

Effect of Time of Cord Clamping on Serum Bilirubin Level among Full Term Babies Born at Tikur Anbessa Specialized Hospital: A Three Arm Randomized Control Trial.

Biruk Hailu Tesfaye (✉ brkhailu41@gmail.com)

Addis Ababa University

Mulugeta Betre Gebremariam

Addis Ababa University

Abiy Seifu Estifanos

Addis Ababa University

Asrat D. Gebremedhin

Addis Ababa University

Research Article

Keywords:

Posted Date: March 9th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-237034/v2>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

Background

Delayed cord clamping (DCC) above one minute is associated with nutritional and developmental benefits for newborns. DCC could also lead to elevated serum bilirubin, leading to jaundice that require phototherapy at the early ages of life. However, evidence on the relationship between DCC and outcomes is limited in resource-limited settings.

Objective

To evaluate the effect of the time of cord clamping on serum bilirubin level at 24 hours post-birth in an Ethiopian Tertiary Care hospital.

Methods

A three-arm, single-blind, randomized controlled trial was conducted between October 2019-January 2020 targeting healthy, full-term neonates. Study participants were randomly assigned into one of the following interventions depending on the timing of cord clamping: immediate cord clamping (< 30 seconds), intermediate cord clamping (60 sec), and delayed cord clamping (180 seconds). The primary outcome is serum bilirubin level in the newborns, which was assessed at 24-hour after birth and before they were discharged home.

Descriptive analysis was applied to assess differences between groups in terms of demographic, obstetric, and social characteristics of participants, while a linear regression model was employed to examine the association between cord clamping time and serum bilirubin level. STATA version 14 was used for statistical analyses.

Result

A total of 141 term newborns were included and randomized into the three categories. Demographic, social and obstetrics factors of the women were not different across groups except labor duration that had a P-value < 0.05. Time of cord clamping was not a significant predictor of total serum bilirubin levels at 24 hours post-birth, whereas cord blood total serum bilirubin (coef. 0.24; $p < 0.05$) and bilirubin nomogram high-risk zone (Coef. 6.25; $p < 0.001$) were significant predictors.

Conclusion

Time of umbilical cord clamping does not affect the total serum bilirubin level of neonates at least within 24 hours of birth.

Introduction

According to global estimates, Ethiopia is one of the top nine countries that contribute half of the total childbirth around the world with more than 9000 births every day.¹ From the total live births, around 75% of them are delivered with spontaneous vaginal delivery under the risk of facing several challenges and complications around the time of birth.²

Jaundice (hyperbilirubinemia) is one of the challenges within the first 24 hours of childbirth. Hyperbilirubinemia is defined as an excessive level of bilirubin ($> 34.2 \mu\text{mol/L}$ or 2 mg/dL) either in the conjugated or unconjugated form.³ Eighty percent of bilirubin is derived from the heme group of hemoglobin, which comes from the destruction of red blood cells (RBCs) in the reticuloendothelial of the liver, spleen, and bone marrow.⁴ The destruction of RBCs could occur either due to premature rupture or excessive RBCs (polycythemia) and is directly influenced by the delay in the clamping time that gives an extra 80-100mL of blood within the first 1–3 minutes to enter the neonate circulation.^{5–7}

The case fatality rate for neonatal jaundice and severe complications in Low- and Middle-Income Countries range between 20% and 60%.⁸ The case in Ethiopia is not different from the rest of Africa; it is estimated that about 13% of neonates born in hospitals develop neonatal jaundice, while 7% of them develop severe related complications like bilirubin encephalopathy.⁹

During the first few minutes after birth, there is a circulation of blood from the placenta to the infant. Delaying clamping of the umbilical cord by 2 to 3 minutes or until the pulsation of the cord stops will allow the physiological transfer of placental blood to the infant.³ Evidence shows that delayed cord clamping is beneficial in preventing neonatal hospital mortality.¹⁰ This is mainly because of its potential to lower the risk of reduced hematocrit level at 24 hours and also reducing the risk of iron deficiency at 3–6 months post-birth.^{10,11} The implementation of delayed cord clamping (DCC) has a good deal of support globally for the healthy outcome of neonates and mothers, despite arguments on its potential adverse effects.

