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RESEARCH ARTICLE

NEONATAL BACTERIAL CONJUNCTIVITIS IN TERTIARY HOSPITALS IN SANA'A CITY, YEMEN

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ABSTRACT

Background: Ophthalmia neonatorum (ON) is the most widespread eye infection occurring in the first 28 days of life. Although most of these cases are benign, some may progress to systemic complications or blindness if left untreated.

Objectives: The current study was conducted with the aim of revealing the bacteriological causes of conjunctivitis in neonates and the antibiotic sensitivity pattern of these bacteria.

Subjects and methods: The study included all neonates at the age of 1 to 28 days presenting at the neonatal nurseries with Neonatal Intensive Care Unit (NICU) and level II care beds in three hospitals; Authority of Al-Thawra General Hospital, Al-Kuwait University Hospital and Al-Sabeen Maternity and Child Hospital in Sana'a city, Yemen. A full history was taken from each nurse and mothers of the neonates included in the study in which the findings were recorded in a predesigned questionnaire including socio demographic, maternal clinical information and therapeutic interventions. To isolate the causative agent, the conjunctival swabs were inoculated on proper media and bacteria were identified by standard microbiological methods and antibiotic resistance was done for the isolates.

Results: 203 swabs were collected from newborns with eye discharge over a nine-month period. Positive growth rate was 51.7%, males were more affected (57.1%), 80% of affected neonates had low birth weight, 71.4% of preterm infants were most affected (p <0.01). There was a significant relationship between invasive and non-invasive mechanical ventilation with neonatal conjunctivitis (p<0.05). Gentamicin showed good *in vitro* sensitivity to all bacteria isolated, *Staphylococcus aureus* (83%), *Escherichia coli* 84.6%, with *P. aeruginosa* it was 60%.

Conclusion: The vast majority of cases of neonatal conjunctivitis were mild with a high level of occurrence; *Staphylococcus aureus* and *Klebsiella pneumoniae* were the major bacterial agents, neonatal conjunctivitis most likely to be a hospital-acquired infection. There was a significant association between phototherapy, non-invasive ventilation and incidence of neonatal conjunctivitis. Gentamicin had high activity against the bacteria isolated in this study.

Keywords: antibiotic sensitivity, bacteriological causes, conjunctivitis, neonates, ophthalmia neonatorum (ON), Yemen.

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INTRODUCTION

Ophthalmia neonatorum (ON) also known as neonatal ophthalmia and/or neonatal conjunctivitis is the most widespread eye infection occurring in the first 28 days of life. Although most of these cases are benign, some may progress to systemic complications or blindness if left untreated[1]. Newborn conjunctiva is sterile at birth but soon becomes colonized by many microorganisms that may be either pathogenic or non-pathogenic, besides it is susceptible to infection, not only because of low levels of antibacterial agents and proteins such

as lysozyme and immunoglobulins A and G, but because the lacrimal membrane and outflow are just beginning to develop. Neonatal ophthalmia are characterized by purulent eye discharge and redness of the conjunctiva with or without swelling of the eyelid, clinical presentations of the eyes of newborns are not etiologically diagnostic; and microbiological with cytology, cultures and microbial sensitivities are mandatory for diagnoses and treatment. The choice of antimicrobial therapy is based on the findings of the laboratory[2]. Neonatal conjunctivitis is a global problem with incidence ranging from 0.9% to 33% in different countries. Neonatal ophthalmia is usually acquired either from the maternal reproductive system or acquired after birth from a hospital or community setting. Notwithstanding, it can be caused by chemical inflammation, bacterial infections, and viral infections, but most cases of conjunctivitis in newborns are caused by bacterial factors[3]. Bacterial pathogens mainly often reported as causative pathogens are *coliforms*, coagulase-negative *Staphylococci*, *pneumococci*, *enterococci*, and *Staphylococcus aureus* which tend to cause mild to moderate disease[4]. In addition there are viruses that cause mild conjunctivitis in neonates such as *rhinovirus*, *adenovirus* and *bocavirus*. *Neisseria gonorrhoeae*, *Pseudomonas aeruginosa*, and *Chlamydia trachomatis* are also associated with severe conjunctival infections[5].

