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Prevalence of Enteric Bacteria and their Antimicrobial Susceptibility among Attending Al-Razi Medical Laboratory in Sabratha City, Libya

Hanan Khalifa Shaghoum

Zoology department, faculty science Zawia, university of Zawia .Libya
h.shaghoum@zu.edu.ly

Abstract

AMR is a critical global health threat, particularly in regions with limited surveillance data. This study aimed to investigate the prevalence of common enteric bacteria and their antimicrobial susceptibility patterns among patients in Sabratha, Libya, to provide essential local data for clinical guidance and public health strategy.
A cross-sectional study was conducted on 50 patients attending Al-Razi Laboratory medical laboratories in Sabratha. Bacterial isolates were identified using standard microbiological procedures. Antimicrobial susceptibility testing was performed using the Kirby-Bauer disk diffusion method according to CLSI guidelines for a panel of commonly used antibiotics. Data on patient demographics, bacterial species, and resistance patterns were analyzed.
The 50 infections were caused equally by *Streptococcus spp.* (n=25, 50%) and *Escherichia coli* (n=25, 50%). A significant gender disparity was observed, with females accounting for 76% (n=38) of cases. *E. coli* showed the highest sensitivity to Ciprofloxacin (34%), while Streptococcus was most sensitive to Levofloxacin (36%). Concerning resistance rates were noted; for instance, *E. coli* showed 16% resistance to Nalidixic acid, and *Streptococcus* showed 12% resistance to Amoxicillin. Overall, 70% of isolates were resistant to at least one antibiotic, and 18% met the criteria for multidrug resistance (MDR), being resistant to three or more antibiotic classes.
This study reveals a significant burden of *E. coli* and *Streptococcus* infections in Sabratha, with a higher prevalence among females. The observed antimicrobial resistance, including notable MDR rates, highlights an urgent need for establishing local antimicrobial stewardship programs, enhancing surveillance, and promoting

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rational antibiotic use to preserve the efficacy of essential medicines in the region.

Keywords: Antimicrobial resistance, Enteric bacteria, Sabratha, Libya, Antibiotic susceptibility.

انتشار البكتيريا المعوية وحساسيتها تجاه المضادات الحيوية بين المراجعين في مختبر الرازي الطبي بمدينة صبراتة، ليبيا

حنان خليفة شغوم

كلية العلوم الزاوية – جامعة الزاوية – ليبيا
h.shaghoum@zu.edu.ly

الملخص

تُعد مقاومة المضادات الحيوية (AMR) تهديدًا خطيرًا للصحة العامة على مستوى العالم، لا سيّما في المناطق التي تفتقر إلى بيانات مراقبة كافية. هدفت هذه الدراسة إلى التحقيق في مدى انتشار البكتيريا المعوية الشائعة وأنماط حساسيتها تجاه المضادات الحيوية بين المرضى في مدينة صبراتة، ليبيا، لتوفير بيانات محلية أساسية تسهم في التوجيه السريري ووضع استراتيجيات الصحة العامة.

أُجريت دراسة مقطعية على 50 مريضًا من المراجعين لمختبر الرازي الطبي في مدينة صبراتة. تم تحديد العزلات البكتيرية باستخدام الإجراءات الميكروبيولوجية القياسية، كما تم اختبار حساسية المضادات الحيوية باستخدام طريقة الانتشار بالقرص (Kirby-Bauer) وفقًا لإرشادات لجنة معايير المختبرات السريرية (CLSI) ، وذلك لمجموعة من المضادات الحيوية الشائعة الاستخدام. جرى تحليل البيانات المتعلقة بالخصائص الديموغرافية للمرضى، وأنواع البكتيريا، وأنماط المقاومة.

تسببت 50 إصابة بكتيرية بشكل متساوٍ في كل من *Streptococcus spp.* (عدد = 25، 50%) و *Escherichia coli* (عدد = 25، 50%). ولوحظ تباين واضح بين الجنسين، حيث شكّلت الإناث 76% (عدد = 38) من الحالات. أظهرت *E. coli* أعلى حساسية تجاه Ciprofloxacin بنسبة 34%، بينما كانت *Streptococcus* أكثر حساسية تجاه Levofloxacin بنسبة 36%. كما سُجّلت معدلات مقلقة من المقاومة؛ إذ أظهرت E. coli مقاومة بنسبة 16% تجاه Nalidixic acid، و Streptococcus مقاومة بنسبة 12% تجاه Amoxicillin. بشكل عام، كانت 70% من العزلات مقاومة

