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Review

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Standardizing cord clamping: bridging physiology and recommendations from leading societies

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Abstract: The timing of umbilical cord clamping has stirred much greater debate and evolution in the field of obstetrics and neonatology, spurred by advances in medical science as well shifting clinical paradigms. This review seeks to address the history, physiology and clinical applications of different umbilical cord clamping practices around a common theme. The history of these practices and their effects on the mothers as well as new-borns have been addressed in this article along with how modern evidence has been shaping our guidelines. By examining the physiological mechanisms underlying umbilical cord clamping (UCC) and the evolving clinical standards, this article seeks to inform healthcare providers and policymakers on the best approaches for optimizing maternal and neonatal health.

Keywords: umbilical cord clamping; cord clamping; delayed cord clamping; cord milking; extra-uterine placental transfusion

Introduction

The timing of umbilical cord clamping has stirred much greater debate and evolution in the field of obstetrics and neonatology, spurred by advances in medical science as well shifting clinical paradigms [1]. Historically, it was common practice to immediately clamp the umbilical cord within 15–30 s of birth. In recent years, research and guidelines have changed the scope from early cord clamping to waiting at least 1–3 min after birth before clamping or even longer if needed, until pulsation of the cord has finished. This change in protocol is based on advancements in the understanding of neonatal physiology as it pertains to the value benefit from enhanced placental transfusion. This review seeks to address the history, physiology and clinical applications of different umbilical cord clamping (UCC) practices around a common theme. The present review addresses the history of these practices and their effects on the mothers as well as new born, along with how modern evidence has been shaping our guidelines. By examining the physiological mechanisms underlying UCC and the evolving clinical standards, this article seeks to inform healthcare providers and policymakers on the best approaches for optimizing maternal and neonatal health.

Historical context of cord clamping

While cutting the umbilical cord is essential, the rationale behind clamping it is more debated. In 1968, Botha reviewed early literature on cord tying or clamping dating back to 1668 [2]. Initially, the neonatal tie or clamp was used to prevent blood loss from the baby before the umbilical vessels closed naturally. Two additional reasons for clamping the placental side of the cord also emerged: to identify when the cord lengthened, signalling placental separation, and to keep bed linen clean by preventing placental blood from leaking from the cut end of the cord. Botha argued that these reasons were 'not sufficient to justify… clamping' [3]. In 1773, Charles White wrote that 'the common method of tying and cutting the navel string in the instant the child is born… has nothing to plead in its favour but custom [4]. In 1801, Erasmus Darwin wrote, 'Another thing very injurious to the child, is the tying and cutting of the navel string too soon; which should always be left till the child has not only repeatedly breathed but till all pulsation in the cord ceases. As otherwise the child is much weaker than it ought to be' [5].

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Nevertheless, early cord clamping gained popularity over time. In 1899, Magennis introduced a 'midwifery surgical clamp' to replace the traditional cloth tie, claiming that this instrumentation would reduce the risk of infection. He recommended clamping the cord 'when it has ceased to pulsate.' While the clamp became a standard tool in third stage management, the exact timing of its application was seldom recorded [6]. One reason clamping before placental delivery became common was the discovery in 1938 of placental and umbilical cord blood as a valuable source for transfusions. Due to its unique immunological and hematopoietic properties, cord blood has been used ever since for treating various conditions, from malaria to malignancies [7]. In the 1940s, research into erythroblastosis fetalis (haemolytic disease of the newborn) highlighted the role of maternal isoimmunization in the disease's pathophysiology. It was believed that early clamping of the umbilical cord would prevent the transfer of 'excessive amounts of maternal antibody-containing blood' to the newborn. The subsequent development of Rh(D) Immune Globulin in the 1960s reduced the need for early clamping, but by that time, the practice had already become routine [8].

Immediate cord clamping, was initially incorporated in the 1960s as a component of active management during the third stage of labor, aimed to mitigate postpartum hemorrhage risk. This approach, encompassing a set of interventions, traditionally included the administration of a prophylactic uterotonic drug alongside immediate cord clamping and controlled cord traction. The rationale behind early cord clamping and controlled cord traction stemmed from concerns about potential complications following uterotonic drug administration, such as the placenta becoming entrapped in the uterus thereby leading to retained placenta and its related complications [9, 10]. A re-evaluation of the elements comprising active management has revealed that while uterotonic drugs effectively decrease the risk of postpartum hemorrhage, controlled cord traction has been found to lack significant additional benefits. Similarly, recent evidence claims that the timing of cord clamping seems to have minimal impact on the risk of postpartum hemorrhage or retained placenta. Moreover, there is accumulating evidence suggesting potential benefits for infants when cord clamping is delayed [11]. Figure 1 summarizes the timeline of events, from delayed to early and back to delayed cord clamping.

