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(RESEARCH ARTICLE)

Retrospective analysis of patterns of drug resistant bacteria isolated from swabs and discharges of patients at Saint Paul Hospital Millennium Medical College, Addis Ababa, Ethiopia

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Abstract

The incidence of multidrug resistant bacteria is threatening our globe nowadays, of which *Staphylococcus aureus*, *Escherichia coli*, *Proteus species*, *Pseudomonas species* and *Klebsiella* species are the most frequent. Diseases such as tuberculosis have become increasingly difficult to treat as drugs become less effective. This study aims to assess drug resistance and susceptibility patterns of bacterial isolates of swabs and discharges of patients. Retrospective analysis was conducted on 290 bacterial isolates of swabs and discharges with their antimicrobial susceptibility pattern at Microbiology Department of Saint Paul's Hospital. Twenty-seven different species of bacteria have been obtained from two hundred and ninety patients who were infected with bacteria among which *S. aureus* is the most frequent followed by Con's (*Staphylococcus* species other than S. *aureus*), *E. coli and Klebsiella* spp. *Staphylococcus aureus* was isolated in 51(17.6%) from the total isolates while Con's, *E. coli* and *Klebsiella* were isolated from 27, 25 and 7, respectively. Out of these isolates, Con's were the most highly resistant among the isolates followed by *S. aureus* and *E. coli*. *Klebsiella* was the most sensitive of all isolates, while the rest showed intermediate pattern of drug susceptibility to the commonly prescribed drugs. Careful surveillance of infection along with appropriate laboratory data, good isolation techniques, procedures, appropriate sensitivity techniques, restrictive antimicrobial policy and rich supply of different antibiotics are critical if the drug resistant bacteria are sustained.

Keywords: Bacterial isolates; Bacterial pathogens; Discharges; Saint Paul Hospital Millennium Medical College; Susceptibility pattern; Swabs

1. Introduction

Antibiotics are life-saving drugs, but unlike drugs used in other therapeutic areas, the future utility of many antibiotics is threatened by the emergence and spread of resistant bacteria. Infection caused by antibiotic-resistant bacteria often results in delay in appropriate antibiotic therapy, rise in patient morbidity and mortality, as well as lengthened hospital stay [1]. The current pipeline for new antibiotics is limited. If antibiotic resistance keeps on increasing, there would be no effective antibiotics in the future. Livermore [2] regarded the past 70 years as an era of immense profligacy, with a squandering of the world's finite resources, including antibiotics. The author further stated that the reality that antibiotics were discovered and squandered within the living memory of a single lifetime has startling achievement for mankind. There are two general categories of antibiotic resistance traits displayed by microorganisms: (i) microorganisms that allow to withstand relatively high levels of a specific antimicrobial agent, which are conferred by mutations in genes responsible for antibiotic uptake or binding sites, as well as those gained by acquisition of genes on

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mobile elements [3, 4, 5]; and (ii) microorganisms that allow genes conferring nonspecific low-level resistance to multiple antibiotics, such as the multiple antibiotic resistance (MAR) locus [6, 7, 8].

Early diagnosis and treatment of infection caused by bacteria remain a major clinical challenge. Most bacteria have multiple routes of resistance to any drug, and they produce vast number of resistant progeny once they become resistant. The microorganisms most likely to be introduced for multiple drug resistance are staphylococci and streptococci. There is always a possibility that these microorganisms especially streptococci are virulent enough to cause a severe local inflammation or fatal septicemia [9].

In Ethiopia, some studies have been conducted on multidrug resistant bacteria of wound infection at Jimma University and Bacteriology of Ocular Infections and Antibiotic Susceptibility Patterns at Gondar University. This study was designed to compare multidrug resistance patterns of pathogenic bacteria isolated from wound swabs and discharges of patients in order to generate information about antimicrobial susceptibility [10].

2. Material and methods

Retrospective study was done in Bacteriology Department of St. Paul Hospital Millennium Medical College using a log book from February 1, 2012-May 1, 2014. The Clinical Bacteriology Department provided a wide range of bacteriological investigation to determine the susceptibility patterns of the isolates. Isolation of pathogenic bacteria was carried out for every patient who had given swabs and discharges in order to determine the susceptibility pattern as source population.