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لنوع واحد على الأقل من المضادات الحيوية، و18% منها صنّفت كمقاومة متعددة للأدوية (MDR) أي مقاومة لثلاث فئات أو أكثر من المضادات الحيوية.
تكشف هذه الدراسة عن عبء كبير من إصابات *E. coli* و*Streptococcus* في مدينة صبراتة، مع انتشار أعلى بين الإناث. وتشير معدلات المقاومة للمضادات الحيوية، بما في ذلك المقاومة المتعددة، إلى الحاجة الملحّة لإنشاء برامج محلية لترشيد استخدام المضادات الحيوية، وتعزيز أنظمة المراقبة، وتشجيع الاستخدام الرشيد للأدوية من أجل الحفاظ على فعالية العلاجات الأساسية في المنطقة.
الكلمات المفتاحية :مقاومة المضادات الحيوية، البكتيريا المعوية، صبراتة، ليبيا، حساسية المضادات الحيوية.

1. Introduction

Enteric bacteria are a major cause of gastrointestinal diseases worldwide which in turn is a great issue in developing countries that may have poor sanitation and health care infrastructure [1]. We see that pathogens which include *Escherichia coli*, *Salmonella spp*., *Shigella spp*. and *Klebsiella spp*. are the main players in cases of diarrhea, dysentery and other gut infections. As the trend of antimicrobial resistance (AMR) which is very much on the rise especially among Gram negative enteric bacteria goes up, it is of great importance to research out the local pictures of what we are dealing with in terms of prevalence and resistance profiles of these bacteria for better clinical management and public health interventions [2]. AMR is a world health emergency which is seeing the efficacy of antibiotics break down and at the same time is putting at risk the treatment of many bacterial infections. In the gut we have a large and varied group of microbes which are key players in the AMR issue [3]. We see bacteria like those in the Enterobacteriaceae family which within the gut are doing most of the work in terms of taking up and passing along resistance genes and therefore we are faced with issues in the treatment of what used to be very routine infections like urinary tract infections, blood stream infections, and diarrhea [4].

The issue of growing MDR enteric bacteria is a great public health challenge which is seen in areas with under developed resource and surveillance systems [5]. We must study the local epidemiology of these resistant strains, which in turn will guide us in our use of empirical antibiotics, put in place effective infection control and to

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develop targeted public health interventions [6]. In Libya, which reports to Sabratha and many other regions health care systems are reporting unique sets of issues. We see that access and the quality of medical labs, which is very important in the diagnosis of bacterial infections and note of their response to antibiotics, is an issue. In addition, we see that conflict which is ongoing, weak infrastructure, and a lack of resources play a role in the quality of health care services and the accuracy of health data [7]. Previous reports have noted the wide spread of AMR in enteric bacteria which we see to also have variable resistance patterns by geography [8]. Also in each area, these variations play into local antibiotic use patterns, infection control methods, and the presence of certain bacterial strains [9]. This a study, which looks at Sabratha city, in particular is required to present data relevant to what is going on at present with enteric bacterial infections and their resistance profiles.

This study reports on the evaluation of the incidence of certain enteric bacteria and their antimicrobial response profiles among patients that present at medical labs in Sabratha city, Libya. We present results which will add to the picture of local Antimicrobial Resistance issues, inform clinical practice and support the development of data based methods to fight antibiotic resistance in the region.

- **Enteric Bacteria and Antimicrobial Resistance**

Invasive enteropathogens that which come from external environmental reservoirs, and pathobionts that develop from commensal gut species [10]. In the human gastrointestinal tract we find approximately 10^14 microorganisms that make up a very structured community which also has the ability to grow and pass on multi drug resistant organisms (MDROs) [11].

- **Global Impact and Surveillance**

The World Health Organization reports that antimicrobial resistance is at the top of the list of global public health issues. Also in terms of economy which is a great issue we see that which if we do not put in place the right interventions by 2050 we may see global death rates from AMR rise to 10 million per year [12].

Surveillance of antibiotic resistance is performed by systems like the National Antimicrobial Resistance Monitoring System (NARMS) which looks at food borne and other enteric bacteria from humans, retail meats, and food producing animals. These systems

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play a key role in identifying resistance trends which in turn inform public health policy [13].

