

Effect of Topical Application of Human Breast Milk, Chlorhexidine and Dry Cord Care on Neonatal Umbilical Cord Separation Time and Rate of Cord Infection : Cluster Randomized Trial

Melat Mekonnen (✉ mesfinmelat1@gmail.com)

Addis Ababa University

Abiy Estifanos

Addis Ababa University

Mulugeta Gebremariam

Addis Ababa University

Yemisrach Biru

Woldia University

Research Article

Keywords: infection caused by bacteria, Chlorhexidine, Butajira Demographic and Health Surveillance

Posted Date: December 28th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-122199/v1>

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

[Read Full License](#)

Abstract

Background- Annually 1 million newborns worldwide die of infection caused by bacteria that enter the body via the umbilical cord. Regarding this the Ethiopia national strategy of new born and child survival identified Chlorhexidine as one of the high impact interventions to minimize neonatal mortality. Whereas, studies have shown Human breast milk application to the neonatal umbilical cord has a shorter cord separation time and lower rate of infection than Chlorhexidine or dry cord care.

Method- From May to November, 2018, a three arm, non- masked, community based, cluster randomized controlled trial was conducted at Butajira Demographic and Health Surveillance site located in the Gurage Zone of the Southern Nations, Nationalities and Peoples´ Region of Ethiopia. Nine sub districts of the Butajira Demographic and Health Surveillance site were randomized into two intervention groups that are human breast milk and Chlorhexidine and a control group which is the dry cord care using a lottery method. From a sample size of 337, data were entered and analyzed for 302 term singleton newborns. Baseline characteristics across the groups were compared by ANOVA for continuous variables and Chi square for categorical variables. Mean cord separation time was compared among the groups using one way ANOVA whereas the secondary outcome i.e. rate of omphalitis was expressed in terms of frequency and was compared among the groups using Chi square. Level of significance was set at $p < 0.05$ with 95% confidence interval.

Result- The mean cord separation time was 5.6 days in the human breast milk group, 5.9days in the Chlorhexidine group, and 5.7days in the dry cord care group but this difference was not statistically significant among the study groups (p value=0.40). The highest signs of cord infection rate were observed in the dry care group and this was significant regarding the redness on the base of the cord stump ($P < 0.001$).

Conclusion- Topical application of human breast milk is related with shorter cord separation time compared to chlorhexidine or dry cord care. It also has reduced incidence of infection, as much as topical chlorhexidine application. Generally the readily available human breast milk should be given further emphasis.

Trial registration- This trial is registered at the Pan African Clinical Trial Registry on 27th August 2020 with a clinical trial registration number of PACTR202008804462886 . It can be accessed using the URL address:<https://pactr.samrc.ac.za/TrialDisplay.aspx?TrialID=593>.

Background

Globally, every year nearly 45% of all under-five deaths occur in the neonatal age group. This is estimated to be around 2.7 million in 2015. Three fourth of all newborn deaths occur in the first week of life. Among which up to two third of newborn deaths can be prevented if effective health measures are provided. The vast majority of deaths take place in developing countries where access to health care as well as skilled care is low [1]. Leading causes of neonatal mortality accounts for preterm birth, intra partum

complications and sepsis in an orderly manner. Preterm birth and intra partum complications accounts for early neonatal death (0-6 days) while in late neonatal period (7-27 days) nearly half of all deaths occurred from infectious causes. In which the risk of death due to preterm birth and intra partum complications and sepsis are 10, 36, and 34 times greater, respectively, in settings with more than 30 neonatal deaths per 1000 live births compared to settings with less than 5 neonatal deaths per 1000 live births [2].

Each year, approximately 1 million newborns worldwide die of infection caused by bacteria that enter the body via the umbilical cord [3]. According to WHO report 300,000 neonates die annually due to tetanus infection, where umbilical cord is the leading route for such an infection [4]. Whereas in Ethiopia, among the top three causes of neonatal mortality severe infection attributes to over 16,100 neonatal deaths annually [5].

So far, studies have shown HBM application has a shorter cord separation time and lower rate of infection while CHX application to have decreased neonatal sepsis among neonatal intensive care unit (NICU) admitted neonates as well as cord infection, when WHO suggests DCC as a standard mode of cord care practice [3-9]. Though there are studies in Ethiopia regarding the application of CHX for umbilical cord care [5], no study has been conducted towards the application of HBM for cord care practice let alone comparing the standard DCC with that of CHX or HBM.

