Saudi Pharmaceutical Journal 31 (2023) 55–64

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Saudi Pharmaceutical Journal

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Original article

Assessment of knowledge, attitude, and practice of antibiotics prescription among healthcare residents at King Abdulaziz medical City, Jeddah, Saudi Arabia

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ARTICLE INFO

Article history:
Received 3 July 2022
Accepted 8 November 2022
Available online 14 November 2022

Keywords:
Antibiotic resistance
Antibiotic prescription
Surgical residents
Non-surgical residents

ABSTRACT

Introduction: Antibiotic resistance (ABR) is defined as bacteria's resistance to therapy despite therapeutic levels of antibiotics. It is a global health concern. Data on the antibiotic prescription practice of physicians, in general, are limited in Saudi Arabia. Therefore, we aim to assess the knowledge, attitude, and practice of antibiotic prescription between surgical and non-surgical residents at King Abdulaziz Medical City (KAMC).

Methods: A cross-sectional study was conducted at KAMC in Jeddah, Saudi Arabia, from September 2019, until March 2020. The questionnaire contained demographic information and 31 questions based on the studied variables: knowledge (17), attitude (4), and practice (10).

Results: The response rate was 83 %. Male to female response rates were 54 % and 46 %, respectively. The majority of respondents (72 %) were non-surgical residents. Positive practice skills showed that 55 % of all healthcare residents always used practice guidelines for antibiotic prescription in their daily work (P-value < 0.001). Most residents (50 %) sometimes used delayed prescriptions. Non-surgical residents discussed ABR with patients more than surgical residents (P-value = 0.028). Lack of patient interest was the common cause for not discussing ABR with patients (42 %). Non-surgical residents had significantly more training on antibiotic prescription (p-value = 0.001). The fear of infection spread due to not prescribing an antibiotic was significantly higher in non-surgical residents (P-value < 0.001). Non-surgical residents (76 %) took a past medical history of antibiotic consumption more than surgical residents (24 %) (P-value = 0.003). Antibiotic prescription for residents was not influenced by advertisements (91 %). The most common resistant organisms reported by residents were insignificant between the two groups. The results also showed that the residents' common choice of antibiotics was not statistically different between surgical and non-surgical residents in most antibiotic classes.

Conclusions: We found that practice guidelines, formal training, and taking patients' past medical histories were significantly higher among non-surgical residents. In contrast, surgical residents were prescribing more antibiotics due to the fear of the spread of the infection. Proper training is essential for all healthcare residents to overcome differences among different specialties.

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Abbreviations: MOH, Ministry of Health; KAMC, King Abdulaziz Medical City; NGHA, National Guard Health Affairs; IRB, Instituitional Review Board; KAIMRC, King Abdullah International Medical ResearchCenter.

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Peer review under responsibility of King Saud University.

Production and hosting by Elsevier

https://doi.org/10.1016/j.jsps.2022.11.005
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1. Introduction

Antibiotic resistance has been emphasized extensively in the past decade as a global concern (Mobarki et al., 2019; Mayers, 2009; "The World Health Report 2007—A Safer Future: Global Public Health Security in the, Geneva, Switzerland. World Health Organization; 2007," n.d.). The risk factors contributing to bacterial resistance include the overuse of antibiotics, inappropriate prescription, and extensive agricultural use of antibiotics (Lee Ventola, 2015). Inappropriate prescription of antibiotics can be in the form of prescribing an antibiotic when it has little or no benefit, not prescribing antibiotics when it is necessary, choosing an antibiotic that is not optimal or selecting an antibiotic whose potential risks outweighs its benefit (Smith et al., 2018). This injudicious prescription is due to choosing the wrong antibiotic, combination, dose, route, or duration (Balkhy, n.d.). Moreover, using no reference sources, deviation from standard use, and uncertainty about the etiology are all factors related to the physician's behavior leading to inappropriate prescription (Balkhy, n.d.; Md Rezal et al., 2015). A study in Riyadh reported that 79 % of adults were using antibiotics without a prescription. Another study in 2011 that included 60 pharmacies showed that almost all pharmacists (97.9 %) dispensed non-prescribed antibiotics (Al-Mohamadi et al., 2013). As a result of the increased data on antibiotic resistance worldwide, the Ministry of Health (MOH)[1] in Saudi Arabia enforced a law that prohibits dispensing medications without prescriptions (Kurdi et al., 2020). As a result, the percentage of non-prescribed antibiotics was reduced to 63 % in 2015 (el Zowalaty et al., 2016). In 2015, a study done in Riyadh to assess physicians' knowledge, perception, and attitude in different public sector hospitals, showed that most physicians were unaware of the rate and pattern of antibiotic resistance in their institutions. Moreover, around one-third of the respondents felt confident regarding their prescribing despite reporting that they did not receive constant training in their specialty and limited utilization of local antibiotics therapy guidelines. The research suggested the need to implement programs to help physicians recognize the significance of evidence-based guidelines in guiding their choice of antibiotics (Baadani et al., 2015). Research has shown no significant difference between junior and senior residents' years of practice. However, the difference was in the training programs that included antibiotics prescriptions. The ones who got trained their knowledge was significantly better (Navarro-San Francisco et al., 2013; Pulcini et al., 2011).

