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A study on Bacteriological Profile of Neonatal Septicemia and Antibiotic Sensitivity Pattern

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Abstract

Background: Neonatal septicemia, a critical neonatal illness, involves multiple bacteria types, frequently Staphylococcus aureus, Escherichia coli, and Klebsiella pneumoniae. Antimicrobial susceptibility varies, however, increased resistance against commonly used antibiotics, such as ampicillin and gentamicin, poses significant challenges. Timely diagnosis and appropriate antibiotics selection, informed by current bacterial profiles and sensitivity patterns, are crucial for improving neonatal outcomes. The aim of this study was to assess the bacteriological profile of neonatal septicemia and antibiotic sensitivity pattern. **Material & Methods:** This cross-sectional study was conducted in Department of Neonatal Intensive Care Unit (NICU), Dr. Sirajul Islam Medical College, Dhaka, Bangladesh, during the period from October 2021 to February 2023. Total 243 neonates with septicemia were included in this study. **Results:** The study sampled 243 subjects, 207 (85.2%) ≤72 hours old, and 36 (14.8%) >72 hours with a female predominance (89.7%). Positive bacterial cultures were seen in 46 (18.9%) individuals, predominantly Pseudomonas (28.2%). Organism incidence varied between early (35 occurrences, 76.1%) and late (11 occurrences, 23.9%) onset groups. More bacteria were observed in females (39 cases, 84.8%) than males (7 cases, 15.2%). Antibiotic sensitivity showed Pseudomonas was most responsive to Cephalosporin (20 cases, 43.5%). Acinetobacter showed the highest resistance to Cephalosporin (10 cases, 21.7%). **Conclusion:** From the findings of this study, it can be concluded that early-onset septicemia had higher bacterial presence than late-onset, and females exhibited more bacterial presence than males. Pseudomonas was the most frequent organism which was most responsive to Ceftazedime.

Keywords:- Bacteriological Profile, Neonatal Septicemia, and Antibiotic Sensitivity Pattern.

INTRODUCTION

Neonatal septicemia, a systemic infection occurring in the first 28 days of life, is a leading cause of neonatal morbidity and mortality worldwide.[1] One of the indicators for assessing a country's health is the neonatal death rate.2 newborn death may be caused by a variety of factors, but septicemia continues to be a leading cause of newborn mortality and morbidity globally. Although incidence varies by country, it is significantly greater in poor countries than in industrialized ones.[2] The World Health Organization (WHO) estimates that 98% of newborn fatalities, which account for nearly 5 million deaths annually, occur in underdeveloped nations.[3] Neonatal septicemia can be classified into early-onset septicemia (EOS) and late-onset septicemia (LOS), depending on whether it occurs within the first

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72 hours or after the 72 hours of life, respectively.[2] The bacteriological profile of neonatal septicemia varies widely, often influenced by geographical location, healthcare practices, and socio-economic factors.[3] In the context of neonatal septicemia, a deep understanding of the bacteriological profile is crucial. The predominant pathogens associated with this infection include gram-positive bacteria such as Streptococcus agalactiae (Group B Streptococcus) and Staphylococcus aureus, and gram-negative bacteria such as Escherichia coli and Klebsiella pneumoniae.[4] However, there has been a noticeable shift in this pattern over time due to changes in maternal and neonatal care practices, and increased antibiotic resistance.[5] In developing countries, however, gram-negative organisms appear to predominate.[6] Another critical facet of managing neonatal septicemia is the understanding of the antibiotic sensitivity pattern of these causative bacteria. This knowledge aids clinicians in selecting the appropriate empiric antibiotic therapy for newborns suspected of sepsis before obtaining culture results.[6] The misuse of antibiotics, often due to lack of susceptibility data, has led to the emergence of multi-drug resistant strains of bacteria, posing a major therapeutic challenge.[7] Antibiotic resistance, a growing global health concern, complicates the treatment of neonatal septicemia. The emergence of multidrug-resistant organisms, particularly methicillin-resistant Staphylococcus aureus (MRSA) and extended-spectrum β-lactamase (ESBL) producing gram-negative bacteria, heightens the urgency for robust antimicrobial stewardship.6 Antimicrobial resistance patterns tend to vary geographically, emphasizing the need for ongoing local surveillance to inform empirical treatment guidelines. The bacteriological profile of neonatal septicemia and the antibiotic sensitivity pattern of the causative organisms can significantly influence the selection of empirical therapy, which is often initiated before the availability of culture results due to the life-threatening nature of neonatal sepsis.[7] A thorough understanding of the causative organisms and their antimicrobial susceptibility patterns is crucial in improving the clinical outcomes and preventing the emergence and spread of antibiotic resistance. The current study was conducted to assess the bacteriological profile of neonatal septicemia and antibiotic sensitivity pattern.[8,9,10,11,12]