Why timing matters in umbilical cord clamping

The timing of UCC is important because it affects the newborn's transition from fetal to neonatal life, impacting their immediate and long-term health outcomes. When the umbilical cord remains unclamped immediately after birth, there is a brief period during which blood continues to flow between the baby and the placenta, known as "placental transfusion." In term births, this blood flow typically concludes within 2 min, though it may persist for up to 5 min [12, 13]. During this time, the infant receives an average of 80–100 mL of additional blood, which can constitute a significant portion, around a third to a quarter, of the newborn's total blood volume at birth. The extra plasma gained from placental transfusion is rapidly integrated into the circulation, resulting in a higher red blood cell count. Consequently, this process contributes approximately 20–30 mg/kg of

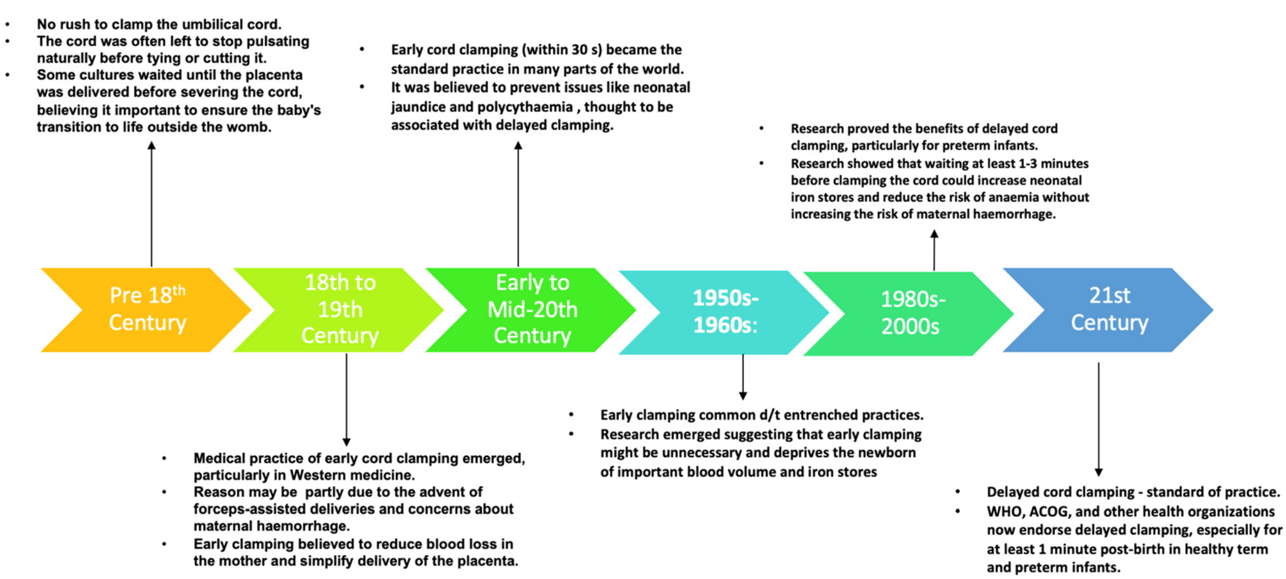

Figure 1: The timeline of events, from delayed to early and back to delayed cord clamping.

iron to the infant's iron stores [14, 15]. DCC provides extra blood volume, which supports the cardiovascular system and helps the newborn transition to breathing outside the womb by providing adequate oxygen delivery during the first few minutes of life. It also increases the transfer of stem cells to the newborn, which can have regenerative properties and potentially improve organ development and repair.

Fetal to newborn physiology

Fetal circulation is characterized by three key shunts, the ductus venosus, foramen ovale, and ductus arteriosus, which direct oxygenated blood from the placenta to vital organs while bypassing the non-functioning lungs. The umbilical vein carries oxygen-rich blood from the placenta to the fetus, while deoxygenated blood returns via the umbilical arteries [16]. Pulmonary vascular resistance remains high due to fluid-filled alveoli, limiting blood flow to the lungs [17]. Cord clamping after birth initiates several physiological changes in a newborn, transitioning from fetal to neonatal circulation. Once the umbilical cord is clamped, the placental circulation is cut off, leading to an increase in systemic vascular resistance. This causes blood pressure in the newborn to rise, which helps maintain blood flow to vital organs. The increase in pressure on the left side of the heart, due to increased pulmonary blood flow, causes the foramen ovale to close. The increased oxygen levels in the blood and loss of placental prostaglandins cause the ductus arteriosus to constrict and eventually close. The ductus venosus, which shunts a portion of the blood flow from the umbilical vein directly to the inferior vena cava, also closes as the umbilical cord is clamped. Before birth, the lungs are fluid-filled, and only a small amount of blood passes through them [16, 17]. After birth, as the lungs expand and the newborn takes its first breaths, pulmonary resistance decreases significantly, allowing more blood to flow through the lungs for oxygenation. These physiological changes are essential for the newborn to adapt to life outside the womb (Figure 2).