Predisposing factors, which can increase the chance of a newborn developing neonatal conjunctivitis include increased shedding of these organisms into the mother's vaginal tract during the last trimester, premature rupture of membranes, and prolonged labor. Neonatal conjunctivitis after cesarean delivery can be due to intrauterine *chlamydial* infection as a result of early rupture of membranes[6]. Many studies have been conducted to study the health problems of infants and children in Yemen, including infectious diseases such as tetanus, protozoa, hepatitis viruses, and even eye problems such as trachoma and corneal ulcers[7-18], but there is no single study regarding Ophthalmia neonatorum prevalence, bacteriological causes, and antibiotic sensitivity pattern, in order to know the realistic recommendations for the routine prevention of the eye, which must be practiced immediately after birth, to prevent the occurrence of this dangerous infection for newborns. The current study was conducted with the aim of revealing the bacteriological causes of conjunctivitis in neonates and the antibiotic sensitivity pattern of these bacteria.

SUBJECTS AND METHODS

Study design: A prospective cross-sectional study.

Study population and study area: The study was conducted over a period of 9 months (February, 2021-October, 2021). The study included all neonates at the age of 1 to 28 days presenting at the neonatal nurseries with Neonatal Intensive Care Unit (NICU) and level II care beds in three hospitals; Authority of Al-Thawra General Hospital, Al-Kuwait University Hospital and Al-Sabeen Maternity and Child Hospital in Sana'a city, Yemen. There were no protocols for prophylaxis to neonatorum ophthalmia in the three hospitals during the period of the study.

Inclusion criteria: All babies at the age of 1 to 28 days presenting with purulent, mucoid or muco-purulent discharge either in one or both eyes.

Exclusion criteria: Hospitalized neonates under treatment.

Sample size calculation: This cross-sectional study was performed on 203 neonates (112 male and 91 female) aged 28 days. The sample size was calculated according to the following: The population of neonates attended to the tertiary hospitals in Sana'a city was 45000 per year. Expected frequency of neonatal conjunctivitis as previous report (15.8%)[19] and acceptable margin of error equal to 5% at 95% confidence level.

Data collection: The complete medical history was taken from the nurses and mothers of the neonates included in the study in which the results were recorded in a pre-designed questionnaire including socio demographic, maternal, clinical information and therapeutic interventions.

Specimen collection: A physical examination was performed on all study population and the severity of conjunctivitis was revealed. Samples were taken by trained healthcare staff using a sterile cotton swab moistened with sterile saline. Two conjunctival swabs were taken, one for each eye, even if the infection was in only one eye. Samples were collected from the lower conjunctival vault avoiding eyelid and eyelash boundaries and inoculated directly onto pre-prepared culture plates and then transported in secure boxes to the Microbiology Laboratory of Kuwait University Hospital to be processed on the same day.

Culturing of eye swabs: To isolate the causative agent, conjunctival swabs were inoculated onto an appropriate medium (all culture media Sigma-Aldrich sources) and bacteria were identified by standard microbiological methods[20].

Culture media included-

Blood agar: used for the growth of a wide range of pathogenic bacteria. It is also required for the detection and characterization of hemolytic bacteria. After inoculation, the medium was incubated aerobic at 37°C for 24-48 h.

Chocolate agar: This medium has been used to grow fastidious pathogens that grow best on this highly nutritious medium. After inoculation, the plates were incubated at 37°C in a candle jar (to provide 5% CO_2) for 24-48 h.

MacConkey agar: It is a selective and differentiating agar that only grows Gram-negative bacterial species; can differentiate Gram-negative organisms based on lactose metabolism. The plates were inoculated with the sample and then aerobically incubated at 37°C for 24 h. Then the inoculated plates were labeled on the agar side with the patient's name and date of receipt. All agar plates were inoculated by slight streaks of cotton swabs onto the agar surface in rows. Growth on the streaks was considered significant, while growth outside the streaks is likely due to contamination.

Identification of bacteria: Bacteria were identified by standard microbiological methods: culture traits of pure

colonies, Gram staining, enzyme production, biochemical tests, and *Enterobacteriaceae* were identified by KB003 TM Hi25 *Enterobacteriaceae* Identification Kit (Hi Media Laboratories, India).

Antibiotic susceptibility testing: Antibiotic resistance was done using Kirby-Bauer disc diffusion methods and interpretation of antibiotic sensitivity results was done according to CLSI[21]. Antibiotic disks and media powders used in NCPHL are usually Sigma-Aldrich sources. GPB and GNB isolates consisting of *P. aeruginosa* (ATCC 27853) *Escherichia coli* (ATCC 25922), and *S. aureus* subsp *Aureus* ATCC 25923 was used as quality control for a routine DDM test recommended in the NCPHL Department of Microbiology.

