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Effect of an Educational Session on Antibiotic Prescription among Primary Healthcare Physicians: An Interventional Study

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Abstract: ***Antimicrobial resistance is an increasing public health problem due to inappropriate antimicrobial use. Do educational interventions affect primary healthcare physicians' antibiotic prescription practice? In this pre-post quasi-experimental interventional study, 43 primary care center Saudi Arabian physicians answered a self-administered questionnaire; institutional antibiotic guidelines and expert opinions were unanimous on factors affecting participants' antibiotic regimen. Moreover, 82% were unaffected by patient/parent antibiotic demands. Differences in antimicrobial resistance knowledge and perception and current antimicrobial use were not significant. A significant post-intervention improvement existed in the practical knowledge of proper antimicrobial selection. All participants exhibited basic knowledge of antimicrobial use and the emerging resistance. The practical knowledge improvement through one educational session indicates the need for such programs to minimize antimicrobial resistance.***

Keywords: antimicrobial use, antibiotic resistance, educational intervention, perception, practical knowledge

1. Introduction

Antibiotics, also called antimicrobial agents (AM), are among the most commonly prescribed medications and self-care medicines for patients, with different global prevalence rates [1]. The early 2010s saw their widespread use, leading to an alarming rise in the problem of antibiotic resistance to microbial pathogens [2]. Nearly 70% of all bacterial infections in hospitals have developed resistance to at least one of the most common antimicrobial agents used to treat them [3]. Inadequate understanding and knowledge among the public was highlighted as the major reason for inappropriate antibiotic use [4, 5]. Although antibiotics target bacteria and do not affect viral agents, they are often incorrectly used for treating viral infections such as Upper Respiratory Tract Infections (URTIs) [6]. El-Gilany found that the prevalence of antibiotic prescriptions at primary healthcare centers for all adult patients with URTIs was 87% [6].

1.2 Literature Survey

Primary healthcare physicians are the first point of contact for patients, playing a vital role in increasing patients' and communities' awareness of antibiotic use. Several studies have shown that physicians are aware that antibiotics resistance and its consequences are a growing issue, and have varying attitudes toward prescribing antibiotics [7, 8]. Conversely, there appeared to be considerable unmet training needs for physicians in antimicrobial prescribing, given their largely inadequate commitment to following the guidelines of AM use [9, 10]. There is also a knowledge deficit among general practitioners in dosage adjustment and selection of proper AM when compared to specialists and residents [10].

There are many professional interventions aimed at improving antibiotic prescribing practices to meet the standards of the Effective Practice and Organization of Care Group (EPOC) pathogens [2]. The most preferable interventions among physicians to overcome the development of antibiotics resistance were educational programs (45.7%), updates on local antibiotic resistance patterns (37.4%), and accessing current antibiograms for local antimicrobial susceptibility tests (34.6%) [8]. Therefore, many studies are encouraging the use of educational interventions targeting physicians to improve antibiotic prescribing practices [11]. A systematic review (including about 78 studies) of educational interventions aimed at improving antibiotic prescribing practices and the dispensing of antibiotics showed that educational interventions can improve antibiotic use [11]. However, some studies reported that, during these interventions, reductions in the costs of antibiotics influenced their use and led to increased bacterial susceptibility [9]. In 2015, two published studies in Riyadh and Jeddah, Saudi Arabia, emphasized the need for focused educational interventions and standardized antimicrobial use, especially among general practitioners, and to revise local antimicrobial guidelines [9, 10].

1.2.3 Problem Definition

This study aimed to address limitations in earlier studies in Saudi Arabia assessing educational interventions to improve antibiotic prescribing practices among physicians. No studies have so far been conducted to assess physicians' awareness about antibiotic use in the eastern region of Saudi Arabia. Two local studies did, however, highly recommend an effective education intervention to improve physicians' awareness. Physician education may therefore motivate them to practice more careful antibiotic use since antimicrobial

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overuse has led to the global issue of antimicrobial resistance. Antimicrobial resistance can affect the quality of management, resulting in decreased efficiency of antimicrobial agents and therefore a worsening of infectious diseases, thereby affecting public health.