Physiological cord clamping or physiology based cord clamping (PBCC)

Physiological-based cord clamping (PBCC) is an individualized approach to umbilical cord management that prioritizes the newborn's transition to independent breathing and circulation before clamping the cord. Unlike delayed cord clamping (DCC), which follows a set time frame, PBCC ensures the infant has established effective breathing and cardiovascular stability before separation from the placenta [18]. A heart rate above 100 beats per minute, improving skin colour, and increasing oxygen saturation indicate readiness for clamping. Additionally, the cord is typically clamped once pulsations slow or cease, signalling that placental transfusion is near completion. By waiting for these physiological signs rather than following a fixed time frame, PBCC supports a smoother neonatal transition, reducing risks such as hypoxia and hemodynamic instability. This approach allows continued placental transfusion, reducing the risks of hypoxia, hypotension, and intraventricular haemorrhage, especially in preterm infants. By maintaining umbilical circulation until the baby is physiologically ready, PBCC supports better oxygenation, hemodynamic stability, and overall neonatal adaptation [19, 20]. While PBCC offers significant benefits, its implementation requires bedside access to neonatal resuscitation and well-trained healthcare providers. It may not be feasible in emergencies where immediate intervention is needed. Compared to immediate and delayed cord clamping, PBCC provides a more individualized method, ensuring each newborn receives the optimal timing for cord clamping based on physiological readiness rather than a fixed duration.

Extrauterine placental perfusion

Extrauterine placental perfusion (EPP) is a technique used during neonatal resuscitation, particularly in very low birth weight (VLBW) infants, born via caesarean delivery. In EPP, after the baby is delivered, the umbilical cord remains attached to the placenta, which is then kept outside the mother's body (hence "extrauterine"). This allows continued blood flow from the placenta to the baby, potentially aiding in the transition from prenatal to postnatal circulation. The method involves transferring the infant, with the placenta still connected, to a resuscitation unit where additional respiratory support, like mask CPAP (Continuous Positive Airway Pressure), can be provided. This approach is believed to offer the benefits of placental transfusion even after the placenta is detached from the uterus, supporting the infant's circulation and oxygenation during the critical moments after birth [21, 22]. PBCC may stabilize the transition from prenatal to postnatal circulation by allowing blood flow from the placenta, when the cord is not clamped before lung aeration. However, it's unclear if a detached placenta has the same effect. Dunn [23] explored delayed cord clamping (DCC) after placental removal in preterm caesarean births decades ago, finding it safe for mother and infant, even at term. A retrospective analysis showed no adverse outcomes associated with EPP. Delayed cord clamping, physiologic

