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Bacterial Meningitis Among Children and Antibiotic Sensitivity Patterns in the East of Libya

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Abstract*— *Background: *Bacterial meningitis (BM) is a life-threatening infection that must be recognized and treated as soon as possible. Bacterial meningitis continues to have a high mortality rate of 100% in untreated cases. According to the WHO, over 171,000 individuals die from the condition each year, despite the fact that treatment is effective.* ***Objectives:*** *To investigate the case management and disease burden of bacterial meningitis among children admitted to Benghazi Medical Hospital for a year, to investigate the trends of bacterial etiology among cases of meningitis, and to isolate, identify, and determine the antibiotic susceptibility patterns of pathogens associated with bacterial meningitis.* ***Material and methods:*** *Cerebrospinal fluid (CSF) samples were taken from children admitted to Pediatric Hospital units, ranging in age from a few days to 13 years, who were suspected of having bacterial meningitis. The doctor usually performs a lumbar puncture.* ***Result:*** *The data for this retrospective investigation was gathered from laboratory records and statistical units. The microbiology unit tested 6306 CSF samples from children from a clinically suspected episode of meningitis. There were (400) cases of BM diagnosed clinically in children, 103 cases of positive CSF bacterial culture, and (77) cases of positive gram staining (41 percent). Meningitis was found in the majority of cases in 225 (56%) male children compared to 175 (44%) female children. Males outnumbered girls by a factor of two (1.3-1). The most common symptom was fever (90 percent), followed by vomiting (60 percent), and poor oral intake (40 percent) (51 percent). The mortality rate was (7%) and coagulase-negative staphylococcus was the most common pathogen isolated (55%), followed by E. coli (15.5%). Next, Staph aureus (14.6), followed by Streptococcus pneumonia (11.7%), Klebsiella pneumonia (9.7%), Acinetobacter spp.(5.8%), and Pseudomonas spp (4.9%). Among the seasonal effect, the highest incidence in the study area occurred in August.* ***Conclusion:*** *E. coli and St. pneumonia were the main causative pathogens of bacterial meningitis in children the area under study. Most species had relatively high resistance to conventional antibiotics as compared to the past.*

***Keywords*—** *Bacterial meningitis, CSF, Pediatric hospital, inflammation, antibiotics.*

I. INTRODUCTION

Bacterial meningitis is an infection of the membranes (meninges) surrounding the brain and spinal cord. It is a major cause of death and disability worldwide {1}. Before the introduction of antibiotics in the 1940s, case fatality rates for epidemic and endemic bacterial meningitis exceeded 70%.

Antibiotic use has decreased case fatality rates of bacterial meningitis to 25% or less. Despite advances in vaccine development and chemoprophylaxis, bacterial meningitis remains a main cause of death and long-term neurological disabilities {2}.

In recent years, two main changes have been observed in the epidemiology of acute bacterial meningitis (3). The first is a decrease in the incidence of *H. influenzae type* b and *S. pneumonia* meningitis in countries where vaccination plans are generally performed against the two bacteria. The second is an increase in the resistant strains of pneumococcus across the world {4}

Acute bacterial meningitis is about 10 times more common in developing countries than in developed countries. Survival depends on early and accurate diagnosis and prompt treatment, which are difficult to achieve {5}. Currently, based on the success of *H. influenza type b* conjugate vaccines, *H. influenza meningitis* has become a disease, found predominantly in adults in the United States and Europe.

In the Netherlands, in a prospective evaluation of adult patients with community-acquired bacterial meningitis, H. influenza comprised 2% of all cases of culture-proven bacterial meningitis. While tuberculosis meningitis (TBM) is uncommon outside of tuberculosis-endemic countries, it is more common in people who have immune problems, such as acquired immune deficiency (AID) {6}.

More than ⅔ of cases of meningitis occur in the first two years of life due to low immunity and high vascularity of the brain. The clinical presentation is vague owing to the immaturity of the CNS in infants and children. As a result, no pathognomy sign or symptom can reliably diagnose the origin of meningitis, and etiological diagnosis is mostly based on CSF analysis and culture {7}. Despite the fact that meningitis is a notifiable disease in many countries, the exact incidence rate is unknown. There had been a decline in the number of meningitis cases. In 2013, meningitis resulted in 303,000 deaths compared to 464,000 in 1990 globally {8}. Beyond the perinatal period, three organisms transmitted from person to person through the exchange of respiratory secretions {9, 10, 11} are responsible for most cases of bacterial meningitis: *Neisseria meningitidis*, *Haemophilus influenzae*, and *Streptococcus pneumoniae* {12, 13, 14, 15}.

