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Original Article

Factors Associated with Neonatal Hyperbilirubinemia in Case Files of All Admitted Inborn and Outborn Neonates in Northwest Ethiopia in 2019

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ABSTRACT

Background: Jaundice is a yellow discoloration of the skin and eyes caused by hyperbilirubinemia. Jaundice usually becomes visible on the sclera at a level of 2 to 3 mg/dL. Each year, about 1.1 million neonates develop hyperbilirubinemia in the world the vast majority of whom live in sub-Saharan Africa and South Asia. In 2016, neonatal jaundice was estimated to account for about 8 under-5 mortalities per 100,000 live births worldwide. This study aimed to assess the prevalence and associated factors of hyperbilirubinemia among all the inborn and outborn neonates at University of Gondar Comprehensive Specialized Hospital in Gondar, Ethiopia.

Methods: The current institutional-based retrospective cross-sectional study was conducted on 399 case files of all the admitted inborn and outborn neonates at University of Gondar Comprehensive Specialized Hospital within March 2017 to March 2019. The extracted data were entered into Epi Info software (version 7.0) and exported and analyzed using SPSS software (version 21.0). Variables with a p-value of less than 0.2 in the bivariate analysis were included in the final model, and the statistical significance was declared at less than 0.05. Both the size and statistically associated factors affecting the results of neonatal hyperbilirubinemia were the main outcome measures in this study.

Results: Overall, 31.6% (n=126) of the admitted neonates developed hyperbilirubinemia. Maternal and neonatal Rhesus (RH) incompatibility, ABO incompatibility, low birth weight, hypoglycemia, and birth trauma were the main statistically significant factors associated with neonatal hyperbilirubinemia.

Conclusion: The prevalence of neonatal hyperbilirubinemia in this study was high in comparison to that reported for other studies carried out on neonatal hyperbilirubinemia in some parts of Ethiopia. The major factors causing hyperbilirubinemia in neonates were RH incompatibility, low birth weight, birth trauma, and hypoglycemia. Therefore, by the early prevention and prompt treatment of hyperbilirubinemia in neonates, it is important to prevent or reduce both short-term and long-term complications related to this condition.

Keywords: Hyperbilirubinemia, Neonatal jaundice, Northwest Ethiopia

Introduction

Hyperbilirubinemia is a common neonatal disorder in up to 60% of term and 80% of preterm neonates in the first week of life (1). When red blood cells break down, a substance called bilirubin is formed. Newborns are not easily able to get rid of the bilirubin, and it can build up in the blood and other tissues and fluids of the neonate's body resulting in hyperbilirubinemia. Jaundice is a yellowish discoloration of the skin, sclera, and mucous membranes often observed in newborns and rarely perceptible until the serum bilirubin level reaches 5-7.0 mg/dL (2, 3, 4). It is caused by the increased production of bilirubin from senescent fetal red blood cells and/or limited bilirubin elimination in newborns. In addition, neonatal bilirubin is not removed quickly enough

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due to the immaturity of the liver.

The serum bilirubin level required to cause jaundice varies with skin tone and body region; however, jaundice usually becomes visible on the sclera at a level of 2 to 3 mg/dL and on the face at about 4 to 5 mg/dL. With increasing bilirubin levels, jaundice seems to advance in a head-to-foot direction, appearing at the umbilicus at about 15 mg/dL and at the feet at about 20 mg/dL (5). Each year, about 1.1 million neonates develop hyperbilirubinemia in the world the vast majority of whom live in sub-Saharan Africa and South Asia (6). In 2016, neonatal jaundice was estimated to account for about 8 under-5 mortalities per 100,000 live births worldwide.

The burden of bilirubin-induced morbidity and mortality was the greatest in Sub-Saharan Africa and South Asia where the sociodemographic index values are within the low-middle or low quintiles. Moreover, neonatal jaundice was the seventh and eighth leading cause of mortality in Sub-Saharan Africa and South Asia, respectively (7). Unless and otherwise the case is early presented and appropriately treated, it can cause bilirubin encephalopathy/kernicterus (8). The passage of bilirubin into the brain can be affected by several factors and results in the risk of acute bilirubin encephalopathy.