Although multiple studies revealed the immediate and long-term benefits of implementing DCC for both the neonate and the mother,³ emerging pieces of anecdotal evidence reported the counter effect of delaying the cord clamping; mainly attributed to the increasing neonatal risk of polycythemia and neonatal jaundice that require phototherapy.^{11,12}

Based on the findings from various randomized clinical trials and reviews, the World Health Organization (WHO) recommends delayed umbilical cord clamping (not earlier than 1 min after birth), as it can improve maternal and infant health and nutrition outcomes.³ However, there is a need for studies to establish the association between DCC and the risk of hyperbilirubinemia on newborns.³ Particularly, there is a relative

paucity of data from resource-limited settings on the clinical outcomes associated with the implementation of delayed clamping. Therefore, creating evidence based on the effect of DCC on outcomes in newborns will be instrumental in informing clinical guidelines.

This study aims to evaluate the effect of time of umbilical cord clamping on serum bilirubin level and the proportion of hyperbilirubinemia that requires phototherapy.

Methods

Study setting

This three-arm parallel randomized control trial was conducted at Tikur Anbessa Specialized Hospital (TASH)—the largest referral and teaching hospital in Ethiopia.

The study protocol (separately attached) was approved by the institutional review board at the College of Health Sciences, Addis Ababa University (AAU/SPH-IRB/0056) and respective departments of obstetrics/gynecology and neonatology within the TASH.

written informed consent was provided by the participants before they were randomized in the study.

Study population and recruitment

The study participants were pregnant women with fetuses that are scheduled for a spontaneous vaginal delivery and with an inclusion criterion of; a gestational age of ≥ 37 weeks as diagnosed with the first day of the last menstrual period (LMP) or ultrasound and those with no gross complications related with the pregnancy and delivery, including mal-presentation, fetal distress, and congenital malformations. Women at greater risk of adverse effects due to delayed clamping were excluded from the study. The main exclusion requirements were those with previa or placenta abruption, early diagnosed fetal anomalies, those with fetal anemia, those with pre-eclampsia or significant maternal anemia.¹³

Participants were recruited in the period between October 2019 and January 2020. (As shown in Fig. 01)

Randomization and interventions

The randomization technique started with random assignment of participants in to blocks and the order of the sequential assignment for the three groups of participants were done using random sequence generator from Excel 2016 program available on Office 2016 package software (Microsoft Corporation).

The eligible participants were initially approached by the principal investigator (who is a research midwife) to obtain consent before or on the day of delivery. The consented participants were randomized into three groups in a 1:1:1 ratio using pre-determined six-block randomization sequences.

The interventions that the different groups received are as follows:

Group 1: clamping of the umbilical cord immediately (< 30seconds) after birth.

Group 2: clamping of the umbilical cord intermediately (30–60 seconds) after birth.

Group 3: clamping of the umbilical cord time was ≥ 180 seconds (3-minutes) after birth.

The allocation of the participants was performed after obtaining their informed consent earlier in the late first stage labor (i.e. ≥ 8 cm cervical dilatation). The principal investigator (PI) prepared the allocation codes with sealed, opaque, and identically colored envelopes initially at the beginning of the study. One of the co-investigators, who was blinded to the participant screening and randomization process, was responsible for opening the envelope and revealing the nature of intervention to the birth attendant when the mother enters the second stage of labor or was ready for childbirth proper.

Outcomes

The primary outcome is the level of total serum bilirubin of the newborns at 24 hours of age and the secondary outcome is the proportion of neonates that developed hyperbilirubinemia before discharge to home.

Data collection procedure

The data collection had two phases. First, around the time of birth; and both maternal and fetal characteristics were recorded. Second, at the age of 24 hours after delivery. Blood samples for the primary outcome were collected from veins and were transported to the laboratory with an anti-coagulated test tube by one of the research investigators within 30 minutes of the sample collection. The source of sociodemographic and obstetric data was the medical record chart of both the mother and the newborn. The rest of the data was obtained from the direct interview of the mother and laboratory findings. The sample size which was calculated using two independent proportions with a power of 90% and $\alpha = 0.05$ resulted in a total of 141 participants that were subsequently categorized into three arms (47 in each group).

The data collectors discussed with eligible participants and/or their companions about the procedure. The discussion includes explaining the risks and benefits associated with the interventions later in the first stage of labor.

Informed consent was then secured either from the participant or respective companions before the second stage labor ensued or upon preparing the mother for delivery.

