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Prevalence of Sepsis among Iranian Newborns with Jaundice: A Meta-Analysis Based on Cross-Sectional Studies

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ABSTRACT

Background: Jaundice is a common life-threatening disease in the neonates. Several factors play a role in the etiology of jaundice. Sepsis is a possible cause of jaundice after blood group incompatibility. Bacterial infection and jaundice may be associated with higher morbidity. To date there exists no systematic review and meta-analysis that evaluated the Prevalence of sepsis in Iranian newborns with jaundice. Thus, in this study we evaluated the prevalence of sepsis among Iranian newborns with jaundice.

Methods: A comprehensive literature search in Persian and English was performed on PubMed, Web of Sciences, Scopus, Google Scholar, Magiran and Scientific Information Database (SID) till July 2021. Data analysis was done by CMA version 2.0 software.

Results: A total of eight publications with 4434 newborns with jaundice out of approximately 105 retrieved articles were selected. 211 neonates had sepsis. Pooled data revealed that the overall prevalence of sepsis among Iranian newborns with jaundice was 4.7% (95% CI 0.041-0.202, $P \leq 0.001$) and there was no publication bias.

Conclusion: This study showed that the prevalence of sepsis among Iranian newborns with jaundice was 4.7% and sepsis was a plausible reason of unexplained Hyperbilirubinemia among newborns with jaundice. To better understand the relationship between jaundice and sepsis, more studies with large sample sizes are needed.

Introduction

Jaundice is a life-threatening disease in neonates and it is the most common reason for hospitalization in the neonatal course (17%-19%).[1,2,3] Generally, about 80% of the preterm newborns and 60% of the full-term neonates manifest jaundice in the first week of life.[4] According to the global burden of disease, jaundice is classified seventh on the list of reasons for fatality in the first 6 days of the neonatal course in the world.[5] A vast range of alterations in the epidemiology of neonatal jaundice has been documented across the world.[3] Neonatal jaundice consequences from hyperbilirubinemia (when total serum bilirubin surpasses 5 mg/dL) and can lead to severe lifelong difficulties and disabilities such as abnormal psychomotor and neurological sequelae (e.g., cerebral palsy, kernicterus), and morbidity based on bilirubin toxicity.[6] Severe hyperbilirubinemia (> 20 mg/dL) that could potentially lead to neurodevelopmental complications and kernicterus is stated to be much rarer, involving less than 2% of newborns.[7,8] Early detection of newborns susceptible to jaundice can help in controlling and treating serious issues.[9] Typically, most jaundice patients are asymptomatic during the hospital visit.[9] In most patients, neonatal jaundice is physiologic and needs no medicine; however, in about 10% of the neonates, the bilirubin level passes the 95th percentile and requires additional monitoring and treatment.[8] For the cure of neonatal jaundice, phototherapy, phenobarbitone, transfusion exchanges, metalloporphyrins and intravenous immunoglobulin are currently the available choices which are selected based on the situations.[10] The etiological reasons for neonatal jaundice are ABO incompatibility, infection (e.g., sepsis and urinary tract infections (UTI)), Rh incompatibility, G6PD deficiency, and cephalohematoma. While, the comprehended predisposing elements for neonatal jaundice consist of prematurity, low birth weight, newborns of diabetic mother and hyperbilirubinemia in siblings.[9,3]

sepsis described as a life-threatening condition due to a dysregulated host reaction to infection is a major contributor to global mortality and morbidity significantly in the first five years of life.[11,12,13]

Sepsis is a systematic reaction to infection which is described by the cardinal symptoms of leukocyte accumulation, inflammation-vasodilation, and increased microvascular permeability. The epidemiology of pediatric sepsis differs from study to study likely because of their various era, nationality, disease symptoms, age groups, and diagnostic measures.[14] Despite progress in healthcare, neonatal and pediatric mortality from severe sepsis is around 11% in high-income countries.[15] Pediatric sepsis persists to be a leading reason for hospitalization in pediatric intensive care units (PICU) and mortality in the United States.[16]