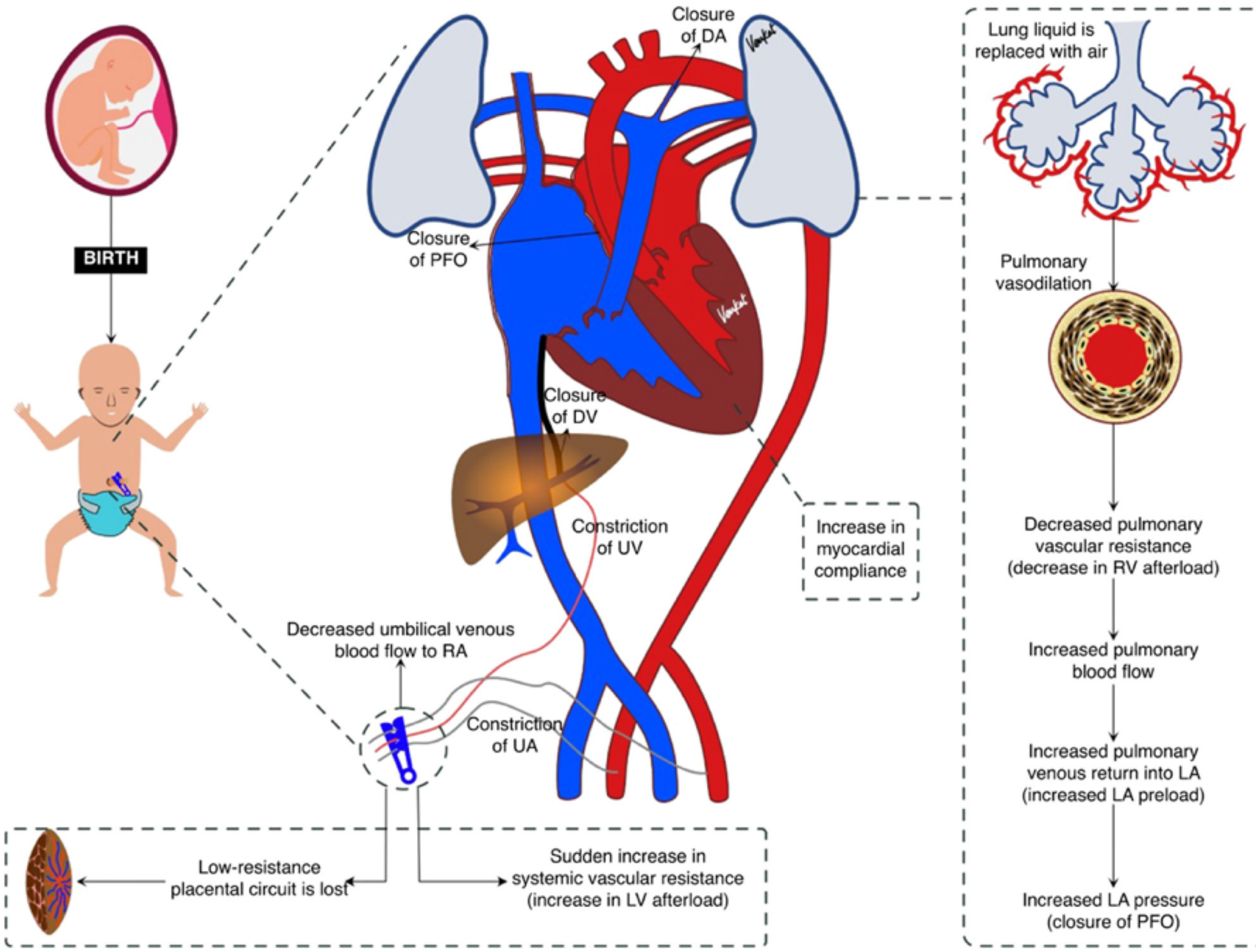

Figure 2: Fetal to neonatal transition after clamping of the umbilical cord (20) (Reproduced from Chakkarapani AA, Roehr CC, Hooper SB, Te Pas AB, Gupta S; ESPR neonatal resuscitation section writing group. Transitional circulation and hemodynamic monitoring in newborn infants. Pediatr res. 2024;96:595–603).

cord clamping and EPP are terms often used interchangeably, but they have some nuanced differences in their definitions and implications (Table 1; Figure 3) [24–44].

Clinical implications, controversies and debates in umbilical cord clamping

There is no universally accepted definition for the duration of “delayed” clamping, leading to varying practices worldwide. Some guidelines recommend waiting 30 s, while others suggest 1–3 min or until the umbilical cord stops pulsating. The lack of consensus complicates clinical decision-making and creates variability in care, particularly in diverse healthcare settings with different resources and protocols. A summary of the leading guidelines in the field are summarised in Table 2. The timing of umbilical cord clamping (UCC) has sparked significant debate among healthcare professionals, researchers, and policymakers due to its implications for both maternal and neonatal outcomes. While there is growing support for delayed cord clamping (DCC), controversies remain regarding its optimal timing, safety, and applicability across various clinical settings [45, 46].

One of the primary concerns associated with DCC is the potential for increased neonatal jaundice due to the additional red blood cell volume transferred to the newborn, which may require phototherapy. Some studies have reported a higher incidence of jaundice in infants who undergo DCC [47], while others find the risk to be manageable and outweighed by the benefits of improved iron status [48, 49]. This has led to disagreements on the safety and feasibility of DCC, particularly in low-resource settings where access to phototherapy may be limited [50, 51]. DCC can

Table 1: A comparison of delayed cord clamping, physiological cord clamping and extra-uterine placental perfusion.

