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The use of Antibiotic in the Neonatal Intensive Care Unit (NICU) at Maternity and Children Hospital in Makkah

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Abstract

Background: Antibiotics can be universally perceived as medicine that adequately controls infectious diseases that genuinely revolutionized health care. Since the discovery of penicillin, the use of antibiotics has significant increased among medical and dental fields. Taking into consideration the increasing prescription of antibiotics will increase resistance leading to a global problem that is a huge concern. The aim of study was to investigate the use of antibiotics at the Maternity and Children Hospital in Makkah within the Neonatal Intensive Care Unit (NICU).

Methods: A retrospective study was conducted at the Maternity and Children Hospital (MACH), Makkah, Saudi Arabia, between January 2019 until December 2021 in the NICU. All neonates born and admitted to the NICU between 2019-2021 with the following parameters: antibiotic usage and diagnosed with infectious disease were included in this study. The data were collected manually using Microsoft Excel form and presented as demographics data: gender, diagnosis, antibiotics used doses and dosage form.

Results: All patients (1968) who were admitted to the NICU from January 2019 until December 2021 and received parenteral antibiotics were included in this study, males 57% and 42% females. The most used antibiotic classes were Aminoglycoside (36.4%), Penicillin (31.7%), and Glycopeptide (12.2%). In addition, the most frequently administered medications have been as follows: Gentamicin, given in three doses (2 mg/mL, 20 mg/2 mL, and 80 mg/2 mL); followed by Ampicillin, administered in two doses (500 mg/vial and 1 gm/vial); and then Vancomycin, given in two doses (5 mg/mL and 500 mg/vial). While the most used in a combined form were Gentamicin and Ampicillin.

Conclusion: the most frequently used medication in NICU was Gentamicin alone or in combination with another antibiotic. Knowing the antibiotics used will allow the hospital to tackle the infectious disease among premature and newly born infants. Therefore, implementing programs to address the excessive usage of antibiotics such as stewardship programs.

Keywords: Antibiotic, Prevalence, Neonate, Intensive Care Unit, Saudi Arabia.

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1. Introduction

Antibiotics can be universally perceived as medicine that adequately controls infectious diseases that genuinely revolutionized health care [1] Since the discovery of penicillin, the use of antibiotics had significant increased among the medical and dental fields [2]. Taking into consideration the increasing prescription of antibiotics will increase resistance leading to a global problem that is a huge concern [1,2].

The global concern about antimicrobial resistance has been considered by the WHO as one of the main causes of morbidity and mortality. One of the recommendations suggested to tackle this issue is by implementing a stewardship program to address the excessive usage of antibiotics. The rational use of antibiotics became an essential requirement even with newborn babies [3].

According to the Centers for Disease Control (CDC), it has been estimated that 20-50% of antibiotics use is unnecessary or in-appropriate [4,5]. Furthermore, with the increasing inappropriate use, this will increase the resistance toward antibiotics, adverse effects, patient staying at the hospital, and hospital costs [4].

An ongoing effort to improve and measure the appropriateness use of antimicrobials by work with health care practitioners to prescribe the 5"**D**"s of antimicrobial therapy: right **D**rug, correct **D**ose, right **D**rug route, right **D**uration, and right timely **D**e-escalation to pathogen, this is called antimicrobial stewardship program (ASP) [6].

ASP aims to reduce antibiotic use, cost-effectiveness, improve patient care, and reduce adverse effects associated with their uses [6].

Saudi Arabia is the annual destination of more than 10 million arrivals from around the world to Makkah and Madinah for Hajj and Umrah. Considering this, the country is undergoing rising rates of antimicrobial resistance (AMR) and the emergence of rare and multi-drug-resistant bacterial strains [7,8].

In late 2014, the Saudi Ministry of Health (MOH) designed a national ASP as part of the Arab Gulf Regional strategy. However, the ASP adoption in Saudi MOH hospitals remains low [8,9].

Moreover, to definition our target population premature babies are infants who are born before 37 weeks of gestation, and infants under 28 days of age are called neonates or newborns [10]. Infants are generally admitted to a Neonatal Intensive Care Unit (NICU) because of the high risk of morbidity and mortality that may be due to infections and underdeveloped immune systems [3,11]. The major life-threatening diseases, such as sepsis, respiratory problems: acute bronchitis, acute respiratory failure, asphyxia during delivery, and complications of premature, malfunctioning digestive systems [3,10].