The prevalence of these organisms varies from region to region, and it differs according to age and climatic conditions {3}. Microbiology laboratories play a critical role in the early identification of the causative bacterium and its antibiotic susceptibility pattern in providing valuable information

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regarding the common causing pathogens in that area and which drugs to start empiric treatment with {16}. Even though bacterial culture is considered the standard method, the negative effect of previous antimicrobial drug usage on its sensitivity makes it necessary to search for non-culture techniques for diagnosis {7}.

In the east of Libya, published studies on meningitis are very rare. Only one research article clinically evaluated bacterial meningitis over twenty-five years (1989-2015). In addition, this is the second large-scale study in Libya to examine bacterial meningitis. The study aims to explore the case management and disease burden of bacterial meningitis among children and to isolate, identify, and determine the antibiotic susceptibility patterns of pathogens associated with bacterial meningitis.

II. Material and Method

A review of medical reports of patients treated in Benghazi Children's hospital in North Libya serves as a reference pediatric center for the entire country. The study was conducted between (January 2018-December 2019) and was performed retrospectively. The patients were evaluated with history, physical examination, laboratory investigation, radiological imaging, and treatment outcomes. CSF samples were collected from children admitted to the hospital aged from a few days up to 15 years old and suspected to have bacterial meningitis; the physician will usually do a lumbar puncture. Usually, 3 tubes of CSF are collected for chemistry, microbiology, and cytology.

CSF samples were tested immediately after collection for the presence of turbidity. Further investigations were performed on these specimens to estimate the level of glucose (Normal value =40-70/mg) using the Beckman instrument), while Integra 400 were used to estimate protein level (Normal value= 15-45mg/dl). Microscopic examination of the samples for white, red blood cells, and bacteria were done. The presence of more than 5 Leukocyte WBC/HPF) in the sample is considered positive for the presence of infection. Typical CSF abnormalities associated with bacterial meningitis include: Turbidity, increased opening pressure (?180mmwater), Pleocytosis (usually of Polymorph nuclear (PMN} leukocytes) ? WBC counts > 5 cells / mm3, decrease glucose concentration (> 45 mg / dl), Increase protein concentration (> 45 mg / dl).

The samples were centrifuged at 2000 RPM for 20 minutes; a sterile Pasteur pipette was used to draw off the supernatant. One drop was used to streak the primary culture medium. One or two drops of sediment were used to prepare the Gram stain. The smears were carefully examined under a microscope for the presence of bacteria.

The samples (the sediment) were cultured and identified by conventional methods, and all samples were inoculated with selective media (Blood agar, and MacConkey agar). The tests were performed as per the manufacturer; the samples were incubated at 37ºC for 24 hrs. Furthermore, all bacteria isolates were identified based on colonies, morphology, cultural features, and biochemical reactions after being cultivated on blood agar and chocolate agar and incubated in a carbon dioxide enriched atmosphere at 35-37 C for up to 48 hours.

Biochemical tests (API systems) are used to identify the names and strains of gram-negative bacteria. Another biochemical test was used to detect gram-positive bacteria. All positive cultures were recorded with information on each pathogen isolated from these cultures, including the name and susceptibility profile.

III. Result

In this retrospective study, the data was collected from the laboratory records and statistical unit. A total of 6306 CSF child samples from a clinically suspected case of meningitis were subjected to a microbiological unit. There were (400) cases clinically diagnosed as BM in children beyond the neonatal period up to 15 years old, who were admitted to the Children's Hospital in Benghazi, Libya (January 2018 – December 2019). Out of them, 103 cases were found to be CSF bacterial culture positive.

The CSF was turbid in the majority of cases. The total white blood cell count in the CSF exceeded 100 cells/mm³ in more than 52% of culture-positive specimens. Of these, about 51% had a WBC >1000 WBC/mm³. The majority of meningitis cases are found in male children rather than females (Table 1). There were 225 (56%) males and 175 (44%) females. The ratio of male to female was (1.3-1).