To our knowledge, data on antibiotic prescription practices of physicians from different specialties are limited in Saudi Arabia. Therefore, the study aimed to assess knowledge, attitude, and factors affecting antibiotic prescription among healthcare residents depending on the specialty as a surgical and non-surgical specialty to determine if residents' specialty is a contributing factor in the practice of antibiotic prescription in Saudi Arabia. Also, to evaluate if pharmaceutical advertisement influence healthcare residents' decisions in prescribing antibiotics.

2. Methods

The study is a cross-sectional study design. It was conducted at King Abdulaziz Medical City (KAMC)[2] at the National Guard Health Affairs (NGHA)[3] in Jeddah, Saudi Arabia, from September 2019, until March 2020. Data was collected through an electronically structured questionnaire using Google forms. There was an extensive literature search, and a questionnaire was made for this study (Alothman et al., 2016; Dutt et al., 2018; Jana et al., 2016; Salm et al., 2018; Thakolkaran et al., 2017; Thriemer et al., 2013; Vardhan et al., 2017). The questionnaire consisted of four parts. The first section consisted of six questions, all related to demographics and general information: age, gender, specialty, years of residency, duration of practice since graduation, and university name. Knowledge was assessed by using 17 questions, while 4 questions were for attitude, and 10 questions were for evaluating practices, respectively. Face validity was carried out by handing over the questionnaire to two medical educationists. For content validity, two independent subject experts were given the questionnaire and got feedback, and minor modifications were made. The questionnaires were pilot-tested from the same setting. Comments and suggestions by the respondents were incorporated to improve the item questions. Reliability testing (internal consistency) was performed from the pilot study to calculate Cronbach's alpha value of 0.632.

Based on the American Board of Medical Specialties, the surgical and non-surgical specialties are as presented in Table 1. The second section of the questionnaire included 14 different statements (four negative statements and ten positive statements) on a five point Likert scale ranging from one (strongly disagree) to five (strongly agree) to assess the residents' knowledge and practice of antibiotic prescription among surgical and non-surgical specialties (Table 2). Reverse coding was done for four negative statements to calculate the mean rank of participants. Sections three and four included statements about the attitude and practice of antibiotic prescription.

The types of questions used are the Likert scale of agreement and frequency, checkboxes, and yes/no questions. The estimated time to finish the questionnaire was about 7 min. The study was approved by the Institutional Review Board (IRB)[4] of King Abdulla International Medical Research Center (KAIMRC),[5] and the study number is SP19/139/J. The questionnaires were disseminated to the residents of KAMC through a link sent to work emails, social media platforms; Twitter, and WhatsApp, and in the hospital setting by filling the questionnaire on the tablet.

Based on the KAMC population size of 439 healthcare residents, the calculated sample size was 206, with a confidence level of 95 % and a margin of error of 5 %. A total of 171 healthcare residents who agreed to participate in the study were included. The non-probability convenient sampling technique was used in order to obtain a representative sample for the research's target population.

Informed consent was obtained from the participants. The purpose of the study, the confidentiality of the participants, and the right to withdraw from the study at any time without penalty were explained at the beginning of the questionnaire. Only the investigators had access to the residents' data. The principal investigator (PI) ensured that all data would be kept secure within NGHA premises.

Data were entered on Microsoft Excel version 2.40 and were analyzed using IBM SPSS® version 20. Qualitative variables included gender, department, and specialty and were presented as frequencies and percentages. Quantitative variables included age, years of residency, and duration of practice since starting the residency program and were calculated using mean and standard deviation. T-test was used to compare the knowledge scores of participants in the surgical vs non-surgical groups. The Chi-square test was used to compare qualitative variables. Analysis of variance (ANOVA) was used to check if the means of more than two groups were significantly different. Finally, regression analysis

[1] Ministry of Health.
[2] King Abdulaziz Medical City.
[3] National Guard Health Affairs.
[4] Institutional Review Board.
[5] King Abdulla International Medical Research Center.