According to the 2016 Ethiopian Demographic and Health survey (EDHS) 74% of all delivery took place at home. Particularly in the South Nation Nationality and Peoples Region (SNNPR) where this study is conducted; only 25.5% of women delivered in a health facility and only 16.9% women had a postnatal checkup in the first 2 days after birth. This leads to the abandonment of hygienic delivery conditions and adequate post natal care which can avert a large proportion of maternal and neonatal deaths occurring during the first 48 hours after delivery and that can minimize newborn infection and maternal risk of complications. Moreover, in such cases cord is cut and tied with unsterilized instruments, commonly coupled with the practice of applying topical substances commonly butter or ointment. The ultimate consequence of such practice may potentially enhance the spread of infection through the viable and opened blood vessels of the umbilical cord stump [10, 11]. Regarding this, the Ethiopia National Strategy of New born and Child survival has identified CHX as one of the high impact interventions to minimize neonatal mortality which currently is 29 per 1000 live births [5].

This generated local evidence regarding which cord care practice sounds appropriately effective in minimizing cord separation time and preventing omphalitis in communities where most of the delivery still continue to take place at home accompanied by potentially and largely unhygienic cord care practices.

Thus, the objective of the study is to determine the effect of topical application of HBM, CHX and DCC on the neonatal umbilical cord separation time and on neonatal umbilical cord rate of infection.

Methods

Study population and design

Data on the effect of umbilical cord cleansing with a once daily application of CHX (as per the Ethiopian Federal Ministry of Health standard of practice[12]) and topical HBM once daily were compared with the WHO recommended DCC practice [13] in terms of cord separation time and rate of cord infection were collected in a three arm, non –masked ,community based cluster randomized controlled trial. This study was conducted at Butajira Demographic and Health Surveillance Site (BDHSS) located in Gurage zone of the Southern Nations, Nationalities and Peoples´ Region (SNNPR) of Ethiopia. The Surveillance System Site consists of 10 kebeles (the smallest governmental administrative unit or sub district) from two woredas (districts) and two zones. Each sub-district has a health post, in which the cluster randomization is based upon. From the 10 sub-districts in BHDSS the 9 sub-districts were included in the study. Then the sub-districts were randomized into three groups; two intervention groups i.e. HBM and CHX group and a control group which is the standard DCC group using a lottery method. Equal numbers of study subjects were assigned to each group. Every procedure was identically conducted for all groups, except for the umbilical cord care. Live born neonates who fulfill the inclusion criteria received either the intervention or the standard care. The primary outcome of the study was cord separation time whereas rate of omphalitis was a secondary outcome. Participants as well as data collectors and supervisors were aware of their study assignment.

Data collection

Alive singleton neonates who were born between May to November, 2018, and did not have any birth complication which require hospital admission, visited within the first three days after delivery, whose mothers were aged 18 and above (for the purpose of avoiding further requirement of parental consent and legal issues) and who would stay in the catchment area for at least 30 days after giving birth (for follow-up purpose) were eligible for enrollment. Enrolled newborns were visited five times by the data collectors. Data collectors of this study were divided into two groups. The first groups were called the intervention group data collectors. They were trained to visit the newborn on the 1st and 3rd day after delivery. By doing so, they enroll the new born according to the inclusion criteria, obtain an informed consent from the mother, train the mother about how to apply and what procedures to follow when applying the cord care regimens according to the assigned group, council the mother about neonatal and maternal danger signs, signs of cord infection, and to seek for medical care whenever she notices these cord infection and danger signs. The other groups of data collectors were called evaluation data collectors, they collect data regarding demographic, maternal, and newborn characteristics, cord care regimen compliance, applications, and study follow-up, cord separation time in days identifying and recording signs of umbilical cord infection (redness, pus or swelling) on the 4th, 8th and 15th day.

Intervention procedure

HBM group: for neonate assigned to the HBM group, the mother was trained at two occasions i.e. at the first and second time of contact by the intervention data collectors to wash her hands using soap or ash and water, and then clean the tip of her breast from inside to outside using a clean wet cloth. Then expose the newborn's cord and apply 10 drops of her breast milk and rub it using her index finger on the tip, bottom and body of the cord. Then after, leave the cord without covering it for air dry and wash hands using soap or ash and water. Repeat this procedure for seven days once daily. Mothers were given a picture chart to remind them of the procedure and to apply the intervention every day.

CHX group: neonates assigned to the CHX group, were provided with one tube (20gm) of 4% chlorhexidine gel manufactured by Addis Pharmaceutical Factory PLC, Adigrat, Ethiopia. The mother was trained at two occasions i.e. at the first and second time of contact by the intervention data collectors to wash her hands using soap or ash and water, pierce the sealed mouth of the tube, then expose the newborn's cord and apply a bean sized gel on the index finger then rub the gel on the tip, bottom and body of the cord. Then after, leave the cord without covering it for air dry and wash hands using soap or ash and water. Close the tube tightly and store it in a cool place where children can't reach it. Repeat this procedure for seven days once daily. Then, dispose the tube in the toilet after the seventh day. Mothers were told to avoid applying the CHX on the neonate's eye, ear or mouth. Moreover mothers were given a picture chart to remind them of the procedure and to apply the intervention every day.