Preterm birth, sepsis, hypoxia, seizures, acidosis, and hypoalbuminemia are the most frequently reported factors influencing the level of neonatal bilirubin. The rate of rising the bilirubin level is equally important with the increased risk of kernicterus in newborns with hemolytic diseases, such as glucose-6-phosphate dehydrogenase (G-6PD) deficiency, ABO, or Rhesus (Rh) hemolytic disease (1, 9). In term and preterm neonates, the serum bilirubin levels are usually lower than 12 and 15 mg/dL spontaneously resolving in the first and second weeks, respectively (10).

Hyperbilirubinemia is an important cause of morbidity in the neonatal period even for healthy and term newborns, especially in the first week of life. Hyperbilirubinemia is frequently associated with both maternal factors, such as blood type, ABO or Rh incompatibility, breastfeeding, and maternal illness (e.g., gestational diabetes), and fetal factors, including cephalohematoma or cutaneous bruising, excessive weight loss after birth, infections, infrequent feeding, gender, polycythemia, G-6PD deficiency, and prematurity (11, 12).

As it is known, there are high rates of neonatal mortality and morbidity in Ethiopia due to one of the complications of neonatal hyperbilirubinemia. The problem is the availability of the actual rate of neonatal hyperbilirubinemia (13). Neonatal hyperbilirubinemia affects the brain, and bilirubin encephalopathy results in long-term sequels, such as sensory-neuronal hearing loss, in the survivors and mortality. Kernicterus Spectrum Disorder is considered the clinical signs associated with bilirubin toxicity that can result in cerebral palsy, seizure, developmental delay, oculomotor dysfunction, and neurocognitive impairment (14-16).

Despite the expansion of the neonatal health care system in Ethiopia, there has still been an increase in the admission of neonates to the neonatal intensive care unit (NICU) with infection, jaundice, low birth weight, inability to feed, hypoglycemia, birth asphyxia, and preterm birth. However, there are a limited number of studies carried out in Ethiopia, particularly in the present study area, demonstrating the status of neonatal hyperbilirubinemia and associated factors. Therefore, this study aimed to assess the prevalence and associated factors of neonatal hyperbilirubinemia based on the case files of all the admitted inborn and outborn neonates to the NICU of University of Gondar Comprehensive Specialized Hospital in Gondar, Ethiopia.

Methods

Study design and participants

This institutional-based retrospective cross-sectional study was conducted on the inborn and outborn neonates admitted to the NICU of University of Gondar Comprehensive Specialized Hospital within March 2017 to March 2019. The data were extracted during May to June 2019. The hospital is located in Gondar and serves more than 7 million individuals living in northwest Ethiopia. The NICU is a unit under the pediatrics and child health department and provides inpatient medical services for neonates. The NICU ward in this hospital is a referral center and one of the largest NICUs in Amhara Region in Ethiopia with an exceedingly high rate of patient admission.

The sample size was determined using a single population proportion formula and finally calculated at 399. The records of the neonates were reviewed, and the risk factors were identified based on the medical files of patients with the diagnosis of neonatal jaundice. The screening method of hyperbilirubinemia performed at University of Gondar Comprehensive Specialized Hospital assessed all the clinical features in relation to neonatal jaundice using complete history taking, physical examination, and laboratory investigation of the bilirubin level.

Eligibility criteria

In this study, a complete enumeration technique was used for all the cases to select the study participants. All the neonates with the age of less than or equal to 28 days who were admitted to NICU at University of Gondar Comprehensive Specialized Hospital within March 2017 to March 2019 were included in the study. However, the neonates with incomplete patient chart information and referring for vaccination were excluded from the study.

Study variables

Neonatal hyperbilirubinemia was the dependent variable. Nevertheless, the sociodemographic variables (e.g., age, gender, and weight), neonatal factors (e.g., prematurity, breastfeeding jaundice, breast milk jaundice, sepsis, and G-6PD deficiency), and maternal factors (e.g., ABO incompatibility and Rh isoimmunization) were the independent variables in this study.

