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RESEARCH ARTICLE

STAPHYLOCOCCUS AUREUS RESISTANCE AGAINST CEPHALOSPORIN ANTIBIOTIC IN ADEN-YEMEN

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Abstract

The study was carried out to determine antibacterial resistance profiles of methicillin-resistant Staphylococcus aureus (MRSA), isolated from clinical samples (n: 352) of patients during the period, from January 2019 to July 2020 in five governmental and private medical laboratories of Aden governorate, Yemen. The results showed, the percentage for resistance ratio is differentiated between samples and the category of cephalosporin antibiotic groups. The highest percentage of resistance was in the wound sample for Cefadroxil, Cefuroxime, and Ceftriaxone at (100%), in addition to 100% in the pus, CSF, and sputum samples for Ceftriaxone antibiotic. Moreover, Cefadroxil has 100 % of resistance in semen, ear, and sputum samples. However, the Staphylococcus aureus isolated from the pharyngeal sample not showed any resistance to all cephalosporin antibiotic groups.

Keywords: Cephalosporin antibiotic, Staphylococcus aureus, Antibacterial resistance.

1. Introduction

In 1948, Italian scientist Giuseppe Brotzu discovered cephalosporin chemicals from Cephalosporium acremonium cultures collected from sewage in Sardinia. Cephalosporins are derived naturally from the fungus Cephaosporium acremonium, which produces cephalosporin C. [**1**]. Cephalosporins, which are physically and pharmacologically linked to penicillin, are the most commonly prescribed antibiotic class. Cephalosporins, like penicillin, contain a beta-lactam ring structure that prevents the bacterial cell wall from being synthesised, therefore the moniker "bactericidal" [**2, 3**].

Enterococcus faecium, Staphylococcus aureus, Clostridium difficile, Klebsiellapneumoniae, Acinetobacterbaumanii, Pseudomonas aeruginosa, and Enterobacteriaceae are among the bacteria that cause resistance to this antibiotic [**4, 5**].

Staphylococcus aureus is one of the most common and severe nosocomial pathogens, and it is often resistant to many medications, making infection treatment challenging [**6**]. It appears to add to the overall burden of Staphylococcus infections in hospitals rather than replacing susceptible S. aureus, and it is linked to a significant increase in mortality from Staphylococcal infection [**7**]. Staphylococcus aureus strains continue to be a major problem in many healthcare institutions, especially since the emergence of Methicillin-resistant Staphylococcus aureus (MRSA), which now account for more than 50% of S. aureus recovered from intensive care unit patients and about 40% of S. aureus isolated from non-intensive care unit patients [**8**].

First-generation cephalosporins have more gram-positive action than Second-generation cephalosporins, and higher-generation cephalosporins have more gram-negative activity than lower-generation cephalosporins. The exception is cefepime, a fourth-generation cephalosporin with gram-positive activity compare to first-generation, and was active to gram-negative compare to third-generation cephalosporins [**9**]. Gram-positive cocci are less resistant to third-generation cephalosporins. They are substantially more effective against enterobacteria and multiple resistant bacteria that are resistant to numerous antibiotics. Third-generation cephalosporins have the added benefit of being active against gram-negative rods. Third-generation cephalosporins are effective against infections of hospitals, such as bacteraemia and pneumonia [**1**].

2. Methodology

2.1. Study model:

A cross-sectional study that carried out from January 2019 to July 2020. The patient data were gathered from the microbiology laboratory unit registration book archives. Questionnaire was used for data collections, includes: sex, specimen type, bacterial isolates, and antibiotic susceptibility pattern to resistance or sensitivity. The questionnaire was adjusted to find resistance and sensitivity to Staphylococcus aureus.

2.2. Study Area

The study was performed in private and public laboratories in Aden hospitals, Aden city :Alborg Medical Lab, AlMadina Medical Laboratories, Modern Medical Laboratories, AL-Reyada Hospital, and Aljumhuria Hospital.

2.3. Inclusion Criteria

Specimens of staphylococcus aureus from both sex (male and female) that resistance or sensitivity to cephalosporins encountered during the study.

2.4. The Collection of Data

Data was collected by fifth-year pharmacy students that well trained according to an organized questionnaire.

2.5. Statistical analysis

The data were analyzed by using Statistical Package for Social Sciences (SPSS) version 21. Descriptive statistics were used to determine the frequency and percentages of antibacterial resistance profiles of (MRSA).

3. Result:

In this study, the percentage for sensitivity ratio is differentiated between samples and the category of cephalosporin antibiotic groups. The highest percentage of sensitivity was the pharyngeal sample for both Cefuroxime and Ceftriaxone at (100%), in addition to 100% sensitivity in the vaginal sample for Ceftriaxone antibiotic. However, wound and sputum samples not showed any sensitivity to all cephalosporin antibiotic groups.

