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ORIGINAL RESEARCH

Evaluation of Blood and Urine Culture Results Obtained in a University Hospital Emergency Department

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ABSTRACT

The identification of emergency department patients at risk of bacteremia is of critical importance, and the culture method is considered the gold standard for diagnosis. Our study aimed to investigate adult patients admitted to the emergency department whose blood and urine cultures were taken with suspicion of bacteremia. In our study, we retrospectively analyzed the data of adult patients who were admitted to Balikesir University, Faculty of Medicine, Department of Emergency Medicine, between February 2020 and October 2024 and whose blood and urine cultures were taken by emergency physicians to test for bacteremia. The mean age of the 991 patients included in the study was 60.9 years. The most common diagnosis was urinary tract infection (36.8%). Bacterial growth was detected in 398 of the 1296 samples included in the study. While growth was observed in 302 (35.4%) of the 853 urine samples, growth was detected in 96 of 443 blood cultures. Ciprofloxacin was the most resistant antibiotic, and amikacin was the most sensitive to the *E. coli* and *K. pneumoniae* isolates taken from the urine cultures. *K. pneumoniae* isolates were more resistant to all antibiotics than *E. coli* isolates. We suggest that guidelines for empirical antibiotic treatment be developed by evaluating aggregated data on bacteremia from healthcare institutions, and that limitations in antibiotic selection by emergency physicians be implemented, as these may enable patients to access appropriate antibiotics more quickly.

Keywords: Emergency department. Antibiogram. Blood culture.

Bir Üniversite Hastanesi Acil Servisinde Alınan Kan ve İdrar Kültür Sonuçlarının Değerlendirilmesi

ÖZET

Acil serviste bakteriyemi riski taşıyan hastaların tespit edilmesi hayati öneme sahiptir. Teşhis için altın standart yöntem olarak kültür incelemesi kabul edilmektedir. Çalışmamızın amacı acil servise başvuran ve bakteriyemi şüphesi ile kültür alınan hastaları incelemektir. Bu doğrultuda, kültür alınan hastaların demografik özellikleri, şikayetleri, izole edilen mikroorganizmaların sonuçları ve antibiyogram sonuçları değerlendirilmiştir. Çalışmamız, Şubat 2020- Ekim 2024 arasında Balıkesir Üniversitesi Tıp Fakültesi Acil Tıp Anabilim Dalındaki hastalardan ve acil hekimleri tarafından bakteriyemi düşünülerek kan ve idrar kültürü alınan 991 erişkin verilerinin retrospektif olarak incelenmesiyle gerçekleştirilmiştir. Çalışmadaki 991 hastanın yaş ortalaması 60,9 dur. Hastalara en sık konulan tanı üriner sistem enfeksiyonu (%36,8) idi. Çalışmaya dahil edilen 1296 örneğin 398'inde bakteriyel üreme olduğu saptandı. Gönderilen 853 idrar örneğinin 302'sinde (%35,4) üreme gözlenirken, gönderilen 443 kan kültürünün 96'sında (%21,6) üreme saptandı. İdrar kültürlerinde gözlenen *K. pneumoniae* ve *E. coli* ve izolatlarının en dirençli olduğu antibiyotik siprofloksasin, en duyarlı olduğu ise amikasin olarak saptanmıştır. *K.pneumoniae* izolatlarının, *E. coli*'ye kıyasla tüm antibiyotiklere daha yüksek oranda dirençli olduğu tespit edilmiştir. Sağlık kuruluşlarının bakteriyemi ile ilgili kayıtları düzenli aralıklarla bakılarak ampirik antibiyotik tedavisi için güncellemeler yapılabilir. Kültürlerin daha hızlı elde edilmesini sağlayacak yöntemlerin geliştirilmesi hayat kurtarıcı bir adım olabilir.

Anahtar Kelimeler: Acil servis. Antibiyogram. Kan kültürü.

