International Journal of Life Sciences, Biotechnology and Pharma Research Vol. 13, No. 9, September 2024 Online ISSN: 2250-3137
Print ISSN: 2977-0122

DOI: 10.69605/ijlbpr_13.9.2024.96

Original Research

Use full ness Of Cord Blood Analysis In Predicting Hyperbilirubinemia In Babies At Risk Of RH And ABO Incompatibility

[1]Dr. Nikita Duhan, [2]Dr. Fauzia Arif, [3]Dr. Pankaj Gyanani, [4]Dr. Ritika Singh Chandel, [5]Dr. Bani Kaur

[1]Junior resident, Department of Pediatrics, Jaipur National Hospital, Jaipur
[2]Associate Professor, Department of Pediatrics, Jaipur National Hospital, Jaipur
[3]Assistant Professor, Department of Pediatrics, Jaipur National Hospital, Jaipur
[4]Junior resident, Department of Pediatrics, Jaipur National Hospital, Jaipur
[5]Junior resident, Department of Pediatrics, Jaipur National Hospital, Jaipur

Corresponding author
Dr. Bani Kaur
Junior resident, Department of Pediatrics, Jaipur National Hospital, Jaipur

Received Date: 20 July, 2024 Accepted Date: 21August, 2024

Abstract

Aim: To evaluate the usefulness of cord blood analysis in predicting hyperbilirubinemia in babies at risk of Rh And Abo incompatibility.

Material And Methods: The present hospital-based prospective observational study was conducted at Jaipur National Hospital, Jaipur among 100 babies born to O+VE or RH-VE mothers, delivered by both cesarean and natural labor from August 2022 to January 2024. The newborns detected to have pathological hyperbilirubinemia were furtherinvestigated by doing a Direct Coomb test, complete blood count, reticulocyte count andperipheral smear and were managed according to standard protocols as per guidelines ofthe American Academy of Pediatrics subcommittee on hyperbilirubinemia.

Results:43% of cases are related to RH incompatibility, while 57% of cases are related to ABO incompatibility.18% of newborns had pathological jaundice. In the ABO and Rh incompatibility groups, clinical jaundice was observed in 52.63% and 27.91% of neonates, respectively.When significant hyperbilirubinemia was present as compared to absent, there was a significantly higher mean Cord bilirubin total.≥1.715 was the optimal cut-off for the value of Cord bilirubin - Total to predict significant hyperbilirubinemia, (AUC = 0.786) with a Sensitivity and Specificity of 85.7% and 56.9% respectively. Less than or equal to 16.5 gm/dl was the optimal cut-off value of Hb, (AUC = 0.831) with a Sensitivity and Specificity of 47.6% and 98.2% respectively. ≥0.21 was the optimal cut-off value of reticulocyte count to predict significant hyperbilirubinemia, (AUC = 0.675) with a Sensitivity and Specificity of 97.6% and 23.2 % respectively Greater Than or Equal to 2.7 was the optimal cut-off value of reticulocyte count to predict significant hyperbilirubinemia, (AUC = 0.793) with a Sensitivity and Specificity of 76.2% and 73.2% respectively. These values can be used as safe risk demarcations in deciding about the time of discharge of ABO-incompatible newborns from the hospital.

Conclusion:It can be concluded from the results that cord bilirubin, haemoglobin, reticulocyte count and positive direct antiglobulin test are good predictors for significant hyperbilirubinemia and severe hemolytic disease.

Keywords: Hyperbilirubinemia, RhIncompatibility, Abo Incompatibility, Cord Blood Analysis
Biomarkers

Introduction:

Hyperbilirubinemia is very common and found in most cases; is also a benign problem in the neonatal period i.e. often physiologic where interventions are not mandatory. This issue is the most common reason for neonatal period babies taking hospital admissions[1]. Over 50% of newborn infants face jaundice.[2] Babies become clinically jaundiced when the bilirubin level touches ~80 μmol/L as mentioned, neonatal jaundice is a common abnormal clinical feature in the initial few days of life because it shows a sign of an underlying disorder (like anemia, infection, liver issues or an inborn error of metabolism).[3] In critical cases, it is highly unconjugated hyperbolic. In the case of early babies discharged from the hospital, babies with ABO incompatibility are at high risk for generating significant Hyperbilirubinemia due to having some degree of ABO is an immune disease.

