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CRP and WBC as Diagnostic Markers for Septicemia and Meningitis

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ABSTRACT

Septicemia and bacterial meningitis remain life-threatening conditions, particularly among newborns and critically ill patients with weakened immunity. The widespread misuse of antibiotics has further complicated diagnosis by contributing to antimicrobial resistance. Rapid, reliable, and cost-effective diagnostic markers are therefore urgently needed. This study aimed to evaluate the diagnostic role of C-reactive protein (CRP) and white blood cell (WBC) **count** in detecting septicemia and bacterial meningitis. A descriptive-analytical, hospital-based design were conducted at Misurata Medical Center, Libya, between January 2023 and May 2024**.** After ethical approval, data were obtained from the Medical Laboratories Department, including blood cultures, cerebrospinal fluid (CSF) cultures, CRP levels, and WBC counts.

A total of 274 patients were enrolled (34% male, 66% female; age range: 1 day–71 years). Pathogens isolated from CSF included Staphylococcus aureus (7 cases), Streptococcus spp. *(1), and* Acinetobacter spp. (1). Blood cultures yielded *S. aureus* (5), *Streptococcus spp.* (3), Acinetobacter spp. *(3),* Klebsiella spp. *(2*), and single isolates of *Bacillus spp.*, Enterococcus spp., and Candida albicans. Correlation analysis showed significant associations between positive blood cultures, elevated CRP, and increased WBC counts, while no significant correlation was found with CSF cultures. The most effective antibiotics identified were amikacin (AK), ciprofloxacin (CIP), gentamicin (CN), ceftriaxone (CRO), piperacillin/tazobactam (TZP), and imipenem (IMP).

1. INTRODUCTION

Septicemia and bacterial meningitis represent critical medical conditions characterized by systemic infection and inflammation, with high morbidity and mortality if not diagnosed promptly. Laboratory markers such as C-reactive protein (CRP) and white blood cell (WBC) **count** are routinely utilized as early indicators of bacterial infection (Benjamin, ET.AL., 1984). Recent evidence underscores CRP's superior sensitivity and specificity in distinguishing bacterial from viral infections, and its predictive value in meningitis—particularly in febrile infants and adults—often surpasses that of WBC count alone. Simultaneously, WBC count remains a practical and accessible marker, especially in resource-limited settings. However, performance parameters may vary by age group, underlying comorbidities, and infection site (NICE, 2024). This study aims to evaluate the diagnostic performance of serum CRP and WBC count, alone or in combination, in detecting septicemia and bacterial meningitis among patients attending Misurata Medical Center.

1.1 Diagnostic Value of White Blood Cell Count in Septicemia and Meningitis:

Physiological basis. During bacterial infection, bone marrow–driven granulopoiesis increases circulating leukocytes—particularly neutrophils—producing leukocytosis with neutrophilia as part of the innate response (chemotaxis, phagocytosis, oxidative killing). In sepsis, both leukocytosis and leukopenia/neutropenia can occur, the latter often signaling more severe or late-stage disease due to marrow exhaustion or consumption. Consequently, the total WBC is an accessible but **non-specific** marker, while the differential (absolute neutrophil count, ANC; neutrophil-to-lymphocyte ratio, NLR) provides additional discriminatory information in systemic bacterial infection. In bacterial meningitis, **CSF** pleocytosis with neutrophilic predominance is a classic hallmark alongside low CSF glucose and elevated protein, reflecting intense neutrophil trafficking into the subarachnoid space (Jeivanth., ET.AL., 2025)

1.2 Comparative performance versus CRP:

Although WBC/ANC are long-standing screening tools, recent evidence consistently shows C-reactive protein (CRP) outperforms WBC in identifying serious bacterial infection (SBI) and in the diagnostic work-up of suspected CNS infection. A 2025 multicenter emergency-department study in children reported no added diagnostic benefit of WBC over CRP for detecting SBI, recommending WBC be reserved for specific indications. Similarly, broader pediatric evidence (including bloodstream infections) finds CRP (and procalcitonin) provide higher discriminative accuracy than WBC alone; combining CRP with WBC/ANC can improve negative predictive value but seldom surpasses CRP's standalone performance. In meningitis specifically, contemporary guidance and studies emphasize CSF indices—CSF WBC predominance, protein, glucose—as primary laboratory discriminators, while CRP (especially CSF-CRP) shows superior accuracy to serum markers; WBC remains supportive rather than definitive. PubMedBioMed Centralnice (PubMed. ET.AL, 2025)

