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Effect of Three Selected Antiseptic Solutions on Umbilical Cord Infection among Neonates

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Abstract: **Umbilical cord infection is one of the major causes of neonatal mortality and morbidity. Approximately one million neonates die annually worldwide due to an umbilical cord bacterial infection during the healing period. The study aimed to determine the effect of three selected antiseptic solutions on umbilical cord infection among neonates. Research design: A quasi-experimental research design. Setting: The study was conducted at postpartum department of the EL Shatby University Maternity Hospital in Alexandria, in addition to subjects' homes. Subjects: A convenience sampling of 90 full-term neonates were recruited in the study. Neonates were allocated into three groups (Group I: received umbilical cord care by Alcohol, Group II: received umbilical cord care by Chlorhexidine, and Group III: received umbilical cord care by Triple dye) by using a simple random sample approach. Tools: Three tools were used. Tool I: Neonate's characteristics and clinical data interview schedule. Tool II: Umbilical cord observational checklist. Tool III: Umbilical Cord Swab Results. Results: About one third of the neonates who received cord care either by Alcohol or by Triple day had positive growth of infection on 5th day (33.3% and 36.7% respectively) compared to only 6.7% of neonates who received cord care with chlorhexidine. The time of cord separation occurred before 7th days among neonates was 6.7% for those who received cord care with chlorhexidine compared to none of those of alcohol and Triple dye groups. Recommendations: Provide health education and support for parents about neonates' cord care practices during hospitalization and at their homes.**

Keywords: **Antiseptics, Cord care practices, Cord separation, Neonates, Umbilical Cord infection.**

I. INTRODUCTION

The umbilical cord (UC) is a vital structure connecting the fetus to the mother in utero [(1)]. It has an important role in fetal nutrition, oxygenation, and excretion of waste products as well as protection against infections [(2-4)]. The cord usually separates between 5 and 15 days after birth. Before the separation, the remaining stump can be considered to be a healing wound and thus a possible route for infection through the vessels into the neonate's blood stream [(1)].

Cord care practices may directly contribute to infections in the neonates which account for a large proportion of the 3.3 million annual global neonatal deaths; of these neonatal sepsis is responsible for more than 15% of neonatal deaths [(2)]. Umbilical cord infection is considered as the major cause of neonatal mortality and morbidity [(5, 6)]. Approximately one million neonates dies annually worldwide due to an umbilical cord bacterial infection during the healing period [(7, 8)].

The World Health Organization (WHO) recommends improving neonates care practices at birth in order to reduce morbidity and mortality. These have been described as essential neonates care (ENC) practices. One of these essential practices is clean cord care which is very important in preventing early neonatal infections [(3)]. Methods of caring for the umbilical stump vary greatly between countries and healthcare settings according to social, cultural, economic and geographic factors [(9)].

The current WHO recommendations for developing countries promote dry cord care under routine circumstances but acknowledge that antiseptics may be helpful when harmful, unhygienic, traditional practices place neonates at increased risk for omphalitis [3]. The World Health Organization recommends topical antiseptics where Alcohol 70%, and Chlorhexidine agents are the most frequent antiseptic solutions used in cord care and on the basis of daily application to the umbilical cord stump during the 1st week of life for neonates who are born at home in settings with high neonatal mortality (30 or more neonatal deaths per 1000 live births) [1, 5, 9].

Cord infection in developing countries can be prevented through increasing access to tetanus toxoid immunization during pregnancy, promoting clean cord care and reducing harmful cord applications and behaviors. Interventions introduced in both developed and developing countries to reduce exposure of the cord to infectious pathogens include clean cord cutting, hand-washing before and after handling the neonate, and application of antimicrobials to the cord stump. Despite the importance of umbilical cord care, both traditionally and medically, there have been few randomized trials investigating the impact of different cord care regimens on rates of local or systemic infections, particularly in developing countries [6, 7].

In 1999, the World Health Organization (WHO) published umbilical cord care recommendations at birth and after discharge from the hospital [3]. For hospital birth, the WHO recommended reducing pathogenic bacterial colonization of the umbilical cord through the use of chlorhexidine, tincture or povidone of iodine, triple dye, silver sulphadiazine, or rubbing alcohol. It has been shown that prevention of microbial colonization of umbilical cords through one of these treatments prevents morbidity when compared with dry cord care [3, 10]. There is still much debate about the best practice for umbilical cord care. It is stated that different types of antiseptic solutions are used in cord care that involve: alcohol 70%, chlorhexidine 0.4%, triple dye, 10% povidone-iodine agents are the most frequent antiseptic solutions used in cord care [11].

