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Microbiological Profile, Antibiotic Sensitivity Pattern, and Maternal Outcomes in Obstetric Patients with Sepsis and Septic Shock: A Prospective Observational Study in a Tertiary Care Hospital

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ABSTRACT

Background: Sepsis and septic shock are the most common causes of maternal morbidity and mortality, especially in developing nations where antimicrobial resistance and late diagnosis complicate treatment. It is essential to learn the microbial spectrum, susceptibility to antibiotics, and outcomes related to maternal care in order to make informed care and minimize morbidity and mortality.

Objective: To identify the microbiological profile, the pattern of antibiotic sensitivity, and maternal outcomes in obstetric patients with sepsis and septic shock at Sohar Hospital Sohar, Oman.

Methods: The study is a prospective cross-sectional study to be carried out in the department of obstetrics and gynecology during the period from February 2020 to July 2020. Sixty obstetric patients who fit the diagnostic criteria of sepsis or septic shock were involved. Culture of blood, urine, and vaginal samples was performed, and identification of the isolates was performed using standard microbiological methods. The Kirby-Bauer disc diffusion test was used to determine the antibiotic sensitivity. SPSS version 26 was used to analyze the data.

Results: Gram-negative bacteria were the most common (73.3%), with Escherichia coli (30%) and Klebsiella pneumoniae (20%) as the most common organisms. Cephalosporins (70%) showed high resistance, and carbapenems and aminoglycosides were the most effective. The overall outcome was a 60% recovery rate and a 6.7% mortality rate, mainly due to multidrug-resistant infections.

Conclusion: Gram-negative pathogens are the greatest cause of obstetric sepsis at Sohar Hospital Sohar, Oman. The prevalence of high antibiotic resistance demonstrates the importance of strong infection control, regular therapy based on cultures, and antibiotic stewardship to enhance maternal outcomes and decrease the mortality related to sepsis

Keywords: *Obstetric sepsis, septic shock, microbiological profile, antibiotic sensitivity, maternal outcomes, Sohar Hospital Sohar, Oman*

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1. INTRODUCTION

Sepsis and septic shock are still one of the most demanding issues in obstetric services as they are a significant cause of maternal morbidity and mortality globally. It is a condition that is marked by an abnormal host response to infection with life-threatening dysfunction of organs, especially when the environment is resource-limited (1). To direct empirical therapy and enhance the survival rates, it is necessary to have a holistic picture of the microbiological spectrum, the pattern of antibiotic sensitivity, and the clinical outcome of obstetric patients. As per recent findings, sepsis cannot be limited by a particular area or socioeconomic background; instead, it is a universal issue requiring context-sensitive studies to streamline clinical management procedures. Microbial etiology of sepsis and resistance patterns are significantly different in geographical locations, and it is therefore required that periodic surveillance is conducted to inform effective antimicrobial policies (2).

The situation with sepsis among obstetric patients is especially complicated due to the nature of the immunological and physiological responses to the pregnancy that alter the way the host reacts to pathogens and antibiotic pharmacokinetics (3). Consequently, it is essential to study these factors in tertiary care hospitals, including Sohar Hospital Sohar, Oman, to resolve the increasing issue of antibiotic resistance and poor maternal outcomes (4). Multidrug-resistant organisms have also increased the complexity of sepsis management in pregnant and postpartum women. It has been recorded that there has been a great difference in microbial isolates and their resistance profile across regions and even within the same institution over time (5). These are explained by the various factors, such as empirical overuse of wide-spectrum antibiotics, poor infection control measures, and low levels of microbiological diagnostic capacity in most developing nations. A polymicrobial infection frequently causes maternal sepsis, with Escherichia coli, Staphylococcus aureus, Klebsiella pneumoniae, and Pseudomonas aeruginosa being the most common isolates in different hospital-based studies (6).

The information on such bacterial distributions and trends of susceptibility is paramount to reflect the required policies of empirical therapy and infection control (7). Furthermore, the need to diagnose and initiate the use of the antibiotics early and as soon as possible is essential to reduce the risks of the emergence of septic shock and subsequent maternal or fetal complications (8). The growing literature highlights the fact that the obstetric pathways of care should also be complemented with infection prevention and the antibiotic stewardship initiatives to decrease the impact of antimicrobial resistance, as well as to improve the maternal health outcomes (9). A significant causal agent of maternal sepsis all over the world is bacterial infections, particularly in the low and middle-income nations where medical institutions and diagnostic capabilities are minimal. In one of the investigations conducted in Tanzania, the researchers emphasized the need to intensify antibiotic stewardship programs and continuous monitoring of the resistance patterns to curb the increasing rate of maternal diseases (10).