1.3 Implications for practice:

In resource-constrained settings, WBC with differential retains value as a rapid, low-cost triage test for septicemia and as part of the CSF panel for meningitis. However, when available, CRP (preferably alongside procalcitonin) should be integrated to strengthen early decision-making; CSF WBC pattern remains central for meningitis classification, with CRP used as a complementary biomarker (Optional, for CSF performance context, 2023)

2. METHOD

This study adopted a descriptive-analytical, hospital-based design at Misurata Medical Center, Libya*, covering* the period from January 2023 to May 2024**.** Ethical clearance was obtained from the Scientific Research Committee prior to data collection. A total of 274 patients were included in the study (34% male, 66% female; age range: 1 day to 71 years). Clinical and laboratory data were retrieved from the Medical Laboratories Department. Laboratory investigations comprised blood cultures, cerebrospinal fluid (CSF) cultures, C-reactive protein (CRP) assays, and white blood cell (WBC) counts**.** Pathogen identification and antibiotic susceptibility testing were carried out according to standard microbiological protocols**.** Finally, statistical analyses, including correlation testing, were performed to evaluate the diagnostic value of CRP and WBC in relation to culture-confirmed septicemia and bacterial meningitis.

2.1 Laboratory techniques:

The blood samples collected were distributed into special tubes for analysis. The first tube contained EDTA for a complete blood count (CBC) for analyzing White blood cells (WBC), the Mindray BC-3000 plus device. The second tube contained heparin for analyzing C-reactive protein (CRP), using the Mindray BS- 430 device.

2.2 Culture Techniques

The samples were received cerebrospinal fluid (CSF) at the microbiology laboratory of Misurata Medical Center. They were distributed according to the planning method on three nutritional media: Blood agar, MacConkey agar, and Chocolate agar. They were incubated in an incubator for 24-48 hours at a temperature of 37°C, except for Chocolate agar, which was incubated in an anaerobic medium, Blood culture samples were incubated in an incubator at 37°C and cultured after three days to confirm the negative result and the blood culture bottle is placed in an incubator at 37°C for 3 days and is cultured on the mentioned media to ensure that the result is negative.

2.3Testing the sensitivity of bacterial isolates to commonly used antibiotics:
A bacterial suspension was made and its turbidity was adjusted with McFarland solution (0.5 w/v) using a cotton swab. Mueller Hinton agar plate was streaked and the plate was left for 5 minutes to dry. The most commonly used antibiotics were added as in the table (1). Antibiotic company (Fortress, Bio analyses, Oxoid, Bio Rad**).**

Table 1. Antibiotic used

Antibiotic	Concentration
Ciprofloxacin (CIP)	5 mcg
Imipenem (IMI)	10 µg
Amikacin (AK)	30mcg
Cefuroxime (CXM)	30mcg
Augmentin (AUG)	30mcg
Cefotaxime (CTX	30mcg
Piperacillin-tazobactam (TZP)	10 µg
Gentamycin (CN)	10µg
Ceftriaxone (CRO)	30µg

2.4 Statistical analysis:
Quantitative variables were expressed as mean ± standard deviation or median and were compared using a two-sample T-test or Mann-Whitney test, depending on whether they were normally distributed or not. Qualitative variables were expressed as percentages and compared using the Chi-square test. The significance level for statistical testing was defined as two-tailed $p < 0.05$. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS)**.**

3. ETHIC APPROVAL

This study was conducted in accordance with ethical standards for research involving human participants. Approval was obtained from the Scientific Research Ethics Committee of Misurata Medical Center, the institution where the research was carried out. All procedures followed the principles outlined in the Declaration of Helsinki, ensuring patient confidentiality, voluntary participation, and the responsible handling of clinical and laboratory data

4. RESULTS AND DISCISSUON

The current study was conducted on cases visiting Misurata Medical Center in all departments from all age groups for both sexes, where the total number reached 274 cases, including 34% male and 66% female as figure (1). This is similar to several studies, including a study in Sudan [15] .While it was different from other studies, which showed a higher percentage of men than women (Al Shaqri, et.al., 2023), (Al-Yosaffi, et.al., 2023).