This study aimed to examine the effect of an educational intervention aimed at improving prescribing practices and the use of antibiotics in the primary healthcare center of the National Guard Hospital, Dammam. The research question was as follows: Would an educational intervention affect physicians' antibiotic prescribing practices, especially those working in the primary healthcare center of the National Guard Hospital, Dammam, Kingdom of Saudi Arabia? The specific objectives were to:

1- Assess physicians' knowledge and perception about antimicrobial use and resistance in the primary care center of the National Guard Hospital, Dammam
2- Assess the educational intervention's effect on the knowledge and perception of antimicrobial use and resistance among physicians in the primary care center of the National Guard Hospital, Dammam
3- Compare the pre- and post-intervention practical knowledge of physicians about proper antimicrobial selection, in the primary care center of the National Guard Hospital, Dammam.

2. Methodology

We performed a pre-post quasi-experimental intervention study to assess the causative effect of an intervention on a target population without any random selection. We distributed a self-administered questionnaire to physicians of the primary healthcare center of the National Guard Hospital in Dammam, Saudi Arabia, from December 2017 to January 2018. Considering our study type, a convenience sample was selected. Therefore, all primary care physicians (male and female), staff physicians, family medicine residents, assistant family medicine consultants, associated family medicine consultants, and family medicine consultants were included in the study. Physicians with a sub-specialty (ear, nose and throat; ophthalmology; dermatology; and psychiatry) were excluded. In addition, those who were on leave, could not participate, or were unwilling to participate were excluded from the study. The sample size was 43 physicians, of which 39 completed the questionnaire (46% male and 54% female). The participants' mean age was 38, and their mean year of experience was 12. Physicians were categorized into 3 groups, as follows: 11 were family medicine board certified, 13 were family medicine residents, and 15 were staff physicians. Among the board-certified physicians, there were 5 consultants, 2 assistant consultants, and 4 associate consultants. Additionally, among the staff physicians, 5 were dental physicians, 2 were staff physicians covering the pediatric clinic, 2 were staff physicians covering the obstetrics and gynecology clinic, and 6 were physicians covering the general practice clinic. In addition, 59% of the physicians managed more than 50 patients per week (Table 1).

Table 1: Number of patient's physicians saw per week

Number of patients per week	<30	6	15.4%
	31–40	4	10.3%
	41–50	6	15.4%
	>50	23	59.0%

The dependent variables were 1) knowledge of current scope of AM use and antimicrobial resistance and 2) practical knowledge of proper selection of AM. The independent variables were 1) demographic data including participants' age and gender and 2) participants' professional profile including job title, position, and years of experience. Position was categorized into 5 groups: 1) staff physician who has finished his/her residency program and is practicing his/her specialty, 2) resident physician who has completed his/her MD and is currently training in a certain specialty, 3) assistant consultant physician who has just completed his/her training program and is licensed in a certain specialty, 4) associate consultant physician who just started his/her career as a consultant and whose work involves supporting a consultant, and 5) consultant physician with at least 3 years of experience in the practice of one medical specialty after finishing the training program. The job titles were categorized as general physician who finished his/her MD but has not undergone special training, family physician, pediatrician, dentist, obstetrician and gynecologist, and other. Physicians' knowledge background was obtained through the first questionnaire, and educational intervention was defined as any attempt to motivate physicians to alter their practice through strategies such as communicating clinical information strategies and communication skills training [12, 13]. The potential confounders were years of experience and level of training.

A formal questionnaire was developed for the study by merging 2 questionnaires from 2 different studies [10, 14]. These questionnaires were modified to suit primary healthcare physicians by eliminating items on the administration of antibiotics via the IV route. However, the items on commonly used oral antibiotics were the same. In addition, 9 multiple choice questions (MCQs) were added to the practical knowledge section. These MCQs were framed on the advice of Dr. Wafa Alnasser, an infectious disease consultant at the National Guard Hospital in Dammam. The tool was validated by 5 experts. The questionnaire comprised 68 items starting with demographic data, job title, and years of experience, as determined by the number of years of clinical practice after obtaining an MD certificate. It has 7 main parts covering the study objectives: the current scope of AM use, questions regarding the usual prescribing practice, factors that affect the choice of antimicrobial regimen, oral antibiotics commonly prescribed in clinical practice, effectiveness of different antimicrobial educational sources, knowledge of antimicrobial resistance, and practical knowledge of proper antimicrobial selection. After the study proposal was approved by an institutional ethics committee, the self-administered questionnaire was distributed to participants during the weekly grand round meeting in the main auditorium of the primary healthcare center, and the participants were requested to respond in the given time. After the questionnaires were collected, a lecture titled "antimicrobial stewardship," which covers all aspects of antibiotic use and resistance, was given by Dr. Wafa