When the mother is ready for delivery, the randomly assigned sealed-envelope containing the group assignment. The investigator monitored the clock with a digital second counter to inform the birth attendant when the time for that particular intervention ended.

After the expulsion of the newborn, the birth attendant had to collect one-milliliter cord blood and handed it to the assistant after separating the cord irrespective of the group assignment. The collected blood samples were then stored in a test tube, transported to the assigned laboratory. The results were recorded on the newborn chart by the attendant according to the hospital protocol.

Statistical analysis and data management

After data collection, the completeness and consistency of the questionnaires were checked. Then both the questionnaires and the variables coded, entered into the Epi-Data manager version 4.4.2.1 (Epi-Data Association, Denmark), and the necessary data cleaning was performed.

Descriptive analysis was performed to compare baseline characteristics of the participants and reported using mean and standard deviation (SD) for discrete-continuous data types. Besides, frequencies and percentages are used for categorical data presentation. Pearson's chi-square test was used to compare categorical variables across the different cord clamping times, and Fisher's exact test used when there were less than five observations within the groups. Kruskal Wallis rank test was also used for comparison of continuous variables based on the time of clamping. We used an unadjusted linear regression model to evaluate the effect of times for cord clamping on serum bilirubin level and multiple linear regression to conduct an adjusted analysis controlling for other important factors. Associations were considered significant at $p < 0.05$ and analyses were performed using STATA version 14 software (Stata Corp LLC, College Station, TX, USA).

Results

Table 1 presents the basic demographic, social, and obstetric characteristics of participant mothers. Most of the participants (102; 72%) aged between 20–34 years, while (29; 20%) of them were under the age of 20 years. A total of 107 (75.88%) participants have had the recommended antenatal visit more than four times. From total participants, 127 (90.07%) had normal and 14 (9.93%) prolonged labor.

Table 1
Demographic and obstetric Summary characteristics of
mothers gave birth at TASH, from October 2019 –
January 2020

	Frequency	Percentage
Age of the mother		
< 20	29	20.57
20–34	102	72.34
≥ 35	10	7.09
Gravidity		
Primiparous	58	41.13
Multiparous	83	58.87
ANC visits		
< 4 times	34	24.12
≥ 4 times	107	75.88
Labor Duration		
Normal	127	90.07
Prolonged	14	9.93
Labor onset		
Spontaneous	120	85.11
Induced	21	14.89
PROM		
Yes	19	13.48
No	122	86.52
Cesarean section history		
Yes	15	10.64
No	126	89.36

The association between maternal and obstetrics factors were also compared based on the different time of umbilical cord clamping (Table 2). None of the factors showed a significant difference across the different cord clamping times except the duration of labor, which is significantly longer in the

intermediate clamping time (P -value of < 0.05) compared with the immediate or delayed clamping groups.

Table 2

Association between maternal and obstetric factors with the time of umbilical cord clamping for mothers who gave birth at TASH from October 2019 – January 2020.

Variables	Immediate clamping (< 30 seconds) (n = 50)	30–60 seconds (n = 45)	Delayed (>= 180 seconds) (n = 46)	P-value
Maternal Age – n (%)				0.261
< 20	11 (22)	10 (22.2)	8 (17.4)	
20–34	36 (72)	29 (64.4)	37 (80.4)	
>=35	3 (6)	6 (13.4)	1 (2.2)	
Gravidity – n (%)				0.629
Primiparous	20 (40)	21 (47)	21 (45.7)	
Multiparous	30 (60)	24 (53)	25 (54.3)	
Chronic Medical illness history – n (%)				0.366
Yes	8 (16)	3 (6.7)	6 (13)	
No	42 (84)	42 (93.3)	40 (87)	
PROM – n (%)				0.800
Yes	7 (14)	7 (15.2)	5 (10.8)	
No	43 (86)	38 (84.8)	41 (89.2)	
Sibling history of jaundice – n (%)				0.309 ^{fe}
Yes	1 (2)	1 (2.2)	2 (4.3)	
No	49 (98)	44 (97.8)	44 (95.7)	
CS history – n (%)				0.882
Yes	6 (12)	4 (8.9)	5 (10.9)	
No	44 (88)	41 (91.1)	41 (89.1)	
Labor Duration – n (%)				0.015
Normal	46 (92%)	36 (80)	45 (97.8)	
Prolonged	4 (8%)	9 (20)	1 (2.2)	
Labor onset – n (%)				0.092