Rh incompatibilities arise in a condition type when a mother Rh factor is negative& infant Rh factor is positive where the mother's immune system produces antibodies that attack the infant RBC leading to

DOI: 10.69605/ijlbpr_13.9.2024.96

hemolytic (HDN) disease in newborns due to which they are at risk for Hyperbilirubinemia.[4] The American Academy of Pediatrics recommends that all new infants be evaluated for risk factors for bilirubin related neurotoxicity initially along with screening bilirubin levels[1]. Approx. 25% to 50% of newborns & even a high percentage of premature infants can develop clinical jaundice. 6.1% of well-term newborns have a maximal serum bilirubin level > 12.9mg/dL where the magnitude shows X>15mg/dL in 3% of normalterm babies[5].

Although Rh isoimmunisation was once thought to be the only cause of pathological jaundice, other factors such as ABO incompatibility (OAI being the most common), red cell membrane defects (hereditary spherocytosis), red cell enzyme defects (i.e. G6PD def), thalassemias, etc. can also play a significant role in the prevalence of pathological jaundice in newborns.[6] Since the development of Rh immunoglobulin as a therapy for neonates with Rh immune hemolytic illness, ABO hemolytic disease has emerged as the prevalent blood group with incompatible hemolytic processes throughout this period. About 25% of pregnancies have fetal-maternal ABO incompatibility, yet only 1 in 10 of these children go on to have a hemolytic illness.[7]

Although it only affects group A and group B infants born to group O mothers, ABO hemolytic illness can manifest itself during any pregnancy, even the first one. Umbilical cord blood bilirubin (UCB) estimation at delivery is feasible, affordable, and non-invasive. The potential value of UCB estimate in predicting eventual Hyperbilirubinemia has been examined in several earlier investigations.[8-10]

The majority of research conducted in our nation focuses on using cord bilirubin levels alone to predict ABO and RH hemolytic illness. The RH and ABO-hemolytic diseases are not well predicted by cord bilirubin levels alone. The likelihood of developing RH and ABO-hemolytic illness may be very well predicted by the combination of cord bilirubin, direct Coomb's test, reticulocyte count, and cord haemoglobin. If the trial shows it to be effective, a newborn may be safely discharged at 48+/-hrs when all the foregoing tests are negative, shortening the hospital stay. As a result, there are financial advantages and a lower risk of nosocomial infection for moms and newborns. It would be a non-invasive early screening tool if cord blood levels could predict RH and ABO hemolytic illness. The present study was conducted to know the usefulness of cord blood analysis in predicting hyperbilirubinemia in babies at risk of Rh and ABO incompatibility.

Material And Methods: The present hospital-based prospective observational study was conducted at Jaipur National Hospital, Jaipur among babies born to O+VE or RH-VE mothers, delivered by both cesarean and natural labor. A total of approximately 100 newborns delivered in Jaipur National Hospital, Jaipur from August 2022 to January 2024.

Inclusion Criteria

a. Newborn with A or B born to O+ mothers or mother RH negative and baby positive blood group Newborn with Gestational Age (GA) >37 weeks.
b. Newborn with birth weight 2.5-4kg.
c. Newborn with APGAR score >7.

Exclusion Criteria

a. Absence of significant illness or major congenital malformation.
b. Neonatal problems like sepsis, hypothyroidism, respiratory distress syndrome.
c. Trauma conditions like Cephalhematoma
d. Significant disease in the mother which can cause hyperbilirubinemia in newborns like gestational diabetes mellitus.

Methodology:

The present study was a hospital-based prospective observational study undertaken to determine the bilirubin, haemoglobin, direct comb test, and reticulocyte counts at birth for subsequent hyperbilirubinemia in neonates. Institutional ethical committee approval and informed consent from parents were obtained, and babies that satisfied the inclusion criteria were enrolled in our study. Considering the above inclusion and exclusion criteria, 100 newborns were delivered by both cesarean and natural labour at Jaipur National University. Cord blood was collected from term babies born to an O-positive or any RHnegative mother and sent for total serum bilirubin and blood grouping evaluation. A detailed history using a study proforma was collected on various neonatal factors like weight at birth, gestational age, sex, and APGAR at 5 minutes. Maternal factors like age, number of births, blood group, mode of delivery, previous siblings with jaundice, maternal diabetes mellitus, and gestational hypertension were collected from the maternal file.