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Alnasser. A month later, the same questionnaire was given out to the same participants in the same settings. No incentive was offered.

Statistical analysis was performed after collecting all questionnaires. Any questionnaire missing more than 50% of the information was disregarded. Data were entered into a personal computer using SPSS Statistics 22. All the variables were coded and checked before entry. All the results were expressed in absolute numbers and percentages. The perception and knowledge of the current scope of AM were evaluated on a 5-point Likert scale ranging from 0 to 4. A wholly correct response was given a score of 4, while a wholly incorrect one was given a score of 0. Partially correct answers were given a 1, 2, or 3 on the Likert scale.

The scoring system for practical knowledge was as follows: 1 point for a correct answer and 0 for an incorrect answer. The means were calculated for the pre- and post-tests, and compared by a paired t-test. This scoring system was used because there were no clear-cut points for perception and knowledge of AM in the literature review. Additionally, the National Guard Health Affairs is not considered an academic practice, making this scoring system suitable, since there is no pre-existing guide to scoring systems for non-academic institutes. A frequency table was drawn with percentages and measures of central tendency and dispersion to explore the study findings. Correlations, paired t-tests, and regression analyses were conducted to estimate the relationships among the variables.

3. Results

3.1 Usual prescribing practices

Participants' antibiotic prescribing frequencies were as follows: 15.4% of participants prescribed them for more than once a day, 20.5% each prescribed them for 3–5 times per week and 1–2 times per week, and 43.6% prescribed them for less than once a week. Moreover, 97.4% of the physicians were against prescribing antibiotics over the phone without examining the patient. Only 38.5% of the physicians had attended continuing educational programs on the rational use of antimicrobials within the past 2 years (Table 2).

Table 2: Usual prescribing practices

Characteristics	N	%
Often prescribe antimicrobial agents		
>Once a day	6	**15.4%**
3–5 times/week	8	**20.5%**
1–2 times/week	8	**20.5%**
<once a week	17	**43.6%**
Approve of clinicians prescribing antimicrobials over phone		
Yes	**1**	**2.6%**
No	**38**	**97.4%**
Attend education on rational antimicrobial prescription in past 2 years		
Yes	**15**	**38.5%**
No	**24**	**61.5%**

3.2 Factors affecting the choice of antimicrobial regimen

Classification similarities were observed in all groups related to comprehensive scientific material, attending courses and lectures, effectiveness and past experience with the drug, knowledge acquired during medical education, and the Saudi National drug formulary. However, there was unanimity (100%) on institutional antibiotic guidelines and expert opinions among the factors affecting their choice of antibiotic regimen. Patient demand, cost of antibiotics, and recommendations by other colleagues were statistically significant (Table 3.1). There was no significant association seen between patient demand and years of experience (Table 3.2).

Table 3.1 Factors affecting the choice of antimicrobial regimen (before intervention)

Factors		N	%	Factors		N	%
Parent/patient demand	Yes	7	17.9%	Clinicians' peace of mind	Yes	5	13.2%
	No	32	82.1%		No	33	86.8%
Reading scientific materials	Yes	38	97.4%	Enough time to educate patient	Yes	5	13.2%
	No	1	2.6%		No	33	86.8%
Attending courses/lectures	Yes	35	89.7%	Institutional antibiotic guidelines	Yes	28	100.0%
	No	4	10.3%		No	0	0.0%
Cost of the antibiotic	Yes	11	28.2%	Knowledge gained during training	Yes	22	95.7%
	No	28	71.8%		No	1	4.3%
Effectiveness from previous experience of drug	Yes	35	89.7%	Expert opinion	Yes	16	100.0%
	No	4	10.3%		No	0	0.0%
Recommended by other colleagues	Yes	13	33.3%	Saudi National Drug Formulary	Yes	12	92.3%
	No	26	66.7%		No	1	7.7%
Knowledge gained from undergraduate/postgraduate training	Yes	35	89.7%				
	No	4	10.3%				