Variables	Immediate clamping (< 30 seconds) (n = 50)	30–60 seconds (n = 45)	Delayed (≥ 180 seconds) (n = 46)	P- value
Spontaneous	45 (90)	34 (75.5)	41 (89.1)	
Induced	5 (10)	11 (24.5)	5 (10.9)	
ABO incompatibility – n (%)				0.851
Yes	4 (8)	5 (11.1)	5 (10.9)	
No	46 (92)	40(88.9)	41 (89.1)	
Rh incompatibility – n (%)				0.527
Yes	2 (4)	4 (8.9)	2 (4.3)	
No	48 (96)	41 (91.1)	44 (95.7)	
PPH – n (%)				0.593
Yes	2 (4)	1 (2.2)	3 (6.5)	
No	48 (96)	44 (97.8)	43 (93.5)	
<i>fe - fisher's exact test</i>				

Table 3 presents the association between neonatal factors and the time of cord clamping. The gender distribution is similar across the three groups. While most of the newborns (94.3%) were fed with breastmilk only, this did not vary based on the time of cord clamping. APGAR score was also not significantly associated with the umbilical cord clamping time.

The majority of the newborns (95.74%) were in the low-risk zone of the bilirubin nomogram within the first 24 hours of their birth and only three (2.12%) newborns required phototherapy within 48–72 hours post-birth, albeit this was not significantly related with time of cord clamping. The mean weight of neonates during birth was 3251gm (\pm 60), 3259gm (\pm 63), and 3247gm (\pm 67) for immediate (< 30 sec), intermediate (30–60sec), and delayed (\geq 180sec) umbilical cord clamping times, respectively. Further, there were no variations in average temperature, and cord blood RBC and TSB between groups.

Table 3
Association of neonatal factors with umbilical cord clamping time of newborns born at TASH
between October 2019 – January 2020.

Variables	Immediate	30–60 seconds	Delayed	P-value
Gender – n (%)				<i>0.727</i>
Male	24 (48%)	25 (56%)	25 (54%)	
Female	26 (52%)	20 (44%)	21 (46%)	
Type of Feeding – n (%)				<i>0.078^{fe}</i>
Breastmilk only	48 (96%)	40 (89%)	45 (98%)	
Formula feeding	0	5 (11%)	0	
Mixed Feeding	2 (4%)	0	1 (2%)	
1st minute APGAR Score – n (%)				<i>0.215</i>
< 7	12 (24%)	10 (22%)	5 (11%)	
>=7	38 (76%)	35 (78%)	41 (89%)	
5th minute APGAR Score – n (%)				<i>0.69^{fe}</i>
< 7	1 (2%)	3 (7%)	1 (2%)	
>=7	49 (98%)	42 (93%)	45 (98%)	
Bilirubin nomogram risk zone – n (%)				<i>1.00^{fe}</i>
Low risk zone	46 (92%)	45 (100%)	44 (96%)	
Low-intermediate risk zone	1 (4%)	0	1 (2%)	
High-risk zone	1 (4%)	0	1 (2%)	
Phototherapy				<i>1.00^{fe}</i>
Yes	1 (2%)	1 (2%)	1 (2%)	
No	49 (98%)	44 (98%)	45 (98%)	
Fetal infections				<i>0.781</i>
Yes	5 (10%)	3 (7%)	3 (7%)	
No	45 (90%)	42 (93%)	42 (93%)	
Weight (gm) - Mean (SD)	3251(60)	3259(63)	3247(67)	<i>0.935^(kw)</i>
Temperature - Mean (SD)	36.14(0.08)	36.3(0.73)	36.22(0.08)	<i>0.347^(kw)</i>
Cord Blood RBC - Mean (SD)	4.57x10 ⁶ (0.07)	4.45x10 ⁶ (0.08)	4.61x10 ⁶ (0.07)	<i>0.489^(kw)</i>

Variables	Immediate	30–60 seconds	Delayed	P-value
Cord Blood TSB - Mean (SD)	1.52 (0.1)	1.45 (0.12)	1.52 (0.16)	0.57 ^(kw)
<i>Definition: fe - fisher's exact test, kw – Kruskal Wallis test</i>				

Unadjusted linear regression of total serum bilirubin amount with umbilical cord clamping time revealed a negative but non-significant association between the two variables (Coef. -0.15; P-value = 0.19). This is presented in Table 4 below.