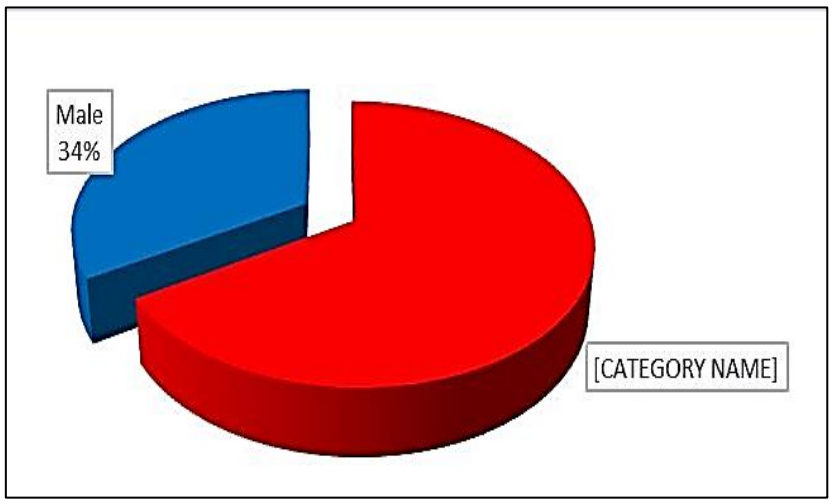

Figure 1. Percentage of cases

Among the data obtained were the age groups of patients, which included from one day to 71 years, and most of the patients were from the age group from one day to 17 years, so the number reached 243 cases, while the age group (18-35) was 4 cases, the age group (36-53) was 5 cases, and the age group (54-71) was 22 cases. This is similar to a study in Yemen, in which the number of patients was limited to ages less than 18 years (Al-Yosaffi, et.al., 2023), as in the figure (2).

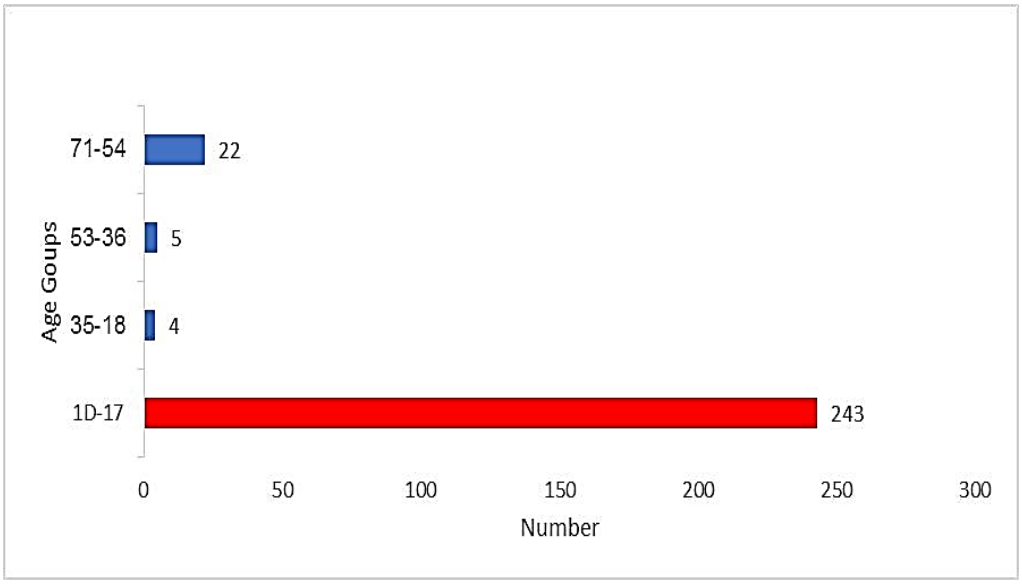

Figure 2. Age groups of cases

Figure 3 shows the distribution of cases according to the departments at Misurata Medical Center. The data showed that most of the cases are from the pediatric and neonatal departments, (Intensive care unit (ICU) (24), Out Patient Department (OPD) (5), Female Medicine Department (FMD) (4), Male Medicine Department (MMD)(2), Pediatric Intensive Care Unit (PICU) (163). Emergency medicine (ER) (4), Neonatal Intensive Care Unit (NICU) (72).