Ethical approval

Written consent was obtained in all parent cases. Ethical approval was obtained from the Medical Research and Ethics Committee of the Faculty of Medicine and Health Sciences, Sana'a University with reference number (2221).

Table 1: General characteristics of the study population.

Variable	Frequency (%)
Gender	
Male	112(55.2)
Female	91(44.8)
Weight	
Normal weight	141(69.5)
LBW	62(30.5)
Gestational category	
Preterm	88(43.4)
Term	115(56.7)
Post-term	0(0)
Onset of conjunctivitis	
First week	112(55.2)
Second week	55(27.1)
Third week	21(10.3)
Fourth week	15(7.4)
Mode of delivery	
SpontaneousVaginal	140(69)
delivery	63(31)
Cesarean section	
Mechanical Ventilation	
Invasive	48(23.6)
Noninvasive	37(18.2)
Without	118(58.1)
Neonatal phototherapy	
(NNPT)	86(42.4)
Yes	117(57.6)
No	
Antimony (Kohl) applied	
Yes	136(67)
No	67(33)
Eye involvement	
Unilateral	86(42.4)
Bilateral	117(57.6)

RESULTS

Of the newborns with eye discharge, 203 swabs were collected over a nine-month period. The general characteristics of all neonates in this study are shown in Table 1. Table 2 shows that the most common bacteria concerned in ophthalmia neonatorum in order of reducing frequency were *S. aureus, Klebsiella pneumoniae, E. coli* and *P. aeruginosa.*

Table 2: The Frequency of isolated bacteria causing neonatal conjunctivitis.

Bacteria	Number of isolates (%)
S. aureus	59(56.2)
K. species	30(28.6)
E. coli	13(12.4)
P. aeruginosa	3(2.9)
Total	105(100)

Table 3 shows that among 105 samples (51.7%) yielded growth and no growth was detected in 98 samples (48.3%), among this males were 60(57.1%) and the females were 45 (42.9%). Difference between the proportions of infected males to females infected was not statistically significant (p=0.56). Eighty percent of affected neonates were low birth weight (the mean±SD weight of the neonates was 2.6±0.5 kg). Out of the total number of 105 bacterial conjunctival neonates, 30 (28.6%) babies were term (gestational age greater than 37 completed weeks), and 75(71.4%) were preterm (gestational age <37 weeks). None of the babies was post-term (gestational age greater than 42 weeks). Most of the affected neonates were premature (p<0.01). The mean age of onset was 8.8±6.7 days. Most cases of neonatal conjunctivitis 78(74.3%) occurred in the first week of life while 21 (20%) presented within the second week of life. The rest of cases 5(4.8%) and 1(0.95%) developed in the third and the fourth week of life, respectively. Bilateral conjunctivitis was present in 117(57.6%) of all neonates, while unilateral involvement was seen in 86 (42.4%) of the patients. Table 4 shows that among 105 neonates with conjunctivitis 70 (66.7%) neonates were delivered vaginally and 35(33.3%) were delivered by cesarean section. There was no relation between the delivery mode with neonatal bacterial conjunctivitis (p = 0.46). A positive history of prolonged rupture of fetal membranes (>18 hours) was documented in 9(8.6%) neonates with conjunctivitis, however, it was not statistically significant (p=0.69). Moreover, no relation between the history of maternal infections of lower genital tract with neonatal bacterial conjunctivitis (p= 0.099). There was a statistically significant between invasive and non-invasive mechanical ventilation with neonatal conjunctivitis (p<0.05) (Table 5). Among 105 neonatal conjunctivitis cases, 3 cases (2.9%) needed invasive mechanical ventilation and 26 cases (24.8%) needed noninvasive mechanical ventilation mainly nCPAP (nasal continuous positive airway pressure) during their stay in neonatal intensive care units (NICU). There was a statistically significant association between Neonatal phototherapy (NNPT) and conjunctivitis (p<0.01). Neonates who experienced phototherapy presented an occurrence rate of conjunctivitis of 59(56.2%) markedly higher than amongst those not including phototherapy criteria 46(43.8%).

Table 3: Demographic data and clinical manifestations among neonates with bacterial conjunctivitis (n=105).

