THE ETIOLOGY OF MICROBIOLOGY CAUSING BACTERIAL MENINGITIS IN NEWBORNS AT THE NATIONAL CHILDREN'S HOSPITAL

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ABSTRACT

Objectives: *Describing the microbial etiology of bacterial meningitis in infants treated at the National Children's Hospital. Subjects and methods: A retrospective descriptive study on 42 medical records of newborns diagnosed and treated for bacterial meningitis at the Neonatal Center of the National Children's Hospital from February 2019 - January 2023.*

Results: *GBS strain accounted for the highest proportion (73.4%), followed by E. coli (13.3%). The antibiotics Aztreonma, Imipenem, Meropenem, Amikacin, Cefotaxime, Moxifloxacin, Vancomycin, Ertapenem, Cefepime were also 100% sensitive to the bacteria tested. Resistance to Clindamycin, Erythromycine, Amoxicillin + Clavulanic Acid, Cefuroxime Aceti was resistant at a very high rate (100.0%). Resistance to the antibiotic Cefazolin appeared at a rate of 50.0%. Gentamycine resistance rate was 40.0%. Piperacillin + Tazobactam, Cefoxitin and Ciprofloxacin were all resistant at a rate of 33.3%.*

Conclusion: *Common bacterial strains causing meningitis were GBS (73.4%), E. coli (13.3%). The antibiotics Aztreonma, Imipenem, Meropenem, Amikacin, Cefotaxime, Moxifloxacin, Vancomycin, Ertapenem, Cefepime were also sensitive to bacteria causing meningitis in newborns.*

Keywords: *infectious meningitis, newborns, bacteria.*

I. INTRODUCTION

Infectious meningitis (IM) is defined as an infection in the central nervous system, caused by bacteria that can produce pus invading the meninges, commonly found in children, especially newborns [1]. In developed countries, Group B Streptococcus (GBS) is the leading cause, accounting for 50% of all infectious meningitis cases, while Escherichia coli accounts for 20% [2]. In Vietnam, bacterial meningitis is still one of the common infectious diseases in children. The main causes of the disease are Streptococcus pneumonia, Echerichia coli and Pseudomonas aeruginosa. The mortality rate due to the disease is recorded at about 10 - 20% [3]. This study was conducted with the aim of: "Describing the microbial etiology of bacterial meningitis in newborns treated at the National Children's Hospital".

II. RESEARCH SUBJECTS AND METHODS

2.1. Research subjects

Including 42 medical records of newborns diagnosed and treated for bacterial meningitis at the Neonatal Center of the National Children's Hospital from February 2019 to January 2023.

** Patient inclusion criteria:*

- Neonatal age (< 28 days);

- Having at least one of the following criteria:

+ Fresh examination or culture of cerebrospinal fluid with bacteria.

+ PCR of cerebrospinal fluid to identify bacteria.

- Having antibiogram results;

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** Exclusion criteria:*

Children who have not had all the tests done: culture or PCR of cerebrospinal fluid

2.2. Research methods

** Research design:*

Retrospective descriptive study.

** Research method*

Collecting medical records of pediatric patients diagnosed and treated for infectious meningitis at the Neonatal Center, National Children's Hospital. Medical records were screened and selected to ensure full information on microbiological testing to determine the cause of the disease and antibiotic susceptibility test results.

** Research criteria*

- Age (unit is months) is determined by calendar year, from the time of birth to the time of hospitalization for treatment;

- Gender: including male and female;

- Bacterial detection method: cerebrospinal fluid microscopy, culture, cerebrospinal fluid PCR test, blood culture;

- CSF microscopy and culture results: bacterial identification;

- CSF PCR test results: bacterial identification;

- Blood culture results: bacterial identification in the blood;

- Antibiogram: including sensitivity, resistance, intermediate and non-sensitivity to antibiotics used for antibiogram.

2.3. Data processing method

The collected data were entered and processed on SPSS 22.0 biomedical statistical software.

III. RESEARCH RESULTS

Table 1. Bacteria detection rate by methods (n=42)

Method	Positive	Negative
	n (%)	
CSF culture	9 (21.4)	33 (78.6)
CSF PCR	41 (97.6)	1 (2.4)
Blood culture	10 (23.8)	32 (76.2)

Comments: The method of detecting bacteria in pediatric patients with bacterial meningitis by PCR of cerebrospinal fluid had the highest rate of 97.6%, while the methods of cerebrospinal fluid culture and blood culture had lower rates of 21.4% and 23.8%, respectively.