	Delayed cord clamping	Physiologic cord clamping	Extrauterine placental perfusion (EPP) [21]
Definition	Delayed cord clamping (DCC) refers to the practice of waiting for a specific period (usually between 30 s to 3 min) after birth before clamping and cutting the umbilical cord.	Physiologic cord clamping (PCC) is the practice of clamping the cord based on physiological signs rather than a specific time period. This usually means waiting until the umbilical cord has stopped pulsating naturally, indicating that the placental transfusion is complete.	The infant and placenta, still connected by an intact umbilical cord, are removed from the uterus and transferred to a resuscitation unit, and thus initiating the respiratory support while allowing continued blood flow through the umbilical cord. Clamped is done, after onset of regular spontaneous breathing, stable HR>100, and adequate oxygen saturation.
Timing	The timing is usually standardized and may be influenced by clinical guidelines or protocols.	The timing is more flexible and individualized, often ranging from 1 to 5 min or longer, depending on the cessation of cord pulsation.	Variable and individualised, as the cord is clamped after achieving a stable HR>100, and adequate oxygen saturation levels.
Objective	The primary aim is to allow a significant amount of blood from the placenta to transfer to the newborn, improving blood volume and iron stores.	The goal is to align the clamping with the newborn's natural physiological transition from fetal to neonatal circulation, ensuring maximal blood transfer and optimal neonatal outcomes.	To improve the newborn's transition from intrauterine to extrauterine life, potentially reducing the risk of complications associated with immediate cord clamping.
Clinical practice	Easier to standardize and implement in clinical settings with specific protocols.	Requires more clinical judgment and observation, potentially varying more between practitioners and situations.	Still experimental, has been tried for a few cases of very low birth weight babies

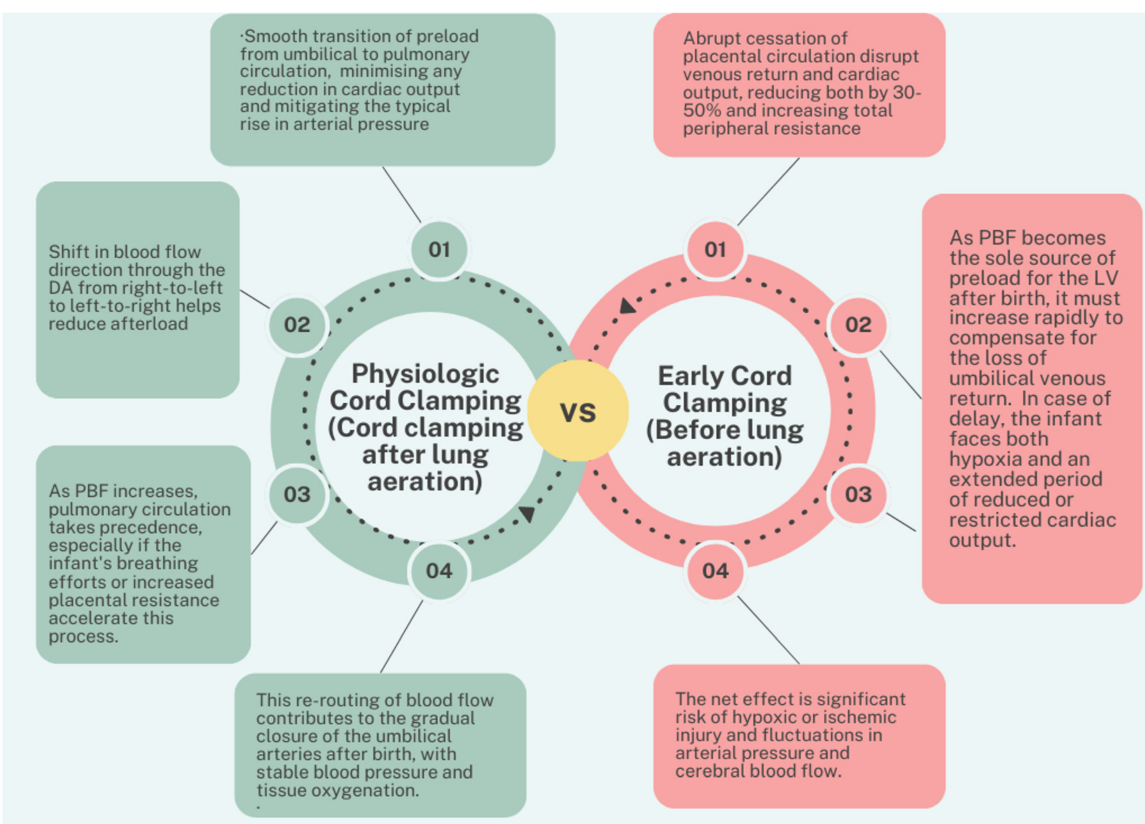

Figure 3: Comparison of physiologic vs. early cord clamping.

result in higher haematocrit levels, potentially causing polycythaemia and hyper viscosity syndrome, which can impair blood flow and oxygen delivery. Critics argue that these risks, though generally rare, necessitate careful monitoring and may not justify DCC in all cases, particularly for high-risk new-borns, such as those with maternal diabetes or growth restriction.