DCC group: neonate assigned to the DCC group, were provided with 30 pieces of "ultra- compact cotton buds". Mothers were trained at two occasions i.e. at the first and second time of contact by the intervention data collectors to wash her hands using soap or ash and water and air dry them. And then expose the newborn's cord and using two cotton buds dry the cord's tip, bottom and body. Then after, leave the cord without covering it for air dry and wash hands using soap or ash and water. Repeat this procedure for seven days once daily. Mothers were given a picture chart to remind them of the procedure and to apply the intervention every day.

Study outcome

In this study cord separation time was defined as the time taken (in completed days) for the full detachment of the umbilical stump from the underlying skin. It was assessed at the home visit on the 4th, 8th and 15th day. The mother's word and the evaluation data collector's confirmation were taken as a report of the cord separation time.

Ompalities was defined in this study as infection of the umbilicus in particular the umbilical stump characterized by redness around the umbilicus might extend to the skin of the stomach, swelling, increased temperature of the area surrounding the umbilicus, and pus. It was assessed at the home visit on the 4th, 8th and 15th day by the evaluation data collector's direct observation of these signs.

Sample size

The sample size for the trial is driven by the primary outcome of cord separation time mean difference using a study conducted in Iran [4]. By assuming an equal sample size number in each group, two sided 95% confidence interval (CI), and 80% power. Mean difference was calculated between the standard cord care regimen (DCC) and the interventions (CHX or HBM). The final sample size was 337.

Analysis

Descriptive statistics was used to describe the baseline characteristics of the study participants. Mean and SD were used for the description of continuous data while frequencies and percentages were used for the description of categorical data. The similarity of the baseline characteristics across the groups were compared by ANOVA for continuous variables and Chi square for categorical variables. Intention to treat analysis was used during the analysis of the outcome variable, the study in which subjects were analyzed as part of the group they have been allocated to regardless of whether they comply with the procedures of the intervention or not. Mean CST was compared among the groups using one way ANOVA whereas the secondary outcome i.e. rate of was omphalitis was expressed in terms of frequency and was compared among the groups using Chi square. Level of significance was set at $p < 0.05$ and 95% CI.

Ethical considerations

Ethical approval was obtained from the school of public health, College of Health science, Addis Ababa University research ethical committee. Separate information sheet was prepared that states the Purpose, benefit, and harm of the study as well as confidentiality and right of participants. After which informed written consent was obtained from the mothers of the newborns during data collection. At the time of enrollment, study participants and their family members were encouraged to contact the data collectors in the unlikely event of any adverse event occurrence. Data collectors were obliged to record and report incidence of adverse events on the separated adverse event reporting form. Moreover they were obliged to advise the mother to seek medical care whenever she notices maternal or newborn danger signs, cord infection and adverse effect of CHX. The right to withdraw from the research process at any point in time was respected. All methods were performed in accordance with the guidelines and regulations of the Declaration of Helsinki.

Results

Study participants

From May 23, 2018- November 19, 2018, a total of 342 live birth newborns were screened from 9 clusters. From which 40 neonates were excluded because they didn't meet the inclusion criteria ($n=13$), they were not visited within three days after birth ($n=8$) and because substances other than the provided cord care regimen before the cord was separated ($n=19$). Finally 302 (BM group 106, CHX group 107, and DC group 89) were enrolled and analysed as shown in the flow chart (see additional file 1).

Baseline comparison

Demographic, maternal, and newborn characteristics are shown in table 1 (see additional file 2). These characteristics were comparable among the HBM, CHX, and DCC group, except for membrane rupture time ($P=0.03$), place of delivery ($P<0.001$).

Cord separation time

The mean cord separation time was 5.7 days among the three groups with 5.6 days, 5.9 days and 5.7 days of cord separation time was observed in the BM, CHX and DC group respectively (table 2). Though this difference was not statistically significant among the study groups (p value=0.40), the maximum cord separation time was recorded in the CHX group (15 days) whereas the minimum cord separation time was recorded both in BM and DC group (3 days).