In addition, neonates represent a susceptible population to infections and neonatal sepsis is a major cause of morbidity and mortality in the world. Therefore, the importance of implanting ASP should be

placed, these programs are slightly different from those used in older children and adults due to the idiosyncrasy of neonatal medicine [12].

Furthermore, the most prescribed medication in NICU is parenteral antibiotics, such as gentamicin which belongs to the aminoglycoside class of antibiotics, vancomycin in the glycopeptide class, and ampicillin in the penicillin class. The treatment with antimicrobial agents is lifesaving, especially in cases where bacterial infection is present [13,14]. Nevertheless, overuse of antibiotics in early life in the community leads to threatening the normal microbiome development in the neonate and increase multi-drug resistance, wheezing, atopic, allergy disorder, and bowel inflammatory disease [13].

In Saudi Arabia, two studies were conducted in the Riyadh region, the results showed that the prevalence of the use of aminoglycosides in the local NICU is higher than the international units. Furthermore, the monitoring and supervision of antibiotics must be applied to ensure adequate consumption of antibiotics [15,16].

Two studies were conducted in China; the excessive use of broad-spectrum antibiotics was the main problem of antibiotic use in Chinese neonatal intensive care units. Furthermore, they used the implementation of a weekly antibiotic round in the NICU as each antibiotic round, a senior attending physician was assigned to collect and report the patient's name, bed number, gestational age, age at admission (day), main diagnosis, criteria for using antibiotics, kinds of antibiotics, and plan of the antibiotic course. Then they reported the total antibiotic usage of the whole NICU as the ratio of patients who were on antibiotics, the ratio of patients who were on a single kind of antibiotic, and the ratio of patients who were on two, three, or above. Additionally, a group discussion was used to inform the final decision regarding the use of antibiotics for a specific patient. The implementation of periodical antibiotic rounds provides an effective strategy for reducing overall antibiotic use in NICU [17,18].

The Maternity and Children Hospital in Makkah stated that they followed Harriet Lane's guidelines. However, this Harriet Lane guideline is licensed by the Saudi Ministry of Health. The Saudi Ministry of Health relies on IDSA and Stanford guidelines (Appendix 1). The Harriet Lane guideline which provides the latest guide to practice and provides methods of using pharmacology in children's care. It is the premier reference for all healthcare providers and students in the health sciences, so existing data is updated every three years by experts at Johns Hopkins Hospital [19].

The aim of this study was to investigate the use of antibiotics at the Maternity and Children Hospital in Makkah within the Neonatal Intensive Care Unit (NICU). This could allow the hospital to tackle the infectious diseases among premature and newly born infants and implement programs to address the excessive usage of antibiotics such as stewardship programs.

2. Subjects and Methods

2.1 Study design

A retrospective observational study was performed using the database available at the NICU of Maternity and Children Hospital in Makkah, Saudi Arabia for the period between January 2019 until December 2021.

2.2 Study Population

This study targeted all premature (born before 37 weeks of gestation) and neonates (0–28 days of age), both genders were included in the study. The study sample included all patients who were diagnosed with infectious diseases in the NICU and received at least one dose of any parenteral antimicrobial medication. Whereas healthy neonates and babies age above 28 days were excluded from this study.

2.3 Study procedures and settings

The study settings were in the Maternity and Children Hospital in Makkah, where the study has been conducted with 2000 total number of beds, with 450 number of admissions, staff working around 50 personnel.

2.4 Statistical Analysis

For data analysis, SPSS version 23 was be used. Retrospective statistics was obtained to summarize data, synthesize, and report the variables. In which, numerical data was presented as mean ± SD, or as median and range according to the type of distribution of each variable. For categorical variables, percentages and frequencies was used. Bar chart, and pie chart were used to represent the results.

3. Results

During the study period from January 2019 to December 2021, around 5261 patients were admitted to the NICU at Maternity and Children Hospital in Makkah. However, 1968 patients were eligible for the study.

The baseline characteristics of patients included in the study are shown in Figure 1, Most of the neonate patients were males representing 57% of the study sample, while the females represented 42%.