Variable	Bacterial conjunctival neonates=105	Non-bacterial conjunctivital neonates=98	OR (>1)	CI (95%)	X^2 (≥ 3.7)	*p*-value (*p*< 0.05)
Gender						
Male	60 (57.1%)	52 (53.1%)	1.2	0.7-1.2	0.34	0.559
Female	45(42.9%)	46 (46.9%)				
Weight						
LBW	84(80.0%)	57(58.2%)	2.9	1.5-5.4	11.3	0.001
Normal weight	21(20.0%)	41(41.8%)				
Gestational period						
Preterm	75 (71.4)	13 (13.3%)	0.1	0.03-0.13	69.8	< 0.01
Term	30 (28.6)	85(86.7%)				
Onset of conjunctivitis	78(74.3%)	34(34.7%)				
First week	21(20.0%)	34(34.7%)	2.7	1-7.4	4.1	0.041
Second week	5(4.8%)	16(16.3%)				
Third week	1(1.0%)	14(14.3%)				
Fourth week						
Eye involvement						
Unilateral	45(42.9%)	41(41.8%)	1.04	0.6-1.9	0.02	0.883
Bilateral	60(57.1%)	57(58.2%)				

OR: Odd ratio; CI: Confidence Intervals; X^2: Chi square; *p*: Probability value

There was not a statistically significant association between application of Alkohl and the occurrence of conjunctivitis (*p*=0.845). Among 105 neonatal conjunctivitis, 71(67.6%) cases were applied Alkohl and 34(32.4%) were not applied Alkohl. Table 6 shows that gentamycin showed a good sensitivity *in vitro* to all isolated bacteria. *S. aureus* was found to be sensitive to gentamycin (83%), followed by Chloramphenicol (77.9%), ofloxacin (64.4%), erythromycin (55.9%) and tetracycline (45.2%). *K. pneumoniae* was resistant to erythromycin and sensitive to gentamycin, ofloxacin, tetracycline and chloramphenicol as following: 56.6%, 43.3%, 40% and 33.3%, respectively. *E. coli* showed sensitivity to gentamycin, ofloxacin and chloramphenicol (84.6%, 46.1%, 40% and 38.4%, respectively). *P. aeruginosa* showed sensitivity only to gentamycin (60%) and ofloxacin (30%).

Table 4: The maternal risk factors in correlation with ophthalmia neonatorum.

Parameter	Bacterial conjunctival neonates n=105	Non-bacterial conjunctivital neonates n=98	OR (>1)	CI (95%)	X^2 (≥ 3.7)	*p*-value (*p*< 0.05)
Mode of delivery						
Vaginal delivery	70(66.7%)	70(71.4%)				
Cesarean section	35(33.3%)	28(28.6%)	0.8	0.44-1.4	0.54	0.46
PROM*						
Present	9(8.6%)	10(10.2%)	0.82	0.32-2.1	0.16	0.69
Absent	96(91.4%)	88(89.8%)				
History of maternal infections of the lower genital tract						
Infected	50(47.6%)	58(59.2%)				
Non-infected	55(52.4%)	40(40.8%)	0.63	0.36-1.1	2.7	0.099

OR: Odd ratio; CI: Confidence Intervals; X^2: Chi square; *p*: Probability value, PROM: Prolonged rupture of membranes.

DISCUSSION

The current study showed that bacteria cultures were positive in 51.7% of the neonates and 48.3% of the neonates were free of demonstrable pathogenic bacteria despite the presence of conjunctivitis. Similar prevalence rates were reported from Saudi Arabia (60%)[22] and Iraq (69%)[23]. On the other hand, higher prevalence rates (81.5% and 80.5%, from United Arab Emirate and Iran, respectively were reported[24, 25]. This wide variation may be attributed to differences in the geographic distribution of pathogens and standards of obstetric and perinatal care. The current results showed that 98 samples (48.3%) did not reveal any growth that might be due to other organisms that had not been researched such as *Candida albicans* or viruses. This negative percentage is higher than Saudi Arabia (40%) and Iraq (31%)[22,23]. The present study shows a high percentage of *S. aureus* as the most common causative agent (56.2%) followed by *K. pneumoniae* (28.6%), *E. coli* (12.4%) and less commonly by *P. auroginosa* (2.9%). Similarly, several studies reported that *S. aureus* is the main bacterial cause of neonatal conjunctivitis from different parts of the world, including the United Arab Emirates, Iran (53.9%), Nigeria (57.1%) and Pakistan (65%)[24-27]. In contrast, *Enterobacter clocae* (26.32%), *K. pneumoniae* (25.36%) and *E. coli* (35%) were the primary isolates from Saudi Arabia, Iraq and India, respectively[22,23,28].

Table 5: Clinical intervention and Alkohl application as risk factors among newborns with bacterial conjunctivitis (n=105).

