BACTERIAL ISOLATES AND THEIR ANTIMICROBIAL RESISTANCE PATTERNS IN NEONATAL SEPSIS RECORDED AT HEVI TEACHING HOSPITAL IN DUHOK CITY / KURDISTAN REGION OF IRAQ

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ABSTRACT

Background: Neonatal sepsis is one of the commonest causes of neonatal mortality in the developing world. There is a continuous change in the patterns of microbial flora and their antimicrobial susceptibility. The aim of this study was to determine the microbial agents causing neonatal sepsis, the susceptibility of these microorganisms to the commonly used antimicrobial agents at Hevi Hospital and to compare the causative agents during the last four years.

Methods: A retrospective study was conducted over a period of four years. From the recorded data of archives of Hevi Teaching Hospital from 2014 till 2017, a total of 1058 blood cultures were taken. The positive and negative cultures were 536 and 522 respectively. From the positive cultures, 555 pathogens were isolated.

Results: The present study revealed that the female to male ratio for neonatal sepsis was 1.5:1 and the most common microorganisms isolated were Coagulase-Negative Staphylococci consisting (58.5%) of cases; followed by *Staphylococcus aureus* (16.6%) and Escherichia coli (7.6%). The higher percentage of neonatal sepsis (30%) was recorded in 2017. There is no statistical significant difference regarding the causative microorganism for the early and late neonatal sepsis except for the Enterococcus species; with their highest percentage among late neonatal sepsis.

Conclusions: This study revealed that resistance against many commonly used antibiotics have been increased which limits the options for treating of neonatal sepsis. This is resulted from uncontrolled use of the antibiotics and lack of policies and guidelines for their use in public health.

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Keywords: Antibiotic, Resistance, Neonatal sepsis

Neonatal sepsis is a serious infection that occurs in infants in their first 28 days of life and is a leading cause of morbidity and mortality of newborns. It is considered be a cause of 26% of all neonatal deaths worldwide[1,2] .The Incidence of neonatal sepsis varies from one country to other but
is more common in developing countries, where it is responsible for about 30-50% of the total of neonatal deaths[3,4]. It comprises a several systemic infections of the newborns including septicemia, osteomyelitis, meningitis, pneumonia and arthritis[5,6].

Depending on the time of starting of the infection, neonatal sepsis has been categorized into early-onset sepsis (EOS) and late-onset sepsis (LOS). Sepsis that

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occurs in the first three days of life called EOS and is often transmitted by vertical transmission from mothers to infants during the intra-partum period[7]. While LOS defined as infection occurring after 72 hours of birth; due to transmission of infection from neonatal intensive care. EOS in term newborns are mainly caused by Group B Streptococci; however Gram-negative bacteria are not rare. A combination of benzyl penicillin and intravenous gentamicin are most commonly used as a guideline in 125 UK hospitals8. Most cases of LOS are attributable to Group B Streptococci and *Staphylococcus species*, while gram negative microorganisms (*Klebsiella spp* and *Escherichia coli*) are responsible for about one third of cases[9].

Early detection and correct management of neonatal sepsis by good care and rational antimicrobial can decrease mortality rate from this disease[10].

Antimicrobial resistance recently considered as a major problem worldwide, about half of the microorganisms that cause severe neonatal bacterial infections reported to be resistant to the first-line (ampicillin or penicillin, and gentamicin) and to second-line (third-generation cephalosporins) treatments that the WHO has been recommended[11]. The first estimation of neonatal deaths due to the neonatal sepsis that results from the antimicrobial resistance was published in 2016[12].

This study was conducted to detect the bacterial agents causing neonatal sepsis (early and late), to determine the antimicrobial susceptibility patterns of the bacterial isolates and to assess the available choices for empirical antimicrobial therapy in patients with neonatal sepsis.

PATIENTS AND METHODS

The antibacterial susceptibility and microbiological data of this study has been obtained from the records of the Microbiology laboratory of Hevi Pediatric Teaching Hospital. A retrospective survey study was carried out by taking the records of patients that revealed positive bacterial blood cultures and their antibacterial susceptibility results from archives for a period of four years (2014, 2015, 2016 and 2017). A total of 1058 blood cultures were recorded. The positive cultures and negative cultures were 536 and 522 respectively. From the positive cultures 555 pathogens were isolated. Neonates age less than 8 days were considered as EOS and those aged 8-90 days wereLOS[13].