Objectives

To assess the bacteriological profile of neonatal septicemia and antibiotic sensitivity pattern.

MATERIAL AND METHODS

This cross-sectional study was conducted in Department of Neonatal Intensive Care Unit (NICU), Dr. Sirajul Islam Medical College, Dhaka, Bangladesh, during the period from October 2021 to February 2023. Total 243 neonates age within 28 days with septicemia were included in this study. Blood culture test was done for every neonate. Positive bacterial cultures were seen in 46 (18.9%) individuals. Antibiotic sensitivity and resistance were also assessed. Consent of the patient's guardians were taken before collecting data. After collection of data, all data were checked and cleaned. After cleaning, the data were entered into computer and statistical analysis of the results being obtained by using windows-based computer software devised with Statistical Packages for Social Sciences version 22. After

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compilation, data were presented in the form of tables, figures and charts, as necessary. P value of less than 0.05 was considered statistically significant.

RESULTS

[Table 1] presents the demographic and bacterial characteristics of the study subjects. The age distribution reveals that 207 individuals (85.2%) fall within the age group of ≤72 hours, while 36 individuals (14.8%) are above the age of 72 hours. In terms of gender, the sample includes 25 males (10.3%) and 218 females (89.7%). The table also provides insights into the bacterial culture test results. Among the sample population, 46 individuals (18.9%) tested positive for bacterial culture, while 197 individuals (81.1%) tested negative. The positive culture results are further categorized by the type of organism identified. The most prevalent organism among the positive culture results is Pseudomonas, with 13 individuals (28.2%) testing positive for this organism. Candida and Staphylococcus aureus are found in 9 individuals each, accounting for 19.6% of the positive results. Staphylococcus epidermidis follows with 6 individuals (13%). Gram (+ve) rod, Klebsiella and Micrcoccus are detected in 4.3% of the positive cases each, while Acinetobacter is found in 6.5% of the positive culture results. [Table 2] presents a breakdown of the pattern of organisms identified in the study subjects by their incidence in different age groups. The table divides the age groups into two categories based on the onset of their identification: "Early onset" being within 72 hours, and "Late onset" being after 72 hours. A variety of organisms are listed, each with the quantity (n) and percentage (%) of occurrences in both age groups. Pseudomonas was found in 9 early onset cases (19.6%) and 4 late onset cases (8.7%). Staphylococcus epidermidis was evenly distributed with 3 cases each (6.5%) in both age groups. Staphylococcus aureus was found in 9 early onset cases (19.6%) but no cases in the late onset group. Candida was more common in early onset with 7 cases (15.2%), compared to 2 cases (4.3%) in late onset. Klebsiella and Gram-positive rods were both found in 2 early onset cases (4.3%) but absent in the late onset group. Micrococcus was found in 2 early onset case (4.3%) but not present in the late onset group. Acinetobacter was the only organism found more frequently in the late onset group with 2 cases (4.3%) as opposed to 1 case (2.2%) in the early onset group. In total, 35 occurrences (76.1%) were in the early onset group, and 11 (23.9%) were in the late onset group. [Table 3] illustrates the distribution of various organisms found in male and female neonates in the study subjects. Pseudomonas was detected in 4 males (8.7%) and 9 females (19.6%). Staphylococcus epidermidis was found in 1 male (2.2%) and 5 females (10.9%). Staphylococcus aureus and Candida both presented a similar pattern, with each being found in 1 male (2.2%) and 8 females (17.4%). Klebsiella, Gram-positive rod, Micrococcus, and a combination of both Gram-positive rod and Micrococcus were not detected in any male neonates but were present in the female group. Klebsiella and Gram-positive rod were each found in 2 females (4.3%), while Micrococcus was detected in 2 females (4.3%). Acinetobacter was also only found in the female group, with 3 cases (6.5%). The overall total shows that the organisms were significantly more common in females, with 39 cases (84.8%), compared to 7 cases (15.2%) in males. This

