

Hypothesis: Clamping the Umbilical Cord may be Unsafe

A proposed factor to be considered in retrospective and prospective outcome studies by the Pregnancy and Infant Working Group of the National Children's Study (NCS)

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1. Placental blood is respiratory blood

Circulation and an adequate volume blood are essential for respiration. The fetal heart is the earliest organ to become functional, and between the fourth and fifth weeks of development begins circulating erythrocytes produced in the embryonic yolk sac [1]. The placenta becomes a major component of the cardiovascular system between the eighth and tenth weeks [1, 2]. Blood is pumped by the fetal heart through the umbilical arteries to the placenta, where replenished with oxygen and nutrients it returns via the umbilical vein [2, 3]. Placental blood is therefore part of the fetal circulatory system, as much as pulmonary blood is after birth.

Erasmus Darwin in 1801 noted, "The placenta is an organ for the purpose of giving due oxygenation to the blood of the fetus; which is more necessary, or at least more frequently necessary, than even the supply of food" [4, p192]. Oxygen is the most urgently essential ongoing need of all species dependent for survival upon aerobic metabolism.

Research by Redmond et al. in 1965 provided dramatic evidence that the infant's first breath redirects blood from the placenta to the lungs [5]. This so-called "placental transfusion" fills the capillaries surrounding the alveoli, causing them to open [6]. Placental blood is respiratory blood, and appears by nature's design intended for perfusion of the lungs at birth [7].

Shunts in the heart supply sufficient circulation to the lungs for growth during gestation but divert the greatest volume to the placenta to receive oxygen. Once pulmonary circulation and breathing are established, these shunts close, but they may remain open with the newborn infant's heart continuing to pump blood through the umbilical arteries for a period of time up to several minutes after birth [8]. Placental respiration therefore does not cease immediately after birth, unless the cord is clamped.

2. Umbilical cord clamping, a human invention

Clamping of the umbilical cord at birth is a human invention, and it has long been the subject of controversy [9-35]. The potential danger of umbilical cord clamping was explained by Charles White in 1773, also indicating how long this controversy has gone on. White recognized that time was required for the changeover from prenatal to postnatal circulation, and that placental circulation should continue during this transition:

"The common method of tying and cutting the navel string in the instant the child is born, is likewise one of those errors in practice that has nothing to plead in its favour but custom. Can it possibly be supposed that this important event, this great change which takes place in the lungs, the heart, and the liver, from the state of a foetus, kept alive by the umbilical cord, to that state when life cannot be carried on without respiration, whereby the lungs must be fully expanded with air, and the whole mass of blood instead of one fourth part be circulated through them, the ductus venosus, foramen ovale, ductus

arteriosus, and the umbilical arteries and vein must all be closed, and the mode of circulation in the principal vessels entirely altered - Is it possible that this wonderful alteration in the human machine should be properly brought about in one instant of time, and at the will of a by-stander?" – White 1773, p 45 [9]

3. Waiting for the first breath, a long tradition

It should go without saying that a newborn infant must be breathing before the umbilical cord is clamped. Until the mid 1980s most textbooks taught this explicitly, and many encouraged waiting for pulsation of the cord to stop, as can be seen from the following quotes:

"If the child be healthy, and not have suffered from pressure, &c. it will cry as soon as it is born, and when respiration is established, it may be separated from its mother..." – Churchill 1850, p 132 [36].

"A strong healthy child, as soon as it is born, will begin to breathe freely, and in most cases cry vigorously. As soon as it has thus given satisfactory proof of its respiratory power, you may at once proceed to separate it from its mother by tying and dividing the umbilical cord." – Swayne 1856, p 20 [37].

"The cord should not be tied until the child has breathed vigorously a few times. When there is no occasion for haste, it is safer to wait until the pulsations of the cord have ceased altogether." – Lusk 1882, pp214-215 [38].

In cases of suspended animation, the cord should not be tied until it has ceased to pulsate, as there is a possibility in such circumstances, of a certain amount of placental respiration..." – Leishman 1888, p 320 [39].

"Q: When an infant is born what is the proper treatment to adopt to severing the umbilical cord? A: You must first assure yourself that the child is alive and breathing ..." – Corney 1899, p 5 [40].

"When respiration is established, let the infant rest on the bed between the thighs of the mother, preferably on its right side or back, avoiding contact with the discharges, while the navel string is attended to. No haste is necessary in tying and cutting the cord, unless relaxation of the uterus, flooding, or some other condition of the mother, requires immediate attention from the physician." – King 1907, pp260-261 [41].