Similar findings were also observed in South Asian backgrounds, where the failure to diagnose the patients early and provide them with advanced therapy often results in more morbidity and mortality of patients with sepsis (11). Obstetric sepsis is a startling problem in Oman because of the poor quality of antenatal care, late referral to the hospital, and improper use of antibiotics in rural and urban health facilities (12). Observational studies conducted in hospitals have established that multidrug-resistant Gram-negative bacteria are becoming more common in the intensive care unit and present a problem with therapeutic decision-making (13). These results highlight that systematic microbiological surveillance in tertiary care facilities is badly required to know the local epidemiological trends and enhance the practice of antimicrobial prescription (14). The patterns of antibiotic sensitivity differ highly in relation to both bacterial species and healthcare settings. The recognition of the causative organism of a particular organism and its resistance pattern offers essential information on the rational use of antibiotics.

Some recent reports have emphasized the prevalence of Gram-negative pathogens, including Klebsiella, Acinetobacter, and E. coli, which frequently have resistance to the third-generation cephalosporins and carbapenems (15). Cases of emergence of the methicillin-resistant Staphylococcus aureus (MRSA) and extended-spectrum beta-lactamase (ESBL)-producing Staphylococcus aureus have been reported as a severe public health concern (16). Massive application of empirical antibiotic treatment, devoid of culture and sensitivity advice, has promoted the development of resistance and made the results of treatment more uncertain. Moreover, the review of meta-analyses worldwide has shown that the existing empirical antibiotic guidelines, particularly in low- and middle-income nations, might not be capable of efficiently combating resistant Gram-negative sepsis anymore (17). As a result, there is an urgent demand to provide region-specific microbial profiles and antibiotic susceptibility data to provide clinical guidelines, particularly in tertiary care hospitals treating high-risk obstetric cases as routine cases (18).

Maternal sepsis has been one of the leading causes of maternal mortality in Oman, even though the healthcare infrastructure has been improving. Sociocultural and logistical obstacles to accessing healthcare services in a good manner usually lead to the presentation of obstetric patients with severe infections (15). These complications, together with the development of multidrug-resistant organisms, complicate the management of these conditions. Sepsis management is still based on empirical antibiotic therapy, but, unless microbiological surveillance is conducted regularly, empirical treatment will not be able to respond adequately to the changing patterns of resistance. Therefore, it is necessary to have an understanding of the bacteriological profile and sensitivity patterns of obstetric patients with sepsis and septic shock in order to mitigate the trend of preventable maternal deaths (16). The purpose of the present research at the Sohar Hospital Sohar, Oman, is to identify the range of microbiological spectrum of the obstetric cases with sepsis and septic shock, and the antibiotic susceptibility pattern and maternal outcome. The study aims to use this prospective observational design to give evidence-based solutions to effective antibiotic stewardship and clinical management practices that can be used based on the local healthcare setting.

Objective: To identify the microbiological profile, antibiotic sensitivity profile, and maternal outcome of obstetric patients with sepsis and septic shock during the study period in Sohar Hospital Sohar, Oman.

2. MATERIALS AND METHODS

Study Design: This was a cross-sectional, prospective observational study.

Study Setting: Department of Obstetrics and Gynecology, Sohar Hospital Sohar, Oman.

Duration of the Study: February 2020 to July 2020.

Inclusion Criteria: Included were all obstetric patients (pregnant or 42 days have passed since delivery) who were hospitalized with a clinical diagnosis of sepsis or septic shock. Clinical criteria such as fever [?] 38 °C, tachycardia, tachypnea, hypotension, and laboratory findings of infection, including leukocytosis, high C-reactive protein (CRP), or positive blood cultures, were used in the diagnosis. Microbiological validation was done to include patients with confirmed cases of bacterial infection, such as urinary tract infection, chorioamnionitis, endometritis, or wound sepsis.

Exclusion Criteria: Patients with non-infectious causes of systemic inflammatory response, including autoimmune diseases, trauma, or hemorrhage, were eliminated. All the patients who had more than 72 hours of antibiotics before admission to the hospital, or a lack of complete clinical or microbiological data, were also not allowed for obtaining proper culture and sensitivity results.