Table 4
Simple regression of the total serum bilirubin level by time of cord clamping of newborns born at TASH from a period of October 2019 – January 2020.

TSB	Coef.	Std. Err.	t	P-value	R ²
Time of cord clamping	-0.1483	0.1134	-1.31	0.193	0.012
_const	1.911158	.2428028	7.87	0.000	

Multiple regression analysis revealed that bilirubin nomogram high-risk zone ($p < 0.001$) and cord blood bilirubin ($p < 0.05$) were significant predictors of serum bilirubin levels within 24 hours of birth. (See Table 5) Besides, delayed cord clamping time to three-minute shows no significant association with the total serum bilirubin (TSB) levels within 24 hours of birth.

Table 5
Multivariate regressions of total serum bilirubin level as affected by different predictors within 24 hours of birth among neonates born at TASH from a period of October 2019 – January 2020.

R² = 0.3614, Adjusted R² = 0.3422					
Total serum Bilirubin level	Coef.	Std. Err.	t	P-value	Beta
Delayed cord clamping	-0.0695	0.162	-0.43	0.669	-0.0298
Cord blood RBC	-0.1056	0.14	-0.75	0.453	-0.0524
Cord blood TSB	0.2395	0.0925	2.59	0.011	0.1962
Nomogram high-risk zone	6.2554	0.976	6.41	< 0.001	0.4859
_Const.	1.7133	0.663	2.58	0.011	–
Abbreviations: RBC, red blood cell; TSB, total serum bilirubin					

A mean difference between 3-minute (delayed) cord clamping and immediate cord clamping groups was - 0.293 in that it was found to be higher among the immediate group. Similarly, Rh incompatibility, 1st and 5th minute APGAR score has a negative mean difference that has no significance between the

groups. On the other hand, fetal infections (TORCH) and ABO incompatibility had a small positive mean difference (0.26 and 0.03 respectively) with no significance (Table 06).

Table 6
Mean difference between selected fetal factors within 24 hours of birth among neonates born at TASH from a period of October 2019 – January 2020.

	Total serum bilirubin (mg/dl) Mean (SD)	Mean Difference	CI (95%)
Time of cord clamping			
Immediate	1.817 (0.2)	-0.293 ^a	1.403346–2.231654
1-minute	1.497 (0.11)		1.271486–1.724069
3- minute	1.524 (0.13)		1.255437–1.793452
Fetal infections (TORCH)			
Yes	1.87 (0.34)	0.266	1.19708–2.54292
No	1.60 (0.09)		1.410165–1.796764
ABO incompatibility			
Yes	1.652 (0.22)	0.038	1.1991–2.105
No	1.613 (0.1)		1.414498–1.813082
Rh incompatibility			
Yes	1.15 (0.18)	-0.496	0.785–1.514
No	1.646 (0.09)		1.452–1.84
1st minute Apgar score			
<7	1.425 (0.51)	-0.198	.4154928 – 2.434507
>=7	1.623433 (0.09)		1.435365–1.811501
5th minute Apgar score			
<7	0.95 (0.05)	-0.672	0.851122–1.048878
>=7	1.622 (0.09)		1.434731–1.810306
^a a difference subtracted from 3-minute clamping time to immediate cord clamping.			

Discussion

This study tested the hypothesis that delayed and immediate umbilical cord clamping would have a similar predictive effect on TSB levels of healthy full-term newborns within 24 hours of birth. Our findings

indicate that the time of umbilical cord clamping did not affect the TSB level that is measured 24 hours after birth. This finding implies supports that the arguments on the safety of DCC unlike previous findings reporting delayed time of cord clamping are associated with increased serum bilirubin and related jaundice and its complications.¹⁴⁻¹⁷

A study conducted on the effects of DCC on residual placental blood volume, hemoglobin and bilirubin levels in term infants indicated that there was a significant increase in the number of neonates required phototherapy when there was a delay in the umbilical cord clamping time to 3 minutes.¹¹ On the contrary, our finding indicates that there were only three newborns (one in each arm) that develops jaundice requiring phototherapy. This may be attributed to the fact that in our study serum bilirubin levels measured within 24 hours after birth and that can minimize the chance of capturing the late (48–72 hours) elevations in serum bilirubin levels.

