication and goal setting is represented in scholarly research defining the impact of delayed cord clamping in terms of implementation of the practice. Practicing delayed cord clamping to reinforce the impact of the newborn supports Imogene King's focus on the interpersonal system that concentrates on interaction, communication, transaction, role and stress of the patient. The midwife's role is to educate parents on DCC, discuss this technique for their birth plan, and preform this practice during birth to meet the patient's goal, making it a positive birth experience. The social system concept of the theory is based on organization, authority, power, status, and decision-making. This system allows the midwife to change her practice and initiate delayed cord clamping for every birth. Also, it is the midwife's responsibility to educate other providers and nurses on the benefits of delayed cord clamping for newborns and mothers. Imogene's Theory of Goal Attainment provides midwives with a theoretical framework to improve and change current practice and patient care for mothers and newborns after birth with delayed cord clamping.

Conclusion

The key results of this critical review emphasize the impact of delayed cord clamping on the newborn. The literature supports delayed cord clamping due to significant health benefits to the newborn. DCC provides a placental transfusion which contains red blood cells and stem cells, increases Hgb and Hct, increases blood volume, decreases anemia in newborns, increases blood pressure soon after delivery, reduces a need for blood transfusion, reduces incidence intraventricular hemorrhage, reduces incidence of necrotizing enterocolitis, improves cerebral oxygenation, and has no impact on active management of the third stage of labor. Preforming delayed cord clamping and keeping the newborn connected to the mother by the placenta and umbilical cord requires minimal training and is free. DCC health effects include illness prevention, health promotion and an increase in mother-infant bonding. Midwives have the ability to practice, advocate and promote this change that allow for delayed cord clamping after one minute post birth or until pulsation ceases. Implementation of this practice will require a collaborative multiple disciplinary approach that can be initiated by midwives. Imogene King's Theory of Goal Attainment provides a theoretical framework to improve patient care for those caring for mothers and newborns during birth. The midwifery model of care, practice and knowledge can be strengthened through increased research focused on the impact of delayed clamping and transitional outcomes of the newborn.

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