Omphalitis

Signs of cord infection (redness on the base of the cord stump and that extended beyond the base of the cord stump, pus, and warm skin around the cord stump) were used to determine omphalitis. There were statistically significant difference among the groups regarding the redness on the base of the cord stump at all visit ($P<0.001$) and this was highly observed in the dry care group on 38, 37, and 32 neonates on the first (4th day), second (8th day) and third visits (15th day) respectively. Redness beyond the base of the cord stump was highly observed on the DCC group on 11, 11 and 9 neonates on the first (4th day), second (8th day) and third visits (15th day) respectively, but this difference was significant among the groups only at the second visit ($P<0.001$). Pus on the cord stump was the highest in the HBM on the first visit (4th day) and it was observed on 7 neonates; on second visit it was the same among the neonates in HBM and DCC 5 neonates each; on the third visit it was highest in the DCC in which it was observed on 5 neonates but all of these differences were not statistically significant among the groups. Warm skin around the cord was highly observed among the CHX group, in which it was observed on 7, 7 and 3 neonates on the first (4th day), second (8th day) and third (15th day) visits respectively, but this difference was significant among the groups only at the second visit ($P<0.03$) (table 3).

Discussion

A three arm, non-masked, community based, cluster randomized controlled trial was conducted at Butajira, Ethiopia on 302 newborns with an objective determining the effect of topical application of HBM, CHX and DCC on the neonatal umbilical cord separation time and assessing the rate of cord infection.

HBM contains large amounts of IgA antibodies, growth factors, namely the transforming growth factors alpha and beta (TGF- α and TGF- β) and the insulin-like growth factors 1 and 2 (IGF-1 and IGF-2), and also leukocytes or polymorphonuclear cells. These factors accelerate complex umbilical cord separation through polymorphonuclear leukocytes present inside the umbilical cord. Regarding this, different studies

had shown that HBM has an effect of shortening cord separation time resulting in reduced chances of acquiring cord infection [3, 4, 7, 8, 9, 14]. Supporting this, our study found the shortest mean CST in the HBM group 5.6 ± 1.3 days and a mean of 5.9 ± 1.7 days in CHX group and 5.7 ± 1.5 in the DCC group, though this difference was not statistically significant ($P= 0.40$) among the groups. This finding was in accordance with the previous six hospital-based trials; in which four of the studies were RCT conducted in Iran comparing the impact of topical application of HBM against CHX, ethanol, dry care, 96% ethyl alcohol, povidone-iodine and silver sulfadiazine [4, 7, 8, 9]; one of the study was quasi-experimental study comparing topical HBM, povidone-iodine, and dry care [3]; whereas the other one is RCT in India comparing HBM group and dry care group [14]. All of these studies had shown statistically significant short mean/median cord separation time in the HBM group. Failure of our study to show a significance difference of CST among the cord care regimen groups could be due to the fact that the current study differs from previously conducted studies in terms of frequency and duration of cord care regimen application (once daily for seven days whereas in other studies the cord care regimen was applied for twice a day for 7 days or till 3 days after the cord had been separated), study design, procedure (using the tip of the index finger to apply BM and CHX rather than using a cotton swab), pre delivery activities (the newborns mother was contacted after delivery unlike the previous studies where the mother was contacted before delivery and provided with birth kits for home delivery and counseling regarding antenatal care (ANC) follow up and health institution delivery). A community based RCT conducted in Bangladesh and Nepal as well as clinical based RCT conducted in Italy and India comparing dry cord care with that of CHX and 70% alcohol found a significant short CST in dry care groups [15-18]. Opposing these findings, a clinical based RCT that compared CHX with DCC conducted in Germany and in India on newborns of NICU, showed a significantly short CST in CHX groups [6, 16]. This could be due to the difference in study subjects and study settings (newborns with gestational age >32 weeks and weighing >1500 g at birth and admitted to NICU were enrolled for the study).

In our study, the overall CST was between 3 to 15 days. The longest CST was recorded in CHX group (15 days) whereas the shortest CST (3 days) was observed both in HBM and DCC group. This finding was consistent with a clinical based RCT study conducted in Iran, in which the shortest CST was observed in a HBM group which was 4 and the longest CST was observed for CHX application groups with 53 days [7]. Thus, this finding could indicate that HBM can hasten CST as much as DCC and better than CHX, which enables it to be used as an alternative cord care regimen.

Studies indicated that the risk factor for neonatal cord infection include unhygienic cord practices, inappropriate cord handling (e.g., cultural application of substances such as engine oil, cow dung, talc powder, or palm oil to the cord); septic delivery secondary to prolonged rupture of membranes or maternal infection; non sterile delivery; prematurity; low birth weight as well as neonates with weakened or deficient immune systems or who are hospitalized and subjected to invasive procedures such as umbilical catheterization [19]. Though a relationship between signs of cord infection and cultural application of substances was not established in our study, we found out that substances such as butter, Vaseline, and animal dung had been applied on the neonate's umbilical cord other than the assigned cord care regimen. The highest frequency of these substances were observed in the DCC group in which butter was applied

on one neonate, animal dung on one neonate and Vaseline on 7 neonates. This finding was important because in a way it indicates that mothers tend to apply substances on the cord when they are not provided with substances that are antimicrobial agents.