Methods: The study population involved all the eligible obstetric patients who attended the hospital with signs and symptoms of sepsis or septic shock. Careful demographic and obstetric history was also taken, such as age, parity, gestational age, and source of infection. The high vaginal swab samples, blood, and urine samples were collected in an aseptic environment prior to the administration of antibiotic therapy. All such specimens were taken to the microbiology lab in the hospital to be cultured and tested in terms of sensitivity using the standard protocols. The bacterial isolates were identified by Gram staining, biochemical reactions, and automated culture systems when possible. The Kirby-Bauer disc diffusion test with CLSI guidelines was used to conduct antibiotic susceptibility testing. Patients were treated in accordance with the protocols of institutional sepsis, and their outcome was observed during hospitalization, such as recovery, development of complications, or death. All of the obtained data were evaluated with the help of SPSS version 26, and the descriptive statistics were used in order to identify the microbiological profile and antibiotic resistance patterns.

Results

A total of 60 obstetric patients with clinically diagnosed sepsis and septic shock were included in the study. The mean age of the participants was 27.8 ± 5.3 years, with the majority (65%) belonging to the 20–30-year age group. Most women were multigravida (56.7%), and 70% of cases occurred in the postpartum period. The predominant sources of infection were puerperal sepsis (36.7%), urinary tract infection (25%), wound infection (20%), and chorioamnionitis (18.3%).

Table 1. Demographic and Clinical Characteristics of Obstetric Patients with Sepsis (n=60)

Variable	Frequency (n)	Percentage (%)
Age (years)		
<20	6	10.0
20–30	39	65.0
>30	15	25.0

Variable	Frequency (n)	Percentage (%)
Parity		
Primigravida	26	43.3
Multigravida	34	56.7
Period		
Antenatal	18	30.0
Postpartum	42	70.0

Most patients presented with fever (100%), tachycardia (90%), and hypotension (45%). Laboratory findings revealed leukocytosis in 76.7% and elevated CRP in 83.3% of patients. Blood cultures were positive in 40 cases (66.7%), while urine and vaginal swab cultures were positive in 12 (20%) and 8 (13.3%) cases respectively.

Table 2. Distribution of Microbial Isolates (n=60)

Microorganism	Frequency (n)	Percentage (%)
Escherichia coli	18	30.0
Klebsiella pneumoniae	12	20.0
Staphylococcus aureus	10	16.7
Pseudomonas aeruginosa	8	13.3
Acinetobacter baumannii	6	10.0
Enterococcus faecalis	4	6.7
Total	60	100.0

E. coli was the most commonly isolated pathogen, followed by *Klebsiella pneumoniae* and *Staphylococcus aureus*. Gram-negative organisms accounted for 73.3% of isolates, indicating a predominant burden of enteric pathogens in obstetric sepsis.

Table 3. Antibiotic Sensitivity Pattern of Major Isolates (n=60)

Antibiotic	Sensitive (%)	Resistant (%)
Piperacillin-tazobactam	65.0	35.0
Meropenem	75.0	25.0
Ceftriaxone	30.0	70.0
Gentamicin	55.0	45.0
Amikacin	68.3	31.7
Vancomycin (*for Gram-positive*)	80.0	20.0

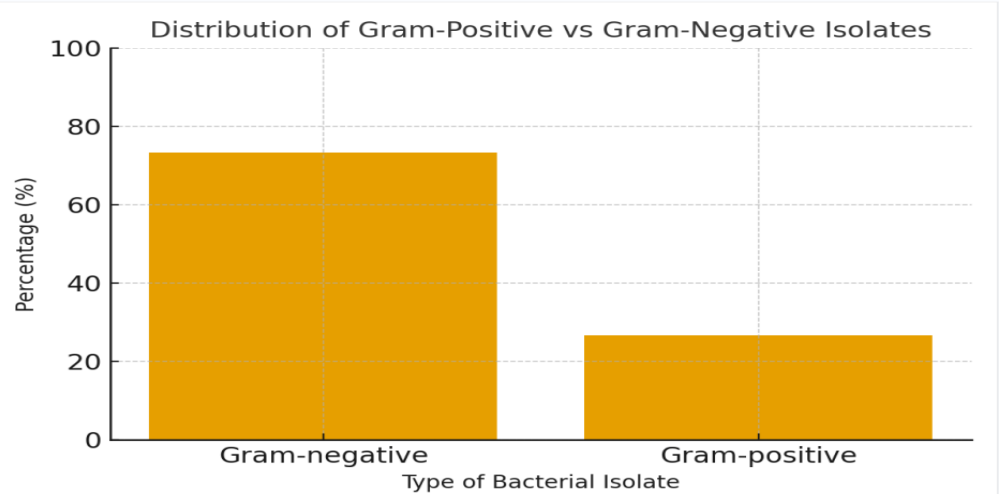
Most *Gram-negative* organisms showed high sensitivity to carbapenems and amikacin, while resistance to third-generation cephalosporins was significant. *Gram-positive* organisms such as *Staphylococcus aureus* were highly sensitive to