Elevated cord blood RBC level or polycythemia was found to be a significant predictor of elevation of TSB around the early hours (24–72 hours) of life.^{12,18} Further, cord blood TSB was also significantly associated with serum bilirubin levels after 24 hours of birth. On the other hand, the cord blood RBC was not different from the normal range in any of the groups, which implies that an umbilical cord clamping time should not be considered as something detrimental to a newborn's health.

In our study, Bilirubin Nomogram high-risk zone was strongly associated with TSB levels within 24 hours of birth. This is different from what was reported previously by Judith *et al*¹⁷ that found an insignificant relationship between these variables. This discrepancy could be attributed to the fact that our study had only one participant in the high-risk zone. Nevertheless, using Bilirubin Nomogram is believed to be a gold-standard measurement to predict, monitor, and manage elevated bilirubin levels at the early hours of the newborn before jaundice and further complications developed.^{19,20}

Limitations of the Study

The existing protocol of newborn care and postpartum hospital stay of the our study area (TASH) was not more than 24 hours and that limited our outcome data collection time to 24 hours only and that can minimize our probability of capturing the late (48–72 hours) complications related to bilirubin level like jaundice requiring phototherapy and can be considered for future studies in this area.

Conclusion

This research finding found out and concluded that the time of umbilical cord clamping will have no significant relationship with the total serum bilirubin levels of neonates at least within 24 hours of birth. Besides, delaying an umbilical cord clamping time to three minutes did not affect elevating the total serum bilirubin levels of neonates that can put them in danger of jaundice requiring phototherapy and it can be considered as an easy and safe procedure that has multifaceted importance for the newborns.

Declarations

Ethical approval and consent

The study participants were only enrolled after receiving an informed consent as mothers of the newborns with extensive explanation of the possible ethical issues including the risk, benefits, autonomy and fairness in allocation of the sampling procedure. All the methods in the protocol were performed in accordance with the relevant guidelines and regulations of National Research Ethics Review Guideline of Ethiopia and Declaration of Helsinki.

The study started after receiving an ethical clearance from School of Public Health and school of medicine (Department of gynecology) and College of Health Science, Addis Ababa University. An approval letter was submitted to College of Health Sciences and followed by the hospital's Gynecology and Obstetrics Department in order to get a professional and administrative permission to conduct the study. The trial was officially registered on <http://pactr.samrc.ac.za/> (an international registration of clinical trials website) with a registration number: *PACTR202010878847651* on date *05/10/2020*.

Consent for publication:

Not applicable.

Availability of data and materials

The dataset supporting the conclusions of this article is available from the corresponding author and can be accessed on a reasonable request through an e-mail: brkhailu41@gmail.com.

Competing interests:

We declare that we have no competing interests.

Funding

Funding for this project comes from UNFPA- Ethiopia under "National capacity strengthened to increase demand for and availability of family planning services, including reproductive health commodities" (project number: ETH08FPS). This funder was informed of the study design and protocols but played no role in the collection, analysis, interpretation, and writing of this manuscript. In addition, Addis Ababa University, College of health Sciences has contributed financially.

Acknowledgement

Author appreciates the continuous help from Supervisors AS, MB, AD for their unreserved advice and supports during design, implementation and dissemination of the study. In addition, I would like to give thanks the data collectors and supervisors especially Sr. Hawa Ali from TASH.

Authors contribution

B.H is the primary investigator and author. M.B helped in the design, implementation, and write-up of the paper. A.S helped in the proposal development, design, implementation, and write-up of the paper. A.D helped in the design and write-up of the paper.

