Delayed umbilical cord clamping in term and near-term newborns

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ABSTRACT

Background and objectives. The authors are shortly reviewing the national and international recommendations for umbilical cord clamping at birth and the most important evidence supporting these recommendations. Also, based on the recommendations discussed, a clinical protocol for delayed umbilical cord clamping (DCC) is proposed.

Keywords: newborn, neonate, late preterm infant, delayed umbilical cord clamping, immediate umbilical cord clamping, clinical protocol

List of abbreviations (in alphabetical order):

DCC — delayed umbilical cord clamping
ICC — immediate umbilical cord clamping

DELAYED UMBILICAL CORD CLAMPING — DEFINITION, PHYSIOLOGY, RISKS, AND BENEFITS

Placental transfusion defines the transfer of the residual placental blood to the newborn during the first minutes of life[1]. This can be accomplished using different methods: delayed cord clamping (DCC), physiological-based cord clamping (PCC), milking of the intact umbilical cord (IUCM), and milking of the cut-umbilical cord (CUCM).

Studies have shown that, by term gestation, about one-third of the blood in the feto-placental unit flows through the placenta and two-thirds through the fetus at any point in time[2] and immediate umbilical cord clamping (ICC) is associated with approximately 30% of the feto-placental blood remaining in the placenta, while DCC for 60 seconds may reduce this blood volume to 20% and DCC for 3-5 minutes is associated with reduction of the feto-placental blood to 13%-3[3]. Increasing the blood content of fetal hemo-globin by increasing the placental transfusion is associated with increased arterial oxygen content and oxygen tissular delivery.

The amount of blood transferred to the neonate by fetal-placental transfusion is determined by some important factors. The most important factor impacting the amount of transfused blood is the time of cord clamping. Farrar et al. [4] has estimated the placental transfusion for vaginal and cesarean deliveries by measuring infant weight gain in the first 5 minutes of life with their cords left intact and found that the mean amount of placental transfusion was 81 ml (range, 50–163 ml) or 25 ml/kg (range, 16–45 ml/kg). Also, Yao et al. [2] have demonstrated that the blood volume of a term neonate is approximately 70 ml/kg after ICC compared to approximately 90 ml/kg using DCC for 3 minutes. Uterine contractions are the main determinant of placental transfusion in spontaneous deliveries with DCC. This is explained by the pressure...
gradient between the umbilical venous pressure between contractions (40-50 mmHg) and during uterine contractions (100 mmHg), thus providing the blood flow from the placenta to the neonatal circulation. Approximately 50% of the placental transfusion is facilitated by uterine contractions during the third stage of labor [1]. Another factor influencing the amount of fetoplacental transfusion is the neonate’s umbilical blood flow. During the third stage of labor, after delivery, the umbilical arteries constrict, minimizing the amount of blood flow from the newborn to the placenta and the umbilical vein remains patent, facilitating the placental transfusion[5]. Neonatal respiration at birth – by creating negative intrathoracic pressure and increasing the gradient between placental vessels and fetal/neonatal right atrium - also influences placental transfusion as the oxygen increase in neonatal blood stimulates umbilical arteries constriction[1]. Pulmonary blood flow is increased secondary to lung aeration, supplying most of the preload to the left ventricle, thus increasing the cardiac output and maintaining cerebral blood flow and oxygenation. Studies have shown that a sufficient placental transfusion, for example by DCC, would increase the cerebral blood flow at birth, reducing the risk for intraventricular hemorrhage[6,7]. On the other hand, in term infants without spontaneous respirations before cord clamping, Ersdall et al[8] have demonstrated an increased risk for death or neonatal intensive care unit (NICU) admission. Studies have shown conflicting results as regards the influence of the position of the infant on the volume of fetoplacental transfusion: Yao et al.[3] have found that positioning the newborn above the placenta decreases placental transfusion to volumes similar to ICC while other studies have found no difference between the amount of transfused blood after DCC for 2 minutes with newborns placed on the maternal abdomen versus positioning the infant at the introitus[9] but positioning the infant on the maternal abdomen immediately after delivery and using DCC for 5-min resulted in a significantly larger placental transfusion compared to DCC for 2 minutes[10].