TABLE 1. No. of meningitis cases according to genders recorded from statistical office 400 cases during (2018-2019).

Gender	Number of cases(n)	Percentage%
Male	225	56%
Female	175	44%
Total	400	100%

Regarding age distribution, as can be seen in Figure (1), the children between (1-5 years) constituted (92%) of the total infected patients.

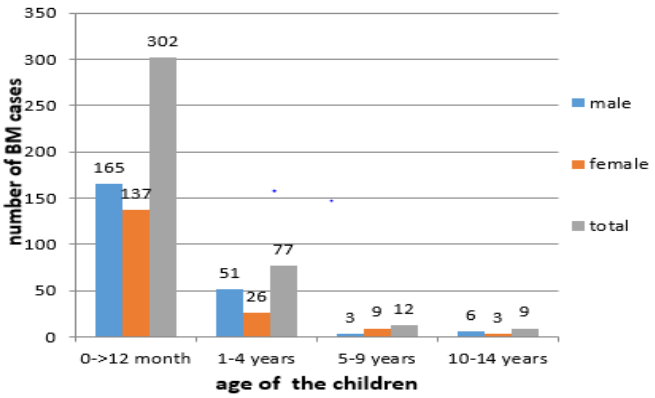

Fig. 1. Number of bacterial meningitis cases in comparison to age

Concerning causative organisms, in the present study, a total of 103 cases were identified with a definite causative agent. As can be seen in Figure 2, gram-positive bacteria were responsible for most cases of meningitis, n =57(55%). The most common pathogen isolated was coagulase-negative *staphylococci*, n=27 (26%), while the most common gram-negative organism was *E. coli*, n =16 (15.5%). Organisms isolated respectively from CSF culture were coagulase-negative *Staphylococci*, n=27(26%), followed by *E. coli* n=16 (15.5),

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then *Staph aureus*, n=15 (14.6%), followed by *S. pneumoniae*, n= 12(11.7%), and *K .pneumonia*, n = 10 (9.7%).

Additionally, current study compared the incidence of the uncommon bacteria that caused meningitis (Table 2). The result is as the following: *Acinetobacter spp*, n=6 (5.8%), then *P. aeruginosa*, n = 5 (4.9%), *Enterobacter spp*, n =5 (4.9%), *Serratia spp*, n = 2 (1.9%), *Streptococcus pyogen*, n =1 (1%) *S. fecales*, n =1 (1 %), *Proteus spp*, n =1 (1%). However, the usual pathogens of meningitis like *N. meningitides* were only 1 (1%), and lastly, *Stenotrophomonas maltophillia*, n =1(1%).

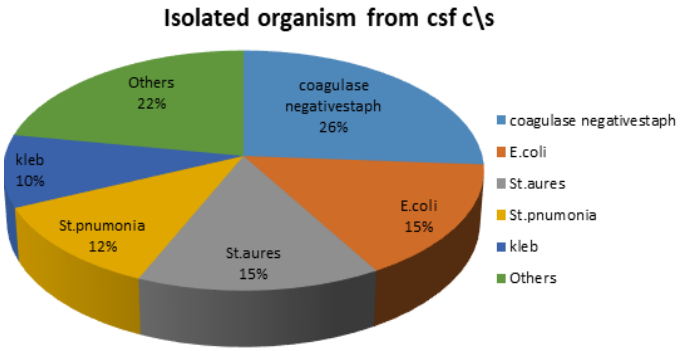

Fig. 2. Organisms isolated from CSF cultures of patients of bacterial meningitis in children's hospital during (January2018 – December2019).

TABLE 2. The uncommon causative organisms in Benghazi city

Causative Organism	Number of Cases
Actinobacteria	6
Pseudomonas	5
Eenterobacter	5
Serratia	2
S. faecalis	1
S. pyogen	1
Stenotrophomonasnaltophillia	1
Total	21

While the antibiotic sensitivities result as shown in our study are 75% of gram-positive organisms were sensitive to vancomycin. The resistance pattern to other drugs tested was Ampicillin (42%). The percentage of amikacin, gentamycin, and the ciprofloxacin-sensitive gram-positive organism is (85%), (82.7%), (80%) respectively. Gram-negative organisms were sensitive to ampicillin (90%), amoxicillin/clavulanic acid (37.5%, ciprofloxacin (60%), Gentamicin (23.5), piperacillin (15%), and chloramphenicol (40%).