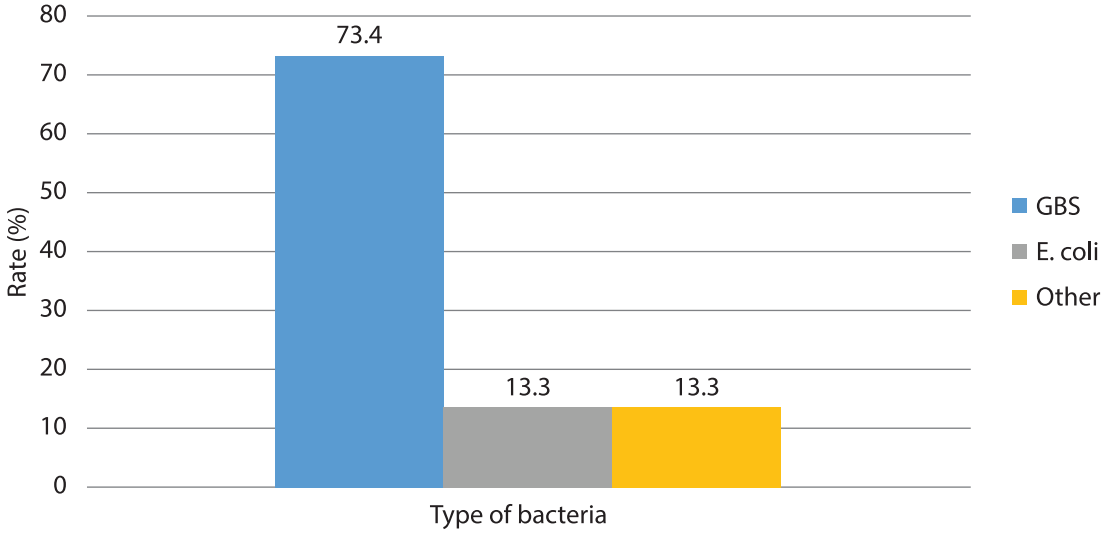

Chart 1. Rate of pathogenic bacteria

Comments: The total number of bacteria infected in 42 children was 45 bacteria, of which GBS accounted for a high rate (73.4%), followed by E. coli (13.3%), other bacteria accounted for 13.3%.

Table 2. Antibiotic resistance rate of bacteria according to antibiogram

Antibiotic	n	Sensitive		Intermediate		Resistant	
		n	%	n	%	n	%
AMP	11	7	63.6	0	0.0	4	36.4
Cefazolin	2	1	50.0	0	0.0	1	50.0
Piperacillin + Tazobactam	3	2	66.7	0	0.0	1	33.3
Cefoxitin	3	2	66.7	0	0.0	1	33.3
Ceftazidime	4	3	75.0	0	0.0	1	25.0
CEF	10	8	80.0	0	0.0	2	20.0
Aztreonam	2	2	100.0	0	0.0	0	0.0
Imipenem	3	3	100.0	0	0.0	0	0.0
Meronem	4	4	100.0	0	0.0	0	0.0
AMK	3	3	100.0	0	0.0	0	0.0
Gentamycine	5	2	40.0	1	20.0	2	40.0
Tobramycine	3	2	66.7	1	33.3	0	0.0
LEV	13	10	76.9	1	7.7	2	15.4
Trimethoprim + Sulfamethoxazol	10	7	70.0	0	0.0	3	30.0
Ampicillin + Sulbactam	3	1	33.3	2	66.7	0	0.0
Ciprofloxacin	3	0	0.0	2	66.7	1	33.3
Cefotaxime	8	8	100.0	0	0.0	0	0.0
Moxifloxacin	6	6	100.0	0	0.0	0	0.0
Benzylpenicillin	8	7	87.5	0	0.0	1	12.5
Vancomycin	8	8	100.0	0	0.0	0	0.0
Clindamycin	3	0	0.0	0	0.0	3	100.0
Erythromycine	3	0	0.0	0	0.0	3	100.0
Amoxicillin + Aicd clavulanic	1	0	0.0	0	0.0	1	100.0
Cefuroxime Axetil	1	0	0.0	0	0.0	1	100.0
Ertapenem	1	1	100.0	0	0.0	0	0.0
Cefepime	1	1	100.0	0	0.0	0	0.0

CEF: ceftriaxon; VAN: vancomycin; MEP: meropenem; CEX: cefotaxim; CET: ceftazidim; AMP: ampixilin; PEN: penixilin; TOB: tobramycin; LEV: levofloxacin; CIP: ciprofloxacin; AMK: amikacin.