- **Prevalence and Susceptibility Patterns**

Studies on the prevalence of enteric bacteria and their antimicrobial susceptibility patterns are essential for understanding the local epidemiological landscape [14]. For instance, a study conducted in Gondar town, Northwest Ethiopia, reported an overall prevalence of enteric bacteria of 13.2% [15]. *Shigella* species were the predominant isolates, with a high susceptibility to ciprofloxacin, ceftriaxone, chloramphenicol, nalidixic acid, and gentamicin. *Escherichia coli* O157:H7 and Salmonella did in fact present high susceptibility to many antibiotics. But we saw a great deal of multidrug resistance in Shigella spp. which made up 38.5% of the isolates some of which were resistant to over five antimicrobials. The total MDR prevalence in that study was 41.2% [16].
These studies bring to light the issue of continuous surveillance and in depth research which is required to track resistance trends and put forth proper treatment methods. In the case of Sabratha which has its own set of health care issues we see a need for a special study which looks at the prevalence and antimicrobial susceptibility of enteric bacteria in patients that use the medical labs.

2. Methodology

- **Study Design and Setting**

This was a cross-sectional study conducted at Al-Razi Laboratory in Sabratha, one of the medical laboratories within the city. The study population will include patients of all ages and genders who attend this laboratory for diagnostic testing, and from whom enteric bacterial isolates are obtained.

- **Sampling and Data Collection**

Samples were randomly collected from Al-Razi Laboratory, Sabratha, and after 24 hours of processing, the growth of two bacterial species was observed *Streptococcus* and *Escherichia coli*. The procedure for isolating, identifying, and testing the antibiotic susceptibility of these bacterial isolates begins with the preparation of selective and differential media, including Nutrient Agar (NA), MacConkey Agar (MAC), Mannitol Salt Agar (MSA), and Salmonella-Shigella Agar (SSA). A bacterial suspension (1 mL) is transferred into a sterile broth tube and incubated at room temperature for 15 minutes. The inoculum is then streaked onto NA,

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MAC, and MSA plates, which are incubated at 37°C for 24 hours. After incubation, colony morphology is observed, and representative colonies are selected for further analysis. The isolates are subsequently subcultured onto MAC and SS Agar plates and incubated again at 37°C for 24 hours. Biochemical identification is performed using catalase, coagulase, and oxidase tests. Finally, antibiotic susceptibility testing is carried out using the standard disc diffusion method (Kirby-Bauer technique) to assess bacterial resistance. Throughout the procedure, biosafety level 2 (BSL-2) precautions must be followed, including the use of appropriate personal protective equipment (PPE) and the proper disposal of biohazardous materials.

- **Data Analysis**

All collected data were entered into the SPSS statistical software package version 20 for analysis. Descriptive statistics were used to summarize the prevalence of different enteric bacterial species and their antimicrobial susceptibility patterns. Results were presented as percentages, mean, and standard deviation.

3. Results

- **Socio-demographic characteristics**

A total of 50 patients were considered in this study; 38 (76%) were females, and 12 (24%) were males se fig. (1). This indicates a higher prevalence of the isolated bacteria among females; the total average age of 50 patients in the study was (1- 60<) with a significant majority being female (38) compared to males (12). This indicates a higher prevalence of the isolated bacteria among females, particularly in the younger (28%) and middle-aged (34%) categories (table 1). The data suggests that gender and age may play a role in the susceptibility to bacterial infections in this population.

Table (1): Distribution of bacteria isolated from th`e study participants

Age group (years)	Male n(%)	Female n(%)	No. of patients	Percentage (%)
1 - 20	6(40)	9(60)	15	30
21 - 40	0(0.0)	19(100.0)	19	38
41 - 60	(33.3)2	4(66.7)	6	12
≥ 60	4(40.0)	(60.0)6	10	20
Total	(24.0)12	(76.0)38	50	100%

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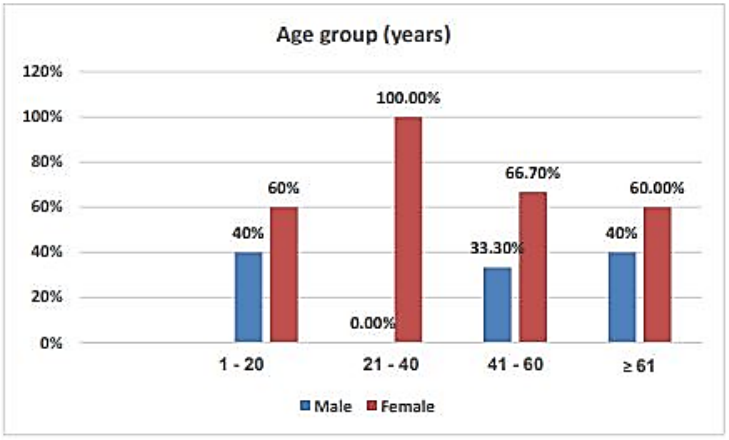