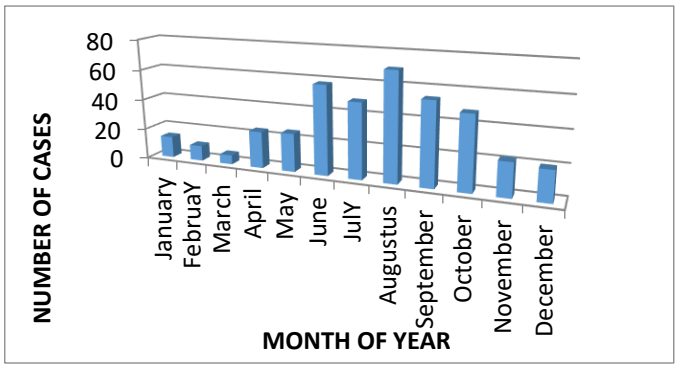

Fig. 3. Shows Seasonal effect on bacterial meningitis

Besides that, current study assessed the Seasonal effect on the incidence of bacterial meningitis in Benghazi hospital among 400 cases of bacterial meningitis. The highest incidence in the study area occurred in August, during the summer seasons from (June to October) as shown in Figure 3.

On the other hand, the percentage of mortality rate from the hospital files (Table 3) were11 cases of mortality from bacterial meningitis. The highest rate associations with death were age and gender. Among (11 cases), 10 of them were with aged less than one year. The male death was 7 cases, while the female death was 4 cases. Fever, poor feeding, and, vomiting is the most common clinical feature. Among (400 cases), 103 were positive by culture, and (77) were positive by gram stain (41%).

TABLE 3. Percentage of mortality rate, clinical feature, and method of diagnosis

Test:	No.	%
Gram stain	88	**22%**
CRP	257	**64%**
CSF C/S	103	**25.7%**
Mean CSF protein	(224)	**56%**
Mean CSF glucose	(49)	
Mean CSF leukocyte count,	(266)	
Clinical feature: -		
Fever	360	**90%**
Vomiting	240	**60%**
Refusal to feed	204	**51%**
Outcome: -		
Death	26	**7%**
live	374	**93%**

IV. DISCUSSION

Bacterial meningitis is still one of the main health problems in children and new-borns. Etiological pathogens of meningitis are relatively diverse. Most researchers have introduced *S. pneumonia*, *H. influenza* type b, and *N. meningitis* as the main pathogens of bacterial meningitis, especially in childhood {4.25}. Researchers had noted the same pathogens by al Bekairy in Sudan {17} Iran {4} and Kingdom of Saudi Arabia {3}. However, a study done by Swann et al at the Queen Elizabeth Central Hospital in Blantyre, Malawi {18} disagreed with the previous study.

In the current study coagulase-negative staphylococcus was the predominated gram-positive pathogen (26 %), which correlated to a study done by Basri et al {19} followed by *E. coli* (15.5%), and then by *S. aureus* (20%), and *S. pneumonia* (16%), as shown in Figure 2.

Among *H. influenza*, the study shows that there is a complete absence of this most usual pathogenic organism of acute bacterial meningitis. Besides, a reduction in the incidence rate of *N. meningitis*, which considered as most other cause of bacterial meningitis organisms, was also observed in this study in comparison to the previous study that was done in 1995 in the same hospital. This finding reflects a good vaccination program in our country.

Although *Listeria monocytogeneis* was found as an important pathogen of bacterial meningitis in other areas, this bacterium was not isolated from the CSF cultures in this study. It is not known, whether this bacterium is not truly prevalent in our country or this is due to the lack of the standard techniques

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required for their isolation. According to previous studies, the prevalence of these pathogens can be different based on time, geographical area, and the patient's age.

Moreover, the majority of meningitis cases found in children less than one year (75.5%) of children and this might attribute to the early developing immune system.