Alcohol is a volatile solution, has optimal bacterial activity in aqueous solution of a concentration of 70% - 90% and it has little bacterial effect out this range. Alcohol in concentration of 70% have been widely recommended in cord care of neonates for its rapidly drying disinfectant of skin and surfaces [1].

Chlohexidine 4% detergent water solution is a wide-spectrum antimicrobial used against Gram-positive and Gram-negative bacteria. Its antibacterial effect is slower than alcohol; however, its permanent effect is stronger due to its affinity to surfaces. It provides an outlasting effect of 6 hours by adhering to the stratum corneum layer of skin. Besides, it rarely causes allergic reactions [5].

Triple dye is a bactericidal agent to both gram-positive and gram- negative bacteria and it is fungicidal but not sporicidal. It is a combination of three ingredients: brilliant green (0.2%), crystal violet (0.1%), and proflavine hemisulfate (0.1%) [12, 13]. Toxicity of triple dye is rare and it has the advantage of a prolonged antibacterial effect after a single application [4].

Pediatric nurses in hospital in collaboration with community health nurses after neonates' discharge during home visits are responsible for protecting neonates from infection and harmful practices. The cord should be observed twice daily by nurses or by caregiver to check bleeding, any herniation, fistula, erythema, swelling, foul odor and purulent discharge. It should be cleaned with tap water and dried well during each diaper change [11]. Applying a small amount of alcohol 70% or another solution may be used depending on the policy of the institution. The diaper should be folded below the umbilical cord to allow for air drying and the clamp may be left on. Moreover, nurses should teach the mothers on how to care for the cord stump till it falls off and how to care for the wound as a result of the cord falling off till it is healed [12].

This study aimed to:

Determine the effect of three selected antiseptic solution on umbilical cord infection among neonates.

Hypotheses of the study:

1- Neonates who received umbilical cord care by alcohol exhibit less signs of cord infection and shorter time of separation than those in Chlorhexidine and triple dye.

2- Neonates who received umbilical cord care by Chlorhexidine exhibit less signs of cord infection and shorter time of separation than those in alcohol and Triple dye.

3- Neonates who received umbilical cord care by Triple dye exhibit less signs of cord infection and shorter time of separation than those in alcohol and Chlorhexidine.

II. MATERIALS AND METHOD

MATERIALS:

Research Design:

A quasi experimental design was used to accomplish this study.

Setting:

The study was conducted at postpartum department of the EL Shatby University Maternity Hospital in Alexandria and Subjects' homes after discharge.

Subjects:

A convenience sampling of 90 full-term neonates who fulfilled the following criteria were included in the study:

-Free from infectious diseases

-Negative umbilical cord swab after birth (within 2 hours)

Simple random sample technique was used for dividing the study sample into three groups (30 neonates in each group) first neonate for group I, second for group II, then third for group III and so…. on.

Group I

It included 30 full-term neonates who received umbilical cord care by Alcohol 70%.

Group II

It included 30 full-term neonates who received umbilical cord care by Chlorhexidine 4% detergent water solution.

Group III

It included 30 full-term neonates who received umbilical cord care by Triple dye (0.2% brilliant green, 0.1% proflavine hemi sulfate, 0.1% gentian violet).

Tools:

Three tools were used to collect the required data:

Tool I: Neonates' Characteristics and Clinical Data Interview Schedule:

It was developed by the researchers after reviewing of literature, it was used to collect data about the study subjects; it entailed information related to: neonates' characteristics as gestational age, sex, birth weight and clinical data as type of delivery, time of delivery.

Tool II: Umbilical Cord Observational Checklist:

It included the criteria of the umbilical cord, signs of inflammation as local infection of the cord (erythema or redness, edema, tenderness), or severe infection as purulent discharge from the stump and identify the day of cord separation.

Tool III: Umbilical Cord Swab Results:

The result of the initial umbilical cord swab after birth as a data base, and the 5^{th} day at home visit, presence of cord infection either positive or negative infection.

METHOD:

1. An official letter was obtained from Faculties of Nursing (Alexandria and Damanhour) and submitted to the responsible authority of the postpartum department at the El Shatby University Maternity Hospital to obtain their approval for data collection after explaining the aim of the study.

2. Tools of the study were developed by the researchers after reviewing the related literature.

3. Tool I was tested for content validity by five experts in the pediatric and community nursing field. (Validity value was 95%).