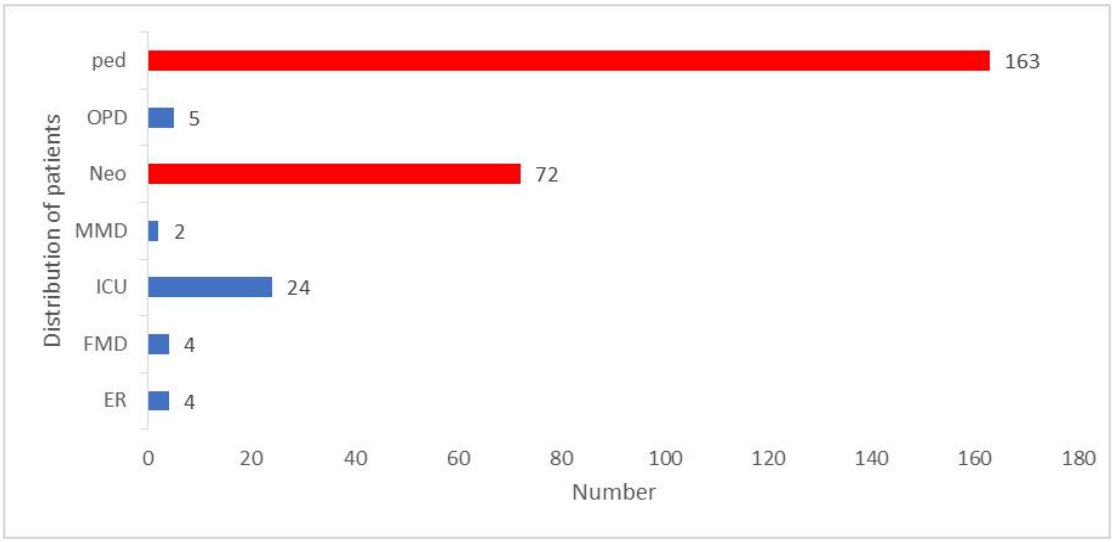

Figure 3. Distribution of patients according to departments.

As the microbial species were isolated from blood culture and spinal fluid culture, they did not include all patients, as some of them had blood cultures done and others did not. The same applies to spinal fluid cultures, which showed that 72 cases did not have a spinal fluid sample figure, while 195 cases did not have a blood culture done. While 192 cases had sterile spinal fluid and 64 cases had sterile blood cultures, there were 9 cases from spinal fluid and 15 cases from blood cultures from which bacterial species were isolated, along with a candida albicans isolation from blood culture as in the figure (4).