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Many patients go to the emergency department with symptoms suggestive of infectious diseases, such as fever, cough, shortness of breath, burning urine, abdominal pain, diarrhea, and sore throat. Some of these patients have serious infections that can lead to complications, such as sepsis and septic shock, which are life-threatening and require urgent medical intervention. Early diagnosis of these infections and the rapid initiation of appropriate treatment are very important for patient management[1]. The evaluation of patients in the emergency department in terms of initial history and physical examination, identification of those at risk of bacteremia, and early initiation of

empirical antibiotic treatment for possible pathogens are necessary to prevent morbidity and mortality[2]. However, it is widely known that resistance to empirically initiated antibiotics is developing at increasing rates.

Culture methods are the gold standard in the diagnosis of infectious diseases. Appropriate culture samples should be taken and sent to the microbiology laboratory as soon as possible, and under the right conditions, before starting antibiotic treatment in patients. Such a practice serves as a model for the correct identification of microorganisms and the determination of antibiotic susceptibilities. If this protocol is followed, it is possible to change the empirical treatment started in the emergency department to an antibiotic treatment directed at the causative agent[3].

Gram-positive cocci (especially *Staphylococcus* spp. and *Enterococcus* spp.) and gram-negative bacilli (especially *Pseudomonas aeruginosa*, *Escherichia coli*, *Acinetobacter baumannii*, and *Klebsiella* spp.) are frequently isolated microorganisms in bacteremia[4.] Gram-negative bacteria are the most common microorganisms, causing urinary tract infections in all age groups and both sexes. Among these, *Escherichia coli* is the most frequently isolated agent (50-90%), followed by *Klebsiella pneumoniae*[5]. However, isolated agents and antibiotic resistance rates vary from hospital to hospital[6]. Furthermore, these rates may vary among different units of the same hospital. Considering that treatment is usually initiated empirically, it would make the most sense for individual centers to follow their own epidemiological surveillance protocols, treatment choices, and patient management approaches[7].

In this study, we aimed to evaluate the demographic characteristics and diagnoses of adult patients admitted to the Department of Emergency Medicine of the hospital involved in the current study, and whose blood and urine cultures were suspected of bacteremia. This was done to determine the distribution and antibiotic resistance rates of the isolated microorganisms and appropriate treatments.

Material and Method

Research Model

This study was designed as a retrospective descriptive observational study. Observational studies are concerned with investigating relationships among characteristics of human populations, after the manner of an experiment, but comparing groups among which the 'treatments' are not randomly assigned[8].

Data Collection

Between February 2020 and October 2024, 1,296 blood and urine culture samples of 991 adult patients with suspected bacteremia, who applied to the emergency department within this time frame, were evaluated. These samples had all been sent to the microbiology laboratory of the hospital. Demographic data, emergency department diagnoses, bacteria isolated from blood and urine culture specimens, and antibiotic susceptibility results were obtained retrospectively from the hospital's electronic information system and laboratory information system. Additionally, surveys, interviews, and/or additional data were not used.

Blood and Urine Culture Analysis

Blood culture samples were monitored in the BD BACTEC FX (Becton Dickinson, USA) automated blood culture system. All samples with a positive growth signal were examined by gram staining and simultaneously inoculated on blood agar, Eosin Methylene Blue (EMB) agar, and chocolate agar media. All plates were incubated at 37°C for 24–48 hours.

All urine samples were inoculated on 5% sheep blood agar and EMB agar with a 0.01 ml capacity sterile plastic ring extract and incubated at 37°C for 24–48 hours. Samples with single/two types of uropathogens and $\geq 10^4$ cfu/ml growth were considered to exhibit significant growth and were then evaluated[9].

Isolates were identified using conventional methods and the BD Phoenix 100 automated identification system (BD Phoenix System, Becton Dickinson, USA). In-vitro antibiotic susceptibilities of the isolates were determined using the Phoenix TM 100 automated identification system (BD Phoenix System, Becton Dickinson, USA) and interpreted according to the European Committee on Antimicrobial Susceptibility Testing (EUCAST) criteria[10].

Ethical Approval

Ethical approval for this study was obtained from Balikesir University Health Sciences Non-Interventional Research Ethics Committee, with decision number 2024/245 dated 17.12.2024.

Statistical Analysis

The collected data were analyzed using SPSS 26.0 software; descriptive statistics (frequency, percentage) and the chi-square test were used for significance testing. Bivariate correlations (Pearson's R and Spearman's tests) were used to evaluate the correlations between the data.