4. Reliability of the tool II was ascertained by measuring the internal consistency of its items using Cronbach's Alpha test which were 0.988.

5. A pilot study was carried out by the researchers on 8 neonates (10% of the sample) who fulfilled the described criteria to ascertain the clarity and feasibility of the tool. Accordingly, necessary modifications were done. Those neonates were excluded from the study subjects.

6. A swab was taken by the pediatric nursing researcher from the neonates' umbilical cord stump on zero day after birth (within 2 hours after birth and before the initial cord care as a base line) using a sterile cotton swab soaked in Amies transport medium from the base of the cord 2-4 hours after birth and immediately sent to the microbiology laboratory for culture.

Each specimen was labelled with the neonate's name, Code and date. Samples were cultured on Columbia blood agar plates, MacConkey's agar plates and Sabaroud dextrose agar plates and were incubated aerobically at 37°C and were inspected for the presence of colony forming units (CFU) after 24 and 48 hours of incubation. Those showing no bacterial growth at the baseline swabs were included in the study.

7. Every neonate's mother was interviewed individually by the researchers on the day of birth at hospital to obtain the necessary data. Researcher teach her how to practice and demonstrate cord care then the mother re-demonstrate it.

8. The cord care was performed twice at birth day for each group by the pediatric nursing researcher in front of mothers at hospital (the first group by alcohol 70%, the second group by chlorhexidine 4% and the third group by triple dye), then the cord care was performed by the mothers at home after discharge twice daily.

9. Home visit was done by the community nursing researcher on the fifth day after discharge to take another umbilical cord swab and observed the methods used by the mothers for cord care of their neonates as well as presence of any signs of umbilical cord infection.

10. Families were called daily by mobile after the 5^{th} day visit, in order to follow the cord condition until cord was separated.

11. Comparison was done between the three groups, to determine which solution was effective regarding no signs or less signs of cord infection and shorter time of cord separation for neonates.

12. Data was collected at January 2018 till June 2018.

Ethical Considerations:

- Written informed consent was obtained from every mother after explaining the aim of the study and their right to withdraw her neonate from the study at any time.
- Confidentiality and privacy were ascertained.

Statistical Data Analysis:

The collected data were coded, tabulated, and statistically analyzed using IBM SPSS statistics (Statistical Package for Social Sciences) software version 22.0, IBM Corp.

- **Descriptive statistics**: were done for quantitative data as minimum& maximum of the range as well as mean ± SD for quantitative parametric data, while it was done for qualitative data as number and percentage.
- **Inferential analyses**: for independent variables were done using Chi square test for differences between proportions while for more than two groups ANOVA test was used.

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- The level of significance was taken at P value < 0.01 is highly statistically significant, otherwise is non-significant. The p-value is a statistical measure for the probability that the results observed in a study could have occurred by chance.

III. RESULT

Table (I) illustrates neonates' characteristics and clinical data during the study period across the three groups. Concerning neonates' gestational age (GA) at birth, it is shown from the table that nearly two thirds (66.7%) of study groups who received cord care with alcohol, Chlorhexidine (63.3%) and Triple dye (70.0%) were born at 40 weeks of gestational age with the mean age of 38.43±1.10 , 38.53±1.17 and 38.67±1.15 respectively. There was no statistical significant difference in GA among the three groups.

Regarding sex of neonates, it is demonstrates from the table that, more than half (53.3%) of group I were males compared to 46.7% and 43.3% in group II and group III respectively. Birth weight among neonates ranged between 2.5 to 3.5 Kg and more with mean birth weight distributions were 3.17±0.56, 3.59±0.52, and 3.30±0.53 in group I, II, and III respectively. There was a statistical significant difference regarding the mean birth weight across the three groups.

It is portray from the table that, more than two thirds of the neonates were borne normally (63.3%, 66.7%, and 73.3% across the three groups I, II, and III respectively).

TABLE (I): PERCENT DISTRIBUTION OF THE STUDIED NEONATES ACCORDING TO THEIR CHARACTERISTICS AND CLINICAL DATA.