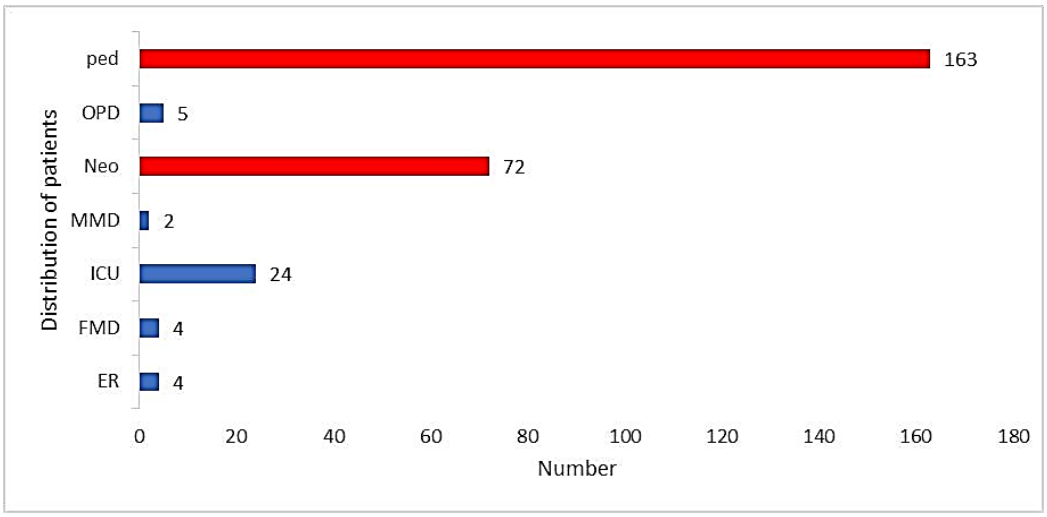

Figure 4. Types of microbial isolates isolated from patients

Figure 5 shows the bacterial and fungal isolated from the cerebrospinal fluid culture and blood culture. We found that most of the isolates were from the blood culture and were more Gram-positive bacteria than Gram-negative bacteria this is similar to several studies, including a study [15], isolated from cerebrospinal fluid *Staphylococcus aureus* (7), *Streptococcus spp*(1), *Acintobacter spp*(1), While isolated from blood culture bacterial species *Staphylococcus aureus* (5), (3) isolates for each Streptococcus spp, *Acintobacte*r spp, *Klebsiella* spp (2) , (1) isolates for each *Bacillus* spp, *Enterococcus* spp, *Candida albicans*, this is similar to several studies, including a studies in Egypt and Yemen (Al Shaqri, et.al., 2024) , (El Sabbagh, et.al., 2024).

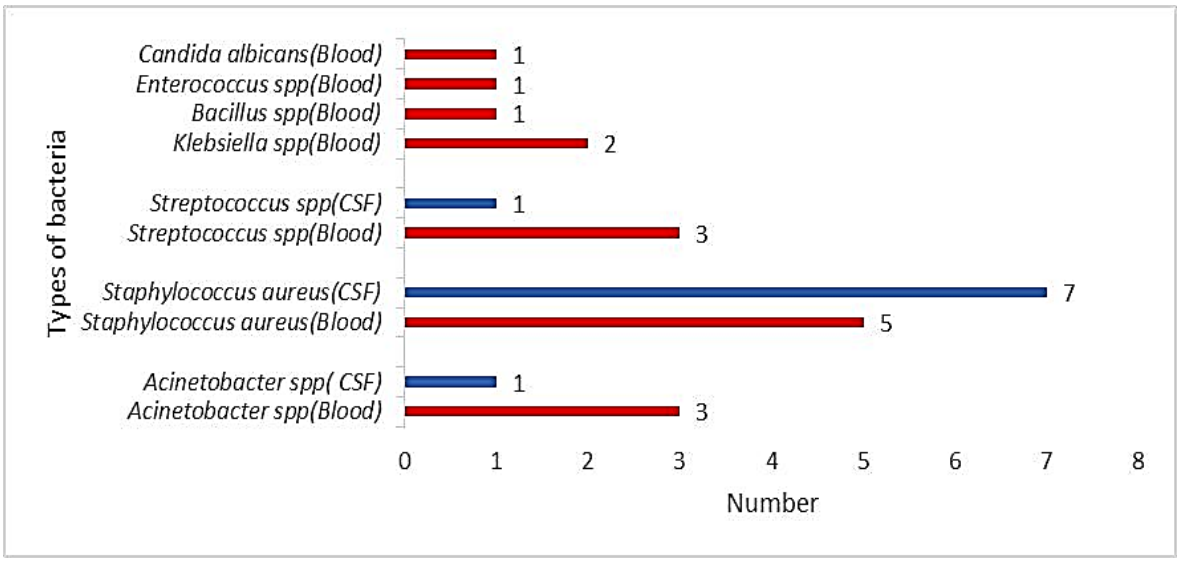

Figure 5. Types of bacteria isolated from patients

Given that the current study was not limited to microbial isolated from blood culture and cerebrospinal fluid only, but rather aimed at early diagnosis of the condition before the culture result appears with the help of blood parameters, white blood cells and C-reactive protein analysis, when studying the relationship between blood culture and blood protein analysis for C-reactive and white blood cells ,as in the table(2,3), we found significant differences, and the significance value was less than 0.01 this is similar to several studies, including a studies[8, 18, 19], While studying the relationship between cerebrospinal fluid, C- reactive protein and white blood cells ,as in the table(4,5) , we found that there were no significant differences and the value was higher than 0.01 this is not similar to several studies, including a studies (Hamaameen, et.al., 2024) , (Honnalli, 2024).