Parameter	Bacterial conjunctival neonates=105	Non-bacterial conjunctivital neonates=98	OR	95% CI	X^2	*p*-value
Mechanical Ventilation	3(2.9%)	45(45.9%)				
Invasive	26(24.8%)	11(11.2%)	0.04	0.01-	52	< 0.01
Noninvasive	76(72.3%)	42(42.9%)	2.6	0.12	6.2	0.013
None				1.2- 5.6		
NNPT						
Exposed	59(56.2%)	27(27.6%)	3.4	1.9-6.1	17	< 0.01
Non-exposed	46(43.8%)	71(72.4%)				
Alkohl (antimony)		65(66.3%)	1.0	0.59-1.9	0.038	0.845
Applied	71(67.6%)	33(33.7%)				
Not applied	34(32.4%)					

OR (Odd ratio) >1 (at risk); X^2 (Chi square) ≥ 3.7; CI: Confidence Intervals; *p* (Probability value) < 0.05 (significant); NNPT: Neonatal phototherapy

The role of *S. aureus* in neonatal conjunctivitis is controversial because it is often isolated from the eyes of asymptomatic neonates[29]. However, in our study only newborns with signs and symptoms of conjunctivitis were evaluated. Although prophylaxis for neonatal *Neisseria gonorrhea* and *C. trachomatis* was not used in these three hospitals; *N. gonorrhoeae* and *C. trachomatis*, which are usually causes of ophthalmia neonatorum, have not been diagnosed. A similar finding of zero or minimal cases of *gonococcus* and *chlamydial* conjunctivitis has been reported elsewhere[26,27].

The findings may indicate a rare occurrence of *gonorrhea* and *chlamydia* in the community. In the current results, 57.1% of ON patients were males and 42.9% were females, this is similar to that reported from Iran, Nigeria and Saudi Arabia with slightly increased in male patients (54.4%),[25] (66.3%)[26] and (51%)[22]. It was also observed in the present results that the majority of positive cases of bacterial cultures occurred between the lowest birth weight (80%) and premature neonates (71.4%), because these groups of neonates are more at risk as confirmed by the results of Dias *et al*[30].

Table 6: Antibiotics susceptibility to isolated bacteria.

Antibiotic	*S. aureus* Sensitivity(%)	*K. pneumoniae* Sensitivity (%)	*E. coli* Sensitivity (%)	*P. aeruginosa* Sensitivity (%)
Chloramphenicol	46 (77.9 %)	10(33.3%)	5(38.4%)	-
Erythromycin	33 (55.9%)	-	-	-
Gentamycin	49 (83%)	17(56.6%)	11(84.6%)	2(60%)
Ofloxacin	38 (64.4%)	13(43.3%)	6(46.1%)	1(30%)
Tetracycline	32 (54.2%)	12(40%)	-	-

This study showed a statistical significance between gestational period and the occurrence of conjunctivitis (p<0.01). Neonates with a positive bacterial culture were 71.4% preterm vs. 28.6% full-term. The finding is in agreement with a study by Dias *et al*., in Portugal[30]. This can be attributed to the fact that conjunctivitis may develop more frequently in premature babies where they spend a long time with their eyes closed or covered, allowing bacteria to multiply, and due to the immature lacrimal system. A functional lacrimal system produces tear components, opening and closing of the eyelids act as a pump to assist tear spreading across the surface of the eye and the lacrimal ducts proceed as a drainage system, which transports away tears with epithelial debris and bacteria[31]. It was also noted in the current study that the vast majority of 78 cases (74.3%) occurred during the end of the first week of life. The finding is in agreement with studies from Nigeria and Iran where the majority of cases occurred within the first week of life and between 1 and 12 days of age, respectively[25,26]. The result indicates that the first week of life is the most susceptible period for conjunctivitis in infants. Also, the mean age of onset in the current study is 8.8 days indicating that ON is postnatally acquired. The results of the current study showed that there was no statistical significance between ON and the conjunctivitis wither it is unilateral or bilateral (p=0.883). Bilateral conjunctivitis was present in 57.1% of patients, and unilateral involvement was seen in 42.9% of the patients. The result is similar to that reported by Afjeiee *et al*[25].

In current study, many risk factors for bacterial neonatal conjunctivitis were evaluated. Some of them are maternal risk factors and the others related to the medical intervention during the stay at hospitals wither in NICU or in the nurseries. It was found that there was no statistical significance between bacterial conjunctivitis and the maternal risk factors like the mode of delivery, PROM and the history of vaginal discharge (p>0.005). These results are similar to results from India, Iran and Pakistan[25,27,28]. This result might be due to the fact that the conjunctivitis is acquired as a

result during the therapy from the hospitals contamination.