Items	Group I "Alcohol 70%"		Group II "Chlorhexidine 4%"		Group III "Triple dye"	
	NO=30	%	NO=30	%	N=30	%
Gestational age						
38 weeks	10	33.3	11	36.7	9	30.0
40 weeks	20	66.7	19	63.3	21	70.0
Range	38.0 - 40.0		38.0 - 41.0		38.0 - 41.0	
Mean±S.D	38.43±1.10		38.53±1.17		38.67±1.15	
	F= 0.335 P=0.7161					
X^2	0.3					
p	0.861					
Sex						
Male	16	53.3	14	46.7	13	43.3
Female	14	46.7	16	53.3	17	56.7
X^2	0.623					
p	0.732					
Weight (kg)						
<2.5	8	26.7	7	23.3	8	26.7
2.5 – < 3	3	10.0	12	40.0	5	16.7
3 – < 3.5	10	33.3	6	20.0	10	33.3
>3.5	9	30.0	5	16.7	7	23.3
Range	2.3 - 4.3		2.3 - 4.5		2.3 - 4.5	
Mean±S.D	3.17±0.56		3.59±0.52		3.30±0.53	
	F= 4.811 P=0.010*					
X^2	9.161					
p	0.165					
Type of delivery						
Normal delivery	19	63.3	20	66.7	22	73.3
Caesarian Section	11	36.7	10	33.3	8	26.7
X^2	0.712					
p	0.700					

F= One-way ANOVA test; X^2 = Chi-squared test * p significant at < 0.01

Table (II) portrays that all of the study subjects (neonates) at group I, II and III, had no signs of infection at the first day as base line assessment compared to the fifth day of assessment. Nearly one third (30.0%) for group I (Alcohol 70%) and 23.3% in group III (Triple dye) developed positive signs of local infection on the fifth day of assessment compared to 10% only in group II (Chlorhexidine 4%). It is observed from the table that group II developed less sings of local

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infection and no severe infection at the 5th day of assessment. There was a statistical significant difference regarding signs of infection where p = 0.017. A statistical significant differences was found between group II and group III where P= 0.015.

TABLE (II): DISTRIBUTION OF THE STUDIED SAMPLE ACCORDING TO THE SIGNS OF CORD INFECTION.

The signs of cord infection	Group I "Alcohol 70%"		Group II "Chlorhexidine 4%"		Group III "Triple dye"	
	No.=30	%	No.=30	%	No.=30	%
1st day base line assessment						
No signs of cord infection	30	100.0	30	100.0	30	100.0
Local cord infection	0	0.0	0	0.0	0	0.0
Severe cord infection	0	0.0	0	0.0	0	0.0
X^2	-					
P	-					
5th day assessment						
No signs of cord infection	20	66.7	27	90.0	18	60.0
Local cord infection	9	30.0	3	10.0	7	23.3
Severe cord infection	1	3.3	0	0.0	5	16.7
X^2	12.008					
P	0.017*					
Chi square test between G1, G2	X^2 = 5.043		P= 0.080			
Chi square test between G1, G3	X^2 = 3.022		P= 0.221			
Chi square test between G2, G3	X^2 = 8.40		P= 0.015*			

X^2 = Chi-squared test * p significant at < 0.01

Table (III) shows the umbilical cord culture swab among different neonatal groups. It is clear from the table that all neonates (100%) in the three groups had no growth of infection in the initial culture swab (according to the criteria of selection). Concerning the 5th day, it is shown from the table that about one third of the two groups who received cord care by alcohol (33.3%) and triple dye (36.7%) had positive growth infection. Only 6.7% of the group who received cord care by chlorhexidine had positive growth infection at the 5th day. A statistical significant differences was found between the three groups where P= 0.0141. Also, a statistical significant differences was found between group I and II as well as group II and III regarding culture swab for infection where p = 0.009 and 0.005 respectively.

TABLE (III): PERCENT DISTRIBUTION OF THE STUDIED NEONATES ACCORDING TO THEIR UMBILICAL CORD CULTURE SWAB FOR INFECTION IN DIFFERENT STUDIED GROUPS.

Umbilical cord culture swab for infection growth	Group I "Alcohol 70%"		Group II "Chlorhexidine 4%"		Group III "Triple dye"	
	No.=30	%	No.= 30	%	No= 30	%
Initial culture swab (base line)						
Negative growth of cord infection	30	100.0	30	100.0	30	100.0
Positive growth of cord infection	0	0.0	0	0.0	0	0.0
X^2	-					
p	-					
5th day culture swab						
Negative growth of cord infection	20	66.7	28	93.3	19	63.3
Positive growth of cord infection	10	33.3	2	6.7	11	36.7
X^2	8.527					
p	0.0141*					

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Chi square test between G1, G2	X^2 = 6.667	P= 0.009*
Chi square test between G1, G3	X^2 = 0.073	P= 0.787
Chi square test between G2, G3	X^2 = 7.954	P= 0.005*

X^2 = Chi-squared test * p significant at < 0.01

Table (IV) illustrates the relation between different solutions used for umbilical cord care and the time of cord separation among the neonates in the three groups. It is shown from the table that, the time of cord separation was in 6.7% among neonates who received cord care with chlorhexidine before 7th days compared to none of those in alcohol and triple dye groups.