The cultures were conducted by collecting blood (1-3ml) in blood culture bottles specific to BacT Alert instrument or in specific bottles manufactured for manual incubation and were incubated for 5 days. Few drops from culture positive bottles were collected by sterile needles and further streaked on media agar plates (blood, chocolate and MacConkey) and incubated for 24h. The isolated bacteria were identified based on their colony morphology, culture characteristics and biochemical reactions. Antimicrobial susceptibility testing was performed on Muller-Hinton agar (except for streptococci which were performed on blood agar plate) using disk diffusion method (Kerby-Bauer disc diffusion) against different antimicrobial agents according to CLSI standards[14]. The antibiotic discs consisted of Penicillin, Ampicillin, Amoxicillin/ clavulanic acid, Piperacilin, Cephalothen, Cefixim, Cefotaxime, Ceftazidime, Amikacin, Gentamicin, Ciprofloxacin, Norfloxacin, Imipenem, Vancomycin, Erythromycin,

Azithromycin, clindamycin and Trimethiprim.

STATISTICAL ANALYSES

The data were coded, computerized and analyzed by SPSS for Windows, version 22, identified by frequencies and percentages. Statistical significance was calculated using P value. P value less than 0.05 was considered as a significant result.

RESULTS

Five hundred and thirty six cases (50.6%) out of 1058 their blood cultures yielded the growth of bacterial pathogen so confirmed as having neonatal sepsis. The total number of isolated bacterial microorganisms was 555; 125 (22.5%) from 2014, 134 (24.1%) from 2015, 128 (23.1%) from 2016 and 168 (30 %) from 2017 (Figure 1). Male constitute 329 (59 %) and female 226 (41 %). Male to female ratio for neonatal sepsis was 1.5:1.

The most common bacterial pathogen caused the neonatal sepsis during all of the four years was Coagulase-Negative Staphylococci consisting (58.5%) of cases; followed by Staphylococcus aureus (16.6%) and Escherichia coli (7.6%) (Figure 2).

EOS constitute (30.8%) of cases. Coagulase-Negative Staphylococci was the commonest pathogen affecting both EOS and LOS with no significant difference (p value > 0.05).

Escherichia coli was the highest among LOS, but without any significant difference (p value > 0.05). Enterococcus species was more in LOS with a significant difference (*p* value < 0.05), (Table 1).

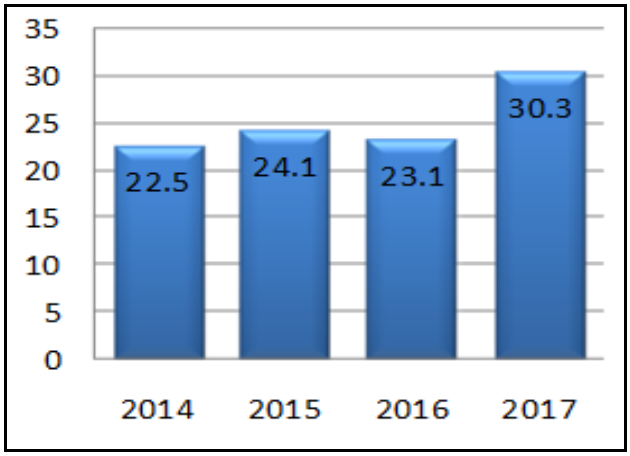

Figure 1: Percentage of Neonatal Sepsis During the Years 2014, 2015, 2016, and 2017