In regarding to other risk factors which result from clinical intervention, we found that there was statistical significance in applying the invasive or noninvasive mechanical ventilation (p<0.05). This result is similar to that reported by Borer *et al.*,[32], and Dias *et al.*,[30], in which ventilation was a risk factor. The association between ON and respiratory support including nCPAP and invasive mechanical ventilation was interpreted as infants needing ventilator assistance may allow respiratory secretions to be transferred from the nasopharynx to the eyes, particularly during suctioning[31]. Another interpretation is that the mechanical ventilation such as nCPAP usually requires more manipulations and operating with hands that lead to contamination with skin normal or potential pathogenic bacteria to the ventitation[31]. There was statistical significance between applying of neonatal phototherapy and the occurrence of bacterial conjunctivitis (p<0.01). This result is similar to the results reported by Faulhaber *et al.*,[33] and Bayatmo-khtari *et al.*,[34]. This association is attributed to the using the eye protection devices during applying of the phototherapy[35]. The eye shield reduces the blinking which has protective effects from bacterial colonization in the conjuntival sac and lead to conjunctivitis[34]. In current study, there was no statistical significance in application of antimony (p=0.845). Pure kohl contains antimony sulfide and trisulfide as its main constituents. It is a traditional eyeliner and is taken from dark stone known in Arabic as “ithmed” stone[36]. Al-kohl is used in our community to darken the eyelids and serve as cosmetics. This result comes in agreement with a study conducted in Nigeria by Isa *et al*[37].

The sensitivity patterns in this study revealed that the highest sensitivity of *S. aureus* was to gentamicin 83% which is similar to the result reported by Dias *et al*[30]. In contrast, in another study in Iraq, *S. aureus* was more sensitive to ciprofloxacin followed by chloramphenicol[23]. *K. pneumoniae* in this study had an average sensitivity of gentamicin 56.6%, while, in another study in Nigeria, *K. pneumoniae* was resistant to gentamicin but sensitive to ceftazidime[26]. *E. coli*, which showed a high sensitivity to gentamicin (84.6%) and moderate sensitivity of *P. aeruginosa* to gentamicin (60%).

CONCLUSION AND RECOMMENDATION

The vast majority of cases of neonatal conjunctivitis were mild with a high level of occurrence, *S. aureus* and *K. pneumoniae* were the major bacterial agents, neonatal conjunctivitis most likely to be a hospital-acquired infection. There was no statistically significant association between maternal risk factors (pre labor rupture of membranes, presence of vaginal discharge and mode of delivery) and neonatal conjunctivitis, but there was a significant association between phototherapy, non-invasive ventilation and incidence of neonatal conjunctivitis. Gentamicin had high activity against the bacteria isolated in this study. Microbiological examinations are needed prior to treatment for cases of neonatal conjunctivitis, routine eye prophylaxis as soon as possible after delivery, regardless of whether it was delivered vaginally or by caesarean section, and health workers in neonatal units should pay attention to infection control practices in order to reduce the level of pollution.

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CONFLICT OF INTEREST

No conflict of interest associated with this work.

AUTHOR’S CONTRIBUTIONS

The first author is a master's student who did the field and lab work and wrote the thesis. All other authors participated in writing the article, reviewing the results and supervising the master's thesis, especially Prof. Ahmed Al-Joufi and Prof. Essam Al-Shamahi.