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suggests a higher prevalence of these organisms in female neonates within the sample group. Table 4 illustrates antibiotic sensitivity and resistance patterns in a study involving 46 samples. Novobiocin, Tetracycline, Vancomycin, and Tegecycline displayed no resistance. Notably, Ciprofloxacin and Co-Trimoxazole showcased the highest sensitivity, both at 43.5%. On the other hand, several antibiotics such as Erythromycin, Cefixime, Aztreonam, Cefuroxime, and Ceftriazone demonstrated complete resistance. The antibiotic Gentamicin showed significant resistance at 34.8% while Amoxiciline revealed a considerable resistance rate at 32.6%. Balanced sensitivity and resistance were observed for several antibiotics like Cefoxitin and Ceftazidime. The table 5 provides antibiotic sensitivity test involving five bacteria: Pseudomonas, Staphylococcus epidermidis, Klebsiella, Staphylococcus aureus, and Acinetobacter. The remaining three bacteria, Candida, Staphylococcus aureus, and Gram (+ve) rod, were not sensitive to any antibiotics. Pseudomonas was most sensitive to Cephalosporin, with 20 cases (43.5%) being successful. Amino glycoside, Ciprofloxacin, Co-Trimoxazole, and Piperacillin were also somewhat effective, while it showed no sensitivity to Tetracycline, Novobiocin, Vancomycin, Linezolid, Penicillin G, Amoxicillin, Chloramphenicol, and Erythromycin. This organism was most sensitive to Cephalosporin (6 cases, 13%) and Tetracycline (6 cases, 13%). It showed no sensitivity to Carbopenem, Klebsiella, Colistin, Penicillin G, Amoxicillin, and Piperacillin. Klebsiella had limited sensitivity, with only Cephalosporin, Carbopenem, and Ciprofloxacin showing any effectiveness. The most effective antibiotic was Cephalosporin, with 1 case (2.2%) being successful. This organism showed a broad sensitivity profile. It responded most to Cephalosporin (15 case, 32.6%), followed by Linezolid and Vancomycin (both 9 cases, 19.6%). However, it showed no sensitivity to Colistin, Penicillin G, and Amoxicillin. This organism showed very limited sensitivity. Amino glycoside, Tetracycline, Ciprofloxacin, Colistin, Co-Trimoxazole, and Piperacillin showed minimal effectiveness, but no sensitivity was observed to the other antibiotics. Table 6 shows the antibiotic resistance in the organisms. Again, Candida, Staphylococcus aureus, and Gram (+ve) rod were excluded in this table as they had no resistance towards any antibiotics. Pseudomonas exhibited resistance most significantly to Cephalosporin, Carbopenem, and Amino glycoside, each with 7 cases (15.2%) showing resistance. The organism showed the least resistance to Chloramphenicol, Piperacillin, and Ciprofloxacin, with only 2 cases (4.3%) showing resistance. There was no resistance to Erythromycin, Co-Trimoxazole, and Linezolid. Staphylococcus epidermidis showed the highest resistance to Cephalosporin, with 8 (17.4%) patients indicating resistance. In contrast, the organism showed the least resistance to Linezolid and Piperacillin. It exhibited no resistance to Carbopenem, Colistin, and Aztreonam. Klebsiella demonstrated the highest resistance to Cephalosporin, with 8 (17.4%) patients indicating resistance. It showed the least resistance to Carbopenem, Co-Trimoxazole, Amoxicillin, Piperacillin, Ciprofloxacin, and Aztreonam. There was no resistance to Erythromycin, Penicillin G, Linezolid, and Chloramphenicol. Staphylococcus aureus