Table 1
Demographic characteristics of study participants.

		n = 171	%
Gender	Female	79	46
	Male	92	54
Non-surgical specialty			
Family Medicine		35	20
Internal Medicine		23	13
Pediatrics		17	10
Emergency Medicine		16	9
Preventive Medicine		1	1
Critical Care Medicine		6	3
Anesthesia		8	5
Anatomical Pathology		1	1
Medical Imaging		5	3
Psychiatry		4	2
Neurology		3	2
Dermatology		3	2
		122	**72**
Surgical specialty			
Ophthalmology		10	6
Obstetrics & Gynecology		9	5
General Surgery		8	5
Orthopedics		7	4
ENT Head & Neck		6	3
Urology		4	2
Plastic Surgery		3	2
Pediatric Surgery		1	1
Neurosurgery		1	1
		49	**28**
Years of residency			
R1		55	32
R2		29	17
*R*3		45	26
R4		31	18
R5		12	7
Duration of practice since graduation		41	24
< 1 year		76	44
1 year - < 3 years		47	28
3 years - < 6 years		7	4
6 years or more			
University of graduation (Bachelor degree of medicine)		72	42
King Abdulaziz University		38	22
King Saud bin Abdulaziz University for Health Sciences		23	13
Umm Al-Qura University		15	9
Ibn Sina National College for Medical Studies		4	2
Taif University		4	2
Taiba University		15	9
Other			

was done to adjust for confounding variables affecting each group's performance. P-value < 0.05 was considered statistically significant.

3. Results

3.1. Description of the respondents

A total of 171 questionnaires were completed out of 206, with a response rate of 83 %. Male to female response rates were 54 % (n = 92) and 46 % (n = 79), respectively. The questionnaire contained four sections. The first section was demographic and basic information about residents, as illustrated in Table 1. The majority of respondents (n = 122, 72 %) were from non-surgical specialties, and only (n = 49, 28 %) were from surgical specialties. Family medicine was the most common specialty (n = 35, 20 %), followed by internal medicine (n = 23, 13 %). Most participants (n = 55, 32 %) were residents in their first year of residency.

3.2. Residents' knowledge and practice of antibiotic prescription

We assessed the residents' knowledge and practice of antibiotic prescription among surgical and non-surgical specialties and found no significant difference in knowledge and practice (Table 2).

3.3. Positive practice for antibiotic prescriptions

Positive practice skills results showed that 55 % (n = 94) of all residents (non-surgical residents n = 79, 84 %, and surgical residents n = 15, 16 %) always used practice guidelines for an antibiotic prescription in their daily work (P-value < 0.001). Residents who sometimes used antibiotic practice guidelines were similar between non-surgical residents 51 % (n = 28) and surgical residents 49 % (n = 27). Only 13 % (non-surgical residents n = 15, surgical residents n = 7) of all residents rarely or never used practice guidelines for prescribing antibiotics.

Most residents (n = 86, 50 %) reported using delayed prescriptions sometimes (non-surgical residents n = 58, 67 %, and surgical residents n = 28, 33 %). Residents who rarely or never used delayed antibiotic strategy were non-surgical residents n = 43, 35 %, and surgical residents n = 19, 39 %. Only 13 % of residents always used the delayed antibiotic prescription strategy, with no statistically significant difference between the two groups regardless of the specialty or residency training levels (P-value = 0.150).

When it comes to checking decisions about antibiotic prescription with colleagues, non-surgical residents (n = 61, 74 %), and surgical residents (n = 22, 26 %), always check their choices with a colleague with no statistically significant difference between the specialties (P-value = 0.370).

Residents who always discussed antibiotic resistance with patients suffering from infections were significantly higher (P-value = 0.028) among non-surgical residents (n = 54, 79 %) compared to surgical residents (n = 14, and 21 %). Non-surgical and surgical residents who rarely or never discuss antibiotic resistance with patients suffering from infections were 25 % and 42 %, respectively. The responses to reasons for not discussing antibiotic resistance with patients were similar between all residents of different specialties, years of residency, and duration of practice and were not statistically significant. According to residents, the lack of patient interest was the most common cause for not discussing ABR with patients (42 %), followed by lack of time (36 %) (Fig. 1).

3.4. Factors affecting attitude and practice for antibiotic prescriptions

The results revealed that non-surgical residents (n = 53, 87 %) had significantly more formal training on a judicious antibiotic prescription (p-value = 0.001) than surgical residents (n = 8, 13 %) (Table 3). Another difference found is that the fear of the spread of infection due to not prescribing an antibiotic was significantly higher (P-value= <0.001) in non-surgical residents (n = 35, 56 %) than in surgical residents (n = 28, 44 %). Non-surgical residents (n = 104, 76 %) took a past medical history of antibiotic consumption more than surgical residents (n = 32, 24 %) with a statistically significant difference (P-value = 0.003). More than two-thirds of all healthcare residents, 89 % (n = 152), answered that they did not have advertisement materials. The difference between non-surgical residents (n = 113, 74 %) and surgical residents (n = 39, 26 %), who did not have advertisement materials, was significantly different (P-value = 0.014). In addition, an antibiotic prescription for residents was not influenced by advertisements (n = 156, 91 %). The difference between surgical and non-

Table 2
Residents' knowledge and practice of antibiotic prescription.