Abbreviations

AAU	Addis Ababa University
ACOG	American College of Obstetrics and Gynecology
BEMONC	Basic and Emergency Obstetric and Newborn care
DCC	Delayed Cord Clamping
ECC	Early Cord Clamping
EMwA	Ethiopian Midwives association
EPS	Ethiopian Pediatric Society
ESOG	Ethiopian Society of Obstetrics and Gynecology
EWEC	Every Woman Every Child
ICC	Immediate Cord Clamping
IRB	Institutional Review Board
LMP	Last Day of Menstrual Period
LMIC	Low and Middle-Income Countries
MOH	Ministry of Health (Ethiopia)
RBCs	Red Blood Cells
RCOG	Royal College of Obstetrics and Gynecology
SDG	Sustainable development goal
SPH	School of Public Health
SVD	Spontaneous Vaginal Delivery
TCC	Time of Cord Clamping
TORCH	Toxoplasmosis, Other viruses, Rubella virus, Cytomegalovirus & Herpes
TSB	Total Serum Bilirubin
UNICEF	United Nations Children’s Fund
WHO	World Health Organization

References

1. UNICEF. Press-releases on global childbirth report. *Press release -childbirth report* January 1, 2018; https://www.unicef.org/media/media_102362.html. Accessed September 2018, January 2018.
2. EPHI, FMOH. *Ethiopian Emergency Obstetric and Newborn Care (EmONC) Assessment*. Ethiopian public health institute; September 2017 2016.
3. WHO. *Guideline: Delayed umbilical cord clamping for improved maternal and infant health and nutrition outcomes*. World Health Organization; 2014.
4. Eichenbaum-Pikser G, Zasloff J. Delayed clamping of the umbilical cord: a review with implications for practice. *Journal of midwifery & women's health*. 2009;54(4):321-326.
5. Drummond G, Kappas A. Chemoprevention of severe neonatal hyperbilirubinemia. *Seminars in perinatology*. 2004;28(5):365-368.
6. Kamisako T, Kobayashi Y, Takeuchi K, et al. Recent advances in bilirubin metabolism research: the molecular mechanism of hepatocyte bilirubin transport and its clinical relevance. *Journal of gastroenterology*. 2000;35(9):659-664.
7. Watson R. Hyperbilirubinemia. *Critical care nursing clinics of North America*. 2009;21(1):97-120, vii.
8. Greco C, Arnolda G, Boo N, et al. Neonatal Jaundice in Low- and Middle-Income Countries: Lessons and Future Directions from the 2015 Don Ostrow Trieste Yellow Retreat. *Neonatology*. 2016;110(3):172-180.
9. Kassa RT, Gudeta H, Assen ZM, Demlew TM, Teshome GS. Neonatal Hyperbilirubinemia: Magnitude and Associated Etiologic Factors among Neonates Admitted at Tikur Anbessa Specialized Hospital, Ethiopia. *Journal of Pregnancy and Child Health*. 2018;5(4):4.
10. Cernadas JMC. Timing of umbilical cord clamping of term infants. *Arch Argent Pediatr*. 2017;115(2):1-7.
11. Mercer JS, Erickson-Owens DA, Collins J, Barcelos MO, Parker AB, Padbury JF. Effects of delayed cord clamping on residual placental blood volume, hemoglobin and bilirubin levels in term infants: a randomized controlled trial. *Journal of Perinatology*. 2017;37(3):260-264.
12. Andersson O, Hellström-Westas L, Andersson D, Domellöf M. Effect of delayed versus early umbilical cord clamping on neonatal outcomes and iron status at 4 months: a randomized controlled trial. *BMJ*. 2011;343(1):12.
13. Purisch SE, Ananth CV, Arditi B, et al. Effect of Delayed vs Immediate Umbilical Cord Clamping on Maternal Blood Loss in Term Cesarean Delivery: A Randomized Clinical Trial. *Jama*. 2019;322(19):1869-1876.
14. Anna Locatelli, Consonni S, Ghidini A. Approach to Decreasing Complications of Prematurity. *Obstet Gynecol Clin N Am*. 2015;1(1):1-20.
15. Duley L, Batey N. Optimal timing of umbilical cord clamping for the term and preterm babies. *Early human development*. 2013;89:905-908.

16. McDonald S, Middleton P. Effect of the timing of umbilical cord clamping of term infants on maternal and neonatal outcomes. *Cochrane Library*. 2008;2008(2):1-29.
17. Saba K, Majeed T, Bukhari MH. Early versus Delayed Umbilical Cord Clamping Leads to Neonatal Anemia. *ANNALS*. 2012;18(3):309-315.
18. Rincon D, Foguet A, Rojas M, et al. [Time of cord clamping and neonatal complications, a prospective study]. *Anales de pediatria (Barcelona, Spain : 2003)*. 2014;81(3):142-148.
19. Bhutani VK. Bilirubin nomogram, a prediction tool, or natural history profile? *Indian pediatrics*. 2013;50(4):365-366.
20. Yu ZB, Han SP, Chen C. Bilirubin nomograms for identification of neonatal hyperbilirubinemia in healthy term and late-preterm infants: a systematic review and meta-analysis. *World journal of pediatrics: WJP*. 2014;10(3):211-218.