Table 2. The relationship between Blood culture and CRP

Chi-Square Tests (B/C and CRP)	
	Asymptotic Significance (2-sided)
Pearson Chi-Square	**0**.006

Table 3. The relationship between Blood culture and WBC

Chi-Square Tests (B/C and WBC)	
	Asymptotic Significance (2-sided)
Pearson Chi-Square	0**.000**

Table 4. The relationship between CSF culture and **CRP.**

Chi-Square Tests (CSF and CRP)	
	Asymptotic Significance (2-sided)
Pearson Chi-Square	0**.730**

Table 5. The relationship between CSF culture and WBC.

Chi-Square Tests (CSF and WBC)	
	Asymptotic Significance (2-sided)
Pearson Chi-Square	**0**.447

While Table No. 6 shows the extent of the correlation between the positivity of the blood culture and the cerebrospinal fluid culture, we find that there are significant differences when their value was less than 0.01.

TABLE 6. THE RELATIONSHIP BETWEEN CSF AND BLOOD CULTURE.

Chi-Square Tests (CSF and B/C)	
	Asymptotic Significance (2-sided)
Pearson Chi-Square	**0.000**

From the results obtained for the sensitivity of the antibiotics used for the isolated bacterial species, we found that most of the antibiotics were sensitive, especially for the Gram-positive bacterial species isolated from the spinal fluid, as shown in the figure (6), while bacteria *(Acintobacter spp, Klebsiella spp)* were sensitive to antibiotics were similar to the study in Qatar (Al-Mulla, et.al., 2014).

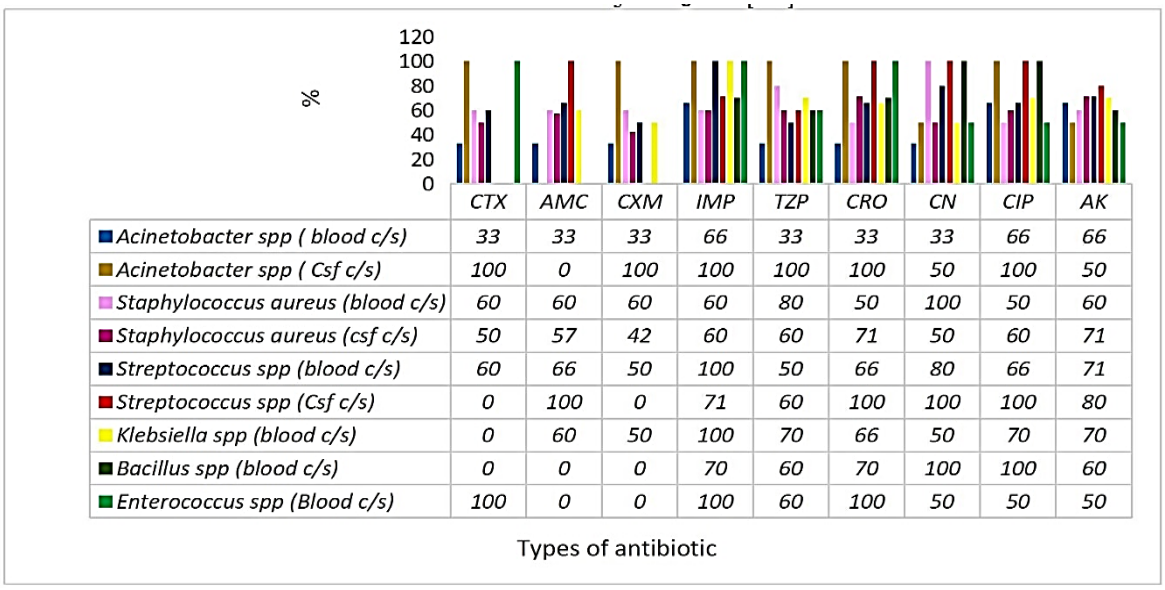

Figure 6. Sensitivity of bacterial isolates to commonly used antibiotics.

5. CONCLUSUIONS:

CRP and WBC count serve as valuable diagnostic tools in identifying septicemia and bacterial meningitis in patients at Misurata Medical Center. Their appropriate use leads to enhanced early diagnosis and effective management of these critical conditions. Further research may help in establishing targeted thresholds for these markers, optimizing their utility in clinical practice

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