The association between sepsis and jaundice, especially in a pediatric population, was recorded in several articles. Bacterial infection has been demonstrated as a cause of neonatal jaundice in prior studies. Jaundice may result either directly from bacterial products or as a result of the host's response to infection. Mostly, both bacterial products and response to infection contribute to the development of jaundice.[17] Additionally, based on Chand N study, specific infections that target the liver may cause jaundice because of the liver injury associated with hepatic infection.[17] Commonly Jaundice is a well-known adverse effect of sepsis or extra bacterial infection. In patients of all ages, Sepsis and bacterial infection are accountable for up to 20% of patients of jaundice in a community hospital environment.[17] Sepsis is more likely to exhibit with jaundice in infants and children than in adults.[17] The incidence of jaundice in newborns differs between 20% and 60%, and the incidence of sepsis in newborns was 16%.[18] But no research assessed the prevalence of sepsis in newborns with jaundice. Furthermore, the distinctions between jaundice related to infection and

other types of jaundice were unknown yet. The purpose of this Meta-Analysis was to determine the prevalence rate of sepsis in the newborns with jaundice in Iran.

Materials and Methods

Search Strategy: The present systematic review was designed to define the prevalence of sepsis in neonatal jaundice. Electronic databases were explored, including Web of Sciences, PubMed/Medline, Scopus, Iranian Scientific Information Database (SID) and Iranmedex, for both English and Persian language papers that were published till July 2021. After searching the related terms in the Medical Subject Headings (MeSH) database, eventually, the keywords included "neonate" OR "neonates" OR "neonatal" OR "newborn" OR "newborns" AND "infant" OR "infants" AND "icterus" OR "hyperbilirubinemia" OR "jaundice" OR "jaundices" AND "infection" OR "sepsis" OR "bacteremia" AND "Iran" OR "Iranian". This systematic review and meta-analysis were performed according to the guideline of PRISMA (preferred reporting items for systematic review and meta-analysis).

Inclusion Criteria: Articles with the following criteria were included in the study: (1) examined population should be Iranian neonates. (2) Articles in Persian and English language, (3) Neonatal jaundice confirmed. (4) Exploring the prevalence of Jaundice with sepsis. (5) Sepsis identified by clinical signs or tests. (6) Availability of sufficient information about the results of studies.

Exclusion Criteria: The subsequent articles were excluded from the study so that just appropriate and relevant Papers were reviewed: (1) Papers that addressed adults. (2) Papers associated with the diagnosis and therapy of neonatal jaundice. (3) Papers those were only available as the abstract.

Data Extraction: The search included cross-sectional or any other type of studies that reported prevalence of sepsis in infants with jaundice, conducted in any parts of Iran on jaundice, term or preterm neonates, and admitted to clinics, hospitals, or neonatal intensive care units (NICU). A total of 105 papers were contained in the study and imported to Mendeley software. Out of which, 30 duplicates were deleted. Then, the titles and abstracts of the remaining papers were checked and 45 papers were extracted on the basis of relevance. In the next step, 22 papers were missed due to incomplete data, clarity of the study procedure, and lack of full text. Finally, 8 papers assosiated to the research subject were studied (Figure 1).

Quality assessment: Two researchers independently assessed the full text of eligible articles using a Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist. In the event of disagreements, two reviewers discussed with a third reviewer to reach consensus.