	N	Mean Rank	Z	p
Inappropriate empiric choices can be a cause of antibiotic resistance				***0.125***
Non-surgical specialties	*122*	*83.04*	*−1.536*	
Surgical specialties	*49*	*93.37*		
Using two or more types of antibiotics at a time is a better choice to control infection				***0.280***
Non-surgical specialties	*122*	*83.51*	*−1.081*	
Surgical specialties	*49*	*92.19*		
When a patient has a cold, I should prescribe him|her an antibiotic to prevent getting a more serious illness				***0.956***
Non-surgical specialties	*122*	*85.90*	*−0.055*	
Surgical specialties	*49*	*86.26*		
Whenever I prescribe an antibiotic, I contribute to the development of antibiotic resistance				***0.274***
Non-surgical specialties	*122*	*83.48*	*−1.093*	
Surgical specialties	*49*	*92.29*		
I think that the overuse of antibiotics is contributing cause of resistance				***0.626***
Non-surgical specialties	*122*	*86.96*	*−488*	
Surgical specialties	*49*	*83.61*		
I believe that inappropriate duration of course can be a contributing cause of resistance				***0.293***
Non-surgical specialties	*122*	*88.32*	*−1.051*	
Surgical specialties	*49*	*80.22*		
I think that antibiotic resistance is an important and serious public health issues worldwide				***0.976***
Non-surgical specialties	*122*	*86.05*	*−0.030*	
Surgical specialties	*49*	*85.88*		
Patient demands and expectations lead to wrong antibiotics prescription				***0.133***
Non-surgical specialties	*122*	*89.40*	*−1.502*	
Surgical specialties	*49*	*77.54*		
I am confident about my knowledge of antibiotics				***0.311***
Non-surgical specialties	*122*	*88.28*	*−1.013*	
Surgical specialties	*49*	*80.33*		
I think that broad spectrum antibiotics are better than narrow spectrum types				***0.955***
Non-surgical specialties	*122*	*86.13*	*−0.056*	
Surgical specialties	*49*	*85.67*		
An antibiotic should be used whenever your patient is having a fever				***0.113***
Non-surgical specialties	*122*	*82.51*	*−1.586*	
Surgical specialties	*49*	*94.69*		
When one prescribes an antibiotic, it is important to know the resistance rate of the bacteria in the local setting				***0.075***
Non-surgical specialties	*122*	*89.88*	*−1.781*	
Surgical specialties	*49*	*76.35*		
For antibiotic guidelines, local guidelines are more useful than international guidelines				***0.629***
Non-surgical specialties	*122*	*84.89*	*−0.483*	
Surgical specialties	*49*	*88.76*		
You would like to have more evidence-based therapy guidelines				***0.864***
Non-surgical specialties	*122*	*85.66*	*−0.171*	
Surgical specialties	*49*	*86.84*		

Z score (standard score) is the number of standard deviations by which the value of a raw score is above or below the mean value of what is being observed or measured. Z-scores range from − 3 standard deviations (which would fall to the far left of the normal distribution curve) up to + 3 standard deviations.

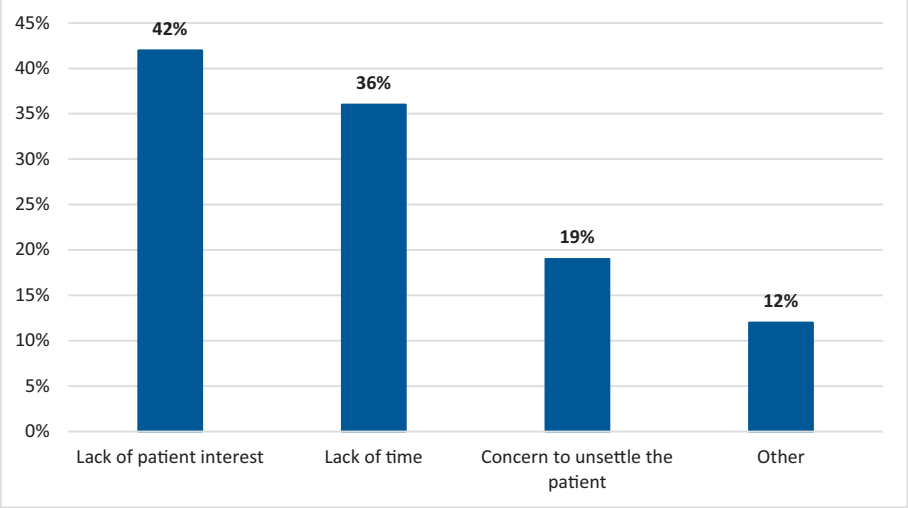

Fig. 1. Reasons residents do not discuss antibiotic resistance with patients suffering from infections.