"As soon as the child is born, its eyes are wiped, any mucus in the air passages is removed, and it is placed in a convenient position between the patient's legs. The cord is tied as soon as it has stopped pulsating, and the infant is then removed." – Jellett 1910, p 350 [42].

"Normally the cord should not be ligated until it has ceased to pulsate..." – Williams 1917, pp 342-343 [43].

"... A compromise is usually adopted, in that the cord is not tied immediately after birth, nor does one wait till the expression of the placenta, but only until the cessation of pulsation in the cord, an average of five to ten minutes." – vonReuss 1921, p 419 [44].

"After waiting until the pulsation in the exposed umbilical cord has perceptibly weakened or disappeared, the child is severed from its mother." – DeLee 1930, p330 [45].

"In most clinics the cord is not tied until pulsation has ceased." – Curtis 1933, p 828 [46].

"...If the infant has cried and has respired well for about five minutes, there is no advantage in leaving it attached any longer to the placenta." – FitzGibbon 1937, p 128 [47].

"As soon as respiration is well established, lay the child on the bed on its side. Wait for a few minutes until the cord shows signs of ceasing to pulsate..." – Johnstone 1949, p 190 [48].

"After waiting until the pulsation in the exposed umbilical cord has ceased, the child is severed from its mother." – Greenhill 1951, p 251 [49].

"The cord is cut after about three minutes or after it collapses." – Greenhill 1955, pp280-282 [50].

"After pulsation in the exposed cord has ceased, using dull scissors, the child is separated from its mother." – Greenhill 1965, p 376 [51]

"The cord is clamped and divided as soon as pulsations have ceased." – Garrey et al. 1974, p359 [52]

"The umbilical cord should be tied up after its vessels stop pulsating, which occurs in 2-3 min following the delivery of the infant." – Bodyazhina 1983, p 156 [53].

"Q: What is the significance of continued pulsation of the arteries in the umbilical cord at birth? A: It means that respiration has not commenced. The physiological stimulus causing closure of umbilical arteries (and ductus arteriosus) is an increase in oxygen saturation of the blood which occurs when the lungs expand with air." – Beischer et al. 1986, p 710 [54].

4. Recent change of opinion

Reasons for clamping the cord early were stated in many of the above textbooks. Cord around the neck occurs in about one out of every four births, and though efforts to loosen the loop are usually encouraged, often the advice was to clamp the cord to hasten delivery. Eastman, editor of the tenth edition of William's Obstetrics in 1950 cited other factors such as apnea from anesthesia, quick repair of the episiotomy, and management of the third stage of labor:

"Whenever possible, clamping or ligating the umbilical cord should be deferred until its pulsations wane or, at least, for one or two minutes.

There has been a tendency of late, for a number of reasons, to ignore this precept. In the first place the widespread use of analgesic drugs in labor has resulted in a number of infants whose respiratory efforts are sluggish at birth and whom the obstetrician wishes to turn over immediately to an assistant for aspiration of mucus and, if necessary, resuscitation. This readily leads to the habit of clamping all cords promptly. Secondly, there is the episiotomy wound to suture; and the quicker the repair is started, the shorter will be the duration of anesthesia, and the less the blood loss from the wound. Finally, modern management of the third stage, especially if ergonovine has been given with the birth of the anterior shoulder, calls for immediate attention to the uterus and furnishes another reason for handing the baby to an assistant or nurse as promptly as possible. These three tendencies of modern obstetrics, then, notwithstanding their several merits, do militate against delayed clamping of the cord." – Eastman 1950, pp397-398 [55].

Efforts to minimize jaundice became another impetus for clamping the umbilical cord early, even after the cause of maternal-infant Rh-factor incompatibility was understood, and exchange-transfusion and RhoGam treatments available [27, 56]. Opinion, not evidence, appears to have led to recruitment of many adherents to this "school of thought" [7].

5. Hypovolemic shock

Waiting for the infant to cry is no doubt instinctive for most obstetricians and midwives before clamping the cord. However, recently developed delivery-room protocols state that the cord should be clamped immediately [57]. This protocol has found its way into several recent textbooks [58-62]. If followed too literally, clamping of the cord before the first breath could not only obstruct the shift of placental blood to the lungs, but also leave the infant in a state of hypovolemic shock. Reports on transfusions and blood volume expanders needed for infants in neonatal intensive care units indicate that hypovolemia may not be an infrequent problem [7, 63].

Most infants do breathe within seconds of birth, but as Dunn [8] pointed out, "There is often a delay after delivery before breathing commences." Continuing pulsation of the umbilical cord stump was observed in newborn infants and correlated with early respiratory distress by Desmond and coworkers in 1959 [64]. The lungs, not the amputated placenta, should become the target of respiratory blood flow after birth. Waiting for the infant to breathe on its own is the best indicator that circulation has shifted from placental to pulmonary respiration.

