

Awareness and Beliefs of Antimicrobial Resistance among Health Professionals working at Tikur Anbessa Specialized Hospital, Addis Ababa: Ethiopia

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Abstract

Introduction: Antimicrobial Resistance (AMR) threatens the effective prevention and treatment of an ever-increasing range of infections caused by bacteria, parasites, viruses and fungi. In recent years, since the rate at which resistance occurs has outpaced the development of new drug replacements, it has become necessary to use the currently available agents, optimally and appropriately. The aim of this study was to assess the medical staff awareness towards the most common resistant bacteria species, the factors contributing to the lack of awareness, and the possible measures to address the awareness gap.

Methods: A structured questionnaire was administered to 205 health care professionals including physicians, pharmacists, and nurses at Tikur Anbessa Specialized Hospitals, Addis Ababa-Ethiopia.

Results: The study identified that most of the responding physicians and pharmacists considered *Pseudomonas aeruginosa* and methicillin-resistant *Staphylococcus aureus* (MRSA) as the most frequently encountered resistant bacterial species. However, nurses recognized both MRSA and extended-spectrum β -lactamase producing Gram-negative bacilli (ESBL) as the most prevalent resistant species. Majority of physicians (79.2%) and pharmacists (79.9%) reported prolonged hospitalization as a factor likely to contribute to the increased incidence of bacterial resistance. About 66.0% of pharmacists indicated that the use of antibiotics without prescription as a significant reason for the development of bacterial resistance. Most of the physicians (71.4%) reported that appropriate infection control is the most important measure to reduce bacterial resistance.

Conclusion: The findings of this study revealed that there was good awareness of the most common AMR etiologies and their risk factors among the different discipline health professionals. Even though there was a varying level of awareness among the health care professionals. Continuous medical education programs would be desirable to keep the health care professionals updated and diminish the future risk of excessive bacterial resistance.

Keywords: Awareness; Antimicrobial Resistance (AMR); Tikur Anbessa Specialized Hospital (TASH); Health professionals

Introduction

Antibiotics are among the most successful therapeutic agents used for combating bacterial infections [1]. Antimicrobial Resistance (AMR) threatens the effective prevention and treatment of an ever-increasing range of infections caused by bacteria, parasites, viruses and fungi [2]. It is an increasingly serious threat to global public health that requires action across all government sectors and society [3,4]. Antibiotics and similar drugs, together called antimicrobial agents, have been used for the last 70 years to treat patients who have infectious diseases. Since the 1940s, these drugs have greatly reduced illness and death from infectious diseases. However, these drugs have been used so widely and for so long that the infectious organisms the antibiotics are designed to kill have adapted to them, making the drugs less effective [5,6].

Resistant bacteria can pass their genes to other bacteria, forming a new antibiotic resistant 'strain' of the bacteria [7]. Resistant strains of bacteria can spread to other people. The development of antibiotics was one of the most important advances of medicine. Many bacterial infections (e.g. tuberculosis and infected wounds) that had previously had no effective treatment and often killed people became treatable with antibiotics, saving millions of lives [8]. Now, because of the overuse and misuse of antibiotics, bacterial infections that were once easily cured with antibiotics are becoming harder to treat, this is due to AMR [9].

Antimicrobial resistance is a global problem, and some of our most significant global threats are multi-drug resistant tuberculosis and drug-

resistant malaria. The World Health Organization (WHO) reported in April 2014 that, "This serious threat is no longer a prediction for the future, and it is happening right now in every region of the world and has the potential to affect anyone, of any age, in any country. Antibiotic resistance when bacteria change so antibiotics no longer work in people who need them to treat infections is now a major threat to public health [10]."

Initially, multiple-drug resistant organisms were encountered mostly in hospitals, where antimicrobials are used most extensively. However, at present, bacterial resistance is found almost as frequently in the community [11]. Several groups of researchers have shown increased drug resistance in the developing countries [9]. For example, the studies from the south eastern Mediterranean region, including Jordan, indicate a high rate of antibiotic resistance, compared with the Western countries [12], along with a predominant consumption of broad-spectrum

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antibiotics in hospital settings. This was postulated as a possible factor behind the documented high rate of bacterial resistance to antibiotics in hospitals in these countries [13].

Problems associated with bacterial resistance include; increased morbidity and mortality, longer duration of patient hospital stay, increased cost of health care, spread of multi-drug resistant bacteria, reduced the effectiveness of treatment and caused a high percentage of hospital-acquired infections are by highly resistant bacteria such as Methicillin Resistant *Staphylococcus aureus* (MRSA) or multidrug-resistant Gram-negative bacteria [1,14]. The number of organisms that developed antibiotic resistance has been steadily increasing over the last 10–15 years, which is a real threat to disease management [15].