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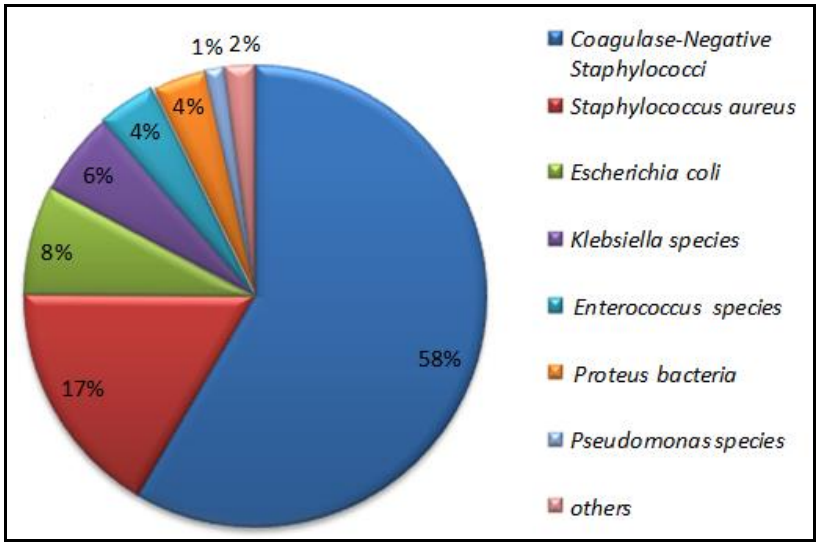

Figure 2: Percentages of the Isolated Microbial Pathogens

Table 1: Distribution of Pathogenic Microbial Agents in Early and Late Onset Sepsis

	Microorganism	Early NS (1-7days) n(%)	Late NS (8-90 days) n (%)	Total n(%)	p- value
Gram positive bacteria	*Staphylococcus aureus*	27(15.9)	65(16.9)	92(16.6)	>0.05
	Coagulase-Negative Staphylococci	97(57.1)	228(59.2)	325(58.5)	>0.05
	Enterococcus species	2(1.2)	21(5.5)	23(4.1)	<0.05
	Bacillus species	0 (0)	4(1)	4(0.7)	>0.05
	Diphtheria species	0(0)	2(0.5)	2(0.4)	>0.05
	Streptococcus agalactiae	1(0.6)	0(0)	1(0.2)	>0.05
	Viridians streptococci	1(0.6)	0(0)	1(0.2)	>0.05
Gram negative bacteria	*Escherichia coli*	16(9.4)	26(6.8)	42(7.6)	>0.05
	Klebsiella species	15(8.8)	18(4.7)	33(5.9)	>0.05
	Proteus species	6(3.5)	15(3.9)	21(3.8)	>0.05
	Pseudomonas species	5(2.9)	3(0.8)	8(1.4)	>0.05
	Brucella species	0(0)	2(0.5)	2(0.4)	>0.05
Fungi	Candida species	0(0)	1(0.2)	1(0.2)	>0.05
Total		170(100)	385(100)	555(100)	

Coagulase-Negative Staphylococci, *Staphylococcus aureus* and *Escherichia col*i are more common among male than female (34.9% and 23.6%), (9.2% and 7.4%) and (4.7 and 2.9) respectively; but without statistically significant difference (p value>0.05). On the other hand *Klebsiella species* are the highest among female (2.7% and 3.2%), this result was not significant statistically at *p* value >0.05 (Table2).

Table2: Distribution of Pathogenic Microbial Agents in Neonatal Sepsis According to Sex

	Microorganism	Male n(%)	Female n(%)	Total n(%)	P value
Gram	Coagulase-Negative Staphylococci	194(34.9)	131(23.6)	325(58.5)	>0.05

positive bacteria	*Staphylococcus aureus*	51(9.2)	41(7.4)	92(16.6)	>0.05
	Viridians streptococci	1(0.2)	0(0)	1(0.2)	>0.05
	Enterococcus species	13(2.3)	10(1.8)	23(4.1)	>0.05
	diphtheria species	1(0.2)	1(0.2)	2(0.4)	>0.05
	Streptococcus agalactiae	1(0.2)	0(0)	1(0.2)	>0.05
	Bacillus species	3(0.5)	1(0.2)	4(0.7)	>0.05
	Proteus species	14(2.5)	7(1.3)	21(3.8)	>0.05
Gram negative bacteria	*Escherichia coli*	26(4.7)	16(2.9)	42(7.6)	>0.05
	Pseudomonas species	7(1.2)	1(0.2)	8(1.4)	>0.05
	Brucella species	2(0.4)	0(0)	2(0.4)	>0.05
	Klebsiella species	15(2.7)	18(3.2)	33(5.9)	>0.05
Fungi	Candida species	1(0.2)	0(0)	1(0.2)	>0.05
Total		329(59.2)	226(40.8)	555(100)	

Coagulase-Negative Staphylococci is the leading pathogen in all four years with a highest level in 2014 and 2016 (74.4% and *56.8% respectively).* *Escherichia* coli (15.4%) were more during 2015.