vancomycin and linezolid.

Table 4. Maternal Outcomes (n=60)

Outcome	Frequency (n)	Percentage (%)
Recovered without complications	36	60.0
Developed complications (e.g., DIC, ARDS)	14	23.3
Required ICU admission	6	10.0
Mortality	4	6.7
Total	60	100.0

The overall recovery rate was 60%, while 23.3% developed complications such as disseminated intravascular coagulation (DIC) or acute respiratory distress syndrome (ARDS). Mortality was 6.7%, primarily in cases of septic shock associated with multidrug-resistant *Klebsiella* and *Pseudomonas* infections.



The predominance of Gram-negative bacteria underscores the need for robust antibiotic stewardship programs and continuous microbiological surveillance to guide empirical antibiotic therapy.

3. DISCUSSION

The present study measured the microbiological spectrum, the antibiotic pattern sensitivity, and the maternal outcome of the obstetric patients with sepsis and septic shock in Sohar Hospital Sohar, Oman. The findings indicated that Gram-negative bacteria were the most common, with Escherichia coli and Klebsiella pneumoniae as the most common Gram-negative isolates and Staphylococcus aureus being the most common Gram-positive isolate. This is supported by the tendencies in the world and region as well that indicate Gram-negative pathogens prevail in the number of cases of sepsis, and have both clinical and epidemiological significance in obstetric infections (1). The etiology of sepsis in the chosen microbes is also heterogeneous, as shown in the same study based on geographic, environmental, and hospital factors, which is also upheld based on the heterogeneity of bacterial isolates in the study (2). Additionally, the prevalence of E. coli and Klebsiella species points to endogenous contamination of the genital or urinary origin, which is why improved hygiene and infection control measures should be employed in the labor and postnatal departments (3).

High resistance to third-generation cephalosporins, which is evident in this paper, has been observed in tertiary hospitals in the developing countries where widespread empirical application of cephalosporins has led to selective resistance pressure (4). Similar trends of resistance have been observed in studies conducted on Sohar Hospital Sohar, Oman and African hospitals, where E. coli and Klebsiella isolates have been proposed to have a higher resistance to beta-lactam antibiotics (5). The current research highlights the increasing issue of Gram-negative multidrug-resistant bacteria in obstetrics, which makes the treatment plan difficult to implement empirically and extends hospitalization. Another recent meta-analysis in sub-Saharan Africa also resulted in similar resistance patterns between bacterial maternal infections,

highlighting the urgency of establishing antibiotic stewardship and surveillance programs in resource-constrained environments (6). Carbapenems like meropenem and aminoglycosides, including amikacin, had the highest sensitivity rates in Gram-negative organisms in the present study. This is in line with the earlier reports that carbapenems are the most effective antibiotics against multidrug-resistant Enterobacteriaceae, although their increasing misuse is likely to lower their effect soon (7).

The resistance patterns presented in this study support the results of other studies in the region and suggest that empirical treatment guidelines should be revised and that the antibiotic selection should be supported by laboratory (8). Equivalent trends were observed in tertiary-level obstetric units in South Asia, where the high resistance to cephalosporin and inconsistent response to aminoglycosides were reported and require a prompt change of antibiotics, guided by culture to ensure better results for mothers (9). Maternal outcomes of the study showed that the maternal mortality was 6.7, which is equivalent to the outcome of other studies published on hospitals in Asia and Africa (10). This rate is fairly small, though alarming, demonstrating the fact that sepsis remains a preventable cause of maternal death. The worldwide statistics show that bacterial sepsis is still one of the five leading causes of maternal mortality, especially in those areas where access to early diagnosis and intensive care is not feasible (11).