Center for disease control and prevention (CDC) reported that each year in the United States, at least 2 million people become infected with bacteria that are resistant to antibiotics and at least 23,000 people die each year as a direct result of these infections [16]. Therefore, AMR is a growing public health concern worldwide. When a person is infected with an antibiotic-resistant bacterium, not only is treatment of that patient more difficult, but the antibiotic-resistant bacterium may spread to other people. In this regard, patients and health care professionals alike can play an important role in combating antibiotic resistance [17].

The CDC data indicated that *Acinetobacter baumannii* (*A. baumannii*) was responsible for 1% of all nosocomial infections and 4% of nosocomial pneumonia in the United States. Furthermore, resistant bacteria have a tendency to become resistant to many antibiotics [1]. The organisms exhibiting antibiotic resistance include MRSA, Vancomycin-resistant enterococci (VRE), Extended spectrum beta-lactamase (ESBL), Carbapenem-resistant Enterobacteriaceae (CRE) or Carbapenemase-producing enterobacteriaceae (CPE), Pneumococcal resistant to penicillin and macrolides, and multiple-drug resistant gram-negative species [6,11,18].

Ethiopia experiences a heavy burden of infectious diseases with a growing prevalence of disease morbidity and mortality. With the increased intensity of antimicrobial use following the increased burden of infectious disease in Ethiopia, AMR remains being a huge concern in the progress of treating infectious diseases. Health care facilities, particularly those which provide service to large number of patients, are a focal point in the emergence of AMR. The misuse of antibiotics by health care providers, unskilled practitioners, and drug consumers, coupled with rapid spread of resistant bacteria and inadequate surveillance contributed to the problem [19].

In recent years, since the rate at which resistance occurs has outpaced the development of new drug replacements, it has become necessary to use the currently available agents, optimally and appropriately [20]. Apart from that assessing the awareness of health professionals in the issue and providing appropriate trainings on how to use the available antibiotics is a wise approach that could help us to challenge the challenges [21]. Increasing awareness of health care professionals, governments, health and funding agencies, and the public as a whole about AMR is therefore very important [22]. In this study, we assessed the medical staff awareness of the most common resistant bacteria species, the factors contributing to the lack of awareness, and the possible measures to address the awareness gap.

Methods and Materials

Study design

A cross sectional survey was conducted from May 1 to June 18, 2016 using standard questionnaire obtained using standard instruments.

Study setting

The study was conducted at TASH, Addis Ababa, Ethiopia. TASH, the largest referral hospital in the country, with 700 beds, was established in 1972; and serving as a teaching specialized hospital for medical students/health science. In 1998, TASH was transferred to Addis Ababa University from the Federal Ministry of Health, and it has since become a University teaching specialized hospital. TASH is now the main teaching specialized hospital for both clinical and preclinical training of most disciplines. It is also an institution where specialized clinical services that are not available in other public or private institutions are rendered to the whole nation [23].

Source population

All health practitioners working in TASH were the source population.

Study population

All health practitioners working in TASH during the study period and willing to participate in the study were the source population.

Sample size and sampling technique

A snowball sampling technique was used in data collection. The investigators asked every participant to nominate another two health care professionals until the desired sample size was obtained (n=205). The study population included a total of 77 physicians, 75 nurses, and 53 pharmacists.

Inclusion and exclusion criteria

Inclusion criteria: All health professionals working in TASH during the study period were included in the study.

Exclusion criteria: Health professionals working in TASH during the study period but unwilling to participate in the study were excluded.

Study variables

Dependent variable: Awareness of health care professionals.

Independent variables: Socio-demographic characteristics (sex and age). Educational level (senior physician, medical resident, BSc/BPharm, MSc). Discipline (Pharmacy, Medicine, and Nursing).