Comments: The antibiotics Aztreonma, Imipenem, Meropenem, Amikacin, Cefotaxime, Moxifloxacin, Vancomycin, Ertapenem, and Cefepime are still 100% sensitive to the bacteria tested for antibiotic susceptibility. Clindamycin, Erythromycin, Amoxicillin + Clavulanic Acid, Cefuroxime Axeti are resistant at a very high rate (100.0%). Cefazolin appears to be resistant at a rate of 50.0%. Gentamycine is resistant at a rate of 40.0%. Piperacillin + Tazobactam, Cefoxitin and Ciprofloxacin were all resistant at a rate of 33.3%.

Table 3. Antibiotic susceptibility rates of bacteria

Antibiotic type	E. coli	Enterococus Faecium	Streptococcus Agalactiae	Bukholderia Cepacia	Acinetobacter Calcocetius baumani complex
AMP (n=11)	0/3	0/1	7/7	-	-
Cefazolin (n=2)	1/2	-	-	-	-
Piperacillin + Tazobactam (n=3)	2/2	-	-	-	0/1
Cefoxitin (n=3)	2/3	-	-	-	-
Ceftazidime (n=4)	2/2	-	-	1/1	0/1
Ceftriaxone (n=10)	1/2	-	7/7	-	0/1
Aztreonam (n=2)	2/2	-	-	-	-
Imipenem (n=3)	2/2	-	-	-	1/1
Meropenem (n=4)	2/2	-	-	1/1	1/1
Amikacin (n=3)	3/3	-	-	-	-
Gentamycine (n=5)	2/3	0/1	-	-	0/1
Tobramycine (n=3)	1/2	-	-	-	1/1
Levofloxacin (n=13)	1/3	1/1	7/7	0/1	1/1
Trimethoprim + Sulfamethazol (n=10)	0/3	-	6/6	1/1	-
Ampicillin + Sulbactam (n=3)	1/2	-	-	-	0/1
Ciprofloxacin (n=3)	1/1	0/1	-	0/1	-
Cefotaxime (n=8)	1/1	-	7/7	-	-
Moxifloxacin (n=6)	-	-	6/6	-	-
Benzylpenicillin (n=8)	-	0/1	7/7	-	-
Vancomycin (n=8)	-	1/1	7/7	-	-
Ertapenem (n=1)	1/1	-	-	-	-
Cefepime (n=1)	1/1	-	-	-	-

Comments: E. coli and Streptococcus Agalactiae are still highly sensitive to common antibiotics today.

IV. DISCUSSION

Regarding the cause of bacterial meningitis, we determined it based on cerebrospinal fluid culture tests, cerebrospinal fluid PCR tests or blood cultures, in which, the method of detecting bacteria in children with meningitis by cerebrospinal fluid PCR has the highest rate at 97.6%, cerebrospinal fluid culture and blood cultures have lower rates of 21.4% and 23.8%, respectively. The results showed that the total number of bacteria infected in 42 children was 45 bacteria, of which GBS accounted for the highest rate (73.4%), followed by E. coli (13.3%), other bacteria accounted for 13.3%.

The ability to identify bacteria causing bacterial meningitis varies by region, territory, country, this is due to the application of different diagnostic techniques and technologies, the time of hospitalization of the child, the use of antibiotics before accurate diagnosis, etc. In our study, the application of PCR technique in determining the cause of the disease has a significantly higher rate of bacterial detection

than the technique of culturing cerebrospinal fluid or blood samples.

For newborns, because the immune system is not yet complete, mainly based on antibodies transmitted from the mother, so common bacteria such as E.coli are very easy to develop, the study by Romain Basmaci et al (2015) showed that meningitis caused by E.coli mainly occurs in newborns (71.1%) [4]. In the study by Do Thien Hai (2018), the most common causes of bacterial meningitis in children were pneumococcus (73.6%), followed by E.coli with 9.6%, H. influenza (5.6%) and other bacteria with lower proportions [5]. In previous studies, the high rate of bacterial meningitis was recorded as H. influenza, but now, thanks to the discovery in vaccine technology, the incidence of this type of bacteria has been effectively reduced. Therefore, in our study, the rate of meningitis causes is different from the previous bacterial infection rate. In addition, the difference in the cause of the disease is also due to the difference in regions, climate, weather, geographical conditions as well as the health system, especially preventive medicine, which has many differences. Although Vietnam has promoted the nationwide expanded immunization program for children, which has greatly helped prevent bacterial meningitis in children, there is still a lack of strict management of drug use, especially antibiotics, which has led to the widespread use of broad-spectrum antibiotics and increased the risk of antibiotic resistance, making treatment difficult.