Our finding regarding signs of cord infection indicated the highest cord infection signs were observed in neonates of the DCC group and least was on neonates of the CHX group and this was statistically significant regarding the sign of redness on the base of the cord stump at all visit ($P < 0.001$) observed on 38, 37, and 32 neonates on the first, second and third visits respectively. This might indicate the importance of antimicrobial agents contained in HBM or CHX. This finding was in alignment with systematic review conducted by Sankar et al that revealed a significant reduction in the incidence of omphalitis in infants who received the intervention; CHX[20]. The literature reviewed by Mullany et al from a developing country like southern Nepal in comparing 4.0% CHX, soap-and-water solution and dry cord care showed a significant reduction of incidence of mild and severe omphalitis in DCC and CHX group. However soap-and-water cleansing showed no protective benefit [21]. A cluster-randomized controlled trial conducted in the Southern province of Zambia showed a diagnosed omphalitis in 200 newborns, of whom 82 were in the CHX group and 118 were in the dry cord care group [22]. In the contrary to these findings, studies conducted in Iran comparing ethanol, dry care and human breast milk as well as comparing application of human milk, 96% ethyl alcohol, and silver sulfadiazine showed no significant difference among the three groups in terms of the frequency of omphalitis [4,9]. Supporting this, a study conducted in Turkey among a single and multiple application of 70% alcohol, 4% CHX, or povidon-iodine showed no significant difference in the rate of omphalitis when compared between the study groups [23].

Despite the effort we have made to identify births within the time limit of three days, we couldn't include all newborns at birth due to delayed reports, which could have limited our understanding of the study outcomes on those who were not included. Moreover omphalities was reported based on the signs of cord infection not through a culture proven test, this may overestimate the incidence. These limitations of the study needed to be acknowledged.

Conclusion

This study found that topical application of HBM is related with comparable if not even shorter mean cord separation time than CHX or DCC. It also has reduced incidence of infection, as much as topical CHX application. Moreover in this study longer cord separation time was associated with cord infection and home delivery. A higher frequency of cord infection and use of cultural application of substances was observed in the DCC group. Generally the readily available human breast milk can be considered as an alternative cord care regime.

Abbreviations

BHDSS: Butajira Health and Demographic Surveillance Site

CHX: Chlorhexidine

CST: Cord Separation Time

DCC: Dry cord care

HBM: Human Breast Milk

NICU: Neonatal Intensive Care Unit

RCT: Randomized Cluster Trial

WHO: World Health Organization

Declarations

Ethical approval and consent to participate and publication

Ethical approval was obtained from the school of public health, College of Health science, Addis Ababa University research ethical committee. Separate information sheet was prepared that states the Purpose, benefit, and harm of the study as well as confidentiality and right of participants. After which informed written consent to participate in the study and to give permission for any publication was obtained from the mothers of the newborns during data collection.

Availability of Data

The datasets used during the current study are available from the corresponding author on reasonable request .

Competing interests and funding

The authors declare no conflict of interest or funding.

Authors' contributions

MMM, ASE and MBG were involved in designing and supervising the research. MMM, ASE and YBB processed the experimental data, performed the analysis, and aided in interpreting the results. MMM, ASE, MBG, and YBB drafted the manuscript and designed the figures. All authors discussed and commented on the manuscript.

Acknowledgments

We thank the school of public health, Addis Ababa University, Ethiopia for approving this study and the study participants for their consent to participate in this study.