Table 3
Factors affecting attitude and practice of antibiotic prescription.

		n	%	*p*-value
Participation in formal training on judicious use of antibiotics/infection control.	Surgical residents	8	13	0.001*
	Non-surgical residents	53	87	
Practice the usage of broad-spectrum antibiotics in every infectious disease.	Surgical residents	15	30	0.803
	Non-surgical residents	35	70	
Fear the spread of infection just because you have not prescribed antibiotics.	Surgical residents	28	44	< 0.001*
	Non-surgical residents	35	56	
Take past medical history of consumption of antibiotics before prescribing antibiotics.	Surgical residents	32	24	0.003*
	Non-surgical residents	104	76	
Having any material advertisement from any pharmaceutical company in your clinic.	Surgical residents	10	53	0.014*
	Non-surgical residents	9	47	
My prescriptions are influenced **by advertisements.**	Surgical residents	6	40	0.371
	Non-surgical residents	9	60	
Do you write the drug brand/market name or the content name in the prescription?				
Surgical specialties				
	Brand name	3	50	0.057
	Generic name	30	24	
	Both	16	40	
Non-surgical specialties				
	Brand name	3	50	
	Generic name	95	76	
	Both	24	60	

Regarding the current information sources on antibiotic therapy and resistance, non-surgical and surgical residents' choices were similar and were not statistically significant (P-value > 0.05).

surgical residents in writing the drug name by brand name, generic name, or both was not significantly different (P-value = 0.057). Most residents wrote drugs by generic name from both groups (non-surgical residents n = 95, 76 %, and surgical residents n = 30, 24 %) (Fig. 2).

The most common resistant organism reported by all healthcare residents (surgical & non-surgical) was *MRSA* (85 %), followed by *ESBL E. coli* (66 %). *Multi-resistance Pseudomonas aeruginosa and extended-spectrum beta-lactamase-producing Klebsiella pneumoniae* were similar among all residents (37 %) (Table 4). No significant differences were observed between surgical and non-surgical residents.

The results also showed that the non-surgical residents' common choice of antibiotics prescribed were approximate to Macro-

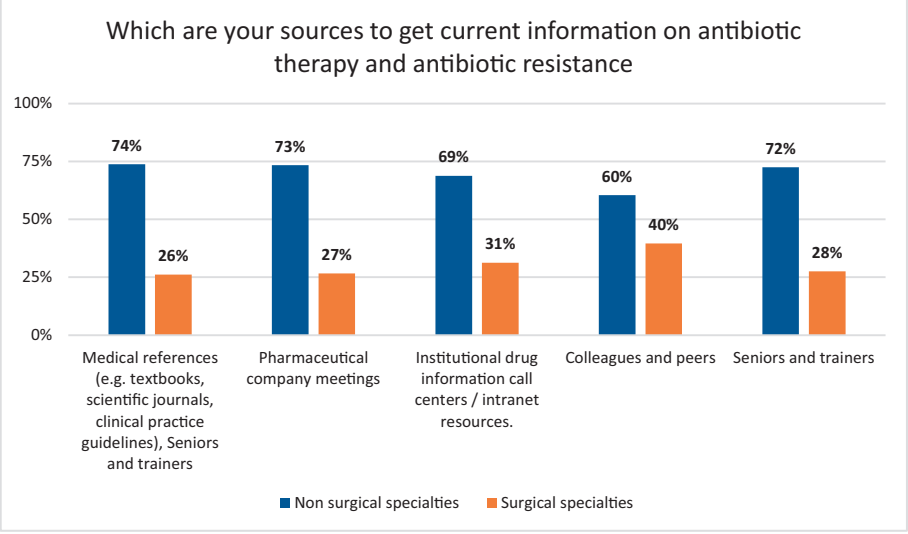

Fig. 2. Sources of current information on antibiotic therapy and resistance.

Table 4
Most common organisms reported at the institution.

	n	%	p-value
Methicillin-resistant Staphylococcus aureus (MRSA) **(n = 145)**			**0.465**
Non-surgical specialties	105	72	
Surgical specialties	40	28	
Extended spectrum beta-lactamase producing Escherichia coli (ESBL E.coli) **(n = 113)**			**0.227**
Non-surgical specialties	84	74	
Surgical specialties	29	26	
Multidrug-resistant Pseudomonas aeruginosa **(n = 64)**			**0.640**
Non-surgical specialties	47	73	
Surgical specialties	17	27	
Extended spectrum beta-lactamase producing Klebsiella pneumoniae **(n = 63)**			**0.076**
Non-surgical specialties	50	79	
Surgical specialties	13	21	
Multidrug-resistant Acinetobacter sp. **(n = 43)**			**0.092**
Non-surgical specialties	35	81	
Surgical specialties	8	19	
Penicillin-resistant Streptococcus pneumonia (PRSP) **(n = 21)**			**0.120**
Non-surgical specialties	18	86	
Surgical specialties	3	14	
Other (n = 5)			**0.323**
Non-surgical specialties	5	100	
Surgical specialties	0	0	