Katheria et al [1] have summarized the theoretical risks of placental transfusion - over-transfusion, symptomatic polycythemia, jaundice, hypothermia, persistent pulmonary hypertension (PPHN), and delayed resuscitation – but mentions that none of these above-described risks occurred in randomized-controlled trials and meta-analyses on term or even preterm infants. No evidence of over-transfusion has been found in randomized controlled trials[11,12]. No hypothermia was reported in the meta-analysis in term and preterm infants[7,13], supposing because of the better peripheral perfusion as the transfused blood is also distributed to the peripheral circulation[14,15]. Despite concerns related to an increased rate and consequences of polycythemia and hyperbilirubinemia, a recent meta-analysis has found no reports of symptomatic polycythemia after DCC[12]. Hyperviscosity was suggested to contribute to an increased risk of PPHN in association with DCC through its effect on pulmonary vascular resistance (namely increased pulmonary arterial pressure) but infants with PPHN tend to have lower Hb compared with infants with respiratory distress without PPHN, suggesting that placental transfusion may have a protective effect against PPHN by promoting pulmonary blood flow and increasing oxygen transport capacity[1]. No significant difference in risk of jaundice and clinical jaundice has been noted in association with DCC large studies and meta-analyses[11,16], not even in infants with alloimmunization requiring intrauterine transfusion[17]. Apgar scores and incidence of low temperature on admission were similar in newborns with DCC at delivery as compared to ICC[18].

Except for the short-term benefits of increased fetoplacental transfusion by DCC as compared to ICC – improved oxygenation, increased blood flow and cardiac output, improved cerebral blood flow, increased blood volume (with reduced need of blood transfusion in sick term neonates and preterm infants), reduced rate of intraventricular hemorrhage, reduced need for inotropes, reduced risk for necrotizing enterocolitis in preterm infants – studies have demonstrated also long-term benefits. Improved iron stores in the first 6 months of age in term infants[1], motor function at 18-22 months corrected age[19] as compared to ICC, improved scores on fine motor and social domain at 4 years, especially in boys[20] were demonstrated following DCC. An interesting benefit of DCC is the transfer, through placental transfusion, of hematopoietic stem cells, cells with promising results as therapy in preterm and term infants with organ injury (including intraventricular hemorrhage, periventricular leukomalacia, hypoxic-ischemic encephalopathy, bronchopulmonary dysplasia, necrotizing enterocolitis, etc.) or hematopoietic cell line deficiencies[21-23].

DELAYED UMBILICAL CORD CLAMPING - NATIONAL AND INTERNATIONAL RECOMMENDATIONS

Based on multiple evidence accumulated in the literature, national and international guidelines for neonatal care have made, recently, firm recommendations as regards umbilical cord clamping at birth. A survey performed in collaboration with the Union of European Neonatal and Perinatal Societies for newborns born in 2018, has shown that in term infants DCC was performed in 69.7% of infants delivered vaginally, 39.4% in infants delivered by elective C-section, and 6.1% in those delivered by emergency C-section, while in late preterm infants DCC was per-
formed in 63.6% in infants born vaginally and in 33.3% of those delivered by C-section. Lower rates of DCC were found in preterm infants born at 29-32 weeks of gestation (18.2% after vaginal delivery and 24.2% in infants delivered by C-section), and in extremely preterm infants (21.2% both in infants delivered vaginally or by C-section)[24].

The Romanian Association of Neonatology has recently revised the Neonatal Resuscitation national guidelines[25] based on the American Academy of Pediatrics and American Heart Association Neonatal Resuscitation, 8th Edition[26] and European Resuscitation Council Guidelines 2021[27] and updated the recommendations for umbilical cord clamping[28-34]. In preparing for assisting a delivery, the neonatal and obstetrical teams must collaborate in trying to evaluate the need for resuscitation by answering four questions: what is the gestational age of the expected infant?; is the amniotic fluid clear?; are there any other risk factors? What is the management plan for the umbilical cord clamping?[25].