2.1. Data analysis

The data collected from the log book was first entered into Excel and then analyzed by statistical software SPSS 20. Descriptive statistics was calculated and the patterns of drug resistant bacteria among patients with respective bacteria isolates were determined and the sex distribution of the patients' bacterial isolates and their susceptibility to the commonly prescribed drugs were assessed.

2.2. Ethical considerations

A letter informing drug administration had been written from school of Medical Laboratory, Addis Ababa University (AAU) two weeks before data collection. Ethical approval letter was obtained from Department of Medical Laboratory Sciences, Departmental Research and Ethics Review Committee. The Hospital was informed about the educational value of the study and assured of its confidentiality. All data had been collected homogeneously without any discrepancy and bias.

3. Results

Of the total of 290 study subjects, 153 (52.76%) were females and 137 (47.24%) were males with age range of 4 days to 85 years. Out of 290 study subjects, bacterial pathogens were isolated from 183 patients with isolation rate of 63.1%. Of the 183 bacterial isolates, 14 (7.65%) ear swabs and 8 (4.37%) nasal swabs were found to be positive. Of the 14 pathogenic ear swab bacterial isolates, *S. aureus* was found to be the most dominant bacterial isolates which comprised 60% resistant forms in females and 59% in males. On the other hand, *E. coli* and *Protease* spp. were found to be the most sensitive bacterial pathogenic isolates in males to the commonly prescribed drugs. However, some species like *Proteus mirabilis*, *Pseudomonas* spp. and *S. aureus* showed intermediate patterns to the commonly prescribed drugs. Out of 8 pathogenic nasal swab bacterial isolates, 5 (62.5%) were found to be positive for drug susceptibility pattern. The Con's made up 63% sensitive and 37% resistant forms in males but 100% sensitive forms in females. *Citrobacter* spp. was found to be the most sensitive while the Con's (37%) the most resistant in males. The remaining bacterial isolates showed intermediate patterns to the commonly prescribed drugs.

Resistant patterns of bacterial isolates from wound swabs were assessed. Of the total of 19 different bacterial isolates, *S. aureus* was the most frequently observed bacteria with sensitivity and resistance of 59% and 35% in males; and 61% and 27% in females, respectively. But most of the remaining bacterial isolates were of intermediate patterns. *Escherichia coli* was the second most frequently observed bacterial isolate with sensitivity, resistance and intermediate patterns of 11%, 74% and 15% in males; and 14%, 82% and 2% in females, respectively. *Staphylococcus* spp. were the most resistant bacterial isolates having a resistant pattern of 90% in males while *E. coli* with 83% in females. On the other hand, *Klebsiella* spp. were the most sensitive bacteria with sensitivity of 100% in males while *Providencia* spp. with susceptibility pattern of 70% in females [Table 1].

Table 1 Drug resistance and susceptibility patterns of pathogenic bacteria isolated from swabs of patients at Saint Paul Hospital Millennium Medical College

Isolates	Ear swab						Nasal swab						Wound swab					
	Male			Female			Male			Female			Male			Female		
	S	R	I	S	R	I	S	R	I	S	R	I	S	R	I	S	R	I
E. coli	7(44)	9(56)	----	----	----	----	----	----	----	----	----	----	2(11)	14(74)	3(15)	5(14)	29(83)	1(3)
S. aureus	10(31)	19(59)	3(10)	2(40)	3(60)	----	4(66)	1(17)	1(17)	----	----	----	37(59)	22(35)	4(6)	20(61)	9(27)	4(12)
P. mirabilis	3(43)	3(43)	1(14)	----	----	----	----	----	----	----	----	----	3(60)	2(40)	----	----	----	----
Con's	2(29)	5(71)	----	3(50)	3(50)	----	10(63)	6(37)	----	4(100)	----	----	----	----	----	5(19)	20(74)	2(7)
Pseudomonas spp.	5(36)	5(36)	4(28)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Klebsiella spp.	1(17)	5(83)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Proteus spp.	4(67)	2(33)	----	----	----	----	----	----	----	----	----	----	7(47)	7(47)	1(6)	8(62)	3(23)	2(15)
Citrobacter spp.	----	----	----	----	----	----	4(80)	1(20)	----	----	----	----	7(64)	3(27)	1(9)	2(33)	----	4(67)
Staph spp.	----	----	----	----	----	----	----	----	----	----	----	----	1(10)	9(90)	----	----	----	----
Salmonella spp.	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	3(60)	1(20)	1(20)
Enterobacter agglomerans	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	3(50)	2(33)	1(17)
Providencia spp.	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	7(70)	3(30)	----
Klebsiella spp.	----	----	----	----	----	----	----	----	----	----	----	----	4(100)	----	----	1(33)	2(67)	----
P. aeruginosa	----	----	----	----	----	----	----	----	----	----	----	----	1(33)	2(67)	----	----	----	----
M. morganii	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	2(40)	3(60)	----
Acetobacter	----	----	----	----	----	----	----	----	----	----	----	----	1(33)	2(67)	----	----	----	----
Proteus vulgaris	----	----	----	----	----	----	----	----	----	----	----	----	1(17)	5(83)	----	----	----	----