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exhibited resistance mostly to Amoxicillin, with 5 (10.9%) patients indicating resistance. This organism also showed notable resistance to Erythromycin. In contrast, it showed the least resistance to Penicillin G, Co-Trimoxazole, and Piperacillin. There was no resistance noted to Carbopenem, Linezolid, Aztreonam, and Colistin. Acinetobacter demonstrated the highest resistance to Cephalosporin, with 10 (21.7%) patients showing resistance. It showed the least resistance to Co-Trimoxazole, Amoxicillin, Piperacillin, Ciprofloxacin, Aztreonam, and Chloramphenicol. This organism exhibited no resistance to Erythromycin, Penicillin G, Linezolid, and Colistin.

Table 1: Demographic and bacterial characteristics (N=243).

Characteristics		**n**	**%**
Age (Hour)	≤72 (Early onset)	207	85.2
	>72 (Late onset)	36	14.8
Sex	Male	25	10.3
	Female	218	89.7
Blood culture test	Positive	46	18.9
	Negative	197	81.1
Name of organism	Pseudomonas	13	28.2
	Staphylococcus epidermidis	6	13.0
	Candida	9	19.6
	Klebsiella	2	4.3
	Staphylococcus aureus	9	19.6
	Gram (+ve) rod	2	4.3
	Micrcoccus	2	4.3
	Acinetobacter	3	6.5

Table 2: Pattern of organisms between age groups (N=46)

Organism found	**Age**			
	Early onset (≤72 hours)		**Late onset (>72 hours)**	
	n	**%**	**n**	**%**
Pseudomonas	9	19.6	4	8.7
Staphylococcus epidermidis	3	6.5	3	6.5
Staphylococcus aureus	9	19.6	0	0.0
Candida	7	15.2	2	4.3
Klebsiella	2	4.3	0	0.0
Gram (+ve) rod	2	4.3	0	0.0
Micrococcus	2	4.3	0	0.0
Acinetobacter	1	2.2	2	4.3
Total	35	76.1	11	23.9

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Table 3: Pattern of organisms between male and female neonates (N=46)

Organism found	**Sex**			
	Male		**Female**	
	n	**%**	**n**	**%**
Pseudomonas	4	8.7	9	19.6
Staphylococcus epidermidis	1	2.2	5	10.9
Staphylococcus aureus	1	2.2	8	17.4
Candida	1	2.2	8	17.4
Klebsiella	0	0	2	4.3
Gram (+ve) rod	0	0	2	4.3
Micrococcus	0	0	2	4.3
Acinetobacter	0	0	3	6.5
Total	7	15.2	39	84.8

Table 4: Antibiotic sensitivity and resistance pattern (N=46).

Antibiotics	**Sensitivity**		**Resistance**	
	n	**%**	**n**	%
Novobiocin	7	15.2	0	0.0
Cefoxitin	7	15.2	7	15.2
Ceftazidime	18	39.1	7	15.2
Gentamicin	12	26.1	16	34.8
Ciprofloxacin	20	43.5	13	28.3
Tetracycline	13	28.3	0	0.0
Colistin	10	21.7	8	17.4
Cefepime	10	21.7	4	8.7
Imipenem	2	4.3	1	2.2
Meropenem	8	17.4	11	23.9
Vancomycin	13	28.3	0	0.0
Co-Trimoxazole	20	43.5	9	19.6
Linezolid	14	30.4	1	2.2
Penicillin G	4	8.7	6	13.0
Amoxiciline	4	8.7	15	32.6
Erythromycin	0	0.0	9	19.6
Amikacin	14	30.4	7	15.2
Piperacillin	13	28.3	6	13.0
Netilmicin	5	10.9	8	17.4
Tegecycline	1	2.2	0	0.0
Chloramphenicol	1	2.2	2	4.3
Cefixime	0	0.0	7	15.2
Aztreonam	0	0.0	6	13.0
Cefuroxime	0	0.0	1	2.2

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Ceftriazone	0	0.0	7	15.2

Table 5: Antibiotic sensitivity in the organism (N=46).