REFERENCES

1. Dey A, Hossain MH, Dey SK *et al*. Neonatal conjunctivitis leading to neonatal sepsis--a case report. Mymensingh Medical J: MMJ 2016; 25(1): 161-162. PMID: 26931268
2. Wadhwani M, D'souza P, Jain R, Dutta R, Saili A, Singh A. Conjunctivitis in the newborn- A comparative study. Indian J Pathol Microbiol 2011; 54:254-7.
3. Kao Y, Tsai MH, Lai MY, *et al*. Emerging serotype III sequence type 17 group B streptococcus invasive infection in infants: the clinical characteristics and impacts on outcomes. BMC Infect Dis. 2019; 19(1):538. *https://doi.org/10.1186/s12879-019-4177-y*
4. Tang, S., Li, M., Chen, H. *et al*. A chronological study of the bacterial pathogen changes in acute neonatal bacterial conjunctivitis in southern China. BMC Ophthalmol 2017; 17, 174. *https://doi.org/10.1186/s12886-017-0570-8*
5. Yazici, Bulent MD, Orucov, Nesimi MD, Ibrahimzade, Gunay MD. Neonatal orbital abscess secondary to *P. aeruginosa* conjunctivitis. Ophthal Plastic Reconst Surg 2017; 33(3):e64-e66. *https://doi.org/10.1097/IOP.0000000000000754*
6. Mohammed A, Ibrahim M, Mustafa A, Ihesiulor U. Maternal risk factors for neonatal conjunctivitis in Aminu Kano Teaching Hospital, Kano, Nigeria. Niger J Basic Clin Sci 2013; 10:60-5.
7. Al-Eryani SA, Alshamahi EYA, Al-Shamahy HA, Alfalahi GHA, Al-Rafiq AA. Bacterial conjunctivitis of adults: causes and ophthalmic antibiotic resistance patterns for the common bacterial isolates. Universal J Pharm Res 2021; 6(1):25-28.*https://doi.org/10.22270/ujpr.v6i1.535*
8. Alshahethi MA, Edrees WH, Mogalli NM, *et al*. Distribution and risk factors for *Giardia lamblia* among children at Amran governorate, Yemen. Universal J Pharm Res 2020; 5(3):1-6. *https://doi.org/10.22270/ujpr.v5i3.413*
9. Alshamahi EYA, Al Shamahy HA Al Nahary AA, AL Magrami RTF, *et al*. Epidemiology and aetiological diagnosis of corneal ulceration in Sana’a City, Yemen. W J Opthalmol Vision Res 2019; 2(5):1-6. *https://doi.org/10.33552/WJOVR.2019.02.000550*