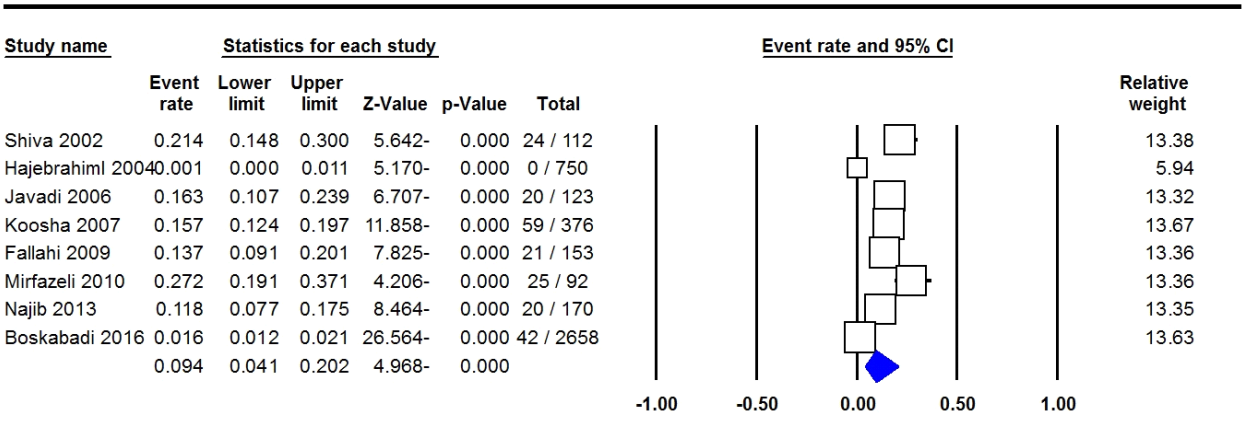

Figure 1. Forest Plot for Prevalence of Sepsis in Iranian Neonates with Jaundice in Overall

The following data were extracted from the full-text articles and entered in standardized extraction checklist: name of first author, year of publication, city, Study duration, Type of study, Sepsis diagnosis, Type of jaundice , Etiology, Gestational age, Number of jaundice, Number of sepsis (%). If a duplicate publication was found or the same population was used in multiple studies, the publication with the larger sample size was included in the meta-analysis.

Statistical analysis: All of the statistical calculations were performed using Comprehensive Meta- Analysis (CMA) software version 2.0 (Biostat, USA). Two-sided P-values < 0.05 were considered statistically significant. Random-effect model meta-analysis was utilized to calculate the prevalence of sepsis in neonatal jaundice, and binomial distribution to calculate standard error in each study.

Heterogeneity in the results of various investigations was analyzed using a Chi-squared-based Q-test with a considerable level of P < 0.1 and I2 statistics with values >75% as significant heterogeneity. Subgroup analysis was used to determine the pooled estimated prevalence of sepsis based on the study population. Moreover, it investigated the effects of the potential heterogeneity factors in the prevalence of sepsis by a moment-based meta-regression model.

A visual inspection of the funnel plot was used to assess potential publication bias. Moreover, Egger's test was done to evaluate the publication bias statistically, in which P < 0.05 was considered statistically significant. If the publication bias tests showed bias existed, the Duval and Tweedie ''trim and fill'' method was used to adjust the bias.

Results

A total of 8 eligible articles with a total sample size of 4434 neonates, were retrieved from 2002 till July 2021. These papers were heterogeneous in terms of inclusion criteria for neonates, sample size, study place, and results (Table 1). They were distributed in different cities of Iran (6 cities). In total, 4434 infants who had jaundice were pooled for assessing the prevalence of sepsis in infants with jaundice. The majority of the study participants included in this review were recruited from hospital wards or mixed hospital and NICU. Table 1 shows the 8 articles included in this review and their features. Also figure 1 depicts the article selection process based on a PRISMA flow diagram. Combined data revealed that the proportion of sepsis in neonates with jaundice was 4.7% (95% CI 0.041-0.202, P ≤ 0.001, Figure 1) totally. The overall prevalence of sepsis in infants with jaundice was 4.7%. In terms of etiology, the most common etiologic causes of neonatal hyperbilirubinemia consisted of Blood group incompatibility and sepsis (Table 1). The overall most common risk factors of neonatal hyperbilirubinemia were unexplored.

Sensitivity Analysis and Heterogeneity Test: We used a leave-one-out sensitivity analysis to identify the effects of individual publications on the overall pooled ORs. The significance of the pooled ORs was not influenced by excluding those studies, indicating that this study pooled ORs were statistically robust and our findings were not dependent on a single study. In the current study there was a statistical significance between-study heterogeneity (I2 = 95.13; pH ≤ 0.001) overall in neonates with jaundice.