Table 1: Comparison resistance ratio between Cefadroxil, Cefotaxime, Cefuroxime, and Ceftriaxone.

percentage	Nasal	Urine	Wound	Vaginal	Pharyngeal	PUS	C.S.F	Semen	Ear	Sputum
Cefadroxil	91	41	100	0	0	67	0	100	100	100
Cefuroxime	20	53	100	50	0	73	0	25	15	100
Ceftriaxone	50	78	100	0	0	100	100	100	50	0
Cefotaxim	100	71	100	50	0	56	67	71	33	100

In this study, the percentage for resistance ratio is differentiated between samples and the category of cephalosporin antibiotic groups. The highest percentage of resistance was the wound sample for Cefadroxil, Cefuroxime, and Ceftriaxone at (100%), in addition to 100% in the pus, CSF, and semen samples for Ceftriaxone antibiotic. Moreover, Cefadroxil has 100 % of resistance in semen, ear, and sputum samples. Ceforuxime showed the most resistance percentage to the sputum sample while cefotaxime was resistant to nasal, wound, and sputum.

However, the pharyngeal sample showed 0 resistance to all cephalosporin antibiotic groups.

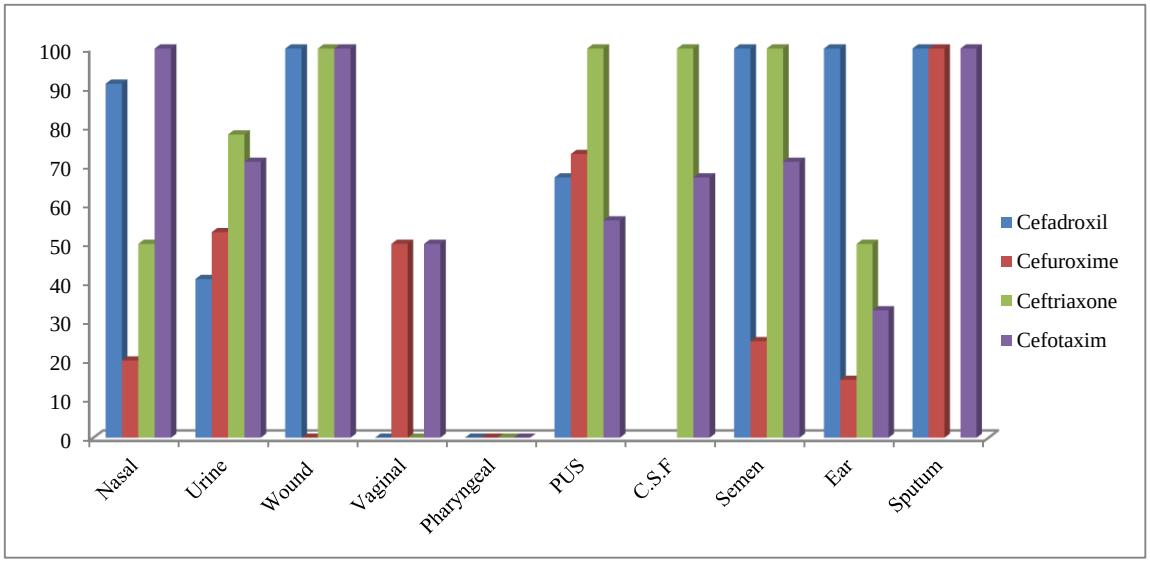

Fig. 1: Comparison resistance ratio between Cefadroxil, Cefotaxime, Cefuroxime, and Ceftriaxone

Figure 1, Shows the data shown in table 1 describing the resistance of 4 groups of cephalosporin in different samples at different percentages and revealed the most resistance to different samples.

Table 2: Percentage of sensitivity and resistance antibiotics belongs cephalosporin category

Percentage	Nasal	Urine	Wound	Vaginal	pharyngeal	Pus	C.S.F	semen	Ear	Sputum
S	25	30	0	55	100	37	29	21	71	0
R	75	70	100	45	0	63	71	79	29	100

The sensitivity and resistance percentage are differentiated between samples and cephalosporin antibiotics with high sensitivity percent in the pharyngeal sample (100%). In contrast, a high resistance percentage was found in wound and sputum samples with (100%).