Results

The ages of the 991 patients whose blood and urine culture samples were evaluated ranged between 18–99 years. The mean age was 60.9 years. Of these patients, 438 (44.1%) were male, and 553 (55.9%) were female. Urinary tract infection (36.8%), gastrointestinal tract infection (15.2%), septicemia (14.2%), pulmonary infection (10.9%), and septicemia (14.2%) were the most common causes of bacteremia in these 991 patients. Orthopedic infection (4.7%), neurological infection (4.3%), cardiac infection (4.3%), viral/parasitic infection (3.8%), dermatological infection (2%), gynecological infection (2.3%), and surgical infection (1.1%) were other notable causes (Table I).

Table I. Diagnoses of patients whose blood and urine cultures were sent for microbiologic examination

Diagnoses	%
Urinary tract infections	36.8
Gynecological infections	2.3
Dermatologic infections	2
Cardiac infections	4.3
Septicemias	14.2
Neurological infections	4.3
Surgical infections	1.1
Pulmonary infections	10.9
Orthopedic infections	4.7
Gastrointestinal infections	15.2
Viral/parasitic infections	3.8
Total	100

Of the 1296 samples sent to the microbiology laboratory, 443 (34.2%) were blood culture samples, and 853 (65.8%) were urine culture samples. In total, 398 of the 1,296 samples showed growth, of which 302 (75.9%) were urine cultures and 96 (24.1%) were blood cultures**.** While growth was observed in 302 (35.4%) of the 853 urine samples, growth was detected in 96 (21.6%) of the 443 blood cultures. Of the 362 patients with culture growth, 46% were male, and 54% were female. The rate of growth in the urine cultures was higher in both men and women than in the blood cultures (Figure 1).

The most frequently isolated microorganism from the urine cultures was *E. coli* (n = 198), followed by *K. pneumoniae* (n = 34), *Enterococcus* spp. (n = 16), and other *Enterobacterales* species (n = 16) (Table II).

In the present study, the most frequently isolated microorganism from the blood cultures was coagulase-negative *Staphylococcus* spp. (n = 29), followed by *E. coli* (n = 25) and *Staphylococcus aureus* (n = 13), respectively (Table III).

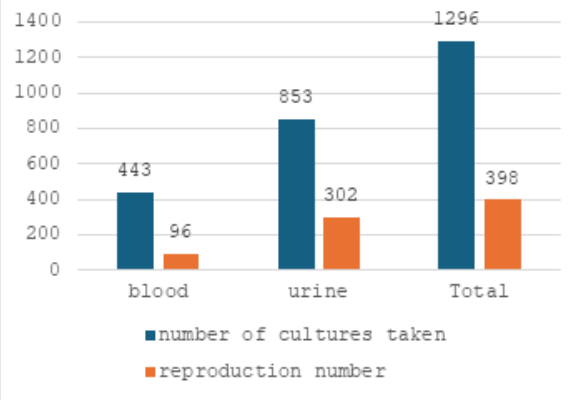

Figure 1.
Culture and growth numbers

Table II. Distribution of microorganisms isolated from urine cultures

Microorganism	Reproduction number	%
Escherichia coli	198	65.5
Klebsiella pneumoniae	34	11.2
Enterococcus spp.	16	5.2
Other *Enterobacterales* species	16	5.2
Candida spp	11	3.6
Pseudomonas spp.	10	3.3
Coagulase-negative *Staphylococcus* spp.	8	2.6
Staphylococcus aureus	4	1.3
Streptococcus agalactiae	3	0.9
Acinetobacter baumannii	2	0.6
Total	302	100

Table III. Distribution of microorganisms isolated from blood cultures

Microorganism	Reproduction number	%
Coagulase-negative *Staphylococcus* spp.	29	30.2
Escherichia coli	25	26
Staphylococcus aureus	13	13.5
Klebsiella pneumoniae	8	8.3
Enterococcus spp.	5	5.2
Pseudomonas aeruginosa	4	4.1
Salmonella spp.	3	3.1
Brucella spp.	2	2
Corynebacterium striatum	1	1
Streptococcus mitis group	1	1
Other	5	5.2
Total	96	100