Data collection methods and tools

The questionnaire contains four parts. In the first part, the demographic data such as age, gender, occupation and level of education were reported. In the second part, each individual was asked to answer a number of questions on his/her awareness regarding bacterial species. The respondents were to choose from a list of five microorganisms known for their increasing resistance to antibacterial, these including MRSA, VRE, ESBL, *Pseudomonas aeruginosa* (*P. aeruginosa*), and *A. baumannii*. They were asked to rate their response on a four point scale (1: Very likely, 2: Somewhat likely, 3: Somewhat unlikely, 4: Very unlikely). The same rating method was used in the other sections of the questionnaire. The third part of the questions concerned the factors contributing to the increasing prevalence of bacterial resistance; seven different factors were listed. The participants were also asked about the possible measures that can be applied to decrease the risk of bacterial resistance. They were to assess 7 different methods currently available to manage bacterial resistance, including among others the reduction of hospital stay, appropriate infection control practices, limiting

unnecessary use of medical instruments, applying better strategies for antibiotic management, etc. In the last section of the questionnaire, the participants were to answer the following question: "In the future, do you think the problem of bacterial resistance can be controlled, or will it become much worse?" The investigator was present to answer any question on the part of the respondents at the time of completing the questionnaire.

Data analysis and management

The data were analyzed using the SPSS, version 20.0. Frequency analysis for different groups of health care professionals was tabulated and the data were compared using the chi-square goodness-of-fit test. For all statistical analyses, the level of significance was set at $P < 0.05$.

Ethical clearance

Ethical approval and clearance to conduct this study was obtained from Addis Ababa University, College of Health Sciences, School of pharmacy research and ethical review committee. All the study population was interviewed with their verbal consent following explanation of the objective and benefit of the study and getting verbal consent.

Operational definitions

Antimicrobial: is a general term for the drugs, chemicals, or other substances that either kill or slow the growth of microbes. Among the antimicrobial agents in use today are antibiotic drugs (which kill bacteria), antiviral agents (which kill viruses), antifungal agents (which kill fungi), and antiparasitic drugs (which kill parasites).

An antibiotic: is a type of antimicrobial agent made from a mold or a bacterium that kills, or slows the growth of other microbes, specifically bacteria. Examples include penicillin and streptomycin.

Bacterial resistance: is the capacity of bacteria to withstand the effects of antibiotics that are intended to kill or control them.

Awareness: the state or condition of being aware; having knowledge.

Results

Majority of the health professionals participated in the study were age in between 25-29 (125, 61%). The numbers of male participants were 115 (56.1%) and there were only 5 master holders and four of them were pharmacists. All the participated medical residents were from school of medicine (Table 1).

The participants were assessed for their awareness to some of the most frequently encountered antibiotic resistant bacteria species, the

physicians pointed both to MRSA (77.9%) and *Pseudomonas aeruginosa* (72.7%) as the species very likely to be associated with resistance to antimicrobials. A similar response was obtained from the pharmacists who ranked MRSA (73.6%) and *P. aeruginosa* (75.1%) as the bacterial species meeting this criterion. The nurses indicated MRSA (48.0%) and ESBL (37.3%) as very likely to be resistant. A two-way contingency table analysis revealed a significant association between the medical profession and the responses indicating MRSA, VRE, Proteus species, ESBL and *P. aeruginosa* χ^2 (6, N=336)=21.2, 24.9, 24.3, 32.6 and 25.6, respectively (Table 2).

The level of awareness of for the important factors contributing to the increasing bacterial resistance were forwarded and physicians responded that, prolonged hospitalization (79.2%), improper use of antibiotics (without medical prescription) (68.8%) and improper antibiotic prescription (67.5%) are the very likely causes of bacterial resistance. The responses given by the pharmacists were consistent with those of the physicians; they indicated the use of antibiotics without prescription (66.0%), inappropriate use of antibiotics (71.7%), and prolonged hospitalization (79.9%) as the factors very likely to contribute to bacterial resistance. The majority of nurses (61.3%) pointed to prolonged hospitalization as the risk factor. A much lower percentage of nurses (25.3%) responded that the extensive use of newer generations of antibiotics is very likely to contribute to the development of bacterial resistance. Significant relations were detected between the medical profession and the responses reporting high rate of patients transfer between hospital units, patients' noncompliance, and the use of antibiotics without prescription (Table 3).

The results regarding the medical staff awareness of the methods used to control current bacterial resistance are presented in Table 4. A high percentage of physicians (71.4%) shared an opinion that applying better infection control practices will very likely to decrease the current bacterial resistance. On the other hand, 73.6% of pharmacists believed that better adherence to the infection control guidelines will very likely reduce bacterial resistance. The nurses (57.3%) thought that implementation of better hygiene practices is the solution that is very likely to reduce bacterial resistance. Two-way contingency table analysis indicated that there is no that much significant associations between the medical profession and most of the strategies proposed for controlling bacterial resistance (Table 4).