Figure (1) Distribution of bacteria isolated from the study participants

Prevalence of *Streptococcus* and *Escherichia coli* Overall, the total number of infections recorded is 50, caused by two types of bacteria: *Streptococcus* and *Escherichia coli*, along with their respective gender breakdowns. *Streptococcus* accounts for 50% of the total infections, with 25 cases reported. Among these, 20 cases (80%) are female and 5 cases (20%) are male, indicating a higher prevalence of this infection in females. Additionally, *Escherichia coli* accounts for 50% of the total infections, with 25 cases reported as well. However, the gender distribution shows that 18 cases (72%) are female and 7 cases (28%) are male, again suggesting a greater impact on females. This data may suggest the need for targeted health interventions or further research into the factors contributing to this gender disparity in infection rates as shown in table 2.

Table 2: Gender Distribution of Infections Caused by Different Bacteria

Type of Bacteria	Male	Female	Total infection	Percentage(%)
Streptococcus	5 (41.7%)	20(62.6%)	25	50%
Escherichia coli	7(47.4%)	18(58.3%)	25	50%
Total	12	38	50	100%

- **Antimicrobial susceptibility pattern**

Summarizes the sensitivity and resistance of two bacterial species, *Escherichia coli* and *Streptococcus*, to a range of antibiotics. The data are presented as percentages of susceptible or resistant cases for each antibiotic. *Escherichia coli* shows the highest sensitivity to

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Ciprofloxacin (34%) and the lowest sensitivity to tobramycin (2%). whereas *Streptococcus* shows the highest sensitivity to Levofloxacin (36%) and the lowest sensitivity to Tobramycin (2%). Both bacteria show significant resistance to certain antibiotics. For example, *E. coli* has a high resistance rate of 16% to Nalidixic and Kanamycin, while *Streptococcus* shows resistance of up to 16% to several antibiotics, including Nalidixic, amoxicillin, and Clavulanic acid. Additionally, the results suggest that certain antibiotics, such as Ciprofloxacin and Levofloxacin, are generally effective against both types of bacteria, while others exhibit varying efficacy table 3.

Table 3: Sensitivity of Bacterial Species to Various Antibiotics

Name of Antibiotic	*Streptococcus*		*Escherichia coli*	
	Resistance	Sensitive	Resistance	Sensitive
Levofloxacin	2%	36%	4%	32%
Erythromycine	2%	22%	12%	6%
Fusidi Acid	None	12%	2%	2%
Kanamycine	16%	14%	6%	20%
Chloramphenicol	6%	22%	8%	24%
Ceftriaxone	4%	26%	6%	16%
Cefoxitin	2%	24%	2%	18%
Norfloxacin	None	13%	2%	18%
Ceftazidime	10%	16%	2%	18%
Tetracyclin	2%	18%	2%	22%
Pipera_Tazo	2%	10%	4%	6%
Amoxicilline	12%	16%	6%	12%
Nalidixic	4%	20%	16%	22%
Ciprofloxacine	None	34%	6%	34%
Amikacin	None	24%	6%	24%
Vancomycin	None	24%	12%	18%
Doxycycline	None	20%	None	26%
Azithromycin	None	18%	None	28%
Imipenene	None	18%	None	6%
Tobramycine	None	2%	None	2%
Cefixime	None	16%	2%	14%
Amoxicillin Clavulanic Ac	2%	16%	None	12%
Nitrofurantion	2%	16%	2%	6%
Gentamicine	None	16%	None	16%
Trimethoprim_Sulfametho	None	16%	6%	6%
Nalidixic_Acid	None	None	4%	10%
Evofloxacin	None	None	None	2%
Cefotaxime	None	16%	None	12%

- **The prevalence of multidrug resistance (MDR)**

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The prevalence of multidrug resistance (MDR) among the isolated enteric bacteria was assessed based on the number of antibiotics to which each isolate showed resistance. As presented in the table 4, 70% of the isolates (35 out of 50) exhibited resistance to at least one antibiotic. Specifically, 26% were resistant to one drug, 24% to two drugs, and smaller proportions exhibited resistance to three or more antibiotics. Notably, 2% of the isolates showed resistance to as many as 10 antibiotics.

On the other hand, 30% of the isolates (15 out of 50) were not resistant to any antibiotics, indicating the presence of non-MDR strains among the sampled population. These findings highpoint a concerning level of MDR among enteric bacteria, with a significant proportion of isolates demonstrating resistance to multiple antimicrobial agents, underscoring the need for continuous surveillance and rational antibiotic use.