Babies were examined daily and looked for evidence of jaundice, sepsis and development of any illness for the first 5 days. Blood for evaluation of total bilirubin wasdrawn at less than 72 hours of life from babies who showed clinical evidence of jaundice. Peripheral venous blood was used to measure serum bilirubin. The gestational age of the newborns was assessed using the new Ballard score.[11] Then all enrolled babies were followed up clinically for the development of jaundice by using the Kramer dermal scale till discharge and further on follow-up up till 1 month of age The neonates were followed up twice daily for clinical jaundice. If they developed clinical jaundice, serum bilirubin was estimated and treatment was given."

DOI: 10.69605/ijlbpr_13.9.2024.96

Cord Blood Analysis: The newborns detected to have pathological hyperbilirubinemia were furtherinvestigated by doing a Direct Coomb test, complete blood count, reticulocyte count andperipheral smear and were managed according to standard protocols as per guidelines ofthe American Academy of Pediatrics subcommittee on hyperbilirubinemia. Significant hyperbilirubinemia in our study was defined as:[12]

• Any elevation in serum bilirubin levels requiring treatment.

• Serum total bilirubin concentration of >0.5 mg/dL/h in the first 24 hours, > or =12mg/dL on day 2, > or =15 mg/dL or more on day 3, were defined to havesignificant hyperbilirubinemia and were started on phototherapy.

Pathological hyperbilirubinemia in our study was defined:

• Clinical jaundice in first 24 hours of life.

• Rate of STB increase >0.2 mg/dl/hour or 5mg/dl/day.

Those babies who on visual inspection had jaundice where the bilirubin levelseemed to be above the 95th centile for age in hours of life as per Bhutani hour-specificbilirubin nomogram were further investigated by estimation of serum total and directbilirubin.

Serum bilirubin estimation was done within 12 hours of collection by Diazitized sulfanilic test. The blood sample collected was stored away from light andrefrigerated between 2-8 0C till the estimation was done.The serum total and conjugated bilirubin were estimated by using a 2-point assay calorimetric auto-analyzer.

Serum bilirubin was estimated using diazo method. Guidelines by the AmericanAcademy of Paediatrics were followed for deciding treatment.Reticulocyte count was estimated by supravital staining with brilliant cresyl blue.Blood was mixed with brilliant cresyl blue and a peripheral smear was examined forpolychromatic RBCs.

Haemoglobin estimation was done with the help of an auto analyzer. Values lessthan 13 g/dL in the cord blood should be regarded as abnormal. Mother's and baby ABOand Rh grouping was done by using the gel card method. Coombs test direct (DCT) orindirect (ICT) of newborns born to mothers whose blood group was O type or Rhnegative to determine the maternal-fetal blood group or Rh incompatibility was done bygel-card method.

Statistical Analysis: Data was entered in Microsoft Excel sheet version 2013. It was then imported into a registered version of SPSS trial version 23 software. Data were analyzed using simple statistics like mean, median and proportions for the general variables. A chi-square test was done to find the association between two or more categorical variables. The critical cord bilirubin level *(SERUM BILIRUBIN, HB, RETIC COUNT, DCT) having the highest sensitivity and specificity was determined with the Receiver operating characteristics (ROC) curve analysis. The sensitivity and specificity were calculated for predicting hyperbilirubinemia. For determining the significance of each test, $P<0.05$ was used.

Results: The mean mother age (mean ±SD) was 24.72±2.161 years with 64% of cases belong to multiparity, rest were primi.57% of cases belong to ABO incompatibility and 43%cases belong to RH incompatibility (graph 1).

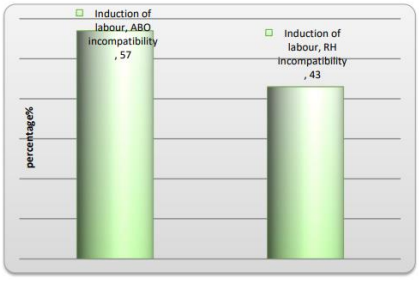
ABO and Rh incompatibility groups, 52.63% and 27.91% newborns respectively developed clinical jaundice. This observation was statistically significant (table 1).