Data extraction and quality control procedures

A standardized structured data extraction checklist was used after the adaptation of the tool based on the literature, national and international standards, and review of patient charts. It was prepared in English, and data extraction was carried out by trained individuals. The data extraction process was daily evaluated, and necessary adjustments were made. Regarding the patient chart with incomplete data, the chart was replaced by another patient chart that was randomly selected. Finally, 399 patient charts were included in this study for analysis.

Data management and analysis

The data were coded and entered a computer using Epi Info software (version 7.0). Then, the data were exported and analyzed using SPSS software (version 21.0). The frequencies and percentages of different variables were computed for description using tables. Each variable with a p-value of less than 0.2 was included in the final model of multivariable logistic regression analysis to control all the confounders. The adjusted odds ratio with a 95% confidence interval was estimated to identify the associated factors with neonatal hyperbilirubinemia. In this study, a p-value of less than 0.05 was considered statistically significant.

Results

Sociodemographic characteristics of the study subjects

Out of 5,922 neonates who were admitted to the NICU of University of Gondar Comprehensive Specialized Hospital, a total of 399 newborns were selected as the study participants within March 2017 to March 2019. Among the selected neonates, 213 (53.4%) newborns were male. The age of 210 (52.6%) patients was less than 1 day on admission. The majority (70.9%) of the neonates were within the weight range of 2,500-4,000 g at birth (Table 1). In addition, prematurity was reported as 35.8% (n=143) in the study participants. Among the neonates who developed hyperbilirubinemia, 38.1% (n=148) of the patients were admitted at the age of less than 1 day. The maternal age was within the range of 25-29 years in 38.1% of the newborns (n=152).

Prevalence of neonatal hyperbilirubinemia

Out of 399 admitted neonates, 126 (31.6%) newborns developed hyperbilirubinemia. The prevalence rates of neonatal hyperbilirubinemia among the male and female neonates were 49.2% (n=62) and 50.8% (n=64), respectively. Out of 126 newborns with hyperbilirubinemia, 13 (10.3%) neonates developed bilirubin encephalopathy; out of those complicated cases, seven (53.8%) patients developed phase two bilirubin encephalopathy (i.e., one of the three phases of bilirubin encephalopathy characterized by symptoms that may include irritability, high-pitched crying, poor feeding, neck hyperextended backward, or hypertonia) finally resulting in the death of four (57.1%) neonates.

In this study, hyperbilirubinemia contributed to about 11.9% (n=15) of neonatal mortalities (Table 2). The majority (62.5%) of the neonatal hyperbilirubinemia cases happened at the onset of days 1-14. All neonatal hyperbilirubinemia cases were tested in the laboratory; therefore, it was shown that the total and direct serum bilirubin levels on admission for 71 (56.3%) and 12 (9.5%) neonates were within the range of 15-20 and > 2 mg/dL, respectively. Regarding the treatments of this disease, 78 (62%) and 30 (23.8%) neonates were treated by phototherapy and both phototherapy and exchange transfusion, respectively.

Factors associated with hyperbilirubinemia among neonates admitted to University of Gondar Comprehensive Specialized Hospital within March 2017 to March 2019

After controlling the confounders in the multivariate regression model, maternal Rh, neonatal Rh, neonatal weight, neonatal hypoglycemia, and trauma during delivery were

Table 1. Sociodemographic characteristics of the study participants at University of Gondar Comprehensive Specialized Hospital in Gondar, Ethiopia, within March 2017 to March 2019