Prevalence of sepsis in infants with jaundice: The Prevalence rate of jaundice due to sepsis is unidentified. It is well understood that clinical presentations of neonatal sepsis includes a wide spectrum, varying from nonspecific signs and symptoms to severe illness as well as fever, poor feeding, vomiting, renal failure and respiratory distress. Sepsis has been well established as a reason of neonatal jaundice in prior studies but the prevalence rate, jaundice presentation time and the distinctions between the jaundice related with sepsis and other types of jaundice were unexplored.

Table 1. Characteristics of Studies Included in Meta-analysis

First author	City	Study duration	Type of study	Sepsis diagnosis	Type of jaundice	Etiolo gy	Gestational age	Number of jaundice	Number of sepsis (%)
Shiva 2002[19]	Tehran	1996-1998	Cross-sectional	CS	-	Breast-feeding	-	112	24 (21.5)
Hajebrahim 2004[20]	Tehran	1997-2000	Descriptive	BC	Jaundice	-	Term	750	0
Javadi 2006[21]	Khoram-Abad	2003	cross-sectional	-	Jaundice	Breast-feeding	44 preterm	123	20 (16.3)
Koosha 2007[22]	Zanjan	2001-2003	Cross-sectional	BC and CS	unexplained	Blood group incompatibility sepsis	Term	376	59 (15.7)
Fallahi 2009[23]	Tehran	2002-2003	Cross-sectional	BC	unexplained	Blood group Incompatibility (27.3%)	Term	153	21 (13.7)
Mirfazeli 2010[24]	Gorgan	2004-2005	Cross-sectional	BC and CS	unexplained severe	41unknown 25 sepsis	Term	92	25 (27)
Najib 2013[25]	Shiraz	2009-2010	Cross-sectional	BC	Severe	Blood group incompatibility	-	170	20 (12)
Boskabadi 2016[26]	Mashhad	2005- 2014	Cross-sectional	BC and CS	unexplained	Day 1-3:blood group incompatibility Day 4-12:sepsis	-	2658	42 (1.5)

Abbreviation: CS: Clinical sign; BC: Blood culture

Diagnosing sepsis can be difficult. The criteria for diagnosis of sepsis include high or low body temperature, fast heart rate and respiratory rate, plus a possible or known infection. Laboratory tests for sepsis include: Complete blood count (CBC), Lacate, C-reactive protein (CRP), Blood culture, Prothrombin time and partial thromboplastin time (PT and PTT), Confirmatory Tests. In the 8 articles, the prevalence of sepsis in jaundice was investigated and the presence of sepsis was diagnosed along with clinical symptoms and blood culture. Out of 4434 neonates with jaundice, 211 had sepsis and the prevalence of sepsis in jaundice was 4.7%.

Publication Bias: The Begg‟s and Egger‟s linear regression tests were applied to test the potential publication bias in the literatures. As shown in figure 2, the shapes of the Begg‟s funnel plot did not show any evidence of publication bias in the current meta-analysis. Moreover, the Egger‟s tests did not show an evidence of publication bias statistically (PBegg‟s = 0.058; PEgger‟s = 0.698), indicating that our pooled data were statistically robust and reliable.

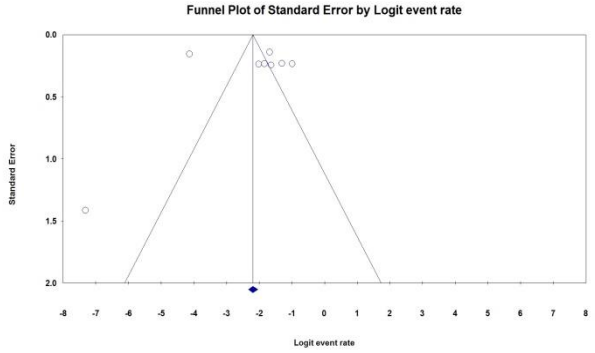

Figure 2. The Funnel Plots of Publication Bias for Prevalence of Sepsis in Neonates with Jaundice in Overall