References

1. The United Nations Inter-agency Group for Child Mortality Estimation (UN IGME): Levels & Trends in Child Mortality 2015 Report. UN IGME; 2015.
2. Shefali O, Joy EL, Daniel RH, Colin M, Simon NC: **Neonatal Causes of Death Estimates for the Early and Late Neonatal Periods for 194 Counties: 2000-2013**. Bulletin of the World Health Organization. 2015; 93: 19-28.
3. Gulsen V, Sezer K: **Umbilical Cord Care: A Pilot Study Comparing Topical Human Milk, Povidone-Iodine, and Dry Care**. JOGNN. 2006; 35: 123-128.
4. Mohammad G, Nematizadeh H: **Impact of Ethanol, Dry Care and Human milk on the Time for Umbilical Cord Separation**. JMPA. 2013; 63: 1117.
5. Save the Children Ethiopia: Implementation of Chlorhexidine for Cord Care, Early Lessons from Four Zones in Ethiopia. Addis Ababa; 2017.
6. Geeta G, Deepak S, Bhanu B: **Effect of Topical Application of Chlorhexidine for Umbilical Cord Care in Comparison with Conventional Dry Cord Care on the Risk of Neonatal Sepsis: a Randomized Controlled Trial**. Journal of Tropical Pediatrics. 2013; 59.
7. Fatemeh A, Zanab H, Mohammad J: **Comparing the Impact of Topical Application of Human Milk and Chlorhexidine on Cord Separation Time in Newborns**. Pak J Med Sci. 2016; 32(1): 239-243.
8. Azar A, Mandana Z, Leila M. **Comparing the Effect of Topical Application of Human Milk and Dry Cord Care on Umbilical Cord Separation Time in Healthy Newborn Infants**. Iran J Pediatr. 2012; 22(2): 158-162.
9. Mousa A, Yadollah Z, Karimollah H, Ghasem J, Hamid T: **The Effect of Topical Application of Human Milk, Ethyl Alcohol 96%, and Silver Sulfadiazine on Umbilical Cord Separation Time in Newborn Infants**. Archives of Iranian Medicine. 2006; 9: 33-39.
10. Central Statistical Agency Ethiopia and ICF: Ethiopia Demographic and Health Survey 2016: Key Indicators Report. Addis Ababa, Ethiopia, and Rockville, Maryland, USA; 2018.
11. Tedbabe D, Yared A, Brian M: **Local Understandings of Care during Delivery and Postnatal Period to Inform Home Based Package of Newborn Care Interventions in Rural Ethiopia: a Qualitative Study**. BMC International Health and Human Rights. 2014; 14:17.
12. Federal Ministry of Health: National Strategy for Newborn and Child Survival in Ethiopia: (2015/16 - 2019/20). Addis Ababa; 2015.
13. Department of Maternal, Child, and Adolescent Health, WHO: Newborn Health Guidelines 2009-12. Geneva; 2012.
14. Soujanya JP, Deepa MR, Frincy F: **Breast Milk Application-an Emerging Trend to Reduce Timing of Cord Separation among Newborns**. Journal of Nursing and Health Science. 2013; 1(4): 39-42.
15. Quattrin R, Lacobucci K, De Tina AL, Gallina L, Brusaferrò: **70% Alcohol Versus Dry Cord Care in the Umbilical Cord Care a Case-Control Study in Italy**. Medicine. 2016; 95(14); 3207.

16. Kapellen TM, Gebauer CM, Brosteanu O, Labitzke B, Vogtmann C, Kiess W: **Higher Rate of Cord-related Adverse Events in Neonates with Dry Umbilical Cord Care Compared to CHX Powder.** Neonatology. 2009; 96(1): 13-8.
17. Mullany LC, Rasheduzzaman S, Ishtiaq M, Peter JW, Amber H, Darmstadt GL, Arifeen SE, Gary LD, Abdullah HB: **Chlorhexidine Cleansing of the Umbilical Cord and Separation Time: A Cluster-Randomized Trial.** Pediatrics. 2013; 131: 708–15.
18. Mullany LC, Darmstadt GL, Khatry SK, Steven CL: **Impact of Umbilical Cord Cleansing with 4.0% Chlorhexidine on Time to Cord Separation Among Newborns in Southern Nepal: A Cluster-Randomized, Community-Based Trial.** Pediatrics. 2006; 118.
19. Bugaje MA, McHoney M, Ameh EA, Lakhoo K: Omphalitis: chapter 20 [http://emedicine.medscape.com/article/975422-overview]
20. Sankar MJ, Chandrasekaran A, Ravindranath A, Agarwal R, Paul VK: **Umbilical Cord Cleansing with Chlorhexidine in Neonates: a Systematic Review.** Journal of Perinatology. 2016; 36: S12-S20.
21. Mullany LC, Darmstadt GL, Tielsch JM: **Safety and Impact of Chlorhexidine Antisepsis Interventions for Improving Neonatal Health in Developing Countries.** Pediatr Infect Dis J. 2008; 25(8): 665–675.
22. Katherine ES, Julie H, Caroline G, Kebby M, Kojo Y, Reuben M, Bowen B, Chipso M, Fern H, Portipher P, Andisen Z, Pascalina C, Godfrey B, Donald MT, William BM, Jonathon LS, Davidson HH: **Effectiveness of 4% Chlorhexidine Umbilical Cord Care on Neonatal Mortality in Southern Province, Zambia (ZamCAT): a Cluster-randomised Controlled Trial.** Lancet Glob Health. 2016; 4: e827–36.
23. Hulya O, Hulya B, Ahmet T, Senay c, Guner S, Mustefa B, Eren O: **Impact of Different Antiseptics on Umbilical Cord Colonization and Cord Separation Time.** J Infect Dev Ctries. 2017; 11(2): 152-7.