With regard to the beliefs on the future developments concerning the problem, a majority of health care professionals expected that the status of bacterial resistance will very likely become worse if the current practices in antimicrobial handling do not change. Only a small

Demographics		Physicians N (%)	Pharmacists N (%)	Nurses N (%)	Total N (%)
Age in year	19-24, n (%)	0	6 (3)	10 (4.9)	16 (7.8)
	25-29, n (%)	41 (20)	39 (19)	45 (22)	125 (61)
	30-34, n (%)	29 (14.1)	8 (3.9)	15 (7.3)	52 (25.4)
	35-39, n (%)	7 (3.4)	0	4 (2)	11 (5.4)
	40-44, n (%)	0	0	1 (0.5)	1 (0.5)
Gender	Male, n (%)	45 (39.1)	37 (32.2)	33 (28.7)	115 (56.1)
	Female, n (%)	32 (35.5)	16 (17.8)	42 (46.7)	90 (43.9)
Education	Residents 1 and 2, n (%)	43 (100)	-	-	43 (100)
	Senior resident, n (%)	34 (100)	-	-	34 (100)
	Bachelor's degree, n (%)	-	49 (92.5)	4 (7.5)	53 (100)
	Master's degree, n (%)	-	4 (80)	1 (20)	5(100)

Total Number (N) of physicians=77, of nurses=75, of pharmacists=53

Table 1: Demographic data of the study participants, Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia, May 1 to June 18, 2016 (n=205).

Bacterial species	R	Physicians		Pharmacists		Nurses		Chi	P
		N	(%)	N	(%)	N	(%)		
MRSA	1	60	77.9	39	73.6	36	48	21.2	0.002
	2	14	18.2	9	20	22	29.3		
	3	3	3.9	5	9.4	15	20		
	4	0	0	0	0	2	2.7		
VRE	1	48	62.3	30	57.7	22	29.3	24.9	0
	2	23	29.9	15	28.8	28	37.3		
	3	5	6.5	5	9.6	18	24		
	4	1	1.3	2	3.8	7	9.3		
Proteus	1	35	45.5	15	28.3	14	18.7	24.3	0
	2	35	45.5	26	49.1	32	42.7		
	3	4	5.2	8	15.1	22	29.3		
	4	3	3.9	4	7.5	7	9.3		
ESBL	1	43	55.8	23	43.4	28	37.3	32.6	0
	2	30	39	17	32.1	29	38.7		
	3	4	5.2	10	18.9	12	16		
	4	0	0	3	5.7	6	8		
<i>Pseudomonas aeruginosa</i>	1	56	72.7	40	75.1	17	22.7	25.6	0
	2	19	24.7	9	17	33	44		
	3	2	2.6	3	5.7	18	24		
	4	0	0	1	1.9	7	9.3		
<i>Acinetobacter baumannii</i>	1	22	28.9	12	22.6	15	20	16.9	0.009
	2	43	56.6	27	50.9	27	36		
	3	10	13.2	12	22.6	27	36		
	4	1	1.3	2	3.8	6	8		
<i>Escherichia coli</i>	1	31	40.3	16	30.2	14	18.7	17.1	0.009
	2	31	40.3	26	49.1	37	49.3		
	3	15	19.5	6	11.3	15	20		

Total N of physicians=77, of nurses=75, of pharmacists=53; MRSA: Methicillin-Resistant *Staphylococcus aureus*; VRE: Vancomycin-Resistant *Enterococci*; ESBL: Extended Spectrum β -lactamase Producing Gram-negative Bacilli. Response(R): 1: Very likely, 2: Somewhat likely, 3: Somewhat unlikely, 4: Very unlikely

Table 2: Medical staff awareness of the most frequently encountered resistant bacterial species in medical practice, Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia, May 1 to June 18, 2016 (n=205).