Delayed umbilical cord clamping for 30-60 seconds is advised (Recommendation grade A), ideally until the lung aeration is started, in term and preterm infants that do not need resuscitation at birth based on evidence of multiple health benefits on short and long-term[25] and evidence suggesting that cord clamping earlier than 30 seconds after delivery may interfere with transition to extraterine life[35-38]. If necessary, the neonatal and obstetrical team may initiate neonatal resuscitation with intact umbilical cord in term and late preterm infants (Option grade A)[25] as this attitude leads to a more physiological postnatal transition compared to ICC[33] and, for moderate and small preterm infants, there is no sufficient data to recommend resuscitation with intact umbilical cord[27,39].

Immediate umbilical cord clamping is recommended (Recommendation grade C) in the following situations:
- interrupted placental circulation (abruptio placentae, hemorrhagic vasa praevia, placenta praevia with hemorrhage, rupture of the umbilical cord)
- multiple pregnancies
- intrauterine fetal growth restriction
- abnormal Doppler evaluations of the umbilical arteries
- abnormal placentation
- affected utero-placental perfusion
- affected blood flow through the umbilical cord
- non-vigorous neonates[25].

Interruption of the placental circulation, placental hemorrhage, and maternal hemodynamic instability do not justify DCC as placental transfusion is improbable, the need for neonatal resuscitation is highly probable[26,27,40], and neonatal resuscitation with intact umbilical cord needs special conditions for maintaining neonatal temperature, and the procedure is still evaluated in studies[26]. Physiological cord clamping – defined as cord clamping until the newborn breathes spontaneously or adequate respiratory support is initiated if needed – is offered by the guideline as alternative umbilical cord management (Option grade B)[25]. This attitude is based on data showing faster respiratory stabilization[40] and a 20% reduction of the death or NICU admission risk for every 10-second delay in cord clamping[26]. Umbilical cord milking is suggested as an option (grade A) in neonates >28 weeks gestational age if DCC cannot be performed[25] as UCM has no benefits compared to DCC[34] and is associated with increased risk of intraventricular hemorrhage in extremely preterm infants[27,42]. Finally, the guideline highlights the importance of maintaining a normal body temperature of the newborn and the importance of maternal-neonatal bonding starting from the very first minutes of life. Thus, another grade A recommendation states that term newborns, from uncomplicated deliveries, with good muscular tone, breathing spontaneously or crying at birth should be cared for and continuously evaluated while in skin-to-skin contact with their mothers during DCC[25]. The recommendation is based on studies that demonstrated that skin-to-skin contact and placental transfusion of warm blood prevent heat loss and have multiple benefits for initiating the relationship between the mother and her infant, maintaining normal blood glucose levels, and breastfeeding support[25,26,43].

Despite a large amount of literature already available, the optimal management of the umbilical cord at birth is still the subject of continuous research. The benefits of DCC are continuously explored in different categories of newborns, settings, and situations[44] as another recent study confirmed that low levels of hemoglobin at birth are associated with increased risk for major neonatal morbidities[45]. The safety and efficiency of respiratory support during DCC were confirmed by Nevill et al[46]. Most probably, the most important unclear and debated aspect of DCC is the optimal duration of DCC[47]. Herold et al[48] have demonstrated that DCC ≥ 60 seconds has benefits for newborns and infants up to 1 year of age, while Malik et al[49] have shown that DCC >120 seconds are associated with maximal levels of hemoglobin and hematocrit without increased risk of hyperbilirubinemia, and DCC >180 seconds was not associated with increased incidence of polycythemia or hyperbilirubinemia. There are also unanswered questions as regards the optimal cord management in non-vigorous infants as they need the benefits of placental transfusion and, at the same time, adequate and prompt resuscitation[50]. Efforts are made, therefore, to evaluate neonatal resuscitation with an
intact cord in terms of feasibility and safety as more attention is needed to maintain normal body temperature and multidisciplinary simulation may be needed for safely performing such complex procedures in a standardized manner[51]. A continuous search for the best evidence is mandatory for updating the clinical guidelines and procedures to achieve the best neonatal outcome in the short and long term.