No.	Variable	Category	n	%
1	Maternal age (year)	15-19	34	8.5
		20-24	103	25.8
		25-29	152	38.1
		30-34	91	22.8
		>34	19	4.8
2	Marital status	Married	373	93.5
		Unmarried	15	3.8
		Divorced	7	1.8
3	Occupational status	Student	39	9.8
		Government employee	59	14.8
		Merchant	74	18.5
		Housewife	227	56.9
5	Educational level	Illiterate	108	27.1
		Ability to read and write	66	16.5
		Grade 1-6	81	20.3
		Grade 7-12	69	17.3
		Certificate and higher	75	18.8
6	Neonatal age on admission	<24 h	210	52.6
		1-7 days	18	4.5
		8-14 days	34	8.5
		15-28 days	13	3.3
7	Gender of neonate	Male	213	53.4
		Female	186	46.6
8	Neonatal birth weight (g)	<2,500	110	27.6
		>2,500-4,000	283	70.9
		>4,000	6	1.5
9	Gestational age	28-37 weeks	143	35.8
		38-42 weeks	147	36.8
		>42 weeks	5	1.3
		Unknown	104	26.1

Table 2. Characteristics of neonates admitted to the neonatal intensive care unit of University of Gondar Comprehensive Specialized Hospital in Gondar, Ethiopia, within March 2017 to March 2019

No.	Variable		n	%
1	Neonatal weight on admission (g)	<2,500	127	31.8
		2,500-4,000	258	64.7
		>4,000	14	3.5
3	Neonate with clinically visible jaundice	1-7 days	109	86.5
		8-14 days	15	11.9
		>14 days	2	1.6
4	Hypoglycemia on admission	Yes	54	13.5
		No	345	86.5
6	Total serum bilirubin level on admission (mg/dL)	8-14	42	33.3
		15-20	71	56.3
		>20	13	10.3
7	Direct serum bilirubin level on admission (mg/dL)	0-0.2	2	1.6
		0.3-1	91	72.2
		1-2	21	16.7
		>2	12	9.5

Table 2. Continued

10	Developed bilirubin (Encephalopathy/Kernicterus)	No	111	88.1
		Yes	15	11.9
11	Stage of encephalopathy/kernicterus	Phase 1	6	40
		Phase 2	7	46.7
		Phase 3	2	13.3
12	Hyperbilirubinemia management	Phototherapy	78	61.9
		Both phototherapy and exchange blood transfusion	30	23.8
		Exchange blood transfusion	18	14.2
15	Condition of discharge with hyperbilirubinemia	Improved	111	88.1
		Mortality	15	11.9

significantly associated with neonatal hyperbilirubinemia. The mothers with Rh incompatibility and newborns with hypoglycemia were 88% and 62% more likely to cause and develop neonatal hyperbilirubinemia, respectively. The Rh-negative newborns were 77% less likely to develop neonatal hyperbilirubinemia, compared to the Rh-positive neonates (Table 3). Those newborns within the body weight range of 2,500-4,000 g were 97% less likely to develop neonatal hyperbilirubinemia, compared to the newborns with a body weight of less than 2,500 g.

Table 3. Bivariate and multivariate logistic regression analyses of associated factors with the prevalence of neonatal hyperbilirubinemia in University of Gondar Comprehensive Specialized Hospital, Gondar, Ethiopia, within March 2017 to March 2019