Discussion

Neonatal jaundice is a medical situation, in which a high serum level of bilirubin is observed in a newborn within 28 days after birth.[27] It is a physiological phenomenon and the main manifestation of many disorders as well.[28] Several factors play a role in the etiology of jaundice. Infection is one of these factors, which accounts for about 6%- 10%. But what is more significant is the role of jaundice as a diagnostic factor in sepsis. Sepsis is one of the leading causes of death in newborns, so early diagnosis is important. Clinical statistics revealed that the incidence of neonatal pathological jaundice is on the height, and bacterial infection is the major factor inducing neonatal pathological jaundice.[29] The pathogenesis of jaundice in systemic infections is multifactorial. The progession of jaundice may occur from an irregularity in the processing of bilirubin by hepatocytes or from other results on the liver that lead to the collection of bilirubin in the body.[17] Bacterial infection and jaundice may be associated with higher morbidity. Multiple articles have investigated the role of jaundice as an earlier sign of sepsis or UTI. Liu Y et al., Evaluated markers of neonatal pathological jaundice associated with a bacterial infection. They showed, in the diagnosis of neonatal pathological jaundice, in addition to clinical symptoms, screening of model serological markers are of high importance for the complete examination of neonatal pathological jaundice. They concluded that the integrated detection of serum inflammatory factors WBC, CRP, PCT, and TRF can be used as a base for earlier diagnosis of pathological jaundice, illness evaluation, treatment advice, and for prediction.[29] Chand N et al., reviewed Sepsis-induced cholestasis in adults. They showed jaundice and hepatic dysfunction usually represents a variety of bacterial infections. They showed sepsis is more likely to be expressed with jaundice in infants and children than in adults.[17] Also several systematic review and meta-analysis evaluated UTI and jaundice in Iranian newborn. But there isn't a systematic review and meta-analysis that evaluated Prevalence of sepsis in Iranian newborns. Here we performed a meta-analysis on the prevalence of sepsis in neonates with jaundice. We finally selected 8 articles that examined sepsis in neonatal jaundice. The results of our meta-

analysis showed that in 4434 Iranian neonates with jaundice, 211 neonates had sepsis and the prevalence of sepsis was 4.7%. There is one meta-analysis that evaluates only sepsis in Iranian infants. In 2020, Akbarian-Rad et al., in a meta-analysis based on 22 studies with 14,683 neonates evaluated the prevalence of neonatal sepsis in Iran. Their pooled data revealed that the prevalence of sepsis was 15.98% among Iranian neonates.[30] When we compared the overall prevalence of sepsis in Iranian newborns with the prevalence of sepsis in jaundiced newborns, we faced a complex situation. Contrary to our belief, the prevalence of sepsis in neonates with jaundice was lower than the overall prevalence of sepsis in neonates. This phenomenon may be due to the antioxidant properties of bilirubin. Similar to our meta-analysis, in 2018, Richard Hansen et al., evaluated Adaptive response of neonatal sepsis-derived Group B Streptococcus to bilirubin. They concluded Physiological jaundice may have beneficial effects in decreasing the growth of pathogenic Group B Streptococci, whereas other evidence proposed that hyperbilirubinemia may be protective in Gram-negative endotoxic shock.[31] Other studies that have examined the prevalence of sepsis in jaundiced newborns in Iran include the following. Maamouri et al., evaluated hyperbilirubinemia and neonatal infection in a cross-sectional study with a total of 434 jaundiced newborns out of which 22 of them had sepsis. They estimated the Prevalence of sepsis in jaundiced infants was approximately 1.7%. They concluded that bacterial infection was a significant reason of unexplained Hyperbilirubinemia among jaundiced neonates. Their results indicate that UTI after sepsis before the first week of life may be related with jaundice.[18] Their results were lower than ours, perhaps because they had fewer samples and people with undiagnosed infections. Except for Haji Ebrahimi who reported zero percent and Boskabadi who reported 5.6 percent, other articles reported a much higher percentage than our study.