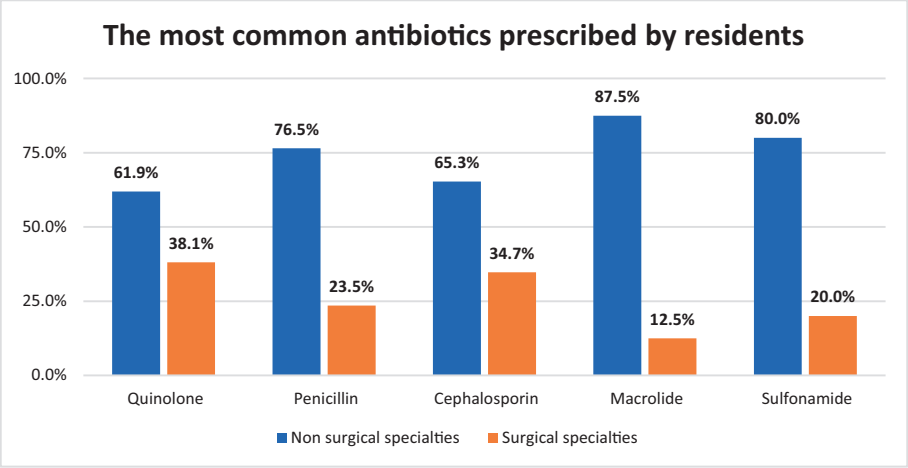

Fig. 3. The most common antibiotics prescribed by surgical and non-surgical residents.

lide (88 %), Sulfonamide (80 %), and penicillin (77 %). On the other hand, surgical residents' antibiotic choices were approximate to Quinolone (38 %), Cephalosporin (35 %), and approximate to Penicillin (24 %) and Sulfonamide (20 %), while Macrolide was the least prescribed (13 %). Furthermore, no statistically significant difference was observed between all residents in antibiotic classes, except for Macrolide (P-value = 0.001) (n = 7, 88 % vs n = 1, 13 %) for non-surgical vs surgical residents, respectively (Fig. 3).

4. Discussion

This study evaluated the knowledge, attitude, and practice of antibiotic prescription between surgical and non-surgical residents at KAMC. The study included Saudi healthcare residents of different specialties, excluding dental and psychiatry residents. Dental residents were excluded because of the limited use of specific antibiotics and the prescription of antibiotics mainly as prophylactic intervention and treatment, while psychiatric residents do not prescribe antibiotics (Koyuncuoglu et al., 2017). The study showed that approximately all residents (96 %) recognize antibiotic resistance (ABR) as a serious health problem worldwide. Furthermore, residents are also aware of the factors contributing to ABR. The current national and global movements focus on reducing and limiting antibiotic resistance by highlighting its consequences ("Kingdom of Saudi Arabia: National action plan on combating antimicrobial resistance [Internet]. World Health Organization; 2017 [cited July 2021]. Available from: //https://www.who.int/publications/m/item/kingdom-of-saudi-arabia-national-action-plan-on-combating-antimicrobial-resistance," n.d.; "U.S. National Action Plan for Combating Antibiotic-Resistant Bacteria (National Action Plan) [Internet]. Centers for Disease Control and Prevention; 2015 [cited July 2021]. Available from: https://www.cdc.gov/drugresistance/us-activities/national-action-plan.html," n.d.). However, the residents seem to be confident about their knowledge of antibiotics

to a lesser extent than expected (45 %). In addition, our study showed that only 36 % of all residents had previous formal training on the judicious use of antibiotics/infection control, with non-surgical residents having more training than surgical residents (87 % vs 13 %). This finding parallels a previous study conducted in Riyadh, where only 28 % of physicians received extra training in microbiology/infectious disease (Alothman et al., 2016). The same study also reported that almost two–thirds of participants rated their current knowledge of antibiotic resistance between average and good and that almost all the participants (92 %) reported that they would prefer to learn recent updates on antibiotics courses and guidelines (Alothman et al., 2016).

Overall, the study demonstrated good professional practice, as 55 % of residents always use practice guidelines for antibiotic therapy. Only 14 % of residents always use delayed antibiotic prescriptions. However, most residents (50 %) sometimes use delayed antibiotic prescriptions, with no significant difference between the groups. Our finding is similar to a study in Germany in 2018, where 29.4 % of general practitioners (GPs) often use delayed antibiotic prescriptions with uncomplicated upper respiratory tract infections (Salm et al., 2018). Delayed antibiotic therapy is one of the critical factors in reducing resistance, especially with common community-acquired infections, however, not in the cases of severe sepsis or septic shock and bacterial meningitis, where immediate treatment is necessary for older and high-risk patients (Andersson et al., 2019; van de Beek et al., 2016).