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Table 3.2: Group statistics

	QIII_1 Parent/patient demand	N	Mean	Std. Deviation	Std. Error Mean
Q5_Years of experience	Yes	7	14.57	11.802	4.461
	No	30	11.17	9.678	1.767

3.3 Effectiveness of different antimicrobial educational sources

Continuing educational sources on different antimicrobials play a vital role in antibiotic prescription. This study showed that the most useful educational source was medical journals, accounting for 95% of responses, followed by information from infectious disease fellows and faculty (87.2%). On the other hand, 59% of participants did not use or were not familiar with the Sanford guide (Table 4).

Table 4: Effectiveness of different antimicrobial education sources

Education source		N	%	Education source		N	%
Attending physicians other than ID faculty	Useful	23	59.0%	Internet websites	Useful	29	74.4%
	Not useful	5	12.8%		Not useful	7	17.9%
	Unfamiliar Do not use	11	28.2%		Unfamiliar Do not use	3	7.7%
Colleagues, fellows, and faculty from infectious diseases	Useful	34	87.2%	Pocket book of infectious disease therapy	Useful	27	69.2%
	Not useful	0	0.0%		Not useful	1	2.6%
	Unfamiliar Do not use	5	12.8%		Unfamiliar Do not use	11	28.2%
Other staff physicians	Useful	19	48.7%	Sanford guide	Useful	12	30.8%
	Not useful	14	35.9%		Not useful	4	10.3%
	Unfamiliar Do not use	6	15.4%		Unfamiliar Do not use	23	59.0%
Medical journals	Useful	37	94.9%	Drug formulary at NGHA Hospital	Useful	28	71.8%
	Not useful	0	0.0%		Not useful	3	7.7%
	Unfamiliar Do not use	2	5.1%		Unfamiliar Do not use	8	20.5%

3.4 Commonly prescribed oral antibiotics in clinical practice

Amoxicillin clavulanate was the most frequently prescribed antibiotic among all the primary health care physicians. However, there was only a significant association between job and amoxicillin (p = .007) (Table 5).

Table 5: Commonly prescribed oral antibiotics in clinical practice

		Board certified		Resident		Staff physicians	
		Count	Column n %	Count	Column n %	Count	Column n %
Penicillin_amoxicillin clavulanat	No	0	0.0%	4	28.6%	1	5.9%
	Yes	8	100.0%	10	71.4%	16	94.1%
Penicillin_amoxicillin	No	2	25.0%	9	64.3%	15	88.2%
	Yes	6	75.0%	5	35.7%	2	11.8%
Cephalosporins_cephalexin	No	6	75.0%	13	92.9%	14	82.4%
	Yes	2	25.0%	1	7.1%	3	17.6%
Quinolones_ciprofloxacin	No	3	37.5%	9	64.3%	13	76.5%
	Yes	5	62.5%	5	35.7%	4	23.5%
Macrolides_erythromycin	No	5	62.5%	11	78.6%	11	64.7%
	Yes	3	37.5%	3	21.4%	6	35.3%
Empirical treatment	No	8	100.0%	14	100.0%	14	82.4%
	Yes	0	0.0%	0	0.0%	3	17.6%
Co-trimoxazole	No	5	62.5%	14	100.0%	12	70.6%
	Yes	3	37.5%	0	0.0%	5	29.4%
Metronidazole	No	5	62.5%	11	78.6%	12	70.6%
	Yes	3	37.5%	3	21.4%	5	29.4%
Tetracycline	No	7	87.5%	13	92.9%	17	100.0%
	Yes	1	12.5%	1	7.1%	0	0.0%
Clindamycin	No	6	75.0%	10	71.4%	13	76.5%
	Yes	2	25.0%	4	28.6%	4	23.5%
Cephalosporins_cefuroxime	No	0	0.0%	5	35.7%	7	41.2%
	Yes	8	100.0%	9	64.3%	10	58.8%
Other metronidazole	No	5	62.5%	9	64.3%	13	76.5%
	Yes	3	37.5%	5	35.7%	4	23.5%