On the whole, the total number of neonates with the exception of Haji Ebrahimi and Boskabadi revealed 1027 and neonates with sepsis was altered to 169, therefore the prevalence of sepsis in neonates with jaundice is 16.4%, which is close to the general prevalence of sepsis in Iran. Our results showed that sepsis in children with jaundice should be considered as one of the possibilities. Given that sepsis is one of the leading causes of death in infants, prompt and timely action is very important in the treatment of sepsis. Therefore, it is advisable to order a blood culture test in symptomatic newborns with jaundice. Also according to Hansen's article, the potential of jaundice in reducing the chances of sepsis should be seriously and carefully evaluated.

Conclusion

The prevalence of sepsis in neonates with jaundice was 4.7%, indicating a moderate prevalence of sepsis in jaundice. Since Sepsis is a life-threatening illness, so in severe jaundice, the possibility of sepsis should also be considered and it is important to pay attention to it. There is a real need for more studies on the correlation between sepsis and jaundice. No particular study has been conducted in this field, but several articles sepsis due to UTI in cases of neonatal jaundice has been studied. Also the possible role in which jaundice plays in protecting infants against sepsis requires further research.

Conflict of Interests

Authors have no conflict of interests.

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References

1. Boskabadi H, Rakhshanizadeh F, Zakerihamidi M. Evaluation of maternal risk factors in neonatal hyperbilirubinemia. Arch Iran Med 2020; 23(2): 128-40.
2. Olusanya BO, Ogunlesi TA, Kumar P, Boo NY, Iskander IF, de Almeida MF, et al. Management of late-preterm and term infants with hyperbilirubinaemia in resource-constrained settings. BMC Pediatr 2015; 15(1): 1-12.
3. Zahed Pasha Y, Alizadeh-Tabari S, Zahed Pasha E, Zamani M. Etiology and therapeutic management of neonatal jaundice in Iran : a systematic review and meta-analysis. World J Pediatr 2020; 16(5): 480-93.
4. Hossain M, Begum M, Ahmed S, Absar MN. Causes, Management and immediate complications of management of neonatal jaundice - A hospital-based study. J Enam Med Coll 2015; 5(2): 104-9.
5. 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.
6. Olusanya BO, Osibanjo FB, Slusher TM. Risk factors for severe neonatal hyperbilirubinemia in low and middle-income countries: A systematic review and meta-analysis. PLoS One 2015; 10(2): e0117229.
7. Das S, van Landeghem FKH. Clinicopathological spectrum of bilirubin encephalopathy/kernicterus. Diagnostics (Basel) 2019; 9(1): 24.
8. Boskabadi H, Omidian M, Mafinejad S. Prevalence and clinical manifestation of glucose-6-phosphate dehydrogenase deficiency in newborns with hyperbilirubinemia in Mashhad, Iran. Maced J Med Sci 2010; 3(4): 383-7.
9. Boskabadi H, Rakhshanizadeh F, Moradi A, Zakerihamidi M. Risk factors and causes of neonatal hyperbilirubinemia: A systematic review study. J Pediatr Rev 2020; 8(4): 211-22.
10. Wan ASL, Mat Daud S, Teh SH, Choo YM, Kutty FM. Management of neonatal jaundice in primary care. Malaysian Fam Physician 2016; 11(2-3): 16-9.
11. Kawasaki T. Update on pediatric sepsis: A review. J Intensive Care 2017; 5(1): 1-12.
12. Singer M, Deutschman CS, Seymour C, Shankar-Hari M, Annane D, Bauer M, et al. The third international consensus definitions for sepsis and septic shock (sepsis-3). JAMA 2016; 315(8): 801-10.
13. Fleischmann C, Scherag A, Adhikari NKJ, Hartog CS, Tsaganos T, Schlattmann P, et al. Assessment of global incidence and mortality of hospital-treated sepsis current estimates and limitations. Am J Respir Crit Care Med 2016; 193(3): 259-72.
14. Ferdosian F, Jarahzadeh MH, Bahrami R, Nafei Z, Jafari M, Raee-ezzabadi A, et al. Association of IL-6 -174G > C polymorphism with susceptibility to childhood sepsis : A systematic review and meta-analysis. Fetal Pediatr Pathol 2021; 40(6): 638-652.
15. Fleischmann-Struzek C, Goldfarb DM, Schlattmann P, Schlapbach LJ, Reinhart K, Kissoon N. The global burden of paediatric and neonatal sepsis: a systematic review. Lancet Respir Med 2018; 6(3): 223-30.
16. Jarahzadeh MH, Jafari M, Seifi- N, Ferdosian F, Bahrami R, Raee-ezzabadi A, et al. Association of PAI-1 4G/5G and ACE I/D polymorphisms with susceptibility to pediatric sepsis : Evidence from a meta-analysis. Fetal Pediatr Pathol 2020:1-17.
17. Chand N, Sanyal AJ. Sepsis-induced cholestasis. Hepatology 2007; 45(1): 230-41.
18. Maamouri G, Khatami F, Mohammadzadeh A, Saeidi R, Farhat AS, Kiani MA, et al. Hyperbilirubinemia and neonatal infection. Int J Pediatr 2013; 1(1): 5-12.
19. Shiva F, Ghotbi F. Neonatl jaundice and essential to evaluation sepsis in icterus neonatal. Research in Medicine 2002; 26(2):111-14. [In Persian].
20. Hajebrahim Tehrani F, Valaie N. Incidence of septicemia and urinary tract infection in newborns with jaundice hospitalized in Mofid hospital. Feyz 2004; 7(4): 58-63. [In Persian].
21. Javadi T, Mohsenzadeh A. Evaluation of the causes of jaundice in neonates admitted to Shahid Madani Hospital in Khorramabad in 2001. Yafte 2006; 7(4): 73-8. [In Persian].
22. Koosha A, Rafizadeh B. Evaluation of neonatal indirect hyperbilirubinaemia at Zanjan Province of Iran in 2001-2003: prevalence of glucose-6-phosphate dehydrogenase deficiency. Singapore Med J 2007; 48(5): 424-8.
23. Fallahi M, Basir MF, Ahmadpour Ghadi Kolaei M. Incidence of sepsis in neonates with