Pathogenic bacteria isolated from pus, abscess and discharge of patients with susceptibility pattern were assessed. Pus was observed to be the most dominant source for most pathogenic bacterial isolates which constituted 51 (17.59%) of the total isolates, of which *S. aureus* 16 (31.37%) was found to be the most dominant with 66% and 25% susceptibility and resistance in males, respectively. But 60% and 27% susceptibility and resistance were obtained in females, respectively. On the other hand, *E*. *coli* which made up 9 (17.65%) of all pus isolates, had resistant and susceptibility patterns in both sexes. Con's isolates were the third most dominant bacterial isolates, which comprised 13.73% of all pus isolates, had 53% and 47% susceptibility patterns in males and females, respectively. Out of all pus isolates, *Klebsiella* spp. were found to be the most resistant bacterial isolates in females, whereas *Providencia* spp. were the most susceptible pathogenic isolates in both sexes. The remaining pathogenic isolates, *Klebsiella* spp. in males; *Protease* and *S. aureus* in females, which were the dominant pathogens, showed intermediate patterns to the commonly prescribed drugs.

Out of the total of 6 different bacterial isolates obtained from urogenital discharges during the 2 years and 3-month period, *Neisseria gonorrhea* was found to be the most frequent while *S. aureus*, *Candida albicans* and *Proteus vulgaris* were the least. *Proteus vulgaris* was observed to be the most resistant bacteria with 67% in males; and *N. gonorrhea* and *C. albicans* with 60 % in females. On the other hand, *E. coli* was proved to be the most sensitive bacterial isolates with sensitivity of 100% in males while 14% intermediate patterns were found in females.

Moreover, of the 7 bacterial isolates found from eye swabs and corneal discharges, Con's, *E. coli* and *Citrobacter* spp., were proved to be the most frequent while *Enterobacter* spp. were the least frequent. *Citrobacter* spp. showed the most sensitivity pattern of 100% and 60%, in males and females, respectively. *Escherichia coli* and *Enterobacter* spp. showed the most resistant patterns of 83% in males and 75% in females [Table 2].

Multiple drug resistance patterns of bacterial isolates were also assessed. *Staphylococcus aureus* was found to show the highest degree of resistance towards different drugs. Forty nine bacterial isolates were found to be sensitive; and 16, 10, 8, 2, 3, and 4 bacterial isolates were resistant to a single, two, three, four, five and more than five drugs, respectively. Con's species were found to be the next most frequently observed bacterial isolates with sensitivity and resistant patterns to one drug, two drugs, three drugs, four drugs, five drugs and more than five drugs in 24, 3, 2, 9, 3, 5, 1 cases, respectively. Out of six cases of *N. gonorrhea*, only one was resistant to more than five drugs while five of them were resistant to three drugs. Moreover, out of 9 cases in *Pseudomonas* spp., only three was resistant to two drugs while 9 of them were sensitive to all drugs, though it was resistant to the remaining drug options for a single case [Table 3].

Table 2 Drug resistance and susceptibility patterns of pathogenic bacteria isolated from pus, abscess and discharge of patients at Saint Paul Hospital Millennium Medical College from Feb1, 2012- May1, 2014.