The maternal mortality in the present study was related mostly to the multidrug-resistant Klebsiella and Pseudomonas infections, confirming once again that antibiotic resistance is a major factor that affects the effectiveness of treatment and survival (12). It was also mentioned that postpartum complications, such as endometritis and wound infections, also contribute significantly to morbidity of sepsis, as it happens with the current findings, which were obtained in a recent single-center retrospective study (13). The intrinsic occurrence of E. coli and Klebsiella in the specified study is consistent with the prior research, in which it is demonstrated that the two pathogens have frequently been attributed to maternal and neonatal sepsis in Tanzania and Ethiopia (14). Such Gram-negative bacteria are normally linked to the invasion of the urinary tract and the genital tract during pregnancy, which can escalate to systemic invasion when left untreated in time.

Correspondence of the findings of the current research to the observational cohorts that have been done across the world also emphasizes the importance of timely identification, isolation of the source of infection, and the administration of appropriate antibiotics to alleviate sepsis-related deaths (15). Moreover, the increasing evidence of the infection of methicillin-resistant Staphylococcus aureus (MRSA)-like infections, which recent pediatric and adult research has suggested, makes one wary of surveillance of Gram-positive pathogens in obstetric care units (16). The incidence of Gram-negative infections is consistent with the evaluation of other nations that have indicated that the E. coli and Klebsiella species have the greatest rates of sepsis in low-income countries and lower-middle-income nations, where empirical antibiotic guidelines might not adequately address local resistance rates (17). Consequently, the provided outcomes emphasize the fact that the development of a local antibiogram and regular updates of empirical antibiotic policy should be generated in order to keep it up to date with the evolution of resistance.

Additionally, there are other preventive measures, such as the use of aseptic techniques in the delivery process, early symptomatic detection of infection, and postnatal follow-up, which are very important in the prevention of sepsis. The given research article also extends the current data on the risks of maternal sepsis and the bacterial etiology in the Oman healthcare environment. According to the growing evidence, maternal age and parity, as well as the postpartum period, were determined to be the possible risk factors that determine the predisposition and the results of infections (18). The findings suggest the importance of active obstetric surveillance, proactive infection precaution strategies, and timely culture-specific antibiotic therapy to positively impact the prognosis of a mother. The findings of all the results show that the problem of antimicrobial resistance and its impact on the health of the mother still exists in developing countries.

In order to reduce the morbidity and mortality associated with sepsis, it can be important to reinforce the microbiological diagnostics, uplift the antibiotic stewardship, and reinforce the infection control activities in the hospitals (15). Consistent education of the local medical personnel on the judicious application of antibiotics and how to prevent the occurrence of infections can also be used to improve clinical outcomes. The present work shows that the Gram-negative bacteria are the most common causative agents of obstetric sepsis in the Sohar Hospital, Sohar, Oman, and the most prevalent agents of the spectrum are E. coli and Klebsiella pneumoniae (17). The fact that the most popular antibiotics like cephalosporins are developing resistance and that the multidrug-resistant strains are still present underlines the great importance of specific antibiotic policies and their monitoring. Laboratory capacity building, evidence-based prescribing, and maternal care paths can be used to reduce the incidence of sepsis and septic shock among obstetric patients.

4. CONCLUSION

As indicated in the current case study of Sohar Hospital, Sohar, Oman, Gram-negative bacteria (mostly Escherichia coli and Klebsiella pneumoniae) are the most common pathogens that lead to obstetric sepsis and septic shock. These were highly resistant to the use of third-generation cephalosporins, but they were susceptible to the carbapenems and the aminoglycosides. The cases of maternal morbidity and maternal mortality have been documented to be highly related to infections of multidrug-resistant strains, and it is in this regard that there is a severe necessity to apply culture-based antibiotic treatment and early treatment. The only solution to counter resistance and hospital-specific antibiotic stewardship

programs is the application of strict measures on infection control, continued microbiological monitoring, and continuous implementation of maternal outcomes. The findings emphasize the importance of early diagnosis, effective administration of antibiotics, as well as multidisciplinary intervention of sepsis to reduce the amount of sepsis-related complications in obstetric patients. It is recommended to undertake future multicentric research on a large scale to investigate more emergent patterns of resistance and to simplify therapeutic regimens to get better maternal health outcomes.

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