Variable	Neonatal bilirubin status		COR (95% CI)	AOR (95% CI)	P-value	
	No	Yes			COR	AOR
Maternal age (year)						
15-19	16	18	1			
20-24	71	32	0.40 (0.181-0.885)	0.61 (0.097-3.930)	0.024	0.609
25-29	116	36	0.27 (0.128-0.596)	3.11 (0.573-16.876)	0.001	0.189
30-34	61	30	0.43 (0.196-0.976)	1.44 (0.300-6.968)	0.043	0.646
>35	9	10	0.98 (0.321-3.041)	3.84 (0.717-20.607)	0.983	0.116
History of jaundice in siblings						
Yes	8	11	3.16 (1.242-8.084)	0.20 (0.032-1.257)	0.016	0.086
No	265	115	1			
Trauma during delivery						
Yes	15	35	6.61 (3.452-12.676)	0.08 (0.028-0.247)	0.000	0.000
No	258	91	1			
Maternal blood group						
A	42	21	1			
B	63	37	1.20 (0.6-2.3)	0.95 (0.304-2.994)	0.634	0.936
AB	77	14	0.36 (0.2-0.8)	0.60 (0.220-1.674)	0.010	0.335
O	91	54	1.20 (0.6-2.2)	2.05 (0.684-6.147)	0.590	0.200
Maternal Rhesus						
Rhesus-negative	24	49	6.60 (3.8-11.5)	0.12 (0.053-0.305)	0.000	0.000
Rhesus-positive	249	77	1			
Hypoglycemia						
Yes	31	23	1.74 (0.97-3.13)	0.38 (0.151-0.955)	0.063	0.040
No	242	103	1			
Neonatal age (day)						
<1	162	48	1			
1-7	10	8	2.70 (1.009-7.222)	2.26 (0.484-10.647)	0.0482	0.299
8-14	22	12	1.84 (0.849-3.990)	0.614 (0.098-3.838)	0.1221	0.602
15-28	9	4	1.50 (0.442-5.086)	1.39 (0.240-8.073)	0.5151	0.711
Neonatal birth weight (g)						
<2,500	82	28	1			
2,500-4,000	185	98	1.55 (0.947-2.542)	0.03 (0.001-0.841)	0.081	0.039
>4,000	6	0	0.00 (0.000-0.000)	0.031 (0.001-0.672)	0.999	0.027
Neonatal sepsis						
Yes	105	32	0.54 (0.341-0.871)	1.47 (0.684-3.171)	0.011	0.322
No	168	94	1			
Neonatal blood group						
A	47	21	0.69 (0.368-1.313)	0.89 (0.258-3.137)	0.262	0.867
B	92	44	0.74 (0.443-1.250)	1.14 (0.422-3.123)	0.264	0.787
AB	64	16	0.38 (0.200-0.755)	1.63 (0.516-5.181)	0.005	0.403
O	70	45	1		0.021	0.867

Table 3. Continued						
Neonatal Rhesus						
Rhesus-negative	23	31	3.54 (1.968-6.391)	0.23 (0.088-0.629)	0.000	0.004
Rhesus-positive	250	95	1			

COR: Crude odds ratio; AOR: Adjusted odds ratio; COR: Crude odds ratio; CI: Confidence interval

Discussion

Overall, the rate of neonatal hyperbilirubinemia in this study was reported as 31.6% (n=126) indicating that the prevalence of neonatal hyperbilirubinemia was high, compared to the findings of other studies in some parts of Ethiopia. Maternal and neonatal Rh, neonatal weight, neonatal hypoglycemia, and trauma during delivery were significantly associated with neonatal hyperbilirubinemia. Currently, myriad studies reported that the occurrence of neonatal jaundice is higher than 60% in term neonates and around 80% in premature neonates in the first week of life, in which bilirubin is non-conjugate, lipid-soluble, and non-polar pigment. Hyperbilirubinemia is a frequent problem in preterm neonates. Studies have shown that up to two-thirds of healthy newborns appear jaundiced during the first postnatal week (2).

The results of a study performed at Northern Ethiopia and Addis Ababa, Ethiopia, on neonatal jaundice showed that the rate of neonatal jaundice was observed to be 37.3% (6), and 44.9% (n=16) of the cases were diagnosed with hyperbilirubinemia out of whom 11 (6.9%) neonates developed bilirubin encephalopathy. The findings of the aforementioned study are in line with the results of the current study. The possible justification may be related to the similarity of the study setting and sociodemographic characteristics.

The result of a study carried out in Nigeria showed that the prevalence of neonatal jaundice was 17.9% among 664 admitted neonates the majority of whom were within 1-2 days (17). The results of the present study demonstrated that the prevalence of neonatal hyperbilirubinemia was 31.6% (n=126). Most of the age groups of the neonates were less than 1 day accounting for 210 (52.6%) newborns out of whom 48 (22.8%) and 8 (16.6%) neonates developed neonatal hyperbilirubinemia and bilirubin encephalopathy, respectively. The increased rates of neonatal hyperbilirubinemia and bilirubin encephalopathy in this study may be related to the level and quality of care for the neonates. The results of a study conducted in Nigeria on neonatal jaundice revealed that 35.0% of all NICU admissions developed neonatal jaundice (18).