Tables

Table 1: Demographic, maternal, and newborn characteristics among the comparison groups

	<i>Breast milk group (n=106)</i>	<i>CHX group (n=107)</i>	<i>Dry cord care group (n=89)</i>	<i>P value</i>
	<i>n(%)</i>	<i>n(%)</i>	<i>n(%)</i>	
<i>Maternal characteristics</i>				
<i>Age</i>				P=0.09
18-27	57 (53.8)	22 (20.6)	38 (42.7)	
28-37	49 (46.2)	63 (58.8)	43 (48.3)	
>=38	0 (0)	22 (20.6)	8 (9.0)	
Mean±SD	27±5	33±5	29±5	
<i>Religion</i>	11 (10.3)			
Orthodox	79 (74.5)	6 (5.6)	12 (13.4)	P=0.23
Muslim	0 (0)	91 (85.1)	77 (86.5)	
Protestant	16 (15.0)	10 (9.3)	0 (0)	
<i>Formal education</i>				P=0.12
No education	38 (35.9)	73 (68.2)	35 (39.3)	
Primary	62 (58.5)	33 (30.8)	43 (48.3)	
Secondary	5 (4.7)	1 (0.9)	10 (11.2)	
other	1 (0.9)	0 (0)	1 (1.1)	
<i>ANC follow-up</i>				P=0.14
No follow up	3 (2.8)	10 (9.4)	6 (6.7)	
At health post	8 (7.5)	46 (43.0)	41 (46.1)	
At health center	91 (85.9)	50 (46.7)	35 (39.3)	
At gov't hospital	2 (1.9)	1 (0.9)	7 (.9)	
At Private hospital	2 (1.9)	0 (0)	0 (0)	
<i>Membrane rupture time(hrs)</i>				
<12hr before birth	96 (90.6)	82 (76.6)	80 (89.9)	P=0.03
12-24hr before birth	8 (7.5)	22 (20.6)	7 (7.9)	
> 24 hrs of before birth	2 (1.9)	3 (2.8)	2 (2.2)	

<i>Duration of labor</i>				P=0.50
12hr	83 (78.3)	83 (77.6)	75 (84.3)	
12-24hr	18 (17.0)	17 (15.0)	8 (9.0)	
>24hr	5 (4.7)	8 (7.5)	6 (6.7)	
<i>Place of delivery</i>				
Home	10 (9.4)	41 (38.3)	22 (24.7)	P=0.00
Health institution	96 (90.6)	66 (61.7)	67 (75.3)	
Infant characteristic				
<i>Sex of the newborn</i>				P=0.56
Male	52 (49.1)	51 (47.7)	49 (55.1)	
Female	54 (50.9)	56 (52.3)	40 (44.9)	

Table 2: Mean cord separation time in days among the study groups

Study groups	Breast milk (106)	CHX (107)	Dry cord (89)	p-value
<i>Mean(days)</i>	5.6	5.9	5.7	P=0.40
<i>Standard deviation</i>	1.3	1.7	1.5	
<i>Minimum CST</i>	3	4	3	
<i>Maximum CST</i>	10	15	13	

Table 3: Signs of umbilical cord infection among the study groups

<i>Sign of cord infection</i>	<i>BM group</i> <i>(106)</i>	<i>CHX group</i> <i>(107)</i>	<i>DC group</i> <i>(89)</i>	<i>P-value</i>
<i>Redness on the base of the cord stump</i>				
1 st visit				
2 nd visit	17 (16.0)	11(10.3)	38 (42.7)	P<0.001
3 rd visit	12 (11.3)	7 (6.5)	37 (41.6)	P<0.001
	9 (8.5)	4 (3.7)	32 (35.9)	P<0.001
<i>Redness beyond the base of the cord stump</i>				
1 st visit				
2 nd visit	10 (9.4)	7 (6.5)	11 (12.4)	P= 0.37
3 rd visit	6 (5.6)	2 (1.8)	11 (12.4)	P<0.001
	5 (4.7)	4 (3.7)	9 (10.1)	P= 0.14
<i>Pus on the cord stump</i>				
1 st visit	7 (6.6)	5 (4.7)	5 (5.6)	P= 0.83
2 nd visit	5 (4.7)	3 (2.8)	5 (5.6)	P= 0.61
3 rd visit	4 (3.7)	1 (0.9)	5 (5.6)	P= 0.18
<i>Warm skin around the cord</i>				
1 st visit				
2 nd visit	3 (2.8)	7 (6.5)	1 (1.1)	P= 0.11
3 rd visit	1 (0.9)	7 (6.5)	1 (1.1)	P= 0.03
	1 (0.9)	3 (2.8)	2 (2.3)	P= 0.91

Supplementary Information

Additional file 1: Study participant's flow chart, a PDF file. It shows a diagrammatic expression of study participants enrollment, exclusion and final number of participants upon which analysis was conducted.