Additionally, the age and sex distributions of cases in this study were consistent with the previous reports. The study shows the male children were the preponderance of (1.3-1). This result is in agreement with a study done by Al-Mazrou et al in Saudi Arabia (1.3:1) {3}, and other study done by Ml KY in India (1.27:1) {7}, which correlated with those seen in studies of Opare et al (1.7:1) (8) but disagreed with the study done by Ahmed in Ethiopia by {20}.

A total of 400 bacterial meningitis cases were identified during the study period. Where most of the cases (75.5%) were aged less than 1 year, the meningeal signs were not easy to elicit; and the main presenting symptoms were fever (90%), vomiting (60%) refuse to feed (51%).

On the other hand, among seasonal effects on the incidence of bacterial meningitis, the highest incidence occurred during the months: August n=70 (17,5%), then June n=58(14.5%), followed by September n= 54 (13,5%), which together form more than 45% of the cases.

The case fatality rate in this study was (6%). According to the literature, lower mortality rates and less frequent complications have been reported from the Castel blanco in USA {21}. Canada. Whereas, higher mortality and morbidity rates have been reported from kim {22}, Ahmed in Ethiopia {20}, Mihret et al., 2016 {23}.

V. Conclusion

The CSF results database was obtained from the Laboratory, department of medical microbiology. CSF culture is the gold standard for the diagnosis of bacterial meningitis. It enables the determination of antibiotic sensitivities to direct appropriate therapy. The results are based on 103 cases from 2 years (January 2018 to December 2019) in Children's Hospital. Benghazi, Libya E. coli and *Staphylococcus aureus* were the main causative pathogens of bacterial meningitis in children in the area under study. Most species have relatively high resistance to conventional antibiotics as compared to the past.

References

[1]. World Health Organization & Centers for Disease Control and Prevention (U.S.). (2011). Laboratory methods for the diagnosis of meningitis caused by Neisseria meningitidis, streptococcus pneumoniae, and haemophilus influenzae : WHO manual, 2nd ed. World Health Organization. http://www.who.int/iris/handle/10665/70765

[2]. Rao BN, Kashbur IM, Shembesh N, El-Bargathy SM. Etiology and occurrence of acute bacterial meningitis in children in Benghazi, Libyan Arab Jamahiriya. East Mediterr Health J 1998;4:50–57. Available from: http://applications.emro.who.int/emhj/0401/emhj_1998_4_1_50_57.pdf?ua=1.

[3]. Rao BN. An etiology and occurrence of acute bacterial meningitis in children in Benghazi, Libya. EMRO, WHO, Int. Publication 1998;4:50-57

[4]. Al-Mazrou YY, Musa EK, Abdalla MN, Al-Jeffri MH, Al-Hajjar SH, Mohamed OM. Disease burden and case management of bacterial meningitis among children under 5 years of age in Saudi Arabia. Saudi medical journal. 2003; 24(12):1300-7.

[5]. Abdinia B, Rezaee MA, Oskouie SA. Etiology and antimicrobial resistance patterns of acute bacterial meningitis in children: a 10-year referral hospital-based study in northwest Iran. Iranian Red Crescent Medical Journal. 2014 Jul; 16(7).

[6]. Baraff, L.J., Lee, S.I. and Schriger, D.L. 1993. Outcomes of bacterial meningitis in children: A meta-analysis. Pediatr. Infect. Dis. J. 12: 389-394.

[7]. Nagarathna, S., Venaakumari, H.B. and Chandramuki, A. (2012) Laboratory Diagnosis of Meningitis. www.intechopen.com http://dx.doi.org/10.5772/29081

[8]. Ml KY. Study of bacterial meningitis in children below 5 years with a comparative evaluation of gram staining, culture, and bacterial antigen detection. Journal of clinical and diagnostic research: JCDR. 2014 Apr; 8(4): DC04.

[9]. Joseph K. L. Opare, et al. Bacterial Meningitis: A Review in the Upper East Region of Ghana 2010-2014 International Journal of TROPICAL DISEASE & Health 10(3): 1-11, 2015, Article no.IJTDH.19398 ISSN: 2278–1005 SCIENCEDOMAIN international www.sciencedomain.org

[10]. Cdc.gov. (2010), Epidemiology of Meningitis Caused by Neisseria meningitides, Streptococcus pneumoniae, and Haemophilus influenzae, chapter 2. Meningitis | Lab Manual | Epidemiology | CDC. [online] Available at: https://www.cdc.gov/meningitis/lab-manual/chpt02-epi.html.