Concerning the 7th – 10th days, 70% of the group who received cord care with chlorhexidine had cord separation within these days compared to 66.7% of neonates received cord care by alcohol and 56.7% of triple dye. No Statistical significant difference was found between the three groups.

TABLE (IV): RELATION BETWEEN DIFFERENT SOLUTIONS USED FOR UMBILICAL CORD CARE AMONG NEONATES AND TIME OF CORD SEPARATION.

Time of cord separation	Group I "Alcohol 70%"		Group II "Chlorhexidine 4%"		Group III "Triple dye"	
	No.=30	%	No.=30	%	No.=30	%
Time of cord separation						
< 7 days	0	0.0	2	6.7	0	0.0
7-10 days	20	66.7	21	70.0	17	56.7
> 10 days	10	33.3	7	23.3	13	43.3
X^2	**6.248**					
p	**0.181**					
Chi square test between G1, G2	X^2 = 2.554		P= 0.279			
Chi square test between G1, G3	X^2 = 2.155		P= 0.142			
Chi square test between G2, G3	X^2 = 4.221		P= 0.121			

X^2 = Chi-squared test * p significant at < 0.001

IV. DISCUSSION

Globally every year about 4 million neonates die in the first 4 weeks of life. Most of these deaths (99%) occur in low income and middle-income countries and about half of the deaths occur at home. It is tragic that most of these deaths are preventable. Pediatric nurses are potential health care professionals who work as a primary care givers in the hospital setting. Caring the umbilical cord at birth is given the most priority, since the uncared umbilical cord may result into infection and in severe case, it may result into the death of the neonate. Umbilical cord sepsis is one among the major causes of neonatal mortality. The umbilical sepsis is preventable if proper care of the cord is taken in time [13]. The promotion of preventive neonatal care practices through home visits by community health nurses and community mobilization has been shown to reduce neonatal deaths in high mortality settings [13].

Despite the importance of umbilical cord care, there have been few randomized trials investigating the impact of different cord care regimens on cord infection rates [14]. Umbilical cord separation is a complicated process. It occurs by dryness of the junction of the cord and the skin of abdomen. During the normal process of separation, small amounts of cloudy mucoid material may collect at that junction, this may be misinterpreted as pus and the cord may appear moist, sticky or smelly. The cord normally falls off between 5 to 15 days after birth [15].

According to WHO recommendations, factors that delay this process are the application of antiseptics to the stump, infection and caesarean section [15]. The finding of the present study showed that time of umbilical cord separation was not significantly among the three groups (Alcohol, Chlorhexidine and Triple Dye). The shorter separation times belonged to Chlorhexidine group was < 7 days and the longest separation times belonged to Alcohol and Triple dye groups respectively were > 10 days (TABLE IV). Moreover, regarding to umbilical cord culture swab for infection growth the current study finding revealed that there was significant differences between group I "Alcohol 70%" and II "Chlorhexidine 4%", as well as group II "Chlorhexidine 4%" and III "Triple dye" (TABLE III). This finding may be attributed to Chlorhexidine has a broad-spectrum topical antimicrobial agent effect used against aerobic and anaerobic

bacteria that has been effective in preventing redness and infection. Chlorhexidine is also biguanides with antiseptic and disinfectant which has immediate bactericidal action and prolonged bacteriostatic against a wide range of Gram-positive and Gram-negative bacteria. The finding of the current study is congruent with several hospital-based studies for alcohol usage in umbilical cord cleaning, those showed that alcohol had lower impact on infection rate and bacterial colonization on umbilical cord stump compared to other antiseptic solutions such as Triple-day and Chlorhexidine ([12, 13, 16, 17]).

Chlorhexidine is one of the most commonly used solutions for cord care. It substantially reduces bacterial colonization and infection of the cord stump [17]. According to the World Health Organization, in case of the need for antiseptic use for cord care, chlorhexidine is the agent of choice [3, 15]. Evidence indicates that cord care using 4% chlorhexidine may reduce the risks of omphalitis, sepsis, and mortality rate in low‐resource settings [16, 17]. Other study reported that compared with the dry cord care method, cord care using chlorhexidine was associated with shorter umbilical cord separation time [16].