3.5 Knowledge and perception about current scope of antimicrobial agents before the educational intervention

All the participants had a similar perspective, and no significant differences were statistically obtained in their knowledge of using antibiotics. Most participants (87.2%) strongly agreed that differentiation between child and adult doses is essential, and most participants agreed (82%) that antibiotic use might cause allergy and lead to death. On the other hand, only 34.2% of the participants disagreed on

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antimicrobial use being essentially based on availability rather than the nature of the disease (Figure 1).

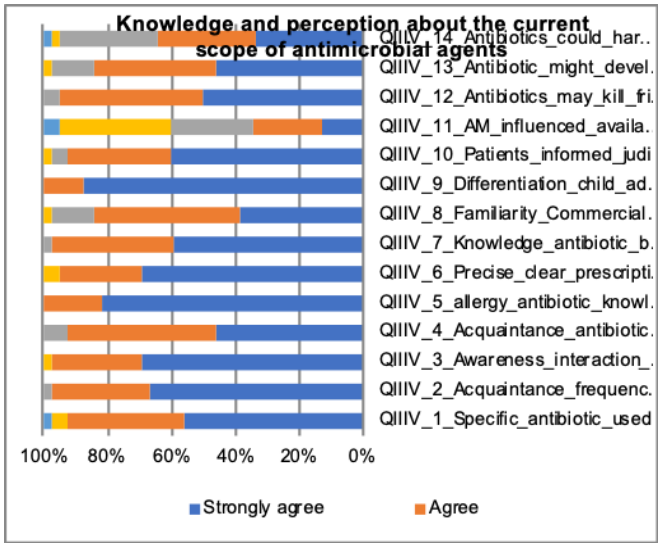

Figure 1: Knowledge and perception about the current scope of antimicrobial agents

3.6 Knowledge about antimicrobial resistance before the educational intervention

All participants showed comparable responses regarding the perception of antimicrobial resistance. Specifically, it affected their daily practice (with 64% reporting "strongly agree" or "agree" to this item). Most participants strongly agreed that antimicrobial resistance is a problem worldwide including in Saudi Arabia (Figure 2), and 66.7% agreed that there is inappropriate antimicrobial use in their clinical practice. In addition, 74.4% strongly agreed that they would like to advance themselves and participate in educational programs for updates on antibiotics.

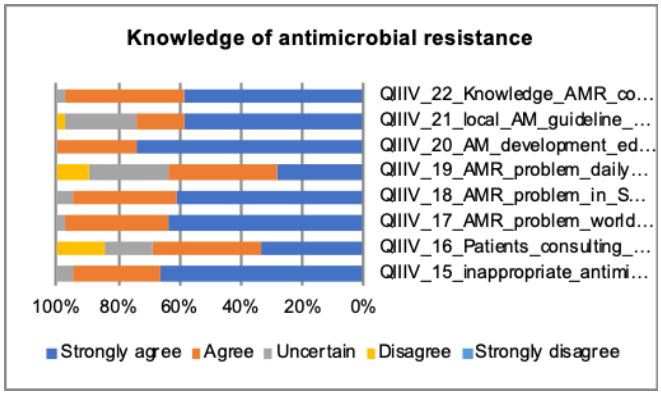

Figure 2: Knowledge of antimicrobial resistance

3.7 Knowledge of the participants regarding the cause of antimicrobial resistance

Most of the participants (84.6%) strongly agreed that using antimicrobials when not necessary leads to increased antibiotic resistance. Interestingly, 30.8% were uncertain about the effect of using different brands of the same antibiotic (Figure 3).