Additional file two: Demographic, maternal, and newborn characteristics among the comparison groups, XLS spreadsheet. It shows basic maternal and newborn characteristics among the comparison groups.

Figures

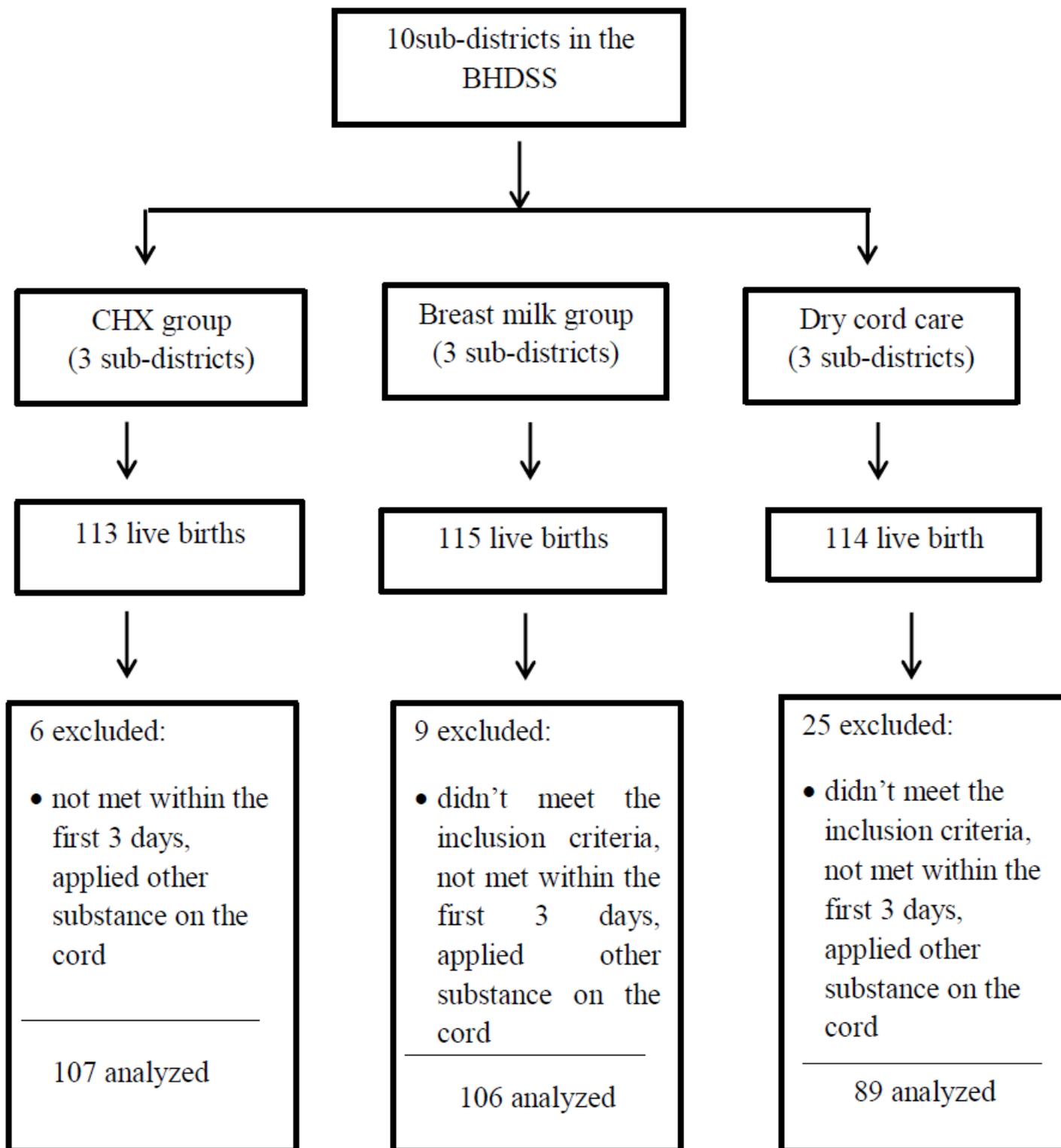


Figure 1

Study participant's flow chart