Staphylococcus aureus (20.7%) and *Enterococcus species* (8.5%) were with their highest percentage in 2016. On other hand, Proteus bacteria (7.1%) and *Klebsiella species* (8.8 %) were with a higher percentage in 2017 (Figure 3).

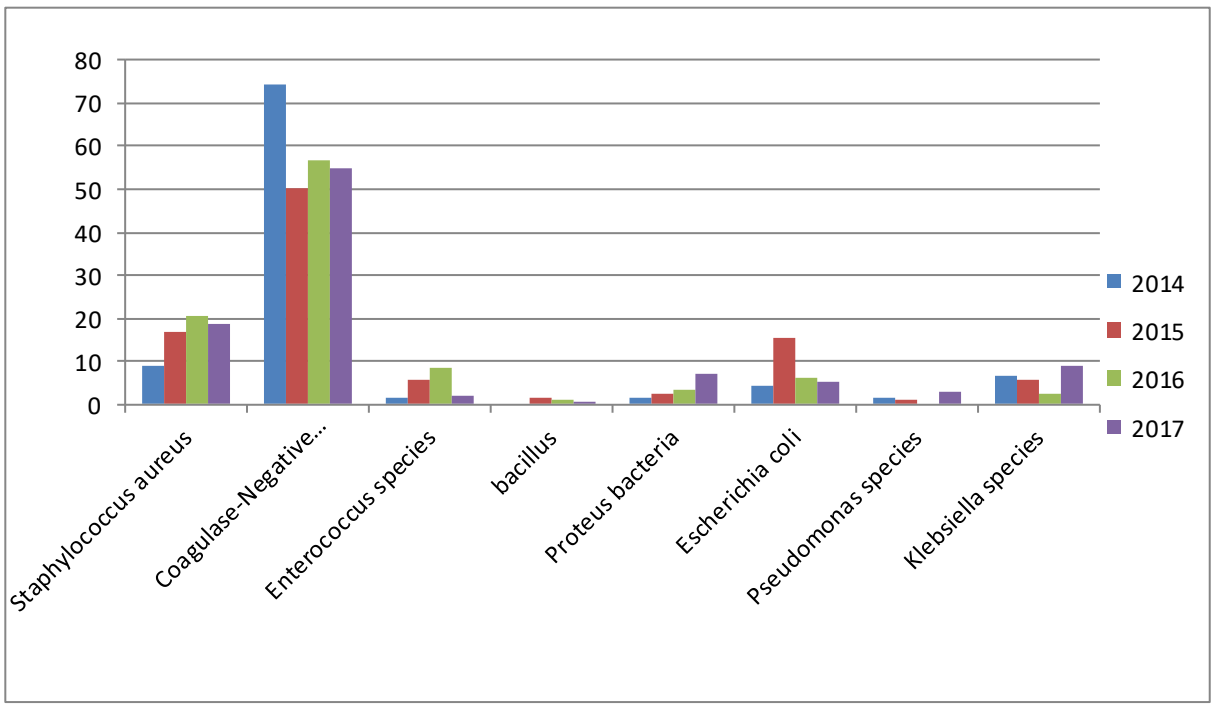

Figure 3: The Bacterial Pathogens Causing Neonatal Sepsis in 2014, 2015, 2016 And 2017

Staphylococcus aureus was with high susceptibility to clindamycin, vancomycin, and Gentamicin (78.3%, 67.4% and 47.8%). Coagulase-Negative Staphylococci is more susceptible for vancomycin and clindamycin (84% and

75.1%); Enterococcus species shows a high susceptibility to clindamycin (82.6%). While the gram negative bacteria *Escherichia coli* and *Klebsiella species*; both are highly susceptible to Imipenem (90.5% and 93.9%) respectively (Table 3).