Cord milking has been proposed as an alternative to DCC, especially in situations where immediate care is required for the newborn. Some studies suggest cord milking may provide similar benefits to DCC [52, 53], such as improved blood volume and oxygenation, while minimizing delays in neonatal resuscitation. However, evidence is mixed, and concerns about potential risks like increased intraventricular haemorrhage in preterm infants have led to cautious adoption [54, 55]. There is debate over whether DCC is appropriate for all births, particularly for preterm infants and those delivered via caesarean section. While some studies indicate that DCC can improve outcomes in preterm infants (e.g., reduced need for blood transfusions, decreased intraventricular haemorrhage), others caution that it could delay urgent interventions or resuscitation. The current recommendation for preterm infants <34 weeks' gestation, who do not require resuscitation, delaying cord clamping can be beneficial compared to early cord clamping. In infants between 28 and 34 weeks' gestation where delayed cord clamping cannot be performed, intact cord milking may be reasonable and for infants <28 weeks' gestation, intact cord milking is not recommended due to potential risks.

Controversy also surrounds the use of DCC in specific populations, such as babies born to mothers with certain conditions (e.g., infections, diabetes) or infants with congenital abnormalities. The variability in recommendations reflects the complex interplay of potential risks and benefits that need to be individualized for each patient. In low- and middle-income countries, the debate is often focused on the feasibility and safety of DCC in environments with limited resources. Challenges such as inadequate access to neonatal care, phototherapy, and the training required to implement new practices create hesitancy to adopt DCC universally [12, 50]. Advocates for DCC in these settings argue for tailored approaches that consider local resources and practices, while opponents stress the need for more robust evidence and infrastructure [12, 50].

The optimal approach to cord management in non-vigorous new-borns also remains uncertain, as few studies have validated effective strategies for this high-risk group. Current guidelines recommend delayed cord clamping for 30–60 s while initiating basic stabilization, such as drying and stimulation, unless immediate resuscitation is required. If the infant remains apnoeic or hypotonic, early clamping may be necessary to facilitate advanced resuscitation, including positive pressure ventilation (PPV) [56, 57]. EPP method may offer benefits similar to delayed cord clamping by improving blood volume and oxygenation, but logistical challenges and feasibility in emergency settings remain concerns. Umbilical cord milking has also been explored as an alternative, though its safety in non-vigorous infants, particularly preterm neonates, is still debated [58, 59]. It has been found to be associated with improved hemoglobin levels, reduced need for resuscitation, and lower incidence of hypoxic-ischemic encephalopathy (HIE) requiring therapeutic hypothermia [60]. The choice of cord management strategy should be individualized, balancing the potential benefits of enhanced placental transfusion against the urgency of resuscitation.

The controversies and debates around umbilical cord clamping underscore the complexity of finding a "one-size-fits-all" solution. As research continues to evolve, it remains critical for healthcare providers to consider individual clinical scenarios, weigh the benefits and risks, and apply evidence-based practices tailored to each case. Disagreements between major health organizations, such as the World Health Organization (WHO) and the American College of Obstetricians and Gynaecologists (ACOG), reflect the need for further research and consensus-building efforts. The authors have tried to summarise the best practices for cord management as of now in Figure 4.

Future directions and research needs

As the field of neonatal care evolves, further research is essential to refine UCC practices and address existing uncertainties. While significant progress has been made, several areas require ongoing investigation to optimize outcomes and ensure evidence-based practices across diverse clinical settings. Research is needed to establish the most beneficial duration for delayed clamping, balancing the advantages of increased blood volume and iron stores against potential risks such as jaundice and polycythaemia. Studies should investigate varying time frames for clamping to identify the optimal period that maximizes benefits while minimizing adverse effects. Research should focus on developing guidelines that are adaptable to individual patient needs and conditions, ensuring that both the neonate and the mother receive the best possible care. Research should explore how delayed clamping can be safely implemented in low- and middle-income countries where resources are limited. Studies should assess practical approaches, including training, equipment needs, and cost-