PROPOSED CLINICAL PROTOCOL

A clinical protocol for DCC at birth implies collaborative efforts of obstetrical and neonatal teams. Since benefits are associated with DCC in vaginal and C-section deliveries, the protocol should be applied in all in-hospital deliveries, with some adjustments according to local policies. The following suggested protocol should be modified according to local settings and policies.

Step 1. A timer should be available and set to alarm at 60 seconds. The timer should be started by the neonatal nurse the moment the infant is born.

Step 2. The neonatal and obstetrical teams assisting the delivery should identify prenatal factors/conditions representing contraindications for DCC:
   a) maternal hemorrhage
   b) maternal hemodynamic instability (hypotension)
   c) interrupted placental circulation (abruptio placentae, hemorrhagic vasa praevia, placenta praevia with hemorrhage)
   d) multiple pregnancies
   e) intrauterine fetal growth restriction
   f) abnormal Doppler evaluations of the umbilical arteries
   g) abnormal placentation
   h) affected uteroplacental perfusion
   i) affected blood flow through the umbilical cord

Step 3. Immediately after delivery, the neonatal and obstetrical teams should perform ICC in the following situations observed after delivery:
   a) rupture of umbilical cord
   b) sudden significant maternal hemorrhage
   c) maternal significant hypotension
   d) non-vigorous newborn
   e) neonatal birth asphyxia
   f) absence of neonatal breathing in 30 seconds (no response to the first steps of the neonatal resuscitation).

Step 4. The obstetrician/midwife will perform DCC if none of the prenatal or postnatal situations/conditions mentioned above are observed.

Step 5. DCC is noted in the infant’s chart: if performed, for how long, in seconds; if DCC was not performed or started and interrupted – the reason leading to this decision.

Important observations:

The temperature in the delivery room/operation room should be adjusted to the gestational age of the infant that will be delivered to avoid hypothermia. At least 2 warm blankets or towels should be at hand to dry the skin of the newborn after delivery. Special measures to prevent heat loss should be prepared for the delivery of preterm infants (hat, an extra blanket/towel).

In term and late preterm infants, and even in moderate preterm infants not needing resuscitation or respiratory support, DCC should be performed while the infant is placed skin-to-skin on the maternal abdomen, in the case of vaginal deliveries.

The neonatal team – neonatologist and neonatal nurse – must continuously observe the infant during DCC, while the obstetrical/anesthesiology team continuously observes and monitors the mother.

QUALITY IMPROVEMENT PROJECT PROPOSAL

As DCC is associated with significant benefits for the infant’s health, it represents a good intervention for a quality improvement project. Here is a plan suggested for such a project:

- evaluation of DCC rate in the unit by randomly assisting deliveries and summarization of the number of births when DCC was performed; calculation of DCC proportion from the overall number of observed deliveries, let’s say X%
- establishing the committee dedicated to implementing the project; for DCC, this should be a mixed team, including both obstetricians and neonatologists, seniors and residents in both specialties, midwives and neonatal nurses
- the aim of the project – for example, increasing the rate of DCC from X% to over 80% in 6 months – should be established and announced to all staff involved in the project
- the quality management service of the hospital can be announced and even involved in the project
- identification of the key factors that may help in achieving the targeted results; usually this step implies dissemination of structured information and national and international recommendations through sessions for obstetricians, neonatologists, and nurses (mostly those working in the delivery room); also, the proposed protocol for DCC should be discussed with all staff involved in the delivery rooms and operation rooms; another key factor would be the timers, that must be present in all the delivery rooms and operation rooms
decisions related to DCC documentation in the neonatal charts: how long did DCC last? why DCC was not performed.

- weekly examination of the neonatal charts
- analysis of the gathered data to find if the aim of the project was accomplished (usually by performing a control chart)
- presentation of the results to all staff involved; discussion on the sustainability of the intervention or, if the target was not accomplished, about ways to improve DCC implementation
- periodic evaluation of the DCC rate to determine if subsequent PDSA (plan-do-study-action) cycles will need to be implemented.
- the project can be published.

Also, on behalf of the Romanian Association of Neonatology, we encourage the units to collaborate in scientific research as this may provide us all with a more objective insight into our performances as professionals and the results of our work, the outcome of our small patients.

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