Table 3: Antimicrobial Susceptibility Results for The Main Bacterial Isolates in All Neonatal Septic Cases

Antibiotic	Micro-Organism				
	Staphylococcus aureus **[n=92](%)**	***Coagulase-Negative Staphylococci*** **[n=325](%)**	***Enterococcus*** **species [n=23](%)**	***Escherichia coli*** **[n=42](%)**	***Klebsiella*** **species [n=33] (%)**
Penicillin	1.1	4.6	4.3	4.8	0
Amoxicillin /clavulanic acid	0	9.8	17.4	9.5	9.1
Ampicillin	0	1.5	8.7	0	9.1
Oxacillin	17.4	18.5	4.3	0	0
Piperacillin	0	0	8.7	0	0
Cefixime	0	0.3	13	9.5	18.2
Cephalothin	19.6	42.2	21.7	7	18.2
Cefotaxime	1.1	0	0	4.8	26.1
Erythromycin	5.4	5.8	4.3	0	0
Azithromycin	2.2	3.4	8.7	0	0
Amikacin	10.9	10.5	0	64.3	48.5
Gentamicin	47.8	60.6	34.7	47.6	30.3
Nalidixic acid	1.1	0.9	0	11.9	9.1
Norfluxacin	1.1	0.9	0	12.4	0
Imipenem	6.5	2	13	90.5	93.9
Vancomycin	67.4	84	70	14.3	6.1
Clindamycin	78.3	75.1	82.6	2.4	26.1
Trimethoprim/ sulfamethoxacole	1.1	2	0	14.3	18.1

DISCUSSION

The causative pathogens in neonatal sepsis differ from place to place and the frequency of the causative organisms various from hospitals to others at different time; which make certain that there is a need for continuous looking out to the responsible organisms and their drug susceptibility pattern at a local level.

Gram-positive bacteria were the main causative pathogens, with CoNS alone accountable for more than half of neonatal sepsis cases. This situation is differs from that in the developing countries, where CoNS have been shown to be at lower percentage[15]. CoNS have been recorded consistently as the main causative pathogens of LOS in the developed countries and also in Kuwait and other Asian countries[16]. Recently there is increasing in care of premature newborns, so those premature infants are extremely vulnerable to less virulent pathogens such as CoNS, which might have contributed to the pattern of LOS seen in the Arab states in the Gulf region[17]. Although CoNS have been detected as the most common causative organisms of LOS, they form part of the skin flora and are a common contaminant; distinguishing contamination

from true infection is very challenging. Increasing tendency of clinicians to interpret CoNS blood culture as an infection rather than a contamination; because of the increasing in the population of premature infants in recent years; can be a cause of the current increase in CoNS infections. A study performed in 5 neonatal intensive care units (NICUs) in the following hospitals: Dubai Hospital and Tawam Hospital in the United Arab Emirates, Al Sabah Maternity Hospital in Kuwait, and King Abdulaziz Hospital and the Maternity and Children's Hospital in Saudi Arabia determine nearly a similar finding[18].

The Second most common organism in this study was *Staphylococcus aureus* (16.6%). While another study conducted in Nigeria and in Nepal determines that the *Staphylococcus aureusis* the main causative pathogen of the neonatal sepsis[2,4]. This variation might be due to differences in the study methodology, environmental and host factors that exist.

Regarding gender, at the present study, males were found to be with a higher prevalence of sepsis compared to the female. Other researchers in Nigeria[19], Ethiopia[20], Iraq[21], and Indonesia[22] reported a similar finding. The higher prevalence of sepsis in males may be explained by the increased biological vulnerability of males to infection[23]. Male sex hormones, androgens, have been shown to be suppressive on cell-mediated immune responses. In contrast, female sex hormones exhibit protective effects which may contribute to the natural advantages of being a female under septic conditions. Thus, the hormonal status has to be considered when treating septic patients[24]. However, Omoregie *et al.* found that there is no significant sex difference in the prevalence of bacterial sepsis among young children in Benin City[25].

This study revealed a high percentage of the LOS (69.2%). Other study enrolled in Iraq (20) revealed that the EOS was more than that of LOS; it was determined that EOS caused by gram-negative bacteria was more frequent than that caused by the gram-positive bacteria in both EOS and LOS. As well as Studies conducted by Mathur *et al* [26] in India and Mokoulo *et al*[27]. in Nigeria reported a higher percentage of EOS. The factors that have been implicated in the highest incidence of LOS in this study are the poor hygiene, poor cord care and bottle feeding. Therefore, there is an urgent need to enlighten the general public on the proper way of care for the newborn infants.