The major factors, including gestational age, Rh incompatibility, G-6PD, ABO incompatibility, hypoglycemia, sepsis, duration of labor, and neonatal gender, were the main factors that were statistically associated with the development of neonatal hyperbilirubinemia (4, 6, 13, 16, 19). The findings of the present study are also in line with most of these associated factors. The results of the current study showed that a large number (n=210; 52.6%) of neonates were admitted during the first 24 h of life. Out of 126 jaundiced neonates, 78 (61.9%) newborns were treated with phototherapy alone, and 30 (23.8%) subjects underwent both exchange blood transfusion and phototherapy 12.6% (n=16) of whom died.

Similarly, a study was carried out to determine the causes and prevalence of neonatal admissions to a Kenyan district hospital. The findings of the aforementioned study showed that neonatal jaundice was particularly associated with a high rate of mortality in the first week of life accounting for 22% of total monthly neonatal admissions, with an in-patient case fatality rate of 26%. Out of 87 neonates admitted with jaundice as a primary problem, 23 newborns received an exchange transfusion 7 (30%) of whom died (20).

Various factors can affect the difference between the finding of the current study and other studies on the mortality effect of hyperbilirubinemia, including the study design, study setting, socioeconomic level of the study population, and other variables. In the present study, the secondary data were used, and while extracting these data there were certain challenges, such as incomplete files and reliability of the findings of the patient files. The G-6PD test was also another challenge in the present study to compare its effects on mortality to other findings because the test was not available. All the aforementioned factors and other things could be the probable reasons for such a variation.

Limitation

It was difficult to detect the contribution of G-6PD deficiency due to no routine screening for this enzyme deficiency in the study region. The reliability of the data registered on the patient chart may also be the other limitation of this study. The cross-sectional nature of this study is

also considered another limitation.

Conclusion

Although the professional staff working in the pediatric angiography unit is experiencing numerous mental and psychological problems, the health system has not taken supportive measures for such personnel. System health problems, such as the shortage of male nurses and forced overtime, have worsened the situation while angiography personnel needs to leave and rest after their shifts due to environmental radiation that exists in this unit. Therefore, health authorities are recommended to take the necessary care and intervention plans to deal with such problems. Attention should also be paid to the recruitment of sufficient numbers of staff for this unit. In addition, given the importance of this unit, it is suggested to take into account the radiation rights and the staff number of leaves. The most important limitation of this study was the low number of participants; however, generalizability is not the goal of a qualitative study. It was aimed to unravel the challenges and problems of the pediatric angiography care team.

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Conflicts of interest

The authors declare that there is no conflict of interest.

Ethical approval and consent to participate

Ethical clearance was obtained from the School of Nursing and Institutional Review Board of the University of Gondar. It was confirmed that based on the Declaration of Helsinki, informed consent was waived and this had been assured by the Institutional Review Board of the University of Gondar because the extracted data from the chart were secondary. The officials of the University of Gondar Comprehensive Specialized Hospital were communicated through a formal letter that was taken from the School of Nursing, and the permission for data collection was granted from the hospital. The confidentiality of the information was maintained through not extracting personal identifiers and storing data in a password secured computer.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used for this study are available upon reasonable request from the corresponding author.

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No specific fund was received for this research project.

Authors' contributions

MT first designed the study, involved in data collection, carried out the analysis, interpreted the results, drafted the paper, and participated in the preparation of all versions of the manuscript. WA, DG, AW, and AT aided in the design and proposal development, checked data collection, helped during the analysis, and revised subsequent drafts of the manuscript. All the authors contributed to analyzing the data, drafting, and critically revising the paper, gave final approval of the version to be published, and agreed to be accountable for all the aspects of the study.