According to Cord Direct Coomb's test, we have found that 94% of cases belong to Negative rest 6% cases belong to Positive tests (graph 2).

ROC curve analysis was performed to determine the optimal cut-off values of Cord bilirubin - Total with significant hyperbilirubinemia. 1.715 was the optimal cut- off the value of Cord bilirubin - Total to predict significant hyperbilirubinemia, (AUC = 0.786) with a Sensitivity and Specificity of 85.7% and 56.9% respectively (graph 3).

ROC curve analysis was performed to determine the optimal cut-off values of HB with significant hyperbilirubinemia. Lesser Than or Equal To 16.5gm/dl was the optimal cut-off value of Hb to predict significant hyperbilirubinemia, (AUC = 0.831) with a Sensitivity and Specificity of 47.6% and 98.2% respectively (graph 4).

ROC curve analysis was performed to determine the optimal cut-off values of DCT with significant hyperbilirubinemia. Greater than or equal to 0.21 was the optimal cut-off value of reticulocyte count to predict significant hyperbilirubinemia, (AUC = 0.675) with a Sensitivity and Specificity of 97.6% and 23.2 % respectively (graph 5).

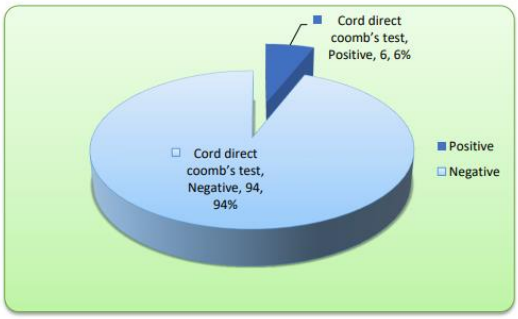


Graph 1: ABO and RH incompatibility

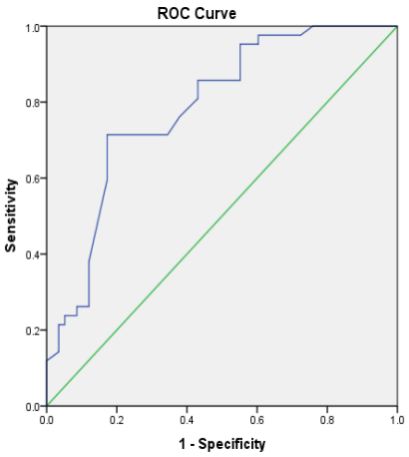
DOI: 10.69605/ijlbpr_13.9.2024.96

Table 1:ABO and RH incompatibility with Significant hyperbilirubinemia

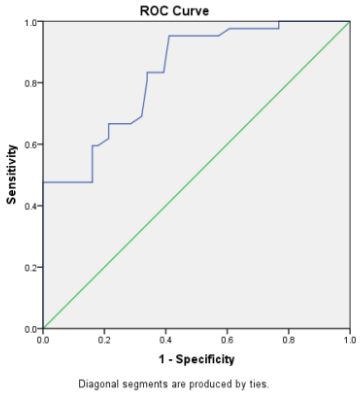
Sig hyperbilirubinemia	ABO incompatibility		RH incompatibility		Grand Total		
	number	percentage %	number	percentage %	number	percentage %	P-values
present	30	52.63	12	27.91	42	42	0.023S
Absent	27	47.37	31	72.09	58	58	
Grand Total	**57**	100	**43**	100	**100**	100	



Graph 2: Cord direct Coomb's test

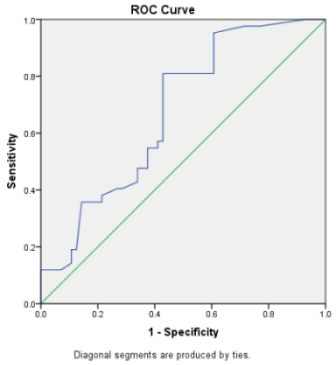


Graph 3: ROC curve analysis and predictive ability of cord blood bilirubin for subsequent significant hyperbilirubinemia