The antibiotic resistance rates of the *E. coli* and *K. pneumoniae* isolates are shown in Table IV. Among the 198 *E. coli* isolates taken from the urine cultures, the most resistant antibiotic was ciprofloxacin

(41.9%), and the most sensitive was amikacin (1.5%). Other antibiotics with high resistance were levofloxacin (38.3%), trimethoprim/sulfamethoxazole (36.8%), ceftriaxone (35.3%), and ceftazidime (32.8%). Among the 34 *K. pneumoniae* isolates taken from the urine cultures, the most resistant antibiotic was ciprofloxacin (52.9%), and the most sensitive was amikacin (8.8%). Other antibiotics with high resistance were ceftriaxone (50%), ceftazidime (50%), piperacillin/tazobactam (47.1%), and amoxicillin/clavulanic acid (47.1%). When both isolates were evaluated among themselves, it was determined that *K. pneumoniae* isolates were more resistant to all antibiotics than those of *E. coli* (Table IV).

Table IV. Antibiotic resistance rates of *E. coli* and *K. pneumoniae* isolates

Antibiotic	*E. coli* (percentage)	*K. pneumoniae* (percentage)
Levofloxacin	38.3	44.1
Ciprofloxacin	41.9	52.9
Trimethoprim/sulfamethoxazole	36.8	44.1
Amoxicillin/clavulanic acid	29.7	47.1
Gentamicin	23.7	29.4
Imipenem	3.1	17.6
Amikacin	1.5	8.8
Meropenem	3.5	17.6
Piperacillin/tazobactam	14.1	47.1
Ceftazidime	32.8	50.0
Ceftriaxone	35.3	50.0

Discussion and Conclusion

Patients with acute infections mostly apply to the emergency department. In addition, patients with skin, respiratory, and urinary tract infections with moderate symptoms usually cannot wait for treatment in outpatient clinics and present to emergency departments[3]. Physicians working in the emergency department should distinguish serious and life-threatening infections from minor infections and identify them quickly[11.] Rapid history taking, physical examination, targeted imaging methods, and laboratory tests can help to find the likely source of infection. At the same time, appropriate cultures should be obtained before initiating antibiotic therapy[12]. Current guidelines recommend obtaining cultures during or after the identification of sepsis before rapid empirical antimicrobial therapy is initiated[13].

Determining the types of microorganisms grown in blood and urine cultures in a clinic is very important for physicians when choosing the right antibiotic empirically until the culture results are available. Many hospitals throughout the world and in our country are conducting scientific research to determine their own culture flora[14]. Knowing the most common pathogen detected in possible bacterial infections in units with rapid circulation and high patient density, such as the emergency department, and rapidly starting treatment for the pathogen will be most beneficial in the patient's recovery process.

The ages of the patients who underwent blood and urine cultures in the present study were between 18–99 years, and growth in the culture results was observed more often in females. In another study, in cultural growth was observed more frequently in males, which is not compatible with our study[15].

The most common reason for admission in this study was urinary tract infection (36.1%), followed by gastrointestinal infection (15.28%) and septicemia (14.2%). Urinary tract infections are the most commonly diagnosed infections in emergency departments[16]. Other studies have also identified the most common diagnosis as urinary tract infection[17]. This distribution indicates that urinary tract infections are among the most common complaints in emergency departments. Septicemia carries an elevated risk of death, with serious clinical pictures. Due to complications such as chronic renal failure and hypertension, urinary tract infections continue to be a major health problem worldwide, generating high economic costs. Urinary tract infections may show different epidemiologic and etiologic characteristics depending on gender, age, and region. Therefore, regional studies conducted at different times are of great importance for a better understanding of the disease, effective treatment of complications, and prevention of complications.