Isolates	Urogenital discharge						Eye swabs and corneal discharge						Pus and abscess					
	Male			Female			Male			Female			Male			Female		
	S	R	I	S	R	I	S	R	I	S	R	I	S	R	I	S	R	I
S. aureus	----	----	----	4(67)	2(33)	----	----	----	----	----	----	----	39(66)	15(25)	5(9)	27(60)	12(27)	6(13)
N. gonorrhea	----	----	----	12(40)	18(60)	----	----	----	----	----	----	----	----	----	----	----	----	----
Con's	----	----	----	17(71)	7(29)	----	3(27)	7(64)	1(9)	----	----	----	9(53)	7(41)	1(6)	7(47)	8(53)	----
C. albicans	----	----	----	2(40)	3(60)	----	----	----	----	----	----	----	----	----	----	----	----	----
E. coli	3(100)	----	----	6(43)	6(43)	2(14)	1(17)	5(83)	----	2(33)	3(50)	1(17)	4(16)	21(84)	----	9(21)	33(79)	----
Proteus vulgaris	1(33)	2(67)	----	----	----	----	----	----	----	----	----	----	1(33)	2(67)	----	----	----	----
Citrobacter spp.	----	----	----	----	----	----	6(100)	----	----	3(60)	1(20)	1(20)	8(50)	8(50)	----	4(67)	2(33)	----
Enterobacter spp.	----	----	----	----	----	----	----	----	----	1(25)	3(75)	----	----	----	----	----	----	----
Proteus spp.	----	----	----	----	----	----	----	----	----	----	----	----	5(71)	2(29)	----	8(48)	5(29)	4(23)
Providencia spp.	----	----	----	----	----	----	----	----	----	----	----	----	9(90)	1(10)	----	7(70)	2(20)	1(10)
Pseudomonas spp.	----	----	----	----	----	----	----	----	----	----	----	----	4(33)	8(67)	----	----	----	----
S. pyrogen	----	----	----	----	----	----	----	----	----	----	----	----	5(71)	2(29)	----	6(43)	7(50)	1(7)
Klebsiella spp.	----	----	----	----	----	----	----	----	----	----	----	----	7(64)	3(27)	1(9)	1(14)	6(86)	----
Edwardsiella spp.	----	----	----	----	----	----	----	----	----	----	----	----	3(37)	4(50)	12(13)	----	----	----

Table 3 Multidrug resistance patterns of bacterial isolates obtained from swab and discharge of patients at Saint Paul Hospital, Feb 1, 2012-May 1, 2014.

Bacterial isolates	Resistance							Total isolates
	Sensitive	Single drug	Two drugs	Three drugs	Four drugs	Five drugs	More than five drugs	
S. aureus	49	16	10	8	2	3	4	51
E. coli	23	2	4	5	4	4	9	25
Con's	24	3	2	9	3	5	1	27
Pseudomonas spp.	9	1	3	-	1	1	1	9
Protease spp.	12	2	3	4	1	1	1	14
N. gonorrhea	6	-	-	5	-	-	1	6
S. pyrogens	5	-	1	1	2	-	-	5
Citrobacter spp.	11	4	4	1	1	-	-	13
Klebsiella spp.	5	1	2	-	-	1	1	5
Total	144	29	29	33	14	15	18	158

The overall susceptibility patterns to the commonly prescribed drugs were assessed. It has become more evident that drug resistance has been increasing in the previous decades. Cefuroxime was found to be the most sensitive and effective drug in treating infections, while Ampicillin was found to be the most ineffective in treating infections with resistance of 72.72%. However, there was a progressive decrease in resistant patterns toward different drugs like ceftriaxone, gentamicin, ciprofloxacin, vancomycin, chloramphenicol and trimethoprim-sulfamethoxazole [Table 4].