Sensitivity	Pseudomonas	Staphylococcus epidermidis	Klebsiella	Staphylococcus aureus	Acinetobacter
Cephalosporin (n, %)	20 (43.5%)	6 (13%)	1 (2.2%)	15 (32.6%)	0
Carbopenem (n, %)	6 (13%)	0	2 (4.3%)	1 (2.2%)	0
Amino glycoside (n, %)	15 (32.4%)	3 (6.5%)	0	6 (13%)	2 (4.3%)
Tetracycline (n, %)	0	6 (13%)	0	5 (10.9%)	2 (4.3%)
Novobiocin (n, %)	0	3 (6.5%)	0	4 (8.7%)	0
Ciprofloxacin (n, %)	11 (23.9%)	2 (4.3%)	1 (2.2%)	5 (10.9%)	1 (2.2%)
Colistin (n, %)	5 (10.9%)	0	2 (4.3%)	0	3 (6.5%)
Vancomycin (n, %)	0	4 (8.7%)	0	9 (19.6%)	0
Co-Trimoxazole (n, %)	12 (26.1%)	0	0	6 (13%)	2 (4.3%)
Linezolid (n, %)	0	5 (10.9%)	0	9 (19.6%)	0
Penicillin G (n, %)	0	0	0	4 (8.7%)	0
Amoxiciline (n, %)	0	0	0	4 (8.7%)	0
Piperacillin (n, %)	11 (23.9%)	0	0	1 (2.2%)	1 (2.2%)
Chloramphenicol (n, %)	0	0	1 (2.2%)	3 (6.5%)	0
Erythromycin (n, %)	0	0	0	0	0
Netilmicin (n, %)	2 (4.3%)	1 (2.2%)	0	1 (2.2%)	1 (2.2%)

Table 6: Antibiotic resistance in the organisms (N=46).

Resistance	Pseudomonas	Staphylococcus epidermidis	Klebsiella	Staphylococcus aureus	Acinetobacter
Cephalosporin (n, %)	7 (15.2%)	8 (17.4%)	8 (17.4%)	6 (13%)	10 (21.7%)
Carbopenem (n, %)	7 (15.2%)	0	1 (2.2%)	0	5 (10.9%)
Amino glycoside (n, %)	7 (15.2%)	4 (8.7%)	4 (8.7%)	2 (4.3%)	4 (8.7%)
Erythromycin (n, %)	0	4 (8.7%)	0	5 (10.9%)	0
Co-Trimoxazole (n, %)	0	3 (6.5%)	2 (4.3%)	3 (6.5%)	1 (2.2%)
Amoxiciline (n, %)	3 (6.5%)	4 (8.7%)	2 (4.3%)	5 (10.9%)	1 (2.2%)
Penicillin G (n, %)	0	5 (10.9%)	0	1 (2.2%)	0
Linezolid (n, %)	0	1 (2.2%)	0	0	0
Piperacillin (n, %)	2 (4.3%)	0	2 (4.3%)	0	2 (4.3%)
Ciprofloxacin (n, %)	2 (4.3%)	4 (8.7%)	1 (2.2%)	4 (8.7%)	2 (4.3%)
Aztreonam (n, %)	3 (6.5%)	0	2 (4.3%)	0	1 (2.2%)
Chloramphenicol (n, %)	1 (2.2%)	0	0	0	1 (2.2%)
Colistin (n, %)	8 (17.4%)	0	0	0	0