Regarding the antimicrobial susceptibility results, this study revealed that the gram positive bacteria (Coagulase-Negative Staphylococci and *Staphylococcus aureus*) were with a high susceptibility to clindamycin and vancomycin. Whereas the gram negative bacteria (Escherichia coli and Klebsiella species; both are highly susceptible to Imipenem (90.5% and 93.9% respectively), similar results were observed by other researcher[28] who found that imipenem had a very high effect on gram negative strains. However, it is recommended that imipenem should be used as a last line antibiotic to avoid the occurrence of the microbial resistance. Thus the maximum resistance was seen against Ampicillin, Penicillin, Cefotaxime and Amoxicillin/ Clavulanic acid. On other

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hand a study enrolled in west Africa[29] found that ampicillin has a moderate rate of antimicrobial resistance. The drug resistance of the microorganisms makes the neonatal sepsis cases to be a rapidly emerging, potential disastrous problem.

This situation is worse in the developing countries because of the lack in the legislation that face the uncontrolled selling of different antimicrobial drugs, shortage of surveillance of the standards of maternity homes and the practices of traditional birth attendants who deliver almost 80% of all births[30].

As a result of combination of microbial characteristics and the selective pressure of antimicrobial use; the problem of antibiotic resistant infections in the developing world has increased consistently in the last few decades[31-34].

Accordingly, in 2017 a research conducted in different areas of Nigeria to determine the antimicrobial resistance of Coagulase-negative staphylococci isolated from Nigerian traditional fermented foods, the study revealed that nearly all of the isolates were resistant (93.8%) to Ampicillin, about (84.5%) of the isolates were resistant to trimethoprim-sulfamethoxazole, 42.9% of the isolates were resistant to oxacillin, 60.7% resistant to Augmentin, 6.8% resistant to Cefotaxime, 40.6% resistant to Ciprofloxacin, (28.1) resistant to Erythromycin, and (21,9%) were resistant to Gentamicin[35]; virtually, when these results compared with that obtained from our study in Hevi Hospital in Dohuk city, it seems to be nearly a close results.

As a conclusion, the most common pathogen causing neonatal sepsis during all four years was Coagulase-Negative Staphylococci, consisting (58.5%) of cases; followed by Staphylococcus aureus (16.6%) and Escherichia coli (7.6%). The neonatal sepsis is affecting male more than females (1.5:1). Most of the isolates were resistant to the commonly prescribed Antimicrobial drugs, and many of these isolates showed a resistance for more than 2 of the antimicrobial drugs.

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ثوختة

شيَوازىّ بةرطريكرنا ئةنتيبويتكان و بةكتريايين دوورخستى د ثيسبوونا خوينىَ يا زاروكىَ ساظا ل نةخوشخانا هيظى يا زاروكان ل باژيَرىّ دهوكىَ

ثشنشين و ئارمانج: ثيسبوونا خوينىَ يا زاروكيَن ساظا ئيَكة ذ بةربةلاظترين ئةطةريَن مرنا زاروكيَن ساظا ل ناظا وهلاتيَت ثيَشدكةظن.وهةردةم ئاريشة ل دور طوهارتنا شيَوازىّ بةكتريا مروظى و شيَوازىَ بةرطريكرنىَ. ئارمانج ذ ظىَ ظةكولينىَ بو دياركرنا ئةو بةكتريايين دبنة ئةطةرىّ ثيسبوونا خوينا بضيكىَ ساظا، بةرطريكرنا زيندةوةران بو بكارئينانا ئةنتيبويتكيَن بةربةلاظ ل نةخوشخانا هيظى يا زاروكان بو بةراوردكرنىَ د ماوىَ ضوار سالان دا.