The latest WHO guidelines recommend application of chlorhexidine to the umbilical cord stump for the first week after birth, for infants born at home in environments with high neonatal mortality rates [15]. The findings of present study in agreement with Shoaeib et al. (2005) who studied the effect of topical alcohol with natural drying, in the alcohol-receiving group, where the mean time of cord separation was longer among alcohol group [18]. The present study findings similar with a study conducted by, Golombek et al. (2002) they reported in their study on 599 infants showed that using topical alcohol on a daily basis caused earlier umbilical cord separation compared to use of triple dye [19].

The current study finding revealed that all neonates (100%) in the three groups had no growth of infection in the initial culture swab. Yet, about one third of the two groups who received cord care by alcohol and triple dye had positive growth cord infection at the 5th day versus to a small percentage among group of chlorhexidine neonates (TABLE III).

Concerning the signs of cord infection, It was observed from the assessment of cord infection that, chlorhexidine group had developed less signs of local infection and no signs of severe infection at the 5th day of all assessment of the study groups (Alcohol, Chlorhexidine and Triple dye) (TABLE II). This could be justified by Chlorhexidine was more effective in reducing umbilical colonization by staphylococcal and streptococcal organisms than alcohol and triple dye. The result of the current study in line with a controlled trial study comparing triple dye, Chlorhexidine and no specific cord care, done by Darmstadt et al. (2010) they found that the Chlorhexidine was superior to triple dye in reducing colonization of the cord [20]. It was also in agreement with two community-based study from Bangladesh, Pezzati et al. (2003) and Mullany et al. (2012) they reported that cord cleansing with 4.0% chlorhexidine and triple dye immediately after birth reduces overall organism-specific colonization of the stump. This reduction was greater and sustained longer with daily cleansing through the first week of life [21, 22].

The findings of the present study were compatible with the results demonstrated by Zupan et al. (2007) and Habibi et al. (2014) they reported that alcohol was to be weaker in reducing colonization compared to other solutions. Alcohol rapidly kills the majority of bacteria in two minutes and prevents umbilical cord from staying wet. However, it instantly evaporates and delays the separation of umbilical cord. Moreover, alcohol was reported less effective to control umbilical colonization and skin infections compared to chlorhexidine, povidone-iodine [11, 12].

A recent meta-analysis showed a significant evidence to suggest that topical application of chlorhexidine to the umbilical cord reduces neonatal mortality and omphalitis in community and primary care settings in developing countries [19, 23]. Moreover, some studies for alcohol usage in umbilical cord cleaning showed that alcohol had lower impact on infection rate and bacterial colonization on umbilical cord stump compared to other antiseptic solutions such as Chlorhexidine [23, 24]. This in contrast to the current study's results , a meta-analysis including many studies mostly from developed countries with low rates of omphalitis, had reported that antiseptic solutions did not decrease the rate of omphalitis when compared to dry cord care, although they reduced bacterial colonization. It must be kept in mind that most of the studies in this meta-analysis were hospital based [6, 23].

Appropriate home-based implementation of care practices that reduce the risk of infection can contribute to significant reductions in neonatal mortality for infants born at home or in facilities if introduced and negotiated in an acceptable way [25].

V. CONCLUSION

Based on the findings of the present study, it was concluded that:

Neonates who received umbilical cord care by Chlorhexidine had less signs of local infection, and no severe infection with few percentages of positive infections compared to the other groups who received umbilical cord care by Alcohol and Triple dye. Despite there was no statistical significant difference found between the three different solutions regarding time of cord separation but the Chlorhexidine gave best result rather than Alcohol and Triple dye.

VI. RECOMMENDATIONS

Based on the current study findings the following recommendations are suggested:

- Provide health education and support for parents during hospitalization and at their homes about neonates' cord care practices, avoidance of harmful ancient practices, normal process of cord separation, and signs of omphalitis infection.

- Neonates' mothers should be educated on the significance of proper hygiene when caring for the umbilical cord and to apply relevant antiseptics in caring for the cord.

- Organize community sensitization on umbilical cord care practices through mass media and health convoy.

- Adopting a policy of home based care which should be provided for those who have poor access to health facility for follow up or any complain.

- Collaboration between health care providers at different settings in the community to promote neonatal health and prevention of infection.

- Further studies are recommended on large numbers, where the groups receives different solutions to cord care to determine which agent more effective.

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