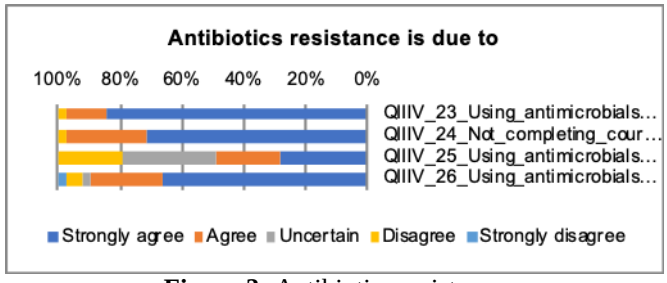

Figure 3: Antibiotics resistance

3.8 Factors influencing misuse/overuse

The participants showed uniform agreement or strong agreement (ranging between 80–90%) on factors that affected the overuse of antimicrobials, such as patients' demand, lack of public health education, and availability of antimicrobials over the counter. However, they had diverse opinions on whether the cost of antimicrobials affected their use, with 35.9% agreeing and 30.8% being uncertain.

3.9 Practical knowledge of proper antimicrobial selection before the educational session

Prior to the educational session, the participants were evaluated on their practical knowledge regarding the selection of correct answers on a 10-item quiz. The mean score of their answers was 3.46.

3.10 Knowledge and perception about the current scope of antimicrobial agents after the educational intervention

There was no significant difference seen before and after the intervention, with a mean of 21.24 before the intervention compared to a mean of 20.37 after. The result also demonstrated a moderate correlation of .470 (Figure 4).

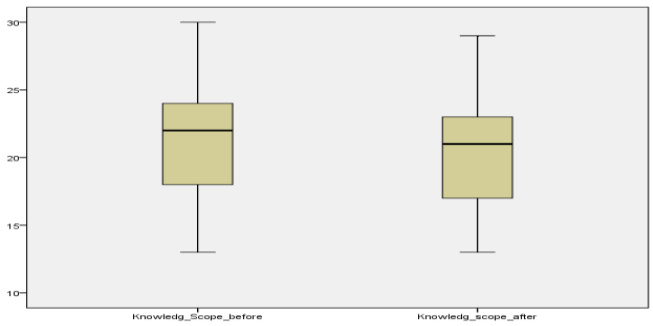

Figure 4: Box plot of knowledge of current scope of antimicrobial agent use before and after education session

3.11 Knowledge about antimicrobial resistance after the educational session

No significant difference was observed before and after the intervention in knowledge regarding antimicrobial resistance, with a mean of 19.41 before the intervention and 19.64 after. There was, however, a strong correlation of paired samples (.703) (Figure 5 and Table 6).

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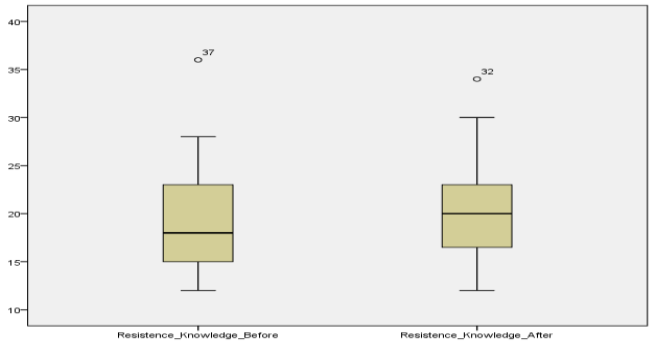

Figure 5: Box plot of knowledge of antimicrobial resistance before and after education session

Table 6: Paired samples t-test of knowledge of current scope of antimicrobial agent use before and after education session

		Paired differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	R Knowledge Before R Knowledge After	-.231	4.120	.660	-1.566	1.105	-.350	38	.728

3.12 Practical knowledge of proper antimicrobial selection after the educational session

The educational session had a significant effect on the participants' practical knowledge of proper antimicrobial selection ($p = .000$), with a mean of 3.46 before the intervention and 7.61 after the intervention. There was a weak to moderate correlation of the paired samples (Table 7 and Figure 6).