Contributing factor	R	Physicians N %	Pharmacists N%	Nurses N%	Chi	P			
Prolonged hospitalization	1	61	79.2	42	79.9	46	61.3	14.2	0.024
	2	14	18.2	10	18.9	18	24.0		
	3	2	2.6	1	1.9	7	9.3		
	4	0	0	0	0	4	5.3		
The use of antibiotics without medical prescription	1	53	68.8	35	66.0	28	37.3	26.6	0.000
	2	22	28.6	14	26.4	33	44.0		
	3	2	2.6	4	7.5	7	9.3		
	4	0	0	0	0	7	9.31		
Inappropriate infection control practices	1	49	63.6	27	50.9	36	48.0	8.2	0.224
	2	21	27.3	20	37.7	29	38.7		
	3	7	9.1	5	9.4	6	8.0		
	4	0	0	1	1.9	4	5.3		
Improper antibiotic prescription	1	52	67.5	38	71.7	37	49.3	12.6	0.050
	2	21	27.3	13	24.5	26	34.7		
	3	4	5.2	2	3.8	10	13.3		
	4	0	0	0	0	2	2.7		
Inappropriate antibiotic use	1	45	58.5	32	60.4	31	41.9	12.4	0.055
	2	27	35.1	18	34.0	28	37.8		
	3	5	6.5	3	5.7	13	17.6		
	4	0	0	0	0	2	2.7		
Patients' noncompliance	1	42	54.5	27	50.9	22	29.7	18.6	0.005
	2	26	33.7	20	37.7	29	39.2		
	3	9	11.7	5	9.4	12	16.0		
	4	0	0	1	1.9	6	8.1		

Response(R): 1: Very likely, 2: Somewhat likely, 3: Somewhat unlikely, 4: Very unlikely

Table 3: Awareness of the most common factors contributing to bacterial resistance, Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia, May 1 to June 18, 2016 (n=205).

percentage of physicians (7.8%), pharmacists (7.5%), and nurses (9.3%) thought that this global problem may be solved in the following few years (Table 5).

Discussion

AMR is a major problem for the global health and economy [24]. In the developing countries, a high rate of infections usually coincides

Contributing factor	R	Physicians		Pharmacists		Nurses		Chi	P
		N	%	N	%	N	%		
Prescribing antibiotics when no blood culture is performed	1	38	49.1	24	45.3	24	32	7.9	0.247
	2	29	37.7	24	45.3	36	48		
	3	9	11.7	5	9.4	12	16		
	4	1	1.3	0	0	3	9		
Increased use of medical instrumentation	1	32	41.6	16	30.2	23	30.7	9.7	0.138
	2	38	49.5	26	49.1	31	41.3		
	3	6	7.8	9	17	18	24		
	4	1	1.3	2	3.8	3	4		
High rate of patients transfer between hospital units	1	41	53.2	19	35.8	22	29.3	18.2	0.006
	2	29	37.7	27	50.9	31	41.3		
	3	6	22.2	6	11.3	15	20		
	4	1	1.3	2	3.8	3	4		
Extensive use of newer generations of antibiotics	1	27	35.1	16	30.2	19	25.3	16.2	0.013
	2	42	54.5	19	35.8	32	42.7		
	3	8	10.4	12	22.6	15	20		
	4	0	0	6	11.3	9	12		
Better hygiene practices	1	51	66.2	21	39.6	43	57.3	11.6	71
	2	20	26	23	34.8	23	30.7		
	3	6	7.8	6	11.3	7	9.3		
	4	0	0	3	5.7	2	2.7		
Appropriate infection control practices	1	55	71.4	39	73.6	38	50.7	18	0.021
	2	18	23.4	12	22.6	25	33.3		
	3	4	5.2	1	1.9	10	13.3		
	4	0	0	0	0	2	2.7		
Reducing hospital stay	1	55	71.4	32	60.4	37	48.3	14.7	0.023
	2	17	22.1	19	35.8	25	33.3		
	3	5	6.5	2	3.8	10	13.3		
	4	0	0	0	0	3	4		
Better adherence to infection control guidelines	1	54	70.1	39	73.6	35	46.7	20.9	0.002
	2	22	28.6	12	22.6	28	37.3		
	3	1	1.3	2	3.8	7	9.3		
	4	0	0	0	0	5	6.7		
Better antibiotic handling strategies	1	55	71.4	34	64.2	40	53.3	8.9	0.177
	2	16	20.8	17	32.1	24	32		
	3	5	6.5	1	1.9	8	10.7		
	4	1	1.3	1	1.9	3	4		

Total N of physicians=77, of nurses=75, of pharmacists=53

Response(R): 1: Very likely, 2: Somewhat likely, 3: Somewhat unlikely, 4: Very unlikely

Table 4: Awareness of the strategies to control emergence of bacterial resistance, Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia, May 1 to June 18, 2016 (n=205).