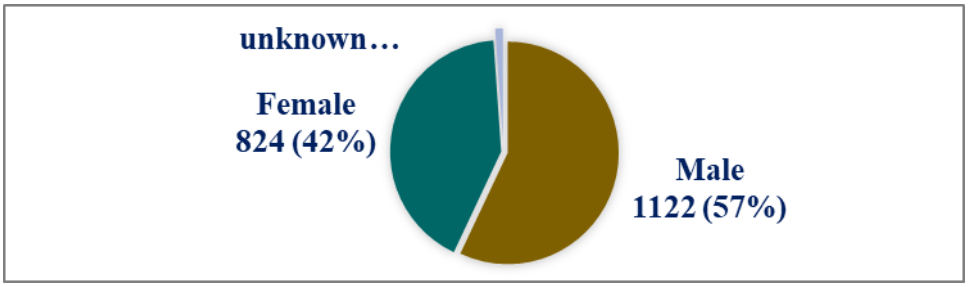

Figure (1) Baseline characteristics of patients

The diagnostic data (Table 1) showed that the most common diagnostic category was under the Respiratory System (38.01%) like Respiratory distress of newborns, COVID-19, Birth asphyxia, and Acute bronchiolitis. Followed by Sepsis infection (33.33%) and then the delivery problems (7.47%). While the Gastrointestinal system accounted for (6.71%).

Table (1) Diagnosis classification in NICU at Maternity and Children Hospital in Makkah

Diagnosis	N (%)
Respiratory system	2167 (38.01%)
Infections	1900 (33.33%)
Delivery	426(7.47%)
Gastrointestinal system	383 (6.71%)
Neurological system	260 (4.56%)
Cardiovascular system	119 (2.08%)
Dermatological	54(0.94%)
Mutations	40(0.70%)
Urinary tract system	28 (0.49%)
Reproductive system	26 (0.45%)
Miscellaneous	298 (5.22%)
Total	5701 (100%)

The percentages of the most used antibiotics classes were shown in (Table 2) as follows; Aminoglycoside (36.4%), Penicillin (31.7%), and Glycopeptide (12.2%).

Table 2. Most antibiotics classes are used in the NICU at Maternity and Children Hospital in Makkah

Antibiotics	N (%)
Aminoglycosides	2074 (36.4%)
Penicillin	1808 (31.7%)
Glycopeptide	695 (12.2%)
Carbapenem	534 (9.4%)
Cephalosporins	424 (7.4%)
Metronidazole	75 (1.3%)
Sulfamethoxazole Trimethoprim	38 (0.7%)
Lincomycin	24 (0.4%)
Fluoroquinolone	10 (0.2%)
Oxazolidinone’s	10 (0.2%)
Macrolide	6 (0.11%)
Polymyxin	3 (0.05%)
Total	5701 (100%)

In addition, the most used medications were Gentamicin in 3 doses (2mg\ml, 20 mg/ 2 ml, 80 mg/ 2 ml) as shown in Figure 2 then Ampicillin in 2 doses (500 mg/ vial and 1 gm/ vial) as shown in Figure 3 then Vancomycin in 2 doses (5 mg/ ml and 500 mg/ vial).

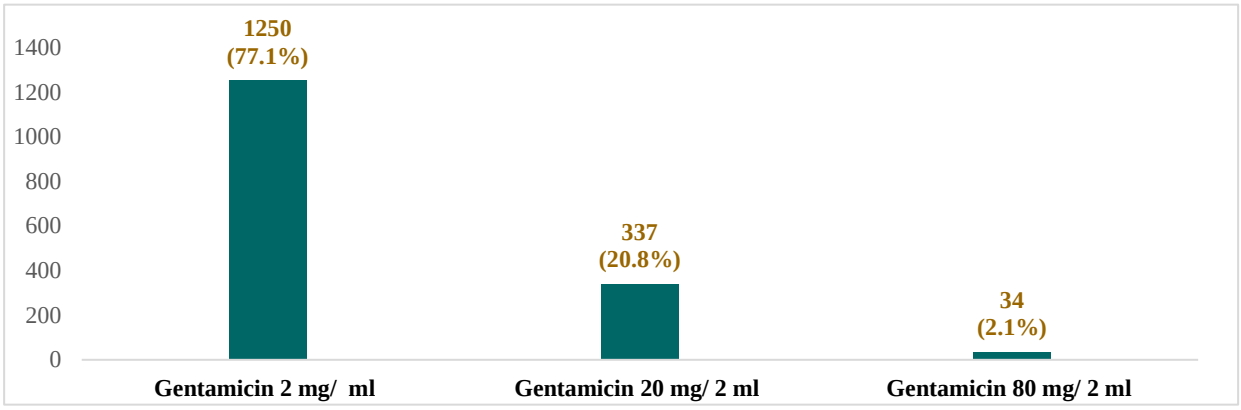

Figure (2)The doses of Gentamicin used in the NICU at Maternity and Children Hospital in Makkah