10. Alshamahi EYA, Al-Eryani SA, Al-Shamahy HA, *et al*. Prevalence and risk factors for Trachoma among primary school children in Sana'a city, Yemen. Universal J Pharm Res 2021; 6(4):19-25. *https://doi.org/10.22270/ujpr.v6i4.636*
11. Alshamahi EYA, Al-Shamahy HA, Musawa YA. Bacterial causes and antimicrobial sensitivity pattern of external ocular infections in selected ophthalmology clinics in Sana'a city. Universal J Pharm Res 2020; 5(3):12-16. *https://doi.org/10.22270/ujpr.v5i3.329*
12. Alshamahi EYA, AlShami HZA, Al-Shamahy HA. Prevalence of *S. aureus* in external ocular infection and the occurrence of MRSA in isolates, Rabat. Clin Ophthalmol J 2020;2(1):1010.
13. Alshamahi EYA. Comparison between limbal and combined limbal and pars plana approaches using vitrectomy to remove congenital cataracts with primary intraocular lens implantation in Yemen. Clin Surg. 2021; 4(8): 1-7. *https://doi.org/10.1155/2016/8951053*
14. Alshamahi EYA, IshaK AA, Aljayfey NH, Al-Shamahy HA. Prevalence and risk factors for trachoma among primary school children in Bajjil District, Al Hudaydah, Western Yemen. Clin Ophthalmol J 2020;1(3):1014.
15. Al-Shamahy HA, Ishak AA. Trends and causes of morbidity in part of children in the city of Sana'a, Yemen 1978-2018: findings of single children's health center. Universal J Pharm Res 2021; 5(6). *https://doi.org/10.22270/ujpr.v5i6.504*
16. Al-Shamahy HA, Ajrah MA, Al-Madhaji AG, *et al*.. Prevalence and potential risk factors of hepatitis B virus in a sample of children in two selected areas in Yemen. Universal J Pharm Res 2019; 4(3). *https://doi.org/10.22270/ujpr.v4i3.269*
17. Ishak AA, Alhadi AM, Al-Moyed KAA, Al-Shamahy HA. Childhood urinary tract infection: clinical signs, bacterial causes and antibiotic susceptibility. Universal J Pharm Res 2021; 6(4). *https://doi.org/10.22270/ujpr.v6i4.643*
18. Nassar M, Al-Shamahy HA, AL-Barq AM. Evaluation of the immune response to polio vaccine in malnourished children in Sana'a city. Universal J Pharm Res 2018; 3(2): 29-33. *https://doi.org/10.22270/ujpr.v3i2.137*
19. Dharmasena A, Hall N, Goldacre R, Goldacre M. Time trends in ophthalmia neonatorum and dacryocystitis of the newborn in England, 2000–2011: database study. Sexually Trans Infect 2015; 91(5): 342-345. *https://doi.org/10.1136/sextrans-2014-051682*
20. Cheesbrough M. District laboratory practice in tropical countries. Cambridge: Cambridge University Press; 2010. *https://doi.org/10.1017/CBO9780511581304*
21. CLSI. Performance Standards for Antimicrobial Disc Susceptibility Tests. (11th edn.), Approved standard M02-A11– Publication of Clinical and Laboratory Standards Institute [CLSI), 2012, USA, 32.
22. Faraz A, Farhan MA. Microbial etiology of neonatal conjunctivitis in a general hospital in Saudi Arabia. Al-shifa J Ophthalmol 2019; 15(1): 30-34.
23. Al-Atrushi AAS, Al-Brefkani A. Ophthalmia neonatorum in Duhok, north of Iraq: bacterial causative agents and their antibiotic sensitivity pattern. Isra Med J 2012; 4(4): 09-213.
24. Nsanze H, Dawodu A, Usmani A, *et al*. Ophthalmia neonatorum in the United Arab Emirates. Annals of tropical paediatrics 1996; 16(1): 27-32.
25. Afjeiee SA, Tabatabaei SR, Fallah F, *et al*. A microbiological study of neonatal conjunctivitis in two hospitals in Tehran, Iran. Asian Pac J Trop Dis 2013; 3(6):429-433. *https://doi.org/10.1016/S2222-1808(13)60096-1*
26. Ogunfowora OB, Ajewole JO, Ajibode HA. Conjunctival bacterial infection among hospitalized neonates. Annals Health Res 2020; 6(2): 230-238. *https://doi.org/10.30442/ahr.0602-12-85*
27. Gul SS, Jamal M, Khan N. Ophthalmia neonatorum. J Coll Physicians Surg Pak 2010; 20:595-598. PMID: 20810051
28. Goel K, Randhawa VS, Saili A, *et al*. Incidence, etiology and risk factors associated with neonatal healthcare-associated conjunctivitis: a prospective study from a tertiary care hospital in India. J Trop Pediatr 2016; 62(1):10-18.*https://doi.org/10.1093/tropej/fmv064*
29. Geng W, Qi Y, Li W, *et al.* Epidemiology of *S. aureus* in neonates on admission to a Chinese neonatal intensive care unit. PLoS One. 2020;15(2):e0211845. *https://doi.org/10.1371/journal.pone.0211845*
30. Dias C, Gonçalves M, João A. Epidemiological study of hospital-acquired bacterial conjunctivitis in a level III neonatal unit. The Sci World J 2013. *https://doi.org/10.1155/2013/163582*
31. Haas J, Larson E, Ross B, See B, Saiman, L. Epidemiology and diagnosis of hospital-acquired conjunctivitis among neonatal intensive care unit patients. The Ped Infect Dis J 2005; 24(7), p.586. *https://doi.org/10.1097/01.inf.0000168742.98617.66*
32. Borer A, Livshiz-Riven I, Golan A, *et al*. Hospital-acquired conjunctivitis in a neonatal intensive care unit: bacterial etiology and susceptibility patterns. American J Infect Cont 2010; 38(8):650–652. *https://doi.org/10.1016/j.ajic.2010.01.002*
33. Faulhaber FR, Procianoy RS, Silveira RC. Side effects of phototherapy on neonates. American J Perinatol 2019; 36(03): 252-257. *https://doi.org/10.1055/s-0038-1667379*
34. Bayatmokhtari M, Maamouri G, Yousefi J, Meshkat M, Hoseyni NM. The effect of ophthalmic patch on conjunctiva of neonates under phototherapy. Pediatr Infect Dis J 1995; 14(12):1091-4. *https://doi.org/10.1097/00006454-199512000-00012*
35. Xiong T, Qu Y, Cambier S, Mu D. The side effects of phototherapy for neonatal jaundice. European J Pediatrics 2011; 170(10):1247-1255. *https://doi.org/10.1007/s00431-011-1454-1*
36. Mohammed A, Ibrahim M, Mustafa A, Ihesiulor U. Maternal risk factors for neonatal conjunctivitis in Aminu Kano Teaching Hospital, Kano, Nigeria. Niger J Basic Clin Sci 2013; 10:60-5. *https://www.njbcs.net/text.asp?2013/10/2/60/122759*
37. Isa A, Elsie S, Nuhu OW. Is topical kohl ophthalmic application associated with neonatal aseptic or bacterial conjunctivitis? Sub-Saharan African J Med 2014; 1(3):138. *https://doi.org/10.4103/2384-5147.138942*