Table 4: Distribution of Multidrug Resistance (MDR) Among Isolated Enteric Bacteria

No. of Antibiotic Resistances	Frequency	Percentage(%)
None	15	30
1	13	26
2	12	24
3	3	6
4	3	6
5	2	4
6	1	2
10	1	2
Total	50	100.0

4. Discussion

This study provides a vital, local overview of the prevalence and antibiotic susceptibility of intestinal bacteria in Sabratha, Libya. The findings conducted a significant burden of infections caused by Streptococcus and Escherichia coli, marked gender disparities in infection rates, and alarming levels of antibiotic resistance.

The main findings of this study are the equal prevalence of *Streptococcus* and *Escherichia coli* (50% each) among the 50 patient samples. While *E. coli* is a common and well-documented intestinal pathogen, the high prevalence of Streptococcus in this context is noteworthy. As shown in Table 2, E. coli and *Streptococcus*

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were the predominant bacterial isolates identified, This may indicate the inclusion of a broader range of clinical sample types (such as urine and blood), where both organisms are common pathogens, rather than being limited to purely intestinal infections, an explanation supported by the study's methodology.

Demographic analysis demonstrated a notable gender disparity, with females accounting for 76% of all recorded infections. This finding aligns with previous research reporting a higher susceptibility of females to bacterial infections, particularly urinary tract infections (UTIs) primarily caused by *Escherichia coli* [17]. Such vulnerability is often attributed to anatomical and physiological differences, including a shorter urethral length and proximity to the perineal region, which facilitate bacterial colonization. Furthermore, recent longitudinal data from a six-year observational study similarly reported an increased prevalence of enteric pathogens among female patients, reinforcing the gender-related trend in infection rates [18].

The antibiotic susceptibility patterns observed in Sabratha show a mixed but concerning picture. shown in Table 3 for *E. coli*, the 6% resistance rate to ciprofloxacin is noteworthy, especially when compared to the much higher rates reported in other parts of the region. For example, studies in Tripoli, Libya, showed a 57.1% resistance rate to ciprofloxacin B [19], and research from Sudan reported a similar rate of 58.4% [20]. In contrast, the results of our study are more closely aligned with an older study from Msallata, Libya, which reported low resistance to this antibiotic [21].

This suggests that while fluoroquinolone resistance is a major problem in major urban centers, its emergence in Sabratha may be at an early stage, representing a critical window for intervention. Similarly, resistance to beta-lactam antibiotics such as amoxicillin in our study (12% of *E. coli*) is concerning, yet it contrasts starkly with the alarming rates seen elsewhere. For example, resistance to amoxicillin and related compounds has been reported to reach 90% in Messallata [21], 74.7% in Egypt [22], and a staggering 97.7% in Sudan [20]. This significant variation underscores the local nature of antibiotic resistance and highlights the urgent need for tailored management programs.

The spread of multidrug resistance poses a significant threat to public health. In our study, 18% of isolates were resistant to three or more antibiotic classes. While these isolates were resistant to three or more classes of antibiotics, the reported MDR rates in Tunisia

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(26.4%) [23] and Egypt (30.3% for *E. coli*) [22] are comparable to the 92.2% prevalence of *E. coli* present, which pales in comparison to the crisis-level prevalence of MDR in Sudan [20], indicating a serious regional threat. The presence of an isolate in our study resistant to ten different antibiotics is a stark warning of the potential emergence of extensively drug-resistant (XDR) organisms in the community. This level of resistance complicates treatment, increases healthcare costs, and leads to worse outcomes for patients in a recent study from Bangladesh, which also reported higher rates of MDR, a trend observed among pathogens that cause diarrhea in children [24].

5. Limitations and Conclusions

The results of this study should be interpreted in the context of its limitations. The small sample size (n=50) limits the generalizability of the results to the entire population of Sabratha or Libya. Furthermore, the study did not differentiate between Streptococcus species, which is critical as different species have very different clinical manifestations and susceptibility profiles. Future research should aim for larger sample sizes, detailed species identification (e.g., using TOF-MALDI or 16S rRNA sequencing), and more detailed clinical data collection to differentiate between community-acquired and hospital-acquired infections.

In conclusion, this study provides valuable baseline data on the prevalence and patterns of antibiotic resistance in bacteria. These findings underscore the urgent need for robust antibiotic stewardship programs and key capacity building in Sabratha, Libya. These findings emphasize enhanced diagnostic testing and ongoing surveillance to monitor resistance trends. Public health interventions should focus on rational antibiotic prescribing, patient education, and infection prevention and control measures to reduce the spread of antibiotic resistance in the region.

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