ريَكيَن كارى: ظةكولينةكا ثاشوةخت هاتة ئةنجامدان د ماوىَ ضوار سالان دا. ذوان زانياريين ب دةست كةفتين ل نةخوشخانا هيظى يا زاروكان ل باذيَرىَ دهوكىَ د ناظبةرا سالين ٢٠١٤ تاكو ٢٠١٧ كؤ تيَدا زانياريين ١٠٥٨ نمونيَت خوينىَ ئةويَن هاتينه هنارتن ژبؤ ضاندنىَ. ذ وان ئةنجامان ٥٣٦ ب ئةريَنى و ٥٢٢ ب نةرينى دةرضوون. ذ ئةنجاميَن ئةريَنى ٥٥٥ بةكتريايين دبنة ئةطةر هاتنة دياركرن.

ئةنجام: د ظىَ ظةكولينىَ دا دةركةفت كؤ ريَذا رةطةزىّ مىَ بؤ رةطةزىّ نيَر ١:٥:١ و بةربةلاظترين بةكتريا هاتية جوداكرن Coagulase Negative Staphylococcus ب ريَذا ٥٨,٥٪ و ل ديظدا Staphylococcus aureus ١٦,٦٪، Escherichia coli ٧,٦٪، ب شيَوةكىَ طشتى هةستيارى ل بةرزترين ئاست دا هاتة تيَبينيكرن ب ريَذا ٣٠% ل سالا ٢٠١٧ بوو. ض ئامار نينن كو ب طرنطى جوداهييَ بكةت دناظبةرا ذبلى جورىَ Enterococcus كو بةرزترين ريَذه هةبوو بوثيسبوونا خوينىَ يا دواكةفتى.

دةستكةفتيين ظةكولينىَ: ئةظىَ ثةكولينىَ ديارکر كؤ بةرطرتن دذى طةلةك ئةنتى بايوتيكيَن بةربةلاف دهيَنة بكارئينان يا زيَدةبوى كؤ دبيتة ئةطةرىّ سنوركرنا هةلبذارتنيَن ضارةسةريَت ظان جؤره هةودانا. ئةظ ضةندە ذى ذ ئةنجامىَ بكارئينانا ئةنتى بايوتيكا ب شيَوةكىَ نةكونترولكرى و نةبوونا ثلان و ريَبةريَن بكارئينانا ئةنتى بايوتيكان د بوارىّ ساخلةميا طشتى دا.

الخلاصة

العزلات البكتيرية وانماط مقاومتها للمضادات الجرثومية في الانتان الوليدي المسجل في مستشفى هيڤي التعليمي بمدينة دهوك/ منطقة كوردستان العراق

خلفية واهداف البحث: الانتان الوليدي يعتبر من اهم الاسباب في موت الأطفال حديثي الولادة في العالم النامي. وهنالك تغير مستمر في الأنماط الجرثومية وحساسيتها للمضادات الجرثومية. تهدف هذه الدراسة الى تحديد المسببات البكتيرية للانتان الوليدي، وحساسية هذه الجراثيمللمضادات الجرثومية الشائعة الاستخدام في مستشفى هيڤي ومقارنتها بالعوامل المسببة خلال السنوات الاربع الاخيرة.

طرق العمل: أجريت دراسة مرجعية للبيانات المسجلة في أرشيف مستشفى هيڤي ولفترة أربع سنوات من عام 2014 حتى عام 2017، تم أخذ ما مجموعه 1058من الزرع الدموي. وقد كانت عينات الزرع الموجبة والسالبة للجراثيم هي 536 و522 على التوالي، وعزلت 555 مسبب مرضي من العينات الموجبة للزرع الجرثومي.

النتائج: أوضحت الدراسة الحالية إن نسبة إصابة الإناث إلى الذكور بالانتان الوليدي كانت 1:5:1 وإن أكثر الجرثيم شيوعاً كانت Coagulase Negative Staphylococci (58.5%) و(16.6%) و(7.6%)Escherichia coli Staphylococci aureus. تم تسجيل النسبة الاعلى من الانتان الوليدي (30%) عام 2017. لا يوجد فرق احصائي معنوي للجراثيم المسببة للانتان الوليدي المبكر والمتأخر.

الاستنتاجات: أظهرت هذه الدراسة تزايداً في مقاومة الجراثيم للعديد من المضادات الحيوية الشائعة الاستخدام مما يحد من خيارات علاج الانتان الوليدي. وتنجم هذه المقاومةعن الاستخدام غير المسيطر للمضادات الحيوية وفقدان السياسات والمبادئ التوجيهية في الصحة العامة.

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