Table 4 Drugs and their susceptibility pattern toward different bacteria

Drug	Resistance		Intermediate		Sensitive	
	Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)
Amp	40	72.72	5	9.10	10	18.18
Cro	21	39.62	1	1.89	31	58.49
Cxm	2	1	4	4	14	95
Te	26	60.47	1	2.32	16	37.21
E	40	48.79	11	13.41	31	37.80
Cn	16	22.54	7	9.86	48	67.60
Cip	32	33.68	0	0.00	63	66.32
P	26	57.78	1	2.22	18	40
Va	4	12.90	9	29.03	18	58.06
C	26	27.96	1	1.07	66	70.97
Ctx	26	54.17	8	16.66	14	29.17
Sxt	19	38.78	0	0.00	30	61.22

Key: Amp- ampicillin. Cro- ceftriaxone. Cxm- cefuroxime. Te- tetracycline. E- erythromycin. Cn- gentamicin. Cip- ciprofloxacin. P-penicillin. Va-vancomycin. C- chloramphenicol. Ctx- cefotaxime. Sxt- trimethoprim-sulfamethoxazole

4. Discussion

In the present study, drug resistance patterns of bacterial pathogens isolated from wound swabs and discharges of patients were assessed. A total of 290 bacterial isolates were identified through the usual culture method and biochemical tests from the suspected patients. The results of the study revealed that bacterial isolates were frequently higher in females than in males. Out of the 290 bacterial isolates, 51(17.59%) were *S. aureus*, 27(9.31%) were Con's, 25(8.62%) were *E. coli* and 14 (4.83%) were *Proteus* species. The results are comparable to studies done in different parts of the world [11, 12].

As opposed to a research done in Dessie Regional Health Laboratory which showed that *S. aureus* was 90% sensitive to gentamycin, norfloxacin and ciprofloxacin [13], this study revealed that these drugs were effective only in 66.32% cases, which indicated an ever-increasing drug resistance pattern.

Similarly, another study conducted on microbial susceptibility of bacterial isolates of open wound fractures at the Black Lion Hospital, Addis Ababa, Ethiopia showed that the susceptibility pattern of gram positive bacteria other than *Clostridium* spp. isolated from the compound wound fractures showed that most of gram positive and gram negative bacteria were very sensitive to gentamicin, ciprofloxacin and norfloxacin which are the most effective drugs against the tested gram-positive bacteria with exception of *Clostridium* spp. However, these drugs had become more resistant to both gram positive and gram negative bacteria [14].

The present study showed a high rate of resistance to the commonly prescribed antibiotic agents as compared to the previous similar studies in the country. This study showed a multidrug resistance of 72.72% which is lower than the research done at Gondar Teaching Hospital which showed a multi-drug resistance in 78.5% of the cases. This may reflect that the measure of antibiotic resistance had become a major problem with greater extent in rural areas due to purchases made without prescription at local pharmacy and sharing of drugs without physicians' consent among patients [15].

Another research which had been conducted on ear discharges in India showed that *S. aureus* was susceptible to Oxacillin in 80% and Erythromycin in 43% of the cases. *Proteus* spp. had sensitivity of 94% to Piperacillin and 83.3%, 81.2%, 62.5% to Ceftazidime, Amikacin and Gentamicin, respectively. This study also pointed out that *Klebsiella* and *E. coli* were sensitive to ciprofloxacin, gentamycin and ceftazidime. On the contrary in most cases, *S. aureus* had sensitivity of 96.9%, and 87.5% to ciproflaxin and gentamycin, respectively [16].

In this study, Cefuroxime and Chloramphenicol were found to be the most effective drugs while Ampicillin and Tetracycline were the least effective. Appearance of drug resistant bacterial isolates to Erythromycin, Vancomycin and Sulfamethoxazole could partly explain the antibiotics used in the study area and in other parts of the country such as Jimma, Gondar and Addis Ababa [10, 14, 15].

5. Conclusion

High prevalence of bacterial isolates was obtained from patients who provided swabs and discharges in the study sites. *Staphylococcus aureus* was found to be the dominant isolates among the remaining bacterial pathogens. Most of the isolates were resistant to many of the antibiotics tested while all isolates of *S. pyrogens* were resistant to two or more antibiotics. However, Cefuroxime was proved to be the most sensitive and effective drug to treat infections. It is, therefore, necessary to do an antibiotic susceptibility test before drug prescription in order to control various bacterial infections which are isolated from swabs and discharges.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors have declared that there is no conflict of interest with respect to the authorship and/or publication of this research paper.

Statement of ethical approval

Ethical clearance was obtained from the Department of Medical Laboratory Sciences, College of Health Sciences, Addis Ababa University, Departmental Research and Ethics Review Committee (DRERC) decision (DRERC/28/14/UND GR) to conduct this research.

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