Graph 4: ROC curve and predictive ability of HB for subsequent significant hyperbilirubinemia

DOI: 10.69605/ijlbpr_13.9.2024.96



Graph 5: ROC curve and predictive ability of DCT for subsequent significant hyperbilirubinemia

Discussion:

Factors in the cord blood that we studied included cord bilirubin, haemoglobin, reticulocyte count and direct Coomb‟s test. The babies were more likely to develop pathological hyperbilirubinemia if they exhibited higher cord bilirubin levels, lower cord haemoglobin, a higher reticulocyte count, and a positive direct Coomb's test. We were trying to determine if the development of pathogenic hyperbilirubinemia was correlated with cord blood bilirubin, haemoglobin, reticulocyte count, and direct Coomb's test positivity.

18 out of 100 babies studied in our study developed pathological jaundice in our study (18 %). Bilirubin peaking was mostly noted on the 3rd and 4th day. Other studies observed development of hyperbilirubinemia in the first 48 hours of life in newborn infants as Gregory M et al[13] (12.87%), Trivedi DJ et al[14] (33.88%), Dhanwadkar SS et al[15](11.4 %), Pradhan A[11] (12.87%) and Kardum D et al[60](14.9%).

In the present study, we have found that 57% of cases belong to ABO incompatibility and 43%cases belong to RH incompatibility, Since only 15% of people have Rh-negative blood, ABO incompatibility is a less serious clinical cause of hemolytic disease of the newborn (HDN) with hyperbilirubinemia, even though Rh incompatibility is the more commonly reported serologic cause of neonatal jaundice. Anti-D globulin prophylaxis given to women who are Rh-negative has reduced Rh incompatibility, which was formerly a major contributor to severe hemolysis.[16]Rh hemolytic disease is still common in many developing countries, particularly India; this is most likely because Rh Ig is not given or inadequate prenatal care is provided. Because of their higher IgG titers, mothers in the 'O' blood group are more likely to experience it than mothers in the 'A' or 'B' blood groups.

Other studies also find similar observations that Apexa S et al[17] also observed that out of 1450 patients, 200(13.79%) developed ABO Incompatibility and 1.37% developed Rh Incompatibility. Sonawane Vijay B et al[5] revealed that the incidence of ABO incompatibility in their study was 33.33% and Rh incompatibility was 4.9%. In comparison with the other studies, it was concluded that the frequency of ABO incompatibilities in our study was higher than Rh incompatibility. According to this study, ABO incompatibility was observed in 53.57% of male children and 61.36% of female children while Rh incompatibility was observed in 46.43% of male children, while 38.64% of female children. This observation was statistically not significant. (P=0.563NS).

Neonatal hyperbilirubinemia remains within the physiological range when there is ABO incompatibility, and the hemolytic illness is quite mild. As this study's results show, it is readily reversible, has little morbidity, and no death. Bilirubin levels will rise above the clinically recommended limit if aggravating diseases that affect bilirubin levels are also associated with ABO incompatibility.

In the present study, a significantly higher mean Cord bilirubin–total was observed in significant hyperbilirubinemia. as compared to in absence. (2.17±0.74 vs 1.51±0.56 mg/dL, respectively) with P values (95th percentile during the first 24 hours) was noted in 56 (34.1% of the cohort, 66.7% of those with hyperbilirubinemia) and 27/56 (48.2%) PTB >95th percentile was recorded within the first 12 hours. Kaplan M et al[18] observed that overall, hyperbilirubinemia developed 85 /164 neonates (51.8%). This did not agree with the study by Menon M et al[19] where they observed that the incidence of neonatal hyperbilirubinemia was almost the same in the case and control group in the study. Kalakheti et al[20], Jones et al[21] Gregory M et al[13] and Kara L. Calkins et al[22] observed that there is a significant association between cord blood total bilirubin levels and the development of pathological hyperbilirubinemia in newborns.