6. Ischemic brain damage

In experiments with monkeys on asphyxia at birth, the first breath was prevented by delivering the newborn head into a rubber sac, and placental respiration stopped by clamping the umbilical cord [65-71]. The purpose was to investigate ways to prevent cerebral palsy, but the asphyxiated monkeys did not develop cerebral palsy, and what Myers termed "a monotonous rank order of brainstem lesions" was the pattern of damage found in the brain [70]. Myers later found that prolonged partial obstruction of placental blood flow late in gestation was the cause of cerebral palsy and its well-known pattern of damage to cortical and subcortical motor systems.

Windle proposed that the brainstem pattern caused by suffocation and umbilical cord clamping at birth might underlie the syndrome known at that time as "minimal cerebral dysfunction" [67, 71]. So-called minimal involvement of the central nervous system corresponds to present-day designations of "attention deficit disorder" or "pervasive developmental disorder," behaviorally-defined syndromes without involvement of motor systems.

The midbrain auditory nucleus, the inferior colliculus, sustained the most severe damage in monkeys subjected to suffocation with umbilical cord clamping. The monkeys were not deaf, but they did not orient to sounds the way normal monkeys do [67, 69].

The ability to learn language "by ear" as most children do should be investigated as the possible result of such damage to the auditory system at birth. The most serious aspect of pervasive developmental disorders (or autism spectrum disorders) is the language disorder. So much more hope can be held out for the child who learns to speak; the child is then regarded as "high functioning." But a pedantic, stilted, parrot-like manner of speaking often remains as a life-long handicap; these are children who will never become quite the person they would have been.

7. Language development

The well-recognized ability of normal young children to learn a second language without a foreign accent provides evidence of the importance of the auditory system for language learning. The brainstem auditory pathway is myelinated and functional by 29 weeks of gestation [72, 73], whereas myelination of the temporal and frontal lobe language circuits continues during the first decade of life [73]. Thus, learning to speak begins before the temporal and frontal language areas of the cortex are complete.

Learning to speak requires "hearing" the boundaries between words and syllables [74]. The healthy human auditory system is then able to disassemble rapid streams of speech into elemental sound components. The rules of syntax are learned with maturation of the cortical language areas, which appear to develop as targets of trophic growth factors produced within nuclei of the brainstem auditory pathway [75, 76]. Ischemic damage of brainstem auditory nuclei at birth would then prevent normal development of the language areas during later childhood.

8. Evidence versus opinion

The evidence from the research with monkeys has been neglected too long. Windle, Myers and other investigators held the opinion that brainstem damage was insignificant and at most responsible for minimal dysfunction [67, 70]. But can any damage within the brain be considered minimal?

Umbilical cord clamping is a tradition based on opinion. It is understandable how clamping the cord might in the past have been thought of as a way to prevent hemorrhage. The thinking that polycythemia and jaundice could be prevented by clamping the cord is more recent. But bilirubin-staining of the brain is selective for particular subcortical nuclei, recognized early-on as the same sites vulnerable to ischemic damage [77-87].

Placental blood is not superfluous; it is not blood that might overload the circulatory system of the infant, nor should it be discarded or stored for possible use in the future. Placental blood is part of an infant's prenatal circulatory system, essential for respiration. The lungs need the placental blood before they can take over the respiratory functions.

9. Increased prevalence of childhood disorders

Prevalence of autism, attention deficit disorder, asthma, diabetes, and other childhood conditions appear to have increased dramatically over the past decade or two. Some of these may be the unintended outcomes of the protocol for immediate umbilical cord clamping, which has become standard practice during the same period of time. Follow-up studies must be conducted far longer than discharge from neonatal care nurseries. Language development is the most important early outcome to investigate.

Failure in school, truancy, school dropout, erratic employment, vagrancy, and criminal activity are later outcomes that should be investigated, as well as seizure

disorder, conduct disorder, antisocial personality disorder, and related problems like explosive rage. Abusive parents, prenatal exposure and early use of alcohol and other drugs have long been blamed for problems of school-aged children and adolescents. However, note the similarity of ischemic brainstem damage to the bilateral symmetric brainstem lesions (Wernicke's encephalopathy) caused by chronic alcohol use.

The evidence seems plentiful enough and too tragic to suggest any further studies with human infants on immediate versus delayed cord clamping. Animal activists may protest, but further investigation of monkeys subjected to suffocation and umbilical cord clamping should be done to determine the extent and seriousness of handicaps caused by ischemic damage of brainstem nuclei, especially those within the auditory pathway.