Another indication of good practice, 72 % of non-surgical residents, compared to 28 % of surgical residents, do not use broad-spectrum antibiotics for every infectious disease, with no statistically significant difference between surgical and non-surgical residents. Also, 80 % of residents take a past medical history of antibiotic consumption before prescription, with a higher rate among non-surgical residents than surgical residents (77 % vs 24 %, P-value = 0.003). The utilization of electronic medical records, according to NGHA policies, allows physicians to prescribe drugs only by their generic name, indicating good practice. We determined that the healthcare residents who always or sometimes discuss this topic with patients were 40 % and 30 %, respectively. Lack of patient interest, according to residents, was the main reason residents did not discuss ABR with patients in this study (42 %). This could be explained by the multiple studies that showed that patients' knowledge of antibiotic resistance is poor in Saudi Arabia (al Saleh et al., 2021; Alenazi et al., 2020; Al-Shibani et al., 2017; Kurdi et al., 2020; Yagoub et al., 2019). Raising the awareness of patients by discussing ABR with them is an important factor that can be improved for the successful reduction of ABR. Therefore, as a health care provider, effective communication with patients includes explaining to the patient when an antibiotic is medically appropriate and the potential harm they may cause in case of misuse. Most residents (85 %) agree that the most common resistant organism seen at their institution was *Methicillin-resistant Staphylococcus Aureus (MRSA)*. This finding is similar to the study done in Riyadh in 2016. However, Multidrug-resistant *Acinetobacter* sp. and Multidrug-resistant *Pseudomonas aeruginosa* were reported a little more than in the current study (Alothman et al., 2016).

Overall, we found some significant differences in the factors affecting our study's attitude and practice of prescribing antibiotics between surgical and non-surgical residents, including past training, following guidelines, and taking a past medical history of antibiotic prescription. Most residents are aware of the leading causes of ABR shown in Table 2. Our findings were similar to previous national and international studies (Alothman et al., 2016; Baadani et al., 2015; Faizullah et al., 2017; Salm et al., 2018). However, this study's main objective was to determine the differences in knowledge, attitude, and practice of antibiotic prescription between surgical and non-surgical residents.

To our knowledge, this is the first study in Saudi Arabia that compares the practice of ABR between surgical and non-surgical residents. We suggest that surgical specialty residents need to focus more on increasing their use of antibiotic guideline references.

4.1. Recommendations

There is a need to improve the knowledge, confidence, and practice of antibiotic prescription to justify the gap between non-surgical and surgical specialty residents through seminars, workshops, conferences, and newsletters for all physicians to follow antibiotic guidelines. In addition, further data on ABR is warranted from other medical centers in Saudi Arabia to assess residents' knowledge and practice of antibiotic prescription. For future practice, we recommend including an initial training course on antibiotic prescription as part of the residency training program preparation and orientation within the first month of the training period. We suggest applying interventions, such as an antimicrobial stewardship program (ASP) by a group of experts in a hospital-based setting, outpatient clinics, and pharmacies, for residents' antibiotic prescription skills to reduce ABR.

4.2. Limitations

The study limitations may include the small sample size because it was collected from one medical center in Saudi Arabia. In addition, the data may be susceptible to recall bias or inaccurate information because most respondents were overwhelmed with exams and daily commitments; thus, we could not reach the calculated sample size number. Another limitation is that Carbapenem was not included among the answers to the question about the most prescribed antibiotic. Finally, it must be taken into consideration that our study did not explore respondents' in-depth knowledge regarding the complications associated with antibiotic resistance or determined the usefulness of potential interventions for therapy.

4.3. Conclusion

When comparing surgical and non-surgical residents, we found that using practice guidelines, past training, and taking patients' medical histories was significantly higher among non-surgical residents. In addition, surgical residents were prescribing more antibiotics than non-surgical residents because they feared the spread of infection. We conclude that proper antibiotics training is essential for all healthcare residents to overcome any differences available between residents of diverse specialties, equalize the practice and attitude of prescribing antibiotics, and reduce antibiotic resistance. Training could be by implementing a reassessment program for junior residents after 2–3 years of residency as an approach for better control of antibiotic prescriptions to be given to patients in the necessary cases. In addition, incorporating the antibiotics learning programs within residency weekly teaching sessions to build a consistent, evidence-based practice among antibiotics use.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix

Assessment of knowledge, attitude, and practice of antibiotics prescription among residents at King Abdulaziz medical City, Jeddah, Saudi Arabia