[11]. Centers for Disease Control and Prevention. 1998. Laboratory methods for the diagnosis of meningitis caused by Neisseria meningitides, Streptococcus pneumoniae, and Haemophilus influenzae. Centers for Disease Control and Prevention, Atlanta, Ga

[12]. Chiba N, Murayama SY, et al. Rapid detection of eight causative pathogens for the diagnosis of bacterial meningitis by real-time PCR. J Infect Chemother. 2009 January; 15:92–98.

[13]. Poppert S, Essig A, Stoehr B .et al. Rapid diagnosis of bacterial meningitis by real-time PCR and fluorescence in situ hybridization. J Clin Microbiol33971600046-43:3390;2005 .

[14]. Corless C, Guiver M, et al. Real-Time PCR Cases of Meningitis and Septicemia Using Streptococcus pneumoniae in suspected meningitidis, Haemophilus influenzae, and Simultaneous Detection of Neisseria. Journal of clinical microbiology, 2001; 39 (4):1553–1558.

[15]. Marco Arosio et al. (2008). Evaluation of the MICROSEQ 500 16S rDNA-based gene sequencing for the diagnosis of culture-negative bacterial meningitis, NEW MICROBIOLOGICAL, 31, 343-349, 2008

[16]. John. J et al (2012). Causes and epidemiology of vaccine-preventable infectious bacterial disease: the prospect and short outcoming of a vaccine. Int J Pharmacy and pharmaceutical Sci, Vol 4, Issue 1, 51-54. ISSN-0975-1491.

[17]. Khan F, Rizvi M, Fatima N, Shukla I, Malik A, Khatoon R (2011). Bacterial meningitis in North India: Trends over a period of eight years. Neurology Asia. 16(1):47–56. [Google Scholar].

[18]. Al Bekairy AM, Al Harbi S, Alkatheri AM, Al Dekhail S, Al Swaidan L, Khalidi N. Bacterial meningitis: An updated review. African Journal of Pharmacy and Pharmacology. 2014 May 15; 8(18):469-78.

[19]. Swann O, Everett DB, Furyk JS, Harrison EM, Msukwa MT, Heyderman RS, Molyneux EM. Bacterial meningitis in Malawian infants< 2 months of age: etiology and susceptibility to World Health Organization first-line antibiotics. The Pediatric infectious disease journal. 2014 Jun; 33(6):560.

[20]. Basri R, Zueter AR, et al. Burden of bacterial meningitis: a retrospective review on laboratory parameters and factors associated with death in meningitis, Kelantan Malaysia. Nagoya J Med Sci. 2015 Feb; 77(1-2):59-68.

[21]. Ahmed, Arslan. (2016) Etiology of bacterial meningitis in Ethiopia 2007 - 2011: a retrospective study. UIO; Duo vitenarkiv. Accessed on 20 June 2016.

[22]. Castelblanco RL, Lee M, Hasbun R. Epidemiology of bacterial meningitis in the USA from 1997 to 2010: a population-based observational study. The Lancet Infectious Diseases. 2014 Sep 30;14(9):813-9

[23]. Kim KH, Sohn YM, Kang JH, Kim KN, Kim DS, Kim JH, Kim CH, Shin YK, Oh SH, Lee HJ, Cha SH. The Causative Organisms of Bacterial Meningitis in Korean Children. J Korean Med Sci. 1998; 13:60-4.

[24]. Mihret W, Lema T, Merid Y, Kassu A, Abebe W, Moges B, Tenna A, Woldegebriel F, Yidnekachew M, Mekonnen W, Ahmed A. Surveillance of Bacterial Meningitis, Ethiopia, 2012–2013. Emerging infectious diseases. 2016 Jan; 22(1):75.

[25]. Torres, S. D., et al. (2022). "Delays in Diagnosis and Treatment of Bacterial Meningitis in NYC: Retrospective Cohort Analysis." Neurohospitalist 12(2): 268-272.

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