indirect hyperbilirubinemia in Shohadaye Tajrish Hospital. Pajoohande 2009; 14 (1): 27-30. [In Persian].
24. Mirfazeli A, Najafi l, et al. Causes of severe and indirect hyperbilirubinemia in neonates admitted to Taleghani Children's Hospital in Gorgan. J Gorgan Univ Med Sci 2010, 11(4): 82-86. [In Persian].
25. Najib KS, Saki F, Hemmati F, Inaloo S. Incidence, risk factors and causes of severe neonatal hyperbilirubinemia in South of Iran (Fars Province). Iran Red Crescent Med J 2013;15(3):260–3.
26. Boskabadi H, Zakerihamidi M, Bagheri F, Boskabadi A. Evaluation of the causes of neonatal jaundice, based on the infant's age at disease onset and age at hospital admission. Tehran Univ Med J 2016; 73(10): 724-31. [In Persian].
27. Lookzadeh MH, Bahrami R, Ekraminasab S. Prevalence of urinary tract infection in Iranian newborns with jaundice: A meta-analysis. World J Peri & Neonatol 2021; 4(1): 40-9.
28. Hansen TWR, Wong RJ, Stevenson DK. Molecular physiology and pathophysiology of bilirubin handling by the blood, liver, intestine, and brain in the newborn. Physiol Rev 2020; 100(3): 1291-346.
29. Liu Y, Sun X, Wang Y, Xing C, Li L, Zhou S. Evaluation of associated markers of neonatal pathological jaundice due to bacterial infection. Iran J Public Health 2021; 50(2): 333-40.
30. Akbarian-Rad Z, Riahi SM, Abdollahi A, Sabbagh P, Ebrahimpour S, Javanian M, et al. Neonatal sepsis in Iran: A systematic review and meta-analysis on national prevalence and causative pathogens. PLoS One 2020; 15(1): e0227570.
31. Hansen R, Gibson S, De Paiva Alves E, Goddard M, MacLaren A, Karcher AM, et al. Adaptive response of neonatal sepsis-derived Group B Streptococcus to bilirubin. Sci Rep 2018; 8(1): 6470.