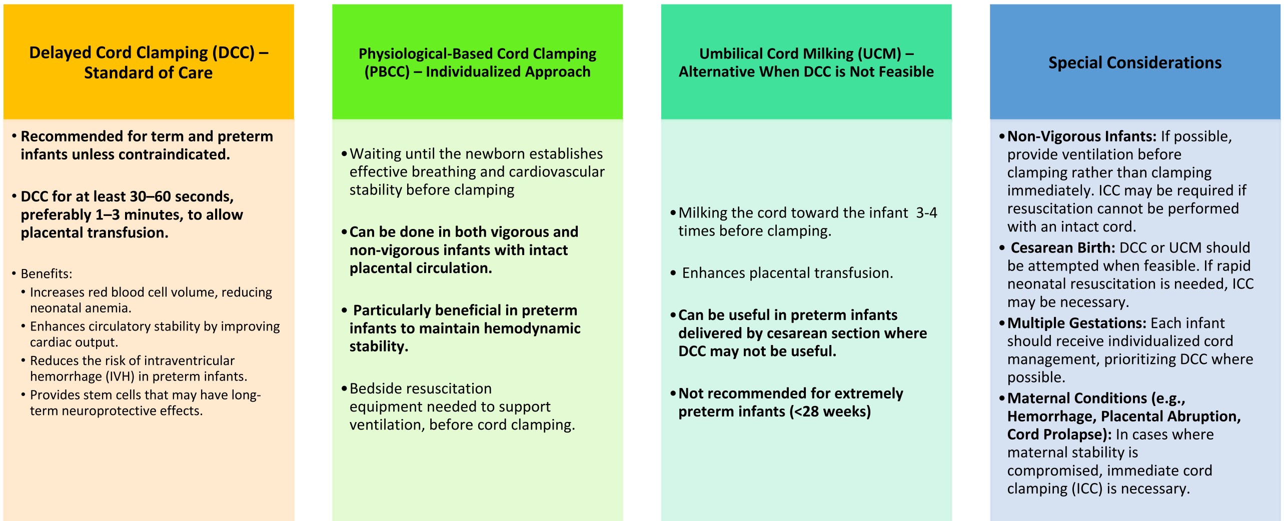

Figure 4: Summary of cord clamping practices: considerations and recommendations.

Table 2: A summary of the leading guidelines on umbilical cord clamping.

Scientific body	Recommendation according to GA and type of delivery	At what time	Benefits/risks of DCC
Italian Recommendation for Placental Transfusion Strategies 2018 [24]	⏳ - VD (T//LPT/PT) CD (T/LPT/PT) 🔀 - CD ✂ - Monochorionic twins, HIV + mothers with higher viral load, CD under GA, foetal hydrops, doubts about integrity of U. Cord, new born with perinatal asphyxia, rhesus disease	T/LPT - 1min PT- 30 s, reassess, if stable 60 s	**Benefits** – Positive effect on neonate haematological parameters, and maintaining cardiac output and less systemic arterial pressure fluctuations **Risks** – NM
ACOG 2017 [25]	⏳ - VD (T/PT) CD(T/PT) ✂ - Multiple gestation, neonates requiring immediate resuscitation, and fetuses in which placental circulation is compromised (abruption, previa, abnormal umbilical artery Dopplers)	30–60 s	**Benefits** – Increases haemoglobin levels and iron stores **Risks** – Small increase in the risk of jaundice requiring phototherapy
WHO 2014 [26]	⏳ VD/CD (T/PT)	1–3 min	**Benefits** – Improves iron reserves, and decreases the risk of IVH, NEC, late onset sepsis in PT. **Risks** – Increased risk of vertical transmission in HIV
RCOG [27]	⏳ T/PT ✂ - Cases with cord prolapse, if newborn is not stable	60 s	**Benefits** – Infants requiring resuscitation **Risks** – NM
European Association of Perinatal Medicine 2024 [28]	⏳ - PT	>30 s	**Benefits** – Increase hemoglobin and hematocrit & decrease risk of IVH & NEC **Risks** – NM
SOGC 2018 [29]	⏳ - PT/T>37 weeks (weigh risk of jaundice with benefits of DCC)	60 s	**Benefits** – Less IVH Less need for transfusions **Risks** – NM
NICE 2015 [30]	⏳ - PT if stable ✂ Unstable PT	60 s	**Benefits** – Not mentioned **Risks** – NM
UK Resuscitation Council 2021 [31]	⏳ T/PT (VD/CD) 🔀 >28 weeks if DCC is not possible.	60 s	**Benefits** – Not mentioned **Risks** – NM
Saudi Neonatology Society on Managing Very Low Birth Weight Infants 2016 [32]	⏳- VLBW	30–60 s	**Benefits** – Not mentioned **Risks** – NM

Table 2: (continued)