10. Dependency and lifelong need for care

Developmental disabilities remain lifelong handicaps. Retrospective data is plentiful. I work in the Massachusetts state hospital for mentally ill prison inmates. Special education, seizure disorder, school dropout, and erratic employment history are documented in the charts for the majority of these patients. Often the comment of a mother is included that her son suffered oxygen deprivation at birth. Many of these birth records could be examined.

Mainstreaming of mentally handicapped people is the goal of current treatment. At the same time, the numbers of people in prisons is increasing, and incarceration is the costliest kind of long-term care. There is no cure for brain damage. Every effort must be made to prevent it, and to acknowledge and change current practices that may be adding to the increasing numbers of handicapped people.

11. Factors in need of closer examination

a) Circulatory overload, polycythemia, and jaundice are current reasons for immediate clamping of the umbilical cord. However, bilirubin-staining is not uniform throughout the brain. It has long been recognized that bilirubin only enters subcortical nuclei vulnerable to ischemic damage. Ischemia causes impairment of the blood-brain barrier that prevents normally high neonatal levels of bilirubin from getting into nerve cells [77-87]; Zimmerman and Yannet pointed out in 1933, "This differs in no way from the well known fact that any intravital dye will localize in zones of injury, and will leave unstained tissues which are not damaged" [81, p757]

b) The placental fetal-maternal blood barrier should prevent fetal blood from entering the maternal circulation where antibodies to the Rh-factor can be produced by an Rh-negative mother. Dunn proposed that clamping the umbilical cord increases blood pressure within the placenta which leads to the leaking of blood [88-89].

c) As long as the umbilical cord pulsates after birth, the newborn cardiovascular system is sending a signal to the placenta for continuing oxygenation and/or blood volume from the mother. The observation of Desmond et al. made in 1959 that continuing pulsation of the umbilical stump is associated with respiratory distress remains an important body of evidence despite having become part of forgotten history [64].

d) The list of environmental worries during pregnancy, infancy, and childhood is long and includes not only fears of bilirubin, but also mercury (in fish, vaccines, and amalgam dental fillings), lead (in air and household paint), prenatal exposure to alcohol and other drugs (including anti-convulsant medications like valproic acid), prenatal exposure to maternal stress hormones, food additives (coloring and preservatives), carbon monoxide and other fumes from second-hand smoke, toxic pollutants like PCBs, prenatal infections like rubella, HIV (and formerly syphilis), food allergens like gluten and lactose, hypoglycemia, and hyperglycemia.

Shouldn't the essential and continuous need for oxygen also be on this list? The evidence is clear, from experiments with monkeys asphyxiated at birth, that the brainstem nuclei of high metabolic rate sustain injury. With time the effect of early brainstem impairment (which some dismiss as minimal) becomes far more widespread [68].

e) A connection should be considered between the greater vulnerability of male infants to complications at birth and the greater numbers of male children who are afflicted with developmental disorders [90-93]. I hold music appreciation groups at work; I take patient requests and create CDs that are compilations of these requests. At Christmas time one patient requested Harry Belafonte's "Mary's Boy Child." As we listened to this song I looked at the men (prison inmates) around the table and realized each and every one was once someone's much desired boy child. Our prisons hold large numbers of, mostly men, many who were also cognitively and behaviorally disturbed from early childhood; the evidence is in their medical charts and offender records.

f) Mahffey and Rosedale in 1957 and 1959 described the frequent disaster of umbilical cord clamping during the assisted birth of thoroughbred foals. The newborn foals often developed a convulsive disorder or appeared to have an autistic-like lack of awareness even of their own mother [22, 94]. Mary, who gave birth to her boy child in a stable, without expert assistance and perhaps with nothing to tie off the cord, does serve as our best role-model.

g) The current common cultural understanding of "umbilical cord" may primarily be the connection an astronaut needs to the mother-ship while out on a space walk, with electronic sensors and signals to maintain air flow and optimum oxygen supply. How far removed we are from helping with human birth at home or observing birth of farm animals.

Pulsations in the umbilical cord of a newborn child signal that oxygen and/or additional blood volume are still needed from the mother. Most infants do breathe within seconds after birth, thus gain the placental transfusion needed for activation of the lungs [5]. For those few who are slow to take the first breath, White's comment on neonatal transition bears repeating:

"The lungs must be fully expanded with air, and the whole mass of blood instead of one fourth part be circulated through them; the ductus venosus, foramen ovale, ductus arteriosus, and the umbilical arteries and vein must all be closed, and the mode of circulation in the principal vessels entirely altered – Is it possible that this wonderful alteration in the human machine should be properly brought about in one instant of time, and at the will of a by-stander?" – White 1773, p 45 [9].

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