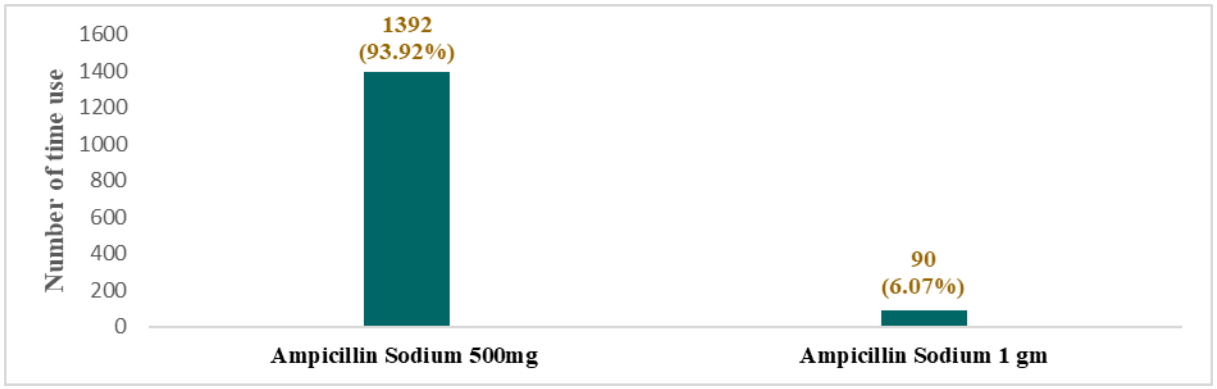

Figure (3) The doses of Ampicillin used in NICU at Maternity and Children Hospital in Makkah.

Figure 4 demonstrates the number of antibiotics used per patient in percentages, in this figure the patients included in the analysis were the target population that met all eligibility criteria who represent 1968. Furthermore, the percentage of the number of antibiotics used per patient for two drugs were (68.47%), for three drugs was (14.08%), and for one drug was (7.83%).

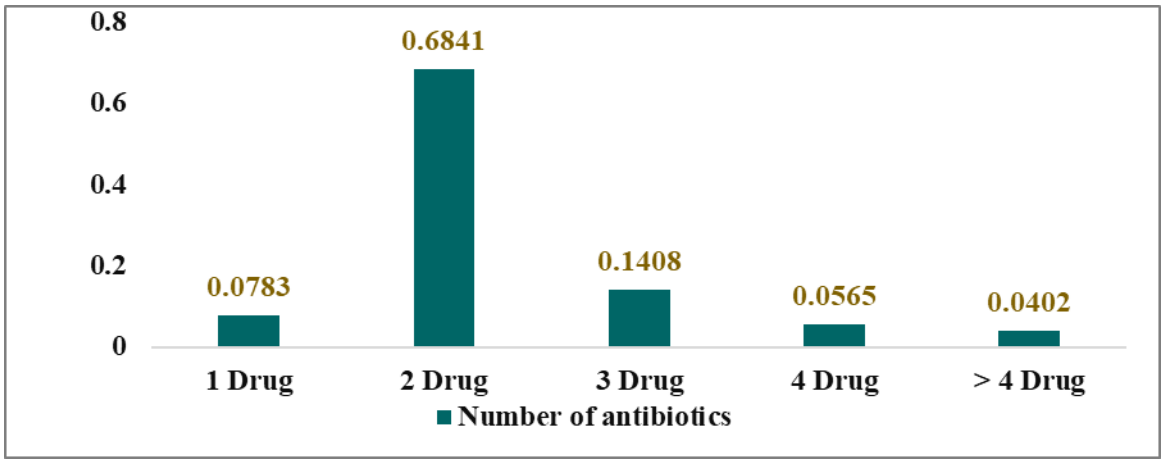

Figure (4) Number of Antibiotics used per patient in % (n=1968).