Scientific body	Recommendation according to GA and type of delivery	At what time	Benefits/risks of DCC
Singapore Resuscitation Council 2016 [33]	⏳ - T/PT 🔀< 29 weeks ✂️ - Monochorionic twins, placental circulation compromised (Abruption, previa, cord avulsion), immediate requirement of resuscitation	30–60 s	**Benefits** – Lower incidence of IVH, NEC, and lower requirement of blood transfusion **Risks** – NM
ANZCOR 2024 [34]	⏳ - T/LPT/PT 🔀 - PT<28 weeks ✂️ - Individualized decisions based on maternal and neonatal risk in multiple gestation, placental abnormalities, foetal anemia/alloimmunization, maternal illness, congenital anomalies and in infants requiring resuscitation	At least 30 s, preferably 60 s	**Benefits** – Not mentioned **Risks** – NM
Swiss Society of Neonatology 2017 [35]	⏳ (VD/CD) T/PT 🔀 (CD – T/PT) and in PT Considered if immediate cord clamping is required	60 s	**Benefits** – Not mentioned **Risks** – NM
Queensland Clinical Guidelines 2022 [36]	⏳ - T/LPT/PT 🔀 PT (28–33+6weeks: Alternative to DCC. Not recommended in PT<28 weeks	60 s	**Benefits** – Increase cardiac output and stable blood pressure, and higher Hb levels **Risks** – Increase incidence of jaundice requiring phototherapy
Association of Ontario Midwives 2024 [37]	⏳ - T/PT	NM	**Benefits** – Improves iron stores and Hb levels **Risks** – NM
FIGO 2014 [38]	⏳ - T/PT ✂️ - Placenta previa, vasa previa, Rh negative mother, newborn needing immediate resuscitation	30–40 s	**Benefits** – Reduces neonatal anemia **Risks** – NM
Canadian Paediatric Society 2015 [39]	⏳ - T/PT (not requiring resuscitation) 🔀: No sufficient evidence to suggest as routine practice	NM	**Benefits** – Not mentioned **Risks** – NM
European Consensus on Management of Respiratory Distress [40]	⏳ - PT(Stable) 🔀 (alternative)	30–60 s	**Benefits** – Not mentioned **Risks** – NM
ERAS – C Section 2018 [41]	⏳ - T/PT	T- 60 s PT- at least 30 s	**Benefits** – T: improves iron stores, decreases anemia during infancy and improves neurological outcomes PT- decreases IVH, NEC, less need for transfusions **Risks** – NM
Turkish Neonatal Society Guidelines in Management of RDS 2018 [42]	⏳ - T/PT 🔀: In emergency situations such as PT requiring resuscitation, maternal bleeding. ✂️ - Infants requiring resuscitation, maternal haemorrhage	30–120 s	**Benefits** – higher hematocrit level, less transfusion requirement, higher blood pressure, lesser NEC and IVH **Risks** – NM
ILCOR 2015 [43]	⏳ - PT(Stable) ✂️ - PT (unstable) 🔀 - PT (28 weeks)	30–60 s	**Benefits** – Increase HB levels, requirement of less transfusions, and decrease incidence of IVH, NEC **Risks** – NM
American Academy of Paediatrics (AAP) [44]	⏳ - T/PT ✂️ - Infants requiring resuscitation	30 s	**Benefits** – Improves anaemia Increases iron stores **Risks** – NM

⏳ - delayed cord clamping; 🔀 - umbilical cord milking; ✂️ - immediate cord clamping; T, term; LPT, late preterm; PT, preterm; VD, vaginal delivery; CD, caesarean delivery; IVH, intraventricular haemorrhage; NEC, necrotizing enterocolitis.

effectiveness, to ensure that the benefits of delayed clamping are accessible in all healthcare settings.

Conclusions

The timing of UCC is a significant aspect of neonatal care that has evolved from traditional practices to evidence-based guidelines. This comprehensive review has explored the historical context of UCC, highlighting how practices have shifted from immediate to delayed clamping based on advancements in medical understanding. The physiological insights presented underscore the benefits of delayed cord clamping, including enhanced blood volume, improved iron stores, and reduced risk of anaemia, while also addressing potential risks such as neonatal jaundice and polycythaemia. The review has also examined the clinical implications of different UCC practices, revealing how immediate and delayed clamping can impact both maternal and neonatal health. Current guidelines advocate for delayed clamping in most cases, given its demonstrated benefits for neonatal outcomes. However, the review also acknowledges ongoing debates and controversies, including concerns about the timing of clamping in specific scenarios, such as preterm births or caesarean deliveries, and in resource-limited settings.

As the evidence base continues to grow, it is crucial for healthcare providers to stay informed about the latest research and guidelines. The implementation of UCC practices should be individualized, taking into account the specific circumstances of each birth, including the health of the mother and the newborn, as well as available resources. Future research should focus on addressing existing gaps, such as the optimal duration of delayed clamping, the management of potential risks, and the application of UCC practices in diverse clinical settings. By integrating historical knowledge, physiological understanding, and current clinical evidence, this review aims to provide a comprehensive perspective on umbilical cord clamping, ultimately guiding practitioners towards informed decision-making and improved outcomes for mothers and their new-borns.

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