References

1. Chib R, Bhandari B. Clinico-demographic profile of hyperbilirubinemia in neonates admitted to a tertiary care hospital. Int J Contempor Pediatr. 2016; 3(2):328.
2. American Academy of Pediatrics Subcommittee on Hyperbilirubinemia. Management of hyperbilirubinemia in the newborn infant 35 or more weeks of gestation. Pediatrics. 2004; 114(1):297-316.
3. American Academy of Pediatrics. Jaundice, what is jaundice? Philadelphia, PA: Elsevier Saunders; 2015.
4. Sharma S. Neonatal hyperbilirubinemia: hospital based study in western region, Nepal. Janapriya J Interdisciplinary Stud. 2016; 5:75-82.
5. Olusanya BO, Ogunlesi TA, Kumar P, Boo NY, Iskander IF, de Almeida MF, et al. Management of late-preterm and term infants with hyperbilirubinemia in resource-constrained settings. BMC Pediatr. 2015; 15(1):39.
6. Lake EA, Abera GB, Azeze GA, Gebeyew NA, Demissie BW. Magnitude of neonatal jaundice and its associated factor in neonatal intensive care units of Mekelle city public hospitals, Northern Ethiopia. Int J Pediatr. 2019; 2019:1054943.
7. Olusanya BO, Teeple S, Kassebaum NJ. The contribution of neonatal jaundice to global child mortality: findings from the GBD 2016 study.

Pediatrics. 2018; 141(2):e20171471.
8. Shapiro SM, Bhutani VK, Johnson L. Hyperbilirubinemia and kernicterus. Clin Perinatol. 2006; 33(2):387-410.
9. Ogunlesi TA, Ogunfowora OB. Predictors of acute bilirubin encephalopathy among Nigerian term babies with moderate-to-severe hyperbilirubinemia. J Trop Pediatr. 2010; 57(2):80-6.
10. Maisels MJ. Neonatal jaundice. Pediatr Rev. 2006; 27(12):443-54.
11. Maisels MJ, Clune S, Coleman K, Gendelman B, Kendall A, McManus S, et al. The natural history of jaundice in predominantly breastfed infants. Pediatrics. 2014; 134(2):e340-5.
12. Stevenson DK, Dennery PA, Hintz SR. Understanding newborn jaundice. J Perinatol. 2001; 21(Suppl 1):S21-4.
13. Federal Democratic Republic of Ethiopia and Ministry of Health. National newborn and child survival strategy document brief summary, 2015-2020, Ethiopia: Postnatal Care; 2015.
14. Aydın M, Hardalaç F, Ural B, Karap S. Neonatal jaundice detection system. J Med Syst. 2016; 40(7):1-11.
15. Click R, Dahl-Smith J, Fowler L, DuBose J, Deneau-Saxton M, Herbert J. An osteopathic approach to reduction of readmissions for neonatal jaundice. Osteopathic Fam Phys. 2013; 5(1):17-23.
16. Kassa R, Gudeta H, Assen Z, Demlew T, Teshome G. Neonatal hyperbilirubinemia: magnitude and associated etiologic factors among neonates admitted at Tikur Anbessa specialized hospital, Ethiopia. J Preg Child Health. 2018; 5(384):2.
17. Mojtahedi SY, Izadi A, Seirafi G, Khedmat L, Tavakolizadeh R. Risk factors associated with neonatal jaundice: a cross-sectional study from Iran. Open Access Maced J Med Sci. 2018; 6(8):1387-93.
18. Omekwe DE, George MD, Kennis BT, Fakuma BN, Evdence CC, Destiny EF, et al. Survey and management outcome of neonatal jaundice from a developing tertiary health centre, Southern Nigeria. IOSR J Dental Med Sci. 2014; 13(4):35-9.
19. Onyearugha CN, Onyire BN, Ugboma HA. Neonatal jaundice: prevalence and associated factors as seen in Federal medical centre Abakaliki, Southeast Nigeria. J Clin Med Res. 2011; 3(3):40-5.
20. English M, Ngama M, Musumba C, Wamola B, Bwika J, Mohammed S, et al. Causes and outcome of young infant admissions to a Kenyan district hospital. Arch Dis Child. 2003; 88(5):438-43.