4. Discussion

Our current study aimed to investigate the use of antibiotics at the Maternity and Children Hospital in Makkah within the Neonatal Intensive Care Unit (NICU) using a retrospective observational study, and data was obtained by using the hospital database. During the study period from January 2019 to December 2021, around 5261 patients were admitted to the NICU at Maternity and Children Hospital in Makkah. However, 1968 patients were eligible for the study. The baseline characteristics of patients showed that most of the neonate patients were male representing 57% of the study sample about 1122 patients, while the female represented 42% about 824 patients.

Compared with a study conducted by Al-Matarya et al [15] the total number of neonates was 3437 in their study and most of the patients were male (59.4%). In Al-Matarya et al. study [15] they mentioned the reason why male was more affected by sepsis than female whereby the cause could be the contribution to the defects in X-linked immuno-regulatory genes. Apart from this, in Al-Matarya et al [15] study, they were focusing only on sepsis cases in a neonate only, while our study focused on all the cases that could lead to a patient's admission to the NICU.

Moreover, our results showed that the most common diagnostic category was under the Respiratory System (38.01%, n=2167) like Respiratory distress of newborns, COVID-19, Birth asphyxia, and Acute bronchiolitis. Followed by Sepsis infection (33.33%, n=1900) and then the delivery problems (7.47%). While the Gastrointestinal system accounted for (6.71%, n=383) and most of it was related to Neonatal jaundice.

However, the miscellaneous represented to be (5.22%, n=290) such as retinopathy of prematurity, disorder of the thyroid, congenital diaphragmatic hernia, and cleft palate.

Nevertheless, regardless of gender, the number of parenteral antibiotics used represented 5701

cases in 1968 patients were admitted to the NICU. The percentages of the most used antibiotics classes were as follows; Aminoglycoside (36.4%, n=2074), Penicillin (31.7%, n=1808), and Glycopeptide (12.2%, n=695). In addition, the most used medications were Gentamicin in 3 doses (2mg\ml, 20 mg/ 2 ml, 80 mg/ 2 ml) Ampicillin in 2 doses (500 mg/ vial and 1 gm/ vial) Vancomycin in 2 doses (5 mg/ ml and 500 mg/ vial). The most used antibiotics in combination were Gentamicin and Ampicillin. This relates to the high percentage of respiratory disease in patients admitted to maternity hospitals. Furthermore, compared to a study conducted by H. Balkhy et al. [16], in their study, they found that the most used medication was Aminoglycosides (45.4%) of monitored antimicrobials in NICU followed by cephalosporins (30.4%), and the duration of use was 12.7 days. In our study, the duration of antibiotics use was 10 ±6.41. However, H. Balkhy et al. [16] stated that their study did not focus only on neonatal ICUs but also pediatric ICUs. Our study focused on a neonate and a premature ICU.

Our results also demonstrated the number of antibiotics used per patient in percentages, in this figure the patients included in the analysis were the target population that met all eligibility criteria representing 1968. Furthermore, the percentage of the number of antibiotics used per patient for two drugs was (68.47%, n=1162), for three drugs was (14.08%, n=239), and for one drug was (7.83%, n=133).

Considering this, the current study is the first local study in Makkah to address antimicrobial consumption among premature and neonatal critical care patients. Moreover, this study has a large sample size. Nevertheless, we acknowledge some limitations: lack of diagnostic data about neonates and premature patients such as patient weight and gender. Additionally, the study was limited in scope as it was conducted at a single center.

5. Conclusion

It has been concluded that the most frequently used medication in NICU was Gentamicin alone or in combination with another antibiotic. The Maternity and Children Hospital in Makkah are recommended to use an antimicrobial program such as stewardship. In addition, they need to establish and monitor antibiotic use among neonates in the hospital.

The current study in our knowledge is the first local study in Makkah to address antimicrobial consumption among premature and neonatal critical care patients.

6. Declarations

6.1 Conflict of Interest Statement

The authors have no conflict of interests to declare.

6.2 Funding Disclosure

This research did not receive any specific grant from funding agencies in the public, commercial,

or not-for-profit sectors.

6.3 Ethical Considerations

The study was reviewed, and the protocol was approved by the Scientific Research Ethics Committee at the College of Medicine, UQU (Institutional Review Board number: HAPO-02-K-012-2022-11-1278), and Maternity and Children Hospital in Makkah.

6.4 Acknowledgements

We Thank the Pharmacy College in Umm Al-Qura University. and Maternity and Children Hospital in Makkah for providing data base for this research, necessary expertise, and information.

6.5 Data availability statement

All the data related to this study are available upon request.

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