Contributing factor	R	Physicians		Pharmacists		Nurses		Chi	P
		N	%	N	%	N	%		
Bacterial resistance will become worse if current practices do not change	1	65	84.4	42	79.2	44	58.7	17.4	0.008
	2	11	14.3	11	20.8	25	33.3		
	3	1	1.3	0	0	5	6.7		
	4	0	0	0	0	1	1.3		
Bacterial resistance will be controlled	1	6	7.8	4	7.5	7	9.3	20.3	0.002
	2	5	6.5	11	20.8	23	30.7		
	3	16	20.8	13	24.5	20	26.7		
	4	50	64.9	25	47.2	25	33.3		

Total N of physicians=77, of nurses=75, of pharmacists=53

Response(R): 1: Very likely, 2: Somewhat likely, 3: Somewhat unlikely, 4: Very unlikely

Table 5: Medical staff beliefs on the future risk of bacterial resistance, Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia, May 1 to June 18, 2016 (n=205).

with a rapid development and spread of microbial resistance [25]. The findings of this study revealed that most of the physicians and nurses in TASH regarded both MRSA and *P. aeruginosa* as highly resistant bacteria. However, the nurses' opinion was somewhat different; they ranked not only MRSA but also ESBL as belonging to the most resistant microorganisms. There is no doubt that the association between the bacterial species listed in the questionnaire and antibiotic resistance varies considerably. The difference in the awareness between representatives of different medical professions can be attributed to individual knowledge and personal experience with such infectious agents. The Gram-positive bacteria resistant to antibiotics are a common cause of nosocomial (hospital-acquired) blood stream infections [26].

MRSA isolates are resistant to available β -lactam antibiotics, including penicillins and cephalosporins [27-29]. Since the late 1970s, MRSA isolates have been the reported cause of many hospital outbreaks worldwide. They can be encountered in small community hospitals, chronic care facilities, and even within the community [30-32]. In addition, resistance to vancomycin has been acquired by the strains of *Enterococcus faecium*, thus accounting for treatment failures. At present, five types of vancomycin resistance have been reported for Enterococci [33]. On the other hand, multidrug resistant *P. aeruginosa* strains are one of the most common Gram-negative bacilli which are the cause of nosocomial infections with a high incidence of morbidity and mortality [34,35].

Many factors have been associated with the emergence and spread of antimicrobial resistance. In fact, the use of antimicrobial agent, by itself, is considered to exert a selective pressure on resistance [25]. In addition, the use of antibiotics for the treatment of non-bacterial, mostly viral, infections, and the overuse of broad-spectrum antibiotics in the management of bacterial infections promotes antibiotic resistance [30], and increases the costs of health care [31]. Inappropriate prescription of more expensive or second-line antibiotics in daily clinical practice is considered even more problematic [36].

A recent report discusses the underlying reasons for the differences in antibiotic prescription practice as applied by health care professionals. A major reason for the large-scale prescription of antibiotics is inadequate knowledge about the consequences of bacterial resistance as a worldwide problem. Secondly, it is believed that the rate of this practice increases due to the growing demand for antibiotics on the part of the patients. This results in the physicians' softening their attitude and responding to these expectations. Thirdly, the educational aspect, which is related mainly to the professional or cultural background of the physicians, is thought to play a role [32]. Finally, it was shown that the physicians who take care of a large number of patients are more likely to prescribe antibiotics when these are not appropriate [33,34].

Nosocomial infections are the most common complications affecting hospitalized patients. About 25% of nosocomial infections apply to patients in the ICU, and almost 70% of these infections are caused by microorganisms that are resistant to one or more antibiotics [35]. Accordingly, it was not surprising that about half of the physicians and nurses in the study population were aware that prolonged hospital stay is a major contributor to greater bacterial resistance. Moreover, about half of the responding physicians thought that the other factors that are likely to contribute to bacterial resistance include the use of antibiotics without prescription and inappropriate antibiotic use, while the nurses pointed to the use of antibiotics without prescription and appropriate infection control practices. In the pharmacists' responses, the focus was on the handling of antibiotics. A high percentage of pharmacists shared an opinion that such factors as the use of antibiotics

without prescription, inappropriate antibiotic use, together with improper prescription of antibiotics are the leading causal factors of the emergence of bacterial resistance.

The discrepancies in the level of awareness of bacterial resistance that were noted between the physicians, pharmacists and nurses can be explained taking into account the medical background of each profession and the field of clinical practice. While the physicians tend to focus more on the diseases and pathogenesis, the pharmacists pay more attention to medications and an improper handling of pharmaceuticals. Moreover, the physicians and nurses are in a closer contact with patients during hospitalization than are the pharmacists. These differences in practice may also add to the different views expressed by representatives of particular medical professions. It is alarming that neither the high rate of patients transferred between different hospital units, nor the patients' non-compliance with infection control guidelines, have been considered the factors leading to bacterial resistance. Actually, many studies have shown that the latter two are the major contributors to the emergence of bacterial resistance [36-38].