Figures

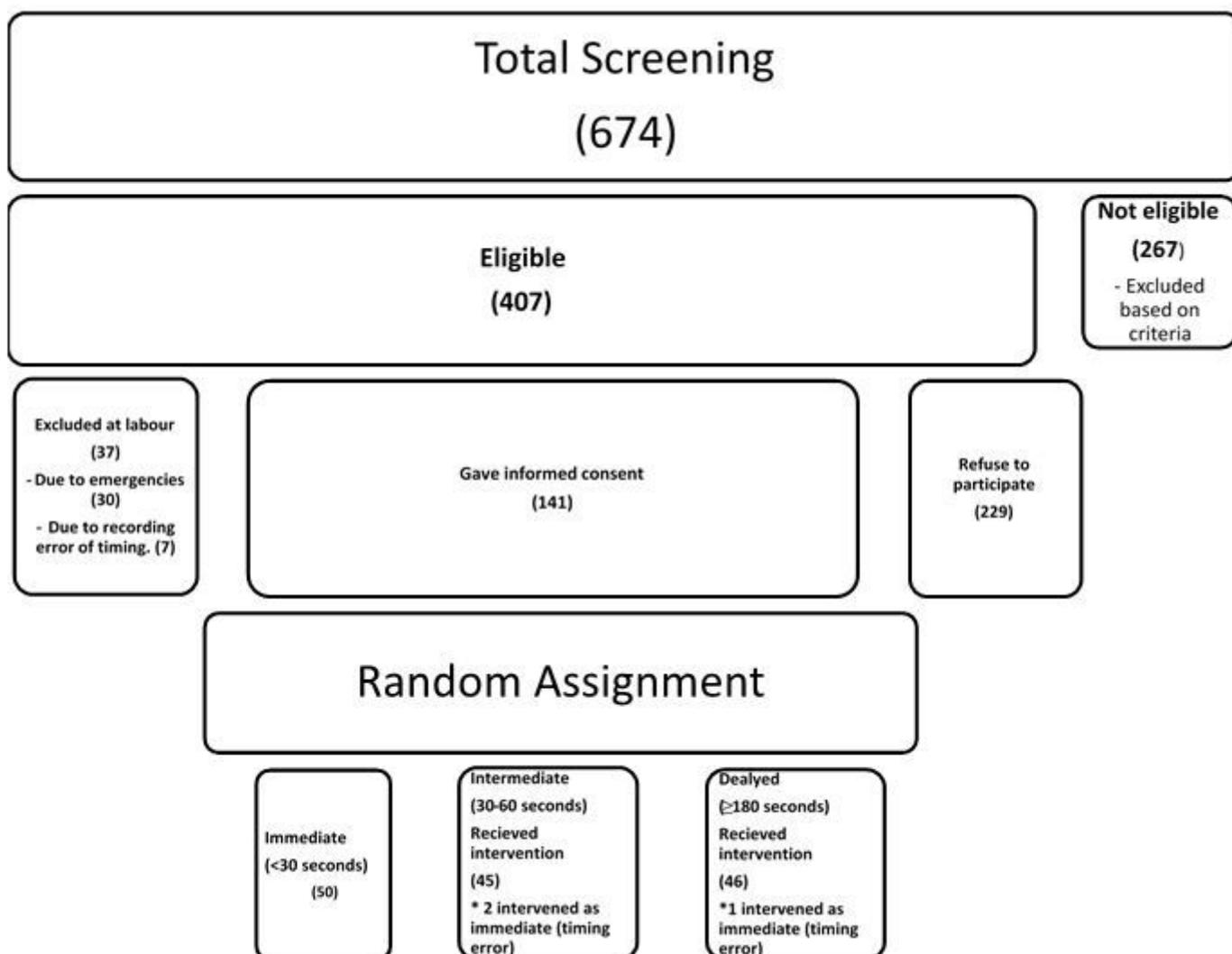


Figure 1

Sampling technique of study participants from mothers came for childbirth at TASH from October 2019 – January 2020.