In a study by Downey et al., urine and blood cultures were compared in the neonatal period, and the concordance in the results was evaluated. The frequency of microorganism growth, according to the culture results, was expressed as *E. coli* 18%, *Candida* 15%, *CNS* 14%, and *Enterococci* 13%. In another study, *CNS* was the most frequently grown microorganism; *Klebsiella, E. coli*, and *Acinetobacter* were grown in that order; *Candida* was not grown; and *Enterococci* rates were found below 5%[15]. In our study, the most frequently grown microorganisms were *E. coli*, *K. pneumoniae*, and *Staphylococcus epidermidis*. While *E. coli* and *K. pneumoniae* were the most frequently grown bacteria in the urine cultures, other *Staphylococcus* spp. bacteria and *E. coli* were the most frequently grown in the blood cultures. *E. coli* was the most frequently isolated microorganism in cultures with growth (55.3%). This was followed by *K. pneumoniae* (9.3%) and *Staphylococcus epidermidis* (5.3%). It is an expected finding that *E. coli* was commonly detected, especially in urinary infections, and that the *Klebsiella* species may play an important role in nosocomial infections.

Çetin et al. found that blood culture results were evaluated, and 67.3% of the microorganisms isolated from the cultures were gram (+) bacteria, 29.4% were gram (-) bacteria, and 3.3% were fungi. The gram (-) bacteria grown were *E. coli*, *Acinetobacter* spp., *Klebsiella* spp., *Pseudomonas* spp., and others, according to their frequency, and the gram (+) bacteria were *S. aureus*, *Enterococcus* spp., and *Streptococcus* spp., according to their frequency[18]. In another study, gram (-) bacteria growth was found more frequently in cultures; the most common gram (-) bacteria was *E. coli*, and gram (+) bacteria were observed most frequently[14].

Complicated urinary tract infections occur in patients with structural anomalies, prostatic hypertrophy, neurogenic bladder, and diabetic patients. Patients presenting with existing urinary symptoms often have complaints such as high fever, burning urine, hematuria, or anuria. In a previous study, the majority (35%) of the patients who applied to the emergency department and had samples tested were patients who presented due to urinary tract infection, and the most frequently isolated bacteria from these patients was *E. coli* (70%)[3]. When the presenting complaints and isolated bacteria were compared, the results were found to be compatible with those of our study.

It should be noted that empirical antibiotic therapy and antibiotic treatment were initiated earlier in patients with positive culture results. These findings suggest that the early acquisition of culture results in patients with suspected infections appearing to be critical in shaping treatment strategies. While antibiotic resistance was previously considered an important problem for nosocomial infections, it has now become a key issue for community-acquired infections[19]. Today, trimethoprim/sulfamethoxazole, ciprofloxacin, and beta-lactams are the most commonly used agents, especially in empirical treatment, and their sensitivity to them is decreasing[20,21].

Similar to the findings in the existing literature, the antibiotics to which *E. coli* and *K. pneumoniae* isolates were most resistant in our study were ciprofloxacin, levofloxacin, trimethoprim/ sulfamethoxazole, ceftriaxone, ceftazidime, piperacillin/tazobactam, and amoxicillin/clavulanic acid. *K. pneumoniae* isolates were found to be more resistant to all antibiotics than those of *E. coli*.

In conclusion, as seen in our study and similar research, culture results may vary from community to community, from hospital to hospital, and even between clinics. Therefore, screening the community flora, the frequency of microorganism growth according to age and special conditions, and the distribution of hospital flora according to the clinic at certain intervals will enable the prediction of possible causative agents of diseases and the early initiation of effective treatment. This will reduce morbidity and mortality, hospitalization time, and treatment costs. Performing such microorganism scans from time to time will also give an idea of the changing flora and the reasons for these fluctuations. At the same time, antimicrobial agent resistance would be detected and could thus form the basis for studies to prevent the development of resistance.

It should be kept in mind that contaminated blood cultures will cause additional increases in patient length of stay, unnecessary antibiotic use, and financial costs. To increase the accuracy of the culture results, aseptic culturing techniques and personal training should be increased. Contamination rates in blood cultures taken in emergency departments are high, and we maintain that the busy emergency department environment is the cause. In our view, improvements should be made to reduce the contamination rate, necessary protocols for blood culture collection should be developed, and employees should be regularly trained.

We believe that local guidelines for empirical antibiotic treatment can be developed by evaluating the aggregated data of healthcare institutions on bacteremia, and re-evaluating the limitations in antibiotic selection by emergency physicians may enable patients to access appropriate antibiotics more quickly. Furthermore, the high incidence of urinary tract infections requires a review of infection management and screening protocols.

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Analysis and interpretation of data: T.K.A.
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