When the risk factors for bacterial resistance are identified, effective measures should be undertaken to reduce the risk of future resistant infections. The strategies for limiting bacterial resistance are consistently discussed in literature. The adoption of certain guidelines, practice parameters, clinical pathways, or protocols, is associated with more appropriate antibiotic use, improved patient outcomes, fewer adverse events and errors, and more importantly, minimized resistance emergence [25,39]. Since nosocomial infections highly contribute to poor outcomes and increased rates of bacterial resistance, hospitals should play a major role in limiting bacterial resistance.

Better infection control strategies in hospitals and regular efficiency checks on these strategies must be put to practice. Such strategies should include reducing unnecessary hospital stay, avoiding or shortening the use of invasive devices, adhering to hand hygiene guidelines, and applying antimicrobial cycling and combination strategies [38-40]. The participants of our study showed a significant awareness of the above approaches. The physicians concentrated on the necessity to apply appropriate infection control practices, while the nurses focused on hygiene practices and the pharmacists were concerned with a better adherence to the infection control guidelines.

Conclusions and Recommendations

Overall our study revealed that there was good awareness to the most common AMR etiologies and their risk factors among the different discipline health professionals. Even though there was a varying level of awareness among the health care professionals. Hence, this does not mean that everything is under control. Some studies at a pipeline are showing the huge burden of AMR at the area. Therefore, continuous medical education programs would be desirable to keep the health care professionals updated and diminish the future risk of excessive bacterial resistance. Educational programs to patients also should be focused as an important role in combating bacterial resistance.

Authors' Contributions

AB discovered the area, designed the study, supervise data collection, worked on the analysis and review of the manuscript; DA collected the necessary data and drafted manuscript, coordinated and wrote the final manuscript; MA reviewed and the whole manuscript and revised the analysis. All authors read and approved the final manuscript.