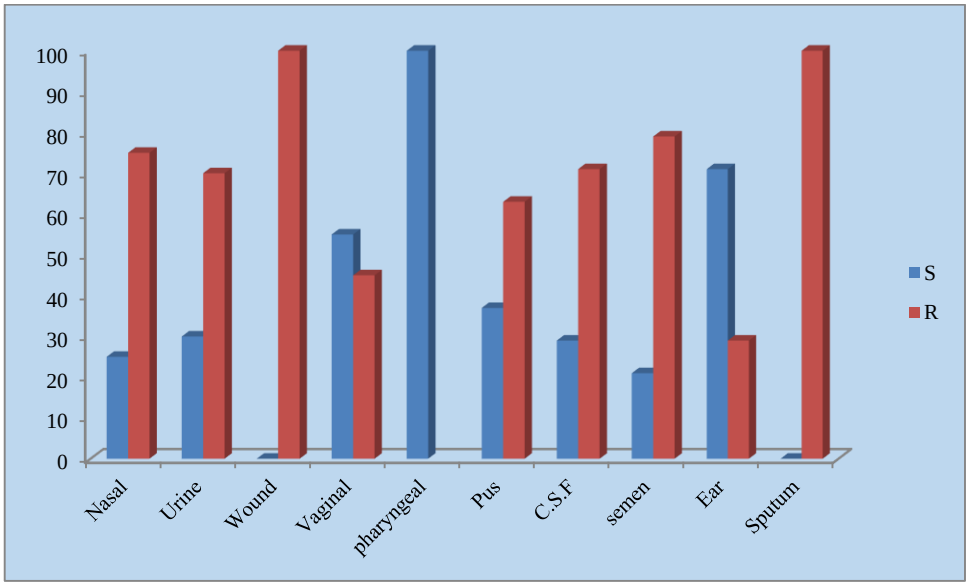

Fig. 2: Percentage of sensitivity and resistance antibiotics belongs to the cephalosporin category

This figure showed the sensitivity and resistance of different samples. The highest resistance percentage was in the sputum and wound samples, followed by semen, nasal, CSF, urine, pus, and vaginal. In comparison, the lowest resistance percentage was found in the ear sample.

Moreover, the sensitivity percentage was the highest in the pharyngeal sample, followed by the ear, vaginal, pus, urine, CSF, nasal, and semen.

4. Discussion:

This study investigated different cephalosporine antibiotics resistance and sensitivity to Staphylococcus aureus in Aden laboratories using different samples.

The data were collected from five main hospitals and laboratories in Aden city. Each laboratory throughout the study period reported variable numbers of antimicrobial-resistant to S.aureus bacteria. The isolated bacterial were of 10 clinical specimens' distribution, and frequency varied in different clinical specimens.

Most S. aureus strains were identified from urine, wound, nasal, pus, semen in our investigation. This is in line with the findings of a prior study conducted in Nairobi [**10**]. Another study on the prevalence and antibiotic susceptibility pattern of S. aureus from clinical isolates in Nigeria showed that a majority of the isolates were from urine specimens (76%) [**11**]. According to the current study's findings, the majority of samples isolated were from urine (46%) however this was lower than in prior studies conducted in Ethiopia between 2013 and 2017 (100 %) [**12**]. Followed by wound (16%) and pus (10%) records may be ascribed to wound and skin infection exposure, making them more susceptible to infections and poor hygiene.

The findings of this investigation revealed that S.aureus isolates exhibited the highest prevalence of cephalosporin antibiotic resistance (100%) in wound and sputum samples. The pharyngeal sample, on the other hand, had the highest frequency of sensitivity. In addition to 100 percent sensitivity, the pharyngeal sample had the highest proportion of sensitivity for both Cefuroxime and Ceftriaxone (100 %). However, all cephalosporin

antibiotic groups demonstrated 0% sensitivity in wound and sputum samples. In terms of resistance percentages, the wound sample for Cefadroxil, Cefuroxime, and Ceftriaxone had the highest proportion of resistance (100 %), as well as 100 % in the pus, CSF, and sputum samples for Ceftriaxone antibiotic. Cefadroxil also demonstrated 100 percent resistance in the sperm, ear, and sputum.

The pharyngeal sample, on the other hand, exhibited no resistance to any of the cephalosporin antibiotic families.

The discrepancy in prevalence could be due to a variety of factors, including the healthcare facilities available in each hospital, the establishment and monitoring of an infection control committee, and the rationale of antibiotic usage, which varies from hospital to hospital [**13, 14**]. Another conclusion from a study on antibiotic resistance for wound infection in Sana'a, Yemen, was the incidence of S. aureus which is a well-known multi-drug resistant pathogen that causes a variety of diseases, and it is one of the most frequent bacterial pathogens in most situations [**15**]. In many countries, the overall burden of staphylococcal illness, particularly methicillin-resistant S. aureus infection, is rising in both healthcare and community settings [**16**].