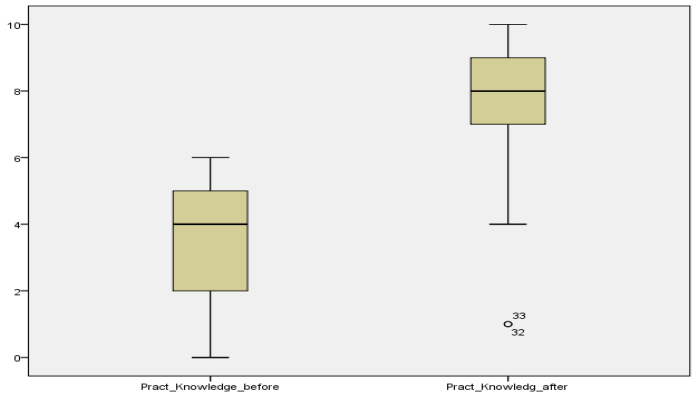

Figure 6: Box plot of practical knowledge before and after the education session

Table 7: Paired sample t-test of the practical knowledge of proper antimicrobial selection before and after the educational session

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Practical knowledge before Practical knowledge after	-4.15385	2.28886	.36651	-4.89581	-3.41188	-11.334	38	.000

4. Discussion

Antimicrobial resistance is highlighted as a major outcome of antimicrobial misuse/overuse. However, there is a need for educating physicians by providing them with accurate information and helping them attains the crucial goal of decreasing this resistance [10].

Almost half of the primary healthcare physicians in our study mentioned that their choice of antimicrobials was markedly influenced by institutional international guidelines and expert opinion. Overall, 70% of their antibiotic prescriptions were influenced by patient expectations toward prescribing an antimicrobial agent and by wanting to prevent any conflict with the patient [15, 16]. However, this was a deviation from the guidelines for high prescriptions; hence, these guidelines should be imposed widely to ensure that they can help overcome the issue of overuse [17].

There was no significant association between years of experience of primary care physicians and patients' demands for antimicrobials (Table 3.2), which is different from what

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was observed in the past, where there was a statistically significant disparity between general practitioners and residents or specialists [10].

Almost all the participants chose medical journals as the source of antimicrobial education in this study. Family physicians also frequently used colleagues' advice as an informational source, followed by journals and books [18]. Amoxicillin clavulanate (Augmentin) was the most commonly prescribed antibiotic among the physicians of the primary health care center in our study. Amoxicillin was also more commonly prescribed by general practitioners, and was often used a placebo (e.g., for a viral infection) [17]. There was a significant association between job (board certified physicians, residents, and staff physicians) and prescribing amoxicillin (Table 5).

On the other hand, this study showed that all the participants had excellent knowledge of the indications, contraindication, magnitude, and causes of increased resistance, besides the increased need for a local antimicrobial guideline (Figure 6, Figure 7, and Figure 8).

In this study, knowledge and perception of the participants regarding the current scope of AM and antimicrobial resistance after the educational intervention were statistically not significant compared to their knowledge and perception prior to the educational session. This was likely because of their excellent basic knowledge and perception (Figure 9, Figure 10). Similarly, no difference was observed in the participants' basic knowledge and perceptions of the current scope of AM and its misuse [10].

There was a significant post-educational-session improvement in the practical knowledge of proper antimicrobial selection compared to the pre-educational session among the physicians of the primary healthcare center. Interestingly, most past studies have indicated that active intervention, such as an educational session, is more effective than is a mix of active and passive interventions or interventions directed toward patients (e.g., educational campaigns) [11].

A systematic review of educational interventions on improving antibiotic use revealed that a majority of the primary healthcare providers reported positive results as an outcome, although some studies reported that educational interventions do not influence the outcome statistically [11].

There were some limitations to this study. This short period between the pre- and post-educational session questionnaire might have affected participant responses. Furthermore, only one session was offered to the participants, owing to difficulties in time management (given that all participants were engaged in their clinical tasks).

5. Conclusion

In conclusion, this study reveals that physicians have clear basic knowledge regarding antimicrobial use and its emerging resistance, regardless of an intervention. However, there was an obvious improvement in their practical knowledge regarding proper selection of AM after just one educational session. This reflects the need to implement antimicrobial educational programs at the national level with updated knowledge in attempt to achieve the primary goal of minimizing antimicrobial resistance.

6. Future Scope

Enhanced and condensed educational programs are needed to ensure adherence to national and international guidelines among physicians in a primary healthcare setting and in a hospital setting.

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