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References

- Hancock RE (2007) The complexities of antibiotic action. *Mol Syst Biol* 3: 142.
- Levy SB (1998) The challenge of antibiotic resistance. *Sci Am* 278: 32-39.
- World Health Organization (WHO) (2016) Antimicrobial resistance.
- Carlet J, Pulcini C, Piddock LJ (2014) Antibiotic resistance: a geopolitical issue. *Clin Microbiol Infect* 20: 949-953.
- Centers for Disease Control and Prevention (2013) Antibiotic resistance threats in the United States, 2013.
- Fauci AS (2001) Infectious diseases: considerations for the 21st century. *Clin Infect Dis* 32: 675-685.
- Mathur S, Singh R (2005) Antibiotic resistance in food lactic acid bacteria—a review. *Int J Food Microbiol* 105: 281-295.
- Rao GG (1998) Risk factors for the spread of antibiotic-resistant bacteria. *Drugs* 55: 323-330.
- Davies J, Davies D (2010) Origins and evolution of antibiotic resistance. *Microbiol Mol Biol Rev* 74: 417-433.
- World Health Organization (WHO) (2014) WHO's first global report on antibiotic resistance reveals serious, worldwide threat to public health. Geneva.
- Wenzel RP, Edmond MB (2000) Managing antibiotic resistance. *N Engl J Med* 343: 1961-1963.
- Borg M, Scicluna E, De Kraker M, Van de Sande-Bruinsma N, Tiemersma E, et al. (2006) Antibiotic resistance in the southeastern Mediterranean—preliminary results from the ARMed project. *Euro Surveill* 11: 164-167.
- Borg MA, Zarb P, Ferech M, Goossens H (2008) Antibiotic consumption in southern and eastern Mediterranean hospitals: results from the ARMed project. *J Antimicrob Chemother* 62: 830-836.
- Okeke IN, Laxminarayan R, Bhatta ZA, Duse AG, Jenkins P, et al. (2005) Antimicrobial resistance in developing countries. Part I: recent trends and current status. *Lancet Infect Dis* 5: 481-493.
- Norby SR, Nord CE, Finch R, ESCMID (2005) Lack of development of new antimicrobial drugs: a potential serious threat to public health. *Lancet Infect Dis* 5: 115-119.
- Centers for Disease Control and Prevention (2017) About antimicrobial Resistance.
- Kessler DA (2009) Protecting and promoting public health. US Food and Drug Administration.
- Provincial Infectious Diseases Advisory Committee (PIDAC) (2013) Screening, testing and Surveillance for antibiotic-resistant organisms (AROs). Public Health Ontario. Toronto, Canada.
- Abegunde DO, Mathers CD, Adam T, Ortegón M, Strong K (2007) The burden and costs of chronic diseases in low-income and middle-income countries. *Lancet* 370: 1929-1938.
- MSH/SPS (2009) Antimicrobials use, resistance and containment baseline survey syntheses of findings. Addis Ababa, Ethiopia.
- Grisso T, Appelbaum PS (1998) Assessing competence to consent to treatment: A guide for physicians and other health professionals. Oxford University Press, USA.
- Slade E, Tamber PS, Vincent JL (2003) The Surviving Sepsis Campaign: raising awareness to reduce mortality. *Crit Care* 7: 1.
- Yeshitela B, Gebre-Selassie S, Feleke Y (2012) Asymptomatic bacteriuria and symptomatic urinary tract infections (UTI) in patients with diabetes mellitus in Tikur Anbessa Specialized University Hospital, Addis Ababa, Ethiopia. *Ethiop Med J* 50: 239-249.
- Martin LJ, Fyfe M, Doré K, Buxton JA, Pollari F, et al. (2004) Increased burden of illness associated with antimicrobial-resistant *Salmonella enterica* serotype Typhimurium infections. *J Infect Dis* 189: 377-384.
- Okeke IN, Klugman KP, Bhatta ZA, Duse AG, Jenkins P, et al. (2005) Antimicrobial resistance in developing countries. Part II: strategies for containment. *Lancet Infect Dis* 5: 568-580.
- Rice LB (2006) Antimicrobial resistance in gram-positive bacteria. *Am J Infect Control* 34: S11-S19.
- Bergogne-Berezin E, Towner K (1996) *Acinetobacter* spp. as nosocomial pathogens: microbiological, clinical, and epidemiological features. *Clin Microbiol Rev* 9: 148-165.
- Sinha M, Srinivasa H (2007) Mechanisms of resistance to carbapenems in meropenem-resistant *Acinetobacter* isolates from clinical samples. *Indian J Med Microbiol* 25: 121.
- Manikal VM, Landman D, Saurina G, Oydna E, Lal H, et al. (2000) Endemic carbapenem-resistant *Acinetobacter* species in Brooklyn, New York: citywide prevalence, interinstitutional spread, and relation to antibiotic usage. *Clin Infect Dis* 31: 101-106.
- Austin DJ, Kristinsson KG, Anderson RM (1999) The relationship between the volume of antimicrobial consumption in human communities and the frequency of resistance. *Proc Natl Acad Sci U S A* 96: 1152-1156.
- Huovinen P, Seppälä H, Kataja J, Klaukka T (1996) The relationship between erythromycin consumption and resistance in Finland. Finnish Study Group for Antimicrobial Resistance. *Ciba Found Symp* 207: 36-41.
- Cadieux G, Tamblyn R, Dauphinee D, Libman M (2007) Predictors of inappropriate antibiotic prescribing among primary care physicians. *CMAJ* 177: 877-883.
- Figueiras A, Caamaño F, Gestal-Otero JJ (2000) Influence of physician's education, drug information and medical-care settings on the quality of drugs prescribed. *Eur J Clin Pharmacol* 56: 747-753.
- Mazzaglia G, Caputi AP, Rossi A, Bettoncelli G, Stefanini G, et al. (2003) Exploring patient-and doctor-related variables associated with antibiotic prescribing for respiratory infections in primary care. *Eur J Clin Pharmacol* 59: 651-657.
- Eggimann P, Pittet D (2001) Infection control in the ICU. *Chest* 120: 2059-2093.
- Wybo I, Blommaert L, De Beer T, Soetens O, De Regt J, et al. (2007) Outbreak of multidrug-resistant *Acinetobacter baumannii* in a Belgian university hospital after transfer of patients from Greece. *J Hosp Infect* 67: 374-380.
- Thomas JK, Forrest A, Bhavnani SM, Hyatt JM, Cheng A, et al. (1998) Pharmacodynamic evaluation of factors associated with the development of bacterial resistance in acutely ill patients during therapy. *Antimicrob Agents Chemother* 42: 521-527.
- Pechere JC (2001) Patients' interviews and misuse of antibiotics. *Clin Infect Dis* 33: S170-S173.
- Fish DN, Ohlinger MJ (2006) Antimicrobial resistance: factors and outcomes. *Crit Care Clin* 22: 291-311.
- Burke JP (2003) Infection control—a problem for patient safety. *N Engl J Med* 348: 651-656.