In Yemen, S. aureus exhibited strong resistance to several medicines used to treat the illness, including cephalosporins. A study conducted in Sana'a, Yemen, revealed that S. aureus had extremely high sensitivity to cefotaxime, vancomycin, and ciprofloxacin in wounds [**15, 16, 17**]. Research on antibiotic susceptibility of MRSA in hospitalized patients in Kenya, Iran, two hospitals in India, and two private hospitals revealed that all of the patients were 100% susceptible to vancomycin. [**10, 13, 18**]

In contrast to our findings, cefotaxime exhibited great resistance (100%) in nasal, wound, and sputum swab samples, whereas research found that Vancomycin had strong resistance (100%) at C.S.F but moderate resistance in four of the specimens.

Furthermore, various percentages of majority resistance were seen with the cephalosporine category depending on the material; comparable results were reported in a previous study [**19**].

The findings were consistent with those of a study conducted in Ethiopia and elsewhere, which found resistance to ampicillin, ceftriaxone, doxycycline, erythromycin, penicillin, and tetracycline to be between (21%) and (82%). In this study, high percent sensitivity of cephalosporins was found in Cefoperazon, Cefopodoxim, and Ticarcillin, Clovulante, and Ticarcillin, Clovulante (100 %) [**18, 20-22**].

Similarly, a study in Sana'a found resistance to cefuroxime (91%), doxycycline (91.2%), and erythromycin (71.5%) [**23**], which was lower than our study, which found resistance to cefuroxime (49%), doxycycline (31%), and erythromycin (52%) and this difference could be due to various interventions during the study period.The most prevalent cause of multidrug-resistant MRSA is the indiscriminate administration of antibiotics without drug sensitivity testing, which might be owing to a lack of sophisticated laboratory facilities, medical practitioners' carelessness, or patients' financial hardship. This is also because MRSA is frequently multidrug-resistant [**24**]. According to a study in 2019 at Aden city also showed a high resistance of S. aureus against Cefepime (60.60%),Cefotaxime (48.27%),Ceftriaxone (51.51%), Ceftazidime (63.63%), and Cefuroxime (33.33%) [**25**].

This research outlines the current degree of resistance, which may be utilized as a guide for effective therapy. Because of treatment failures and a lack of efficient medication, Yemen's all-resistance rate might lead to a rise in mortality and morbidity.

Furthermore, in a nation with little resources, such as Yemen, the economic effects might be much worse, since rising treatment expenses deplete money. The frequent, irrational use of broad-spectrum antibiotics, as well as the availability of antibiotics as over-the-counter medications in this metropolis, has inevitably resulted in the creation of extremely resistant bacteria. Antibiotic resistance is a global issue. These concerns are now widely seen as a public health hazard, particularly in Aden city in 2019 [**25**].

5. Conclusion

The information within this study provides essential data on antimicrobial resistance and sensitivity in Aden, Yemen. A rising percentage in the distribution of resistance rather than sensitivity among the Staphylococcus aureus recovered from clinical samples in Aden city can be concluded.

The study showed that *S.aureus* isolates had the highest frequency of resistant (100%) cephalosporin antibiotics category found in wound and sputum samples. However, the highest frequency of sensitivity was found in the pharyngeal sample. Consequently, antibiotic susceptibility testing is an essential guide for choosing suitable antibiotic treatments for bacterial infections. So, the antimicrobial resistance profile and a cooperative work of all health workers and society for rational prescribing patterns, dispensing, and using antibiotics are recommended to avoid the prevalence of resistance among Staphylococcus aureus and all antimicrobial pathogenic infections.

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مقالة بحثية

مقاومة البكتيريا العنقودية (Staphylococcus aureus) للمضادات الحيوية (cephalosporin) عدن، اليمن

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المُلخّص

اجريت هذه الدراسة لتقدير المقاومة المضاد بكتيرية للبكتيريا العنقودية(Staphylococcus aureus) ، المعزولة من عينات السريرية مختلفة (MRSA) للمرضى خلال الفترة يناير 2019 حتى يوليو 2020م في خمسة من المختبرات الحكومية والخاصة. اظهرت اختلاف في نسبة المقاومة بين العينات ونوعية مجموعات .(Cephalosporin) ظهرت أعلى نسبة مقاومة في عينات الجروح ضد (Cefadroxil, Cefuroxime, and Ceftriaxone) عند نسبة (100%)، و أيضا كانت المقاومة (100%) في عينات القيح (pus)، سائل النخاع الشوكي (CSF) و البلغم (sputum) ضد المضاد الحيوي.(Ceftriaxone) كذلك البكتيريا مقاومة كاملة (100%) ضد (cefadroxil) في عينات السائل المنوي، الاذن و البلغم.

البكتيريا العنقودية المعزولة من عينات الحنجرة لم تظهر أي مقاومة ضد جميع مجموعة المضاد الحيوي (cephalosporin).

الكلمات المفتاحية: المضاد الحيوي (cephalosporin)، البكتيريا العنقودية، المقاومة المضاد بكتيرية.

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