Direct coomb’s test is usually negative or weakly positive in babies with ABO incompatibility. In our study, the Direct Coomb’s test was positive in only 6 % of the babies studied and the association of the Direct Coombs test and significant hyperbilirubinemia 5/6% of infants developed clinically significant jaundice, of whom 6 were DCT + ve This observation was statistically not significant. (P= 0.091). Sarici SU et al[12] observed that there were significant differences between the newborns who did and the newborns who did not develop significant hyperbilirubinemia with

DOI: 10.69605/ijlbpr_13.9.2024.96

the presence of a direct antiglobulin test positivity (6 of 23 vs 0 of 107) and a sibling with neonatal jaundice (6 of 23 vs 5 of 102). Jones et al[21] found that out of 1411 term births with a documented a UCB, 30 newborns (2.7%) experienced clinically significant jaundice, with 8 of them having DAT + ve (0.6%), primarily as a result of ABO incompatibility. Both the development of DAT + ve jaundice (area under the ROC curve = 0.996) and all-cause jaundice (area under the ROC curve = 0.74) were substantially predicted by ECB.

ROC curve analysis was performed to determine the optimal cut-off values of Cord bilirubin - Total with significant hyperbilirubinemia. 1.715 was the optimal cut-off for the value of Cord bilirubin - Total to predict significant hyperbilirubinemia, (AUC = 0.786) with a Sensitivity and Specificity of 85.7% and 56.9% respectively. Trivedi DJ et al[14] observed that unconjugated cord serum bilirubin levels ≥ 2.0 mg/dl and total cord serum bilirubin ≥ 2.5 mg/dl were found to be high-risk markers for newborn hyperbilirubinemia prediction. Dhanwadkar SS et al[23] observed that umbilical cord bilirubin >3 mg/dl showed a good predictor for early detection of hyperbilirubinemia. Bernaldo AJN et al[24] found that 2.0 mg/100 ml was the most helpful cut off limit for unconjugated bilirubin in cord blood. Gregory M. et al (2012)[13] found that the possibility of developing pathological jaundice may be predicted with a sensitivity of 84.1%, specificity of 88.5%, positive predictive value of 98%, and negative predictive value of 45.1% if the critical cord bilirubin level is ≥ 2.50 mg/dl.

According to Menon M et al (2016)[19], the total cord bilirubin cut off point is 2.05. This was determined by ROC analysis. Pradhan A[11] concluded that for predicting the risk of developing pathological jaundice, a critical cord bilirubin level of 2.50 mg/dl has a sensitivity of 84.1%, specificity of 88.5%, positive predictive value of 98%, and negative predictive value of 45.1%. According to Sharma IK et al[25], the receiver operating characteristic (ROC) curve revealed 1.90 mg/dl as the CBB cut-off value. The CBB exhibited a sensitivity of 97.4%, specificity of 40.6%, and positive predictive value (PPV) of 71.09%. According to Kardum D et al[26](2021), umbilical cord bilirubin had a cut-off value of 34 µmol/L a sensitivity of 76.85% and a specificity of 69.58% in identifying hyperbilirubinemia in the first 48 hours. The receiver operating characteristic curve had an area under the curve of 0.80 (95% CI: 0.78-0.82).

The findings of this study indicate that, according to current operational criteria, the incidence of pathological hyperbilirubinemia can be consistently predicted by cord blood total bilirubin levels. To avoid the long-term effects of hyperbilirubinemia, which is a preventable cause of neurological sequelae (kernicterus), early clinical examination and bilirubin quantification are crucial.

ROC curve analysis was performed to determine the optimal cut-off values of HB with significant hyperbilirubinemia. Lesser Than or Equal To 16.5gm/dl was the optimal cut-off value of Hb to predict significant hyperbilirubinemia, (AUC = 0.831) with a Sensitivity and Specificity of 47.6% and 98.2% respectively Hb is a specific tool for the development of Neonatal hyperbilirubinemia ROC curve analysis was performed to determine the optimal cut-off values of reticulocyte count with significant hyperbilirubinemia. Greater Than or Equal To 2.7 was the optimal cut-off value of reticulocyte count to predict significant hyperbilirubinemia, (AUC = 0.793) with a Sensitivity and Specificity of 76.2% and 73.2% respectively.