A. Demographics and general information

Age: Years.
Gender:
☐Female.
☐ Male.
Specialty:
☐ Internal Medicine ☐ General Surgery.
☐ Obstetrics & Gynecology ☐ Pediatrics.
☐ Family Medicine ☐ Anesthesia ☐ Emergency Medicine.
☐ Neurology ☐ Psychiatry☐ Medical Imaging.
☐ Dermatology ☐ Orthopedics☐ Urology.
☐ Ophthalmology ☐ Plastic Surgery.
☐ *ENT* ☐ Head & Neck ☐ Neurosurgery.
☐ Anatomical Pathology ☐ Pediatric Surgery.
☐ Preventive Medicine.
☐ Critical Care Medicine ☐ Oral & Maxillofacial Surgery.
Years of residency:
☐ R1 ☐ *R*3.
☐ R2 ☐ R4.
☐ R5.
Duration of practice since graduation:
☐ < 1 year.
☐ 1 year - < 3 years.
☐ 3 years - < 6 years.
☐ 6 years or more.
University of graduation (Bachelor degree of medicine):
☐ King Saud bin Abdulaziz University for Health Sciences.
☐ King Abdulaziz University.
☐ Umm Al-Qura University.
☐ Taiba University.
☐ Other.

B. Do you agree or disagree with the following statements?

Statement/question	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1. Inappropriate empiric choices can be a cause of antibiotic resistance.					
2. Use 2 or more type of antibiotics at a time is better choice to control infection.					
3. When a patient has a cold, I should prescribe him an antibiotic to prevent getting a more serious illness.					
4. Whenever I prescribe an antibiotic I contribute to the development of antibiotic resistance.					
5. I think widespread use of antibiotics is a contributing cause of resistance.					
6. I believe injudicious use of antibiotics can lead to exacerbation of prolongation of illness.					
7. I believe that the inappropriate duration of the course a contributing cause to resistance.					
8. I think antibiotic resistance is an important and serious public health issue worldwide.					
9. Patient demands and expectations lead to wrong antibiotics prescription.					
10. I am confident about my knowledge of antibiotics					
11. I think that broad spectrum antibiotics are better than narrow spectrum types.					
12. Do you think antibiotic should be used in any case once you have fever.					
13. When one prescribes an antibiotic, it is important to know the resistance rate of the bacteria in the local setting.					
14. For antibiotic guidelines local guidelines are more useful than international guidelines.					
15. Would you like to have more evidence-based therapy guidelines					

C. How often do you do these actions?

Statements	Always	Sometimes	Rarely	Never
16. Do you use the strategy of delayed antibiotic prescribing?				
17. Do you use practice guidelines for antibiotic therapy during your daily work?				
18. Do you check your decisions about antibiotic prescription with a colleague?				
19. Do you discuss the subject of antibiotic resistance with your patients suffering from infections? (if always skip to question 21, otherwise, continue to question 20)				

Reasons not to talk with patients about antibiotic resistance. Please check all the options that apply.

☐ Lack of time.
☐ Concern to unsettle the patient.
☐ Lack of patient interest.

Which are your sources to get current information on antibiotic therapy and antibiotic resistance? Please check all the options that apply.

☐ Medical references (e.g. textbooks, scientific journals, clinical practice guidelines).
☐ Pharmaceutical company meetings.
☐ Institutional drug information call centers / intranet resources.
☐ Conferences and symposiums.
☐ Colleagues and peers.
☐ Seniors and trainers.

Which of the following resistant organisms do you see at your institution? Please check all the options that apply.

☐ Multidrug-resistant Pseudomonas aeruginosa.
☐ Multidrug-resistant Acinetobacter sp.
☐ Extended spectrum beta-lactamase producing Escherichia coli (ESBL E. coli).
☐ Extended spectrum beta-lactamase producing Klebsiella pneumoniae.
☐ Penicillin-resistant Streptococcus pneumonia (PRSP).
☐ Methicillin-resistant Staphylococcus aureus (MRSA).
☐ Others.

Which of the following are the most common antibiotics do you prescribe?
arrange them from 1 to 7 where 1 is the most common and 7 is the least common.

☐ Penicillin.
☐ Cephalosporin.
☐ Quinolone.
☐ Macrolide.
☐ Sulfonamide.
☐ Others.

D. Please choose one item.

Have you participated in formal training on judicious use of antibiotics/infection control?

☐ Yes.
☐ No.

Do you practice the usage of broad-spectrum antibiotics in every infectious disease?

☐ Yes.
☐ No.

Do you feel inappropriate prescription of antibiotics can lead to resistance?

☐ Yes.
☐ No.

Do you fear the spread of an infection just because you have not prescribed antibiotics?

☐ Yes.
☐ No.

Do you take past medical history of consumption of antibiotics before prescribing antibiotics?

☐ Yes.
☐ No.

Do you have any advertisement material from any pharmaceutical company in your clinic?

☐ Yes.
☐ No.

Are your prescriptions influenced by advertisements?

☐ Yes.
☐ No.

Do you write the drug brand/market name or the content name in the prescription?

☐ Brand name.
☐ generic name.
☐ Both.

THANK YOU FOR PARTICIPATING IN THIS STUDY.

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