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DISCUSSION

The conducted research aimed to investigate the bacteriological profile of neonatal septicemia and antibiotic sensitivity pattern. The demographic data shows a high prevalence of bacterial colonization in individuals aged ≤72 hours (85.2%), and females (89.7%). Additionally, bacterial culture tests were positive in 18.9% of the sample population which is similar to other studies.[13] Pseudomonas was the most prevalent (28.2%) bacterial organism followed by Candida, Staphylococcus epidermidis, and Staphylococcus aureus. But, in other studies, Staphylococcus epidermidis, Staphylococcus aureus, and Klebsiella were more prevalent.[14,15,16] In bacterial organism test, there were more early onset cases (76.1%) as compared to late onset cases (23.9%). This trend was consistent across most organisms, except for Acinetobacter, which was found more frequently in the late onset group. This could suggest that the initial bacterial colonization within 72 hours of birth is more diverse and possibly influenced by factors such as acquired from fetal life, delivery method and early life environment.[17] This finding is consistent with other studies.[18,19] In terms of antibiotic sensitivity, Pseudomonas was found to be most sensitive to Cephalosporin, and Staphylococcus aureus responded most to the same antibiotic, which is in line with the literature stating their high effectiveness against Gram-negative bacteria. Amino glycoside, Ciprofloxacin, Co-Trimoxazole, and Piperacillin were also somewhat effective, while it showed no sensitivity to Tetracycline, Novobiocin, Vancomycin, Linezolid, Penicillin G, Amoxicillin, Chloramphenicol, and Erythromycin. This organism was most sensitive to Cephalosporin (6 cases, 13%) and Tetracycline (6 cases, 13%). It showed no sensitivity to Carbopenem, Klebsiella, Colistin, Penicillin G, Amoxicillin, and Piperacillin. Klebsiella had limited sensitivity, with only Cephalosporin, Carbopenem, and Ciprofloxacin showing any effectiveness. The most effective antibiotic was Cephalosporin, with 1 (2.2%) patient being successful. This organism showed a broad sensitivity profile. It responded most to Cephalosporin (15 cases, 32.6%), followed by Linezolid and Vancomycin (both 9 cases, 19.6%). However, it showed no sensitivity to Colistin, Penicillin G, and Amoxicillin. This organism showed very limited sensitivity. Amino glycoside, Tetracycline, Ciprofloxacin, Colistin, Co-Trimoxazole, and Piperacillin showed minimal effectiveness, but no sensitivity was observed to the other antibiotics. In the study of Islam QR et al.[15] Gentamicin, a commonly used antibiotic in our nurseries was found 15.4%, 16.7% & 44.4% sensitive to K. pneumoniae, E. coli & S. aureus respectively. In another study of Jyothi P et al,[18] best overall sensitivity among Gram-negative isolates was to imipenem (93%), followed by amikacin (52%) and netilmicin (41%). Gram-positive isolates had sensitivity of 91% to linezolid, 68% to tetracycline, 64% to piperacillin/tazobactam erythromycin, and 52% to ciprofloxacin. In the study of Yadav NS et al,[21] gentamicin (90%) and ofoxacin (90%) were the most sensitive and ampicillin (76%) was the most resistive antibiotics against S. aureus. Furthermore, in assessing antibiotic resistance, each bacterial species displayed resistance to at least one antibiotic. Pseudomonas, Staphylococcus epidermidis, and Klebsiella were particularly resistant to

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Cephalosporin. The phenomenon of antibiotic resistance is a pressing issue in the medical field and could be attributed to various factors such as overuse of antibiotics and lack of new antibiotics being developed. In the study of Pokhrel B et al,[20] majority of causative organisms have developed resistance to these frequently used antibiotics; Amoxicillin, Cefotaxime and Oxacillin from the beta-lactam group. In the study of Muley VA et al,[16] resistance ranging from 50% to 73% was observed in Gram-negative isolates for co-trimoxazole, cefotaxime, ampicillin and ceftazidime. Gram-positive isolates had shown the resistance ranging from 42% to 71% against co-trimoxazole, cefazolin, amoxycillin and penicillin.

Limitations of the study

In our study, there was small sample size and absence of control for comparison. Study population was selected from one center in Dhaka city, so may not represent wider population. The study was conducted at a short period of time. The sampling was retrospective and there was no random allocation, so there is risk of selection bias.

CONCLUSIONS

From the findings of this study, it can be concluded that early-onset septicemia had higher bacterial presence than late-onset, and females exhibited more bacterial presence than males. Pseudomonas was the most frequent organism. Antibiotic sensitivity varied, with Pseudomonas most responsive to Ceftazedime. However, numerous bacteria showed resistance, most notably Acinetobacter to Cephalosporin. The research emphasized the influence of age, gender, and bacteria type on septicemia and antibiotic response. future studies are needed to confirm these findings and further investigate the underlying mechanisms of antibiotic resistance in these bacteria.

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