Pradhan A54 concluded that a cord reticulocyte level of 4.95% had a sensitivity of 60.6%.ChakrahariS et al[27] indicate that after 72 hours of life, newborns at risk of developing hyperbilirubinemia can be identified with the help of predictive methods based on a cord reticulocyte level of 4.95%. According to the study, assessing cord reticulocytes may help identify infants who won't likely need further testing or care. ROC curve analysis was performed to determine the optimal cut-off values of DCT with significant hyperbilirubinemia. Greater Than or Equal To 0.21 was the optimal cut-off value of reticulocyte count to predict significant hyperbilirubinemia, (AUC = 0.675) with a Sensitivity and Specificity of 97.6% and 23.2% respectively DCT is neither specific nor sensitive screening tool for development of Neonatal hyperbilirubinemia. Cord blood bilirubin, reticulocyte counts, and HB can be used as predictors of subsequent neonatal hyperbilirubinemia. These findings are consistent with previous studies investigating the role of these biomarkers in predicting neonatal hyperbilirubinemia.

Conclusion: Early screening and appropriate management of hyperbilirubinemia are needed for the prevention of complications in newborns. There is slight decrement in the significant burden of untreated critical neonatal jaundice which indirectly or directly causing potential neurological sequelae. The prediction of neonatal hyperbilirubinemia has widespread implications, especially in our country, where there are limited resources. The purpose of this study was to verify whether cord bilirubin levels and other investigations predicted the development of significant hyperbilirubinemia.

Neonatal hyperbilirubinemia – one of the frequent conditions in neonates & the most frequent pathological cause leading to hyperbilirubinemia (i.e. Rh or ABO) incompatibility. For ABO incompatibility scenario where in case if jaundice occurs then it remains within physiological boundaries only. In the presence of some aggravating conditions, it may present as pathological jaundice. The outcome is the significant morbidity and not

DOI: 10.69605/ijlbpr_13.9.2024.96

mortality. So prevention of aggravating factors is very important in the case of ABO and Rh incompatibility.
The study concluded that umbilical cord bilirubin predicts neonatal jaundice, particularly hemolytic jaundice, in infants and mothers of O+ve blood group, prompting reconsideration of this knowledge, cost-effective, and non-invasive method. The study found that cord bilirubin, haemoglobin, reticulocyte count and positive direct antiglobulin test are good predictors for significant hyperbilirubinemia and severe hemolytic disease. For infants of mothers with blood group O, UCB predicts the development of neonatal jaundice. Fortunately, estimates of a UCB can be considered as one of the strategies for early identification of such risks of neonatal hemolytic jaundice.

Reference:

1. STOLL B. Digestive system disorders. Nelson Textbook of Pediatrics. 2004.
2. Madden JM, Soumerai SB, Lieu TA, et al/ Length-of-stay policies and ascertainment of post discharge problems in newborns. Pediatrics. Jan 2004;113(1):42–9.
3. Porter ML, Dennis BL. Hyperbilirubinemia in the term newborn. American familyphysician. 2002;65(4):599-607.
4. Chen HL, Wu SH, Hsu SH, et al. Jaundice revisited:recent advances in the diagnosis and treatment of inherited cholestatic liverdiseases. Journal of biomedical science.2018;25(1):1-3.
5. Sonawane Vijay B. Study of Correlation of ABO And RhIncompatibility with Risk of Neonatal Hyperbilirubinemia in A Tertiary Care Hospital. Indian Journal of AppliedResearch.2022;12(2).
6. Murray N, Roberts I. Haemolytic disease of the newborn. Archives of Disease inChildhood – FetalandNeonatal Edition. 2007;92(2):83-F88.
7. Thumjaa A, Vindhiya K. Cord Bilirubin as A Predictor ofSignificantHyperbilirubinemia in Abo In-compatibility. IJCRT 2018;6(1).
8. Chen JY, Ling UP, et al. Prediction of development of neonatalhyperbilirubinemia in ABO incompatibility.Zhonghua Yi Xue Za Zhi (Taipei)1994; 53:13-8.
9. Knupfer M, Pulzer F, Gebauer C, et al. Predictive valueof umbilical cord blood bilirubin for postnatal hyperbilirubinaemia. Acta Paediatr. 2005;94(5):581–7.
10. Bernaldo AJ, Segre CA. Bilirubin dosage in cord blood: could it predict neonatalhyperbilirubinemia? Sao Paulo medical journal of Revistapaulista de medicina. 2004;122(3):99–103.
11. Pradhan A, LamichaneyRCord blood bilirubin level as a predictor of development of pathological hyperbilirubinemia in new-borns. 2017;4:1519– 1524.
12. Sarici SU, Yurdakök M, Serdar MA, et al. An early (sixth-hour) serum bilirubin measurement is useful in predicting the development of significant hyperbilirubinemia and severe ABO hemolytic disease in a selective high-risk population of newborns with ABO incompatibility. Pediatrics.2002;109(4).
13. Gregory ML, Martin CR, Clohertyjp. Neonatal hyperbilirubinemia in: Cloherty Jp, Eichenwald Ec, Hansen Ar, Starkar, Eds. Manual of neonatal care. Lippincott William‟s and Wilkins. 7th ed. Philadelphia2012:304-9.
14. Trivedi DJ, Markande DM, Vidya BU, et al. Cord serum bilirubin and albumin in neonatal hyperbilirubinemia. Int j integrative sci innovation tech (iii). 2013;1(2):39.
15. Dhanwadkar SS, Christo S. RasalamMasoodet Z. Effectiveness of early clinical assessment and bilirubin estimation for prediction of neonatal hyperbilirubinemia. International J. Contemporary Pediatrics. 2016;3:477-84.
16. Reddy VV. Intracorpuscular defects lead to increased erythrocyte destruction. In: Rodak Bf, Fristma Ga, Doig K, Editors. Haematology: clinical principles and applications. 3rd ed. Philadelphia: saunders-elsevier. 2007; 286-310.
17. Apexa S. Patel, Deepak A. Desai, Aneri R. Patelassociation of abo and rh incompatibility with neonatal hyperbilirubinaemiaintJreprod contracept obstet gynecol.2017;6(4):1368-1375.
18. Kaplan M, Hammerman C, Vreman HJ, et al. Hemolysis and hyperbilirubinemia in antiglobulin positive, direct abo blood group heterospecific neonates. The journal of pediatrics. 1nov 2010;157(5):772-7.
19. Menon M,Sreejyothi G, Raveendranath K.Incidence of early neonatal hyperbilirubinemia in abo incompatibility and cord bilirubin as a predictor for phototherapy: int j pediatr res 2016;3(4):221-227.
20. Kalakheti Bk, Singh R, Bhatta NK, et al. Risk of neonatal hyperbilirubinemia in babies born to 'o' positive mothers: a prospective cohort study. Kathmandu UnivMed J. 2009;7(25):11-5.
21. Jones KD, Grossman SE, Kumaranayakam D, et al. Umbilical cord bilirubin as a predictor of neonatal jaundice: a retrospective cohort study. BMC pediatrics. 2017;17:1-6.
22. Calkins K, Roy D, Molchan L, et al. Predictive value of cord blood bilirubin for hyperbilirubinemia in neonates at risk for maternal-fetal blood group incompatibility and hemolytic disease of the newborn. J Neonatal Perinatal Med. 2015;8(3):243-50.
23. Dhanwadkar SS, Christo S. Rasalam, Masoodet Z. Effectiveness of early clinical assessment and bilirubin estimation for prediction of neonatal hyperbilirubinemia. International J. Contemporary Pediatrics. 2016;3:477-84.
24. Bernaldo A Jn, Segre Cam. Bilirubin dosage in cord blood could predict neonatal hyperbilirubinemia. Sao Paulo med j. 2004;122:99-103.
25. Sharma IK, Kumar D, Singh A, et al. Ratio of cord blood bilirubin and albumin as predictors of neonatal hyperbilirubinaemia. Clin exp hepatol. dec 2020;6(4):384-388.
26. Kardum D, Serdarušić I, Biljan B, et al. Cord blood bilirubin and prediction of neonatal hyperbilirubinemia and perinatal infection in newborns at risk of hemolysis. Jornal de Pediatria. 2021;97:440-4.
27. Chakrahari S, Patil M, Bijapure HR. Umbilical Cord Blood Bilirubin, Albumin, Reticulocyte Count, and Nucleated Red Blood Cells to Predict Subsequent Hyperbilirubinemia in Term Neonates: A Prospective Observational Study. Cureus. 2023;15(4): 37598.