Based on the results of the test to identify bacteria causing bacterial meningitis in newborns in the study, we evaluated the results of the antibiotic susceptibility test, showing that the antibiotics Aztreonma, Imipenem, Meropenem, Amikacin, Cefotaxime, Moxifloxacin, Vancomycin, Ertapenem, and Cefepime were 100% sensitive to the bacteria tested for antibiotic susceptibility. Clindamycin, Erythromycin, Amoxicillin + Clavulanic Acid, Cefuroxime Axeti were resistant at a very high rate (100.0%). Cefazolin showed resistance at a rate of 50.0%. Gentamicin resistance rate was 40.0%. Piperacillin + Tazobactam, Cefoxitin and Ciprofloxacin were all resistant at 33.3%. E. coli and Streptococcus Agalactiae were also highly sensitive to common antibiotics today.

Vu Thi Kim Lien et al (2015) showed that the rate of staphylococcal strains resistant to Ciprofloxacin (49%), Oxacilin (49%), Meropenem (15%) [6]. Research by Do Thien Hai (2018), when conducting an antibiotic susceptibility test, showed that the antibiotics Vancomycin, Rifamycin, Tobramycin, Immipenem were still 100% sensitive to bacterial strains, however, Penicillin was resistant to 87.5%. Some other antibiotics had lower resistance rates such as Ceftriaxone (21.57%), Levofloxacin (5.13%) and Ciprofloxacin (10.34%) [5].

The increasing rate of antibiotic resistance is partly due to the increasingly common abuse of antibiotics, especially in Vietnam, where buying antibiotics is very easy. In addition, most people buy drugs without being examined, diagnosed, or prescribed by a specialist, which contributes to choosing inappropriate antibiotics, which are not only ineffective in treating the disease but also allow bacteria to adapt to the environment where many types of antibiotics are widespread and not strictly controlled as they are today.

V. CONCLUSION

There were 45 strains of bacteria found to be the cause of bacterial meningitis in 42 children, of which GBS accounted for the highest rate (73.4%), followed by E. coli (13.3%), and other bacteria accounted for 13.3%.

The antibiotics Aztreonma, Imipenem, Meropenem, Amikacin, Cefotaxime, Moxifloxacin, Vancomycin, Ertapenem, and Cefepime are still 100% sensitive to bacteria. Meanwhile, other antibiotics such as Clindamycin, Erythromycin, Amoxicillin + Aicd clavulanic, Cefuroxime Axeti are resistant at a very high rate (100.0%). The antibiotic Cefazolin appears to be resistant at a rate of 50.0%. Gentamycine is resistant at a rate of 40.0%. Piperacillin + Tazobactam, Cefoxitin and Ciprofloxacin are all resistant at a rate of 33.3%.

REFERENCES

1. **Furyk JS, Swann O, Molyneux E**. Systematic review: neonatal meningitis in the developing world. Tropical Medicine and International Healt 2011;16(6):672-679. https://doi.org/10.1111/j.1365-3156.2011.02750.x
2. **Klinger G, Chin CN, Beyene J** *et al*. Predicting the Outcome of Neonatal Bacterial Meningitis. Pediatrics 2000;106(3):477-482. https://doi.org/10.1542/peds.106.3.477
3. **Nguyen Huu Chau Duc, Truong Thi Na, Tran Thi Hanh Chan**. Study of clinical and paraclinical characteristics and treatment outcomes of bacterial meningitis in children. Journal of Clinical Medicine 2022;80, 54-58. https:// doi.org/10.38103/jcmhch.80.8
4. **Basmaci R, Bonacorsi S, Bidet P** *et al*. Escherichia Coli Meningitis Features in 325 Children From 2001 to 2013 in France. Clinical Infectious Diseases 2015;61(5):779-786. https://doi.org/10.1093/cid/civ367
5. **Do Thien Hai.** Epidemiological, clinical, paraclinical characteristics and treatment outcomes of bacterial meningitis in children treated at the National Children's Hospital (2015 - 2016), Doctoral Thesis in Medicine, National Children's Hospital 2018.
6. **Vu Thi Kim Lien, Tran Thi Hai Au, Do Thi Quynh Nga**. Rate and level of antibiotic resistance of Staphylococcus Aureus strains at Hue Central Hospital in 2013-2014. Journal of Preventive Medicine 2015;12(172):42.