

Research Article

Knowledge, Attitude, Perception and Practice of Pharmacy Students Concerning Antibiotic Use and Antibiotic Resistance

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Abstract

Background: Antibiotic resistance is an alarming situation in the healthcare sector, where the practice of healthcare professionals plays a vital role in preventing antibiotics-related harm. A cross-sectional study was conducted to analyze the knowledge, attitude, perception, and practice of antibiotic use and resistance among the final year pharmacy students of a Malaysian private medical university.

Methods: A cross-sectional study was carried out among the pharmacy students. The study instrument consists of a set of questions to analyze respondents' demographic details, knowledge of antibiotics, and antibiotic resistance, attitude and perception towards antibiotics usage, and general perception on global issues of antibiotic resistance were used.

Results: A total of 98 respondents completed the survey and the response rate was 74.8%. Most of the respondents (93%) get a prescription from healthcare professionals to purchase antibiotics, and the majority of them (98%) aware of the importance of stop taking antibiotics once they completed their full course as directed by the healthcare professionals. However, 29% of respondents did not know that antibiotic-resistant bacteria can spread from one another and 48% were having the misconception that there are not many people like them to stop antibiotic resistance.

Conclusion: The final year pharmacy students of this private medical university have good knowledge of antibiotics and resistance, with moderate to less attitude and perception on the use of antibiotics. There were few gaps identified in the current curriculum where the students are lacking knowledge on antibiotics practice. These gaps must be improved through appropriate curriculum revision and the incorporation of more continuous educational programs at the graduate and post-graduate levels.

Keywords: Healthcare professionals; Antibiotics; Resistance; Pharmacy; Medical; Knowledge

Introduction

Antibiotics are extremely powerful agents to fight against bacterial infection either by killing the bacteria or by preventing them from reproducing [1-3]. However, the inappropriate utilization of antibiotics has brought about a global crisis known as Antibiotic Resistance (AR). According to the World Health Organization (WHO), the continuous escalation of AR worldwide has been greatly associated with the inappropriate usage of antibiotics [4,5].

The escalation of AR has led to higher morbidity rates and greater mortality worldwide [6-8]. If AR is not curbed, our next generation would not have any effective antibiotics [9-11]. Pre-antibiotics era-like situations would occur, and even simple infections could kill. Therefore, WHO has urged the community to take prompt resolutions

to overcome this global problem [12]. Effective interventions should start from the education of Health Care Professionals (HCPs) who are going to educate the community in the future. The important step towards training HCPs is at the undergraduate level because a proper education at this level will have a higher impact on these future HCPs when they started practicing in society. Undergraduate pharmacy students are one of the major dispensers of antibiotics in the future days [10,13-16]. It is essential to analyse the baseline antibiotics awareness of these pharmacy students. Hence, this study was aimed to assess the level of final year pharmacy students' knowledge, attitude, and perception of antibiotics and their resistance, as well as analyse the area for improvement in the practice of antibiotics usage.

Methods

A cross-sectional study was carried out among the final-year pharmacy students of a private medical university in Malaysia for a period of four months. A simple random sampling method was adopted to recruit the sample size. The sample size was calculated using the Raosoft[®] sample size calculator with a 95% confidence interval, 5% margin of error, and 50% response distribution. The total sample of this study was 98.

The Joint Committee on Research and Ethics of the Institute for Research, Development and Innovation (IRDI), International Medical University has approved the current study, and the approval number is BPI-01-2019(32)]. In this study, a questionnaire consists of two major sections was used to access the respondents' demographic details and

Citation: Palanisamy Sivanandy, Tan Si Jie. Knowledge, Attitude, Perception and Practice of Pharmacy Students Concerning Antibiotic Use and Antibiotic Resistance. *J Clin Pharmacol Ther.* 2021;2(2):1015.

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Publisher Name: Medtext Publications LLC

Manuscript compiled: Jul 30th, 2021

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knowledge on antibiotics and its resistance. Forty-one questions with varying responses like Likert scale (5-point response), true or false, and specific answers type will be used in this study.

Each study participant was requested to fill up an informed written consent before taking part in the study. The data obtained from the respondents was strictly kept confidential; to maintain the respondent's anonymity a random code number was given to each participant. The questionnaires collected were analyzed for its appropriateness and calculation was done on the data collected. Chi-square (χ^2) test was performed to analyze the differences in knowledge, attitude, and perception about antibiotics and its resistance among the pharmacy students. Cronbach's α was calculated to check the reliability of the items.

Results

In this study to assess the knowledge, attitude, perception, and practice of pharmacy students on antibiotic use and its resistance in Malaysia, 131 pharmacy students were invited to participate in this study, among them, 98 responded with the filled questionnaire and the response rate was found to be 75%. All the respondents were within 19 years - 24 years old, and most were Chinese. The demographic details of the respondents are presented in Table 1.

Table 1: Demographic characteristics of the respondents (n=98).

Characteristics	Male	%	Female	%	Total	%
	26	26.53	72	73.47	98	100
Age						
19-24	26	26.53	72	73.47	98	100
Race						
Malay	1	1.02	3	3.06	4	4.08
Chinese	23	23.47	67	69.37	90	91.84
Indian	1	1.02	0	0	1	1.02
Others	1	1.02	2	2.04	3	3.06

Most of the respondents in this study said they took antibiotics in the last 6 months (28%) for at least one occasion to treat their illness. Most of them claimed that they received a prescription from healthcare professionals (93%) to get antibiotics for their illness. Among the participants, most received advice from Health Care Professionals (HCPs) in the direction of taking antibiotics, there were 97% of the respondents purchased antibiotics from the medical store or pharmacy. The data are shown in Table 2.

A majority (98%) of them stated 'they should stop taking antibiotics only when they have completed the full course as directed by HCPs. Besides, many disagreed that 'it is okay to consume antibiotics that given to a friend or family member to treat a similar illness (98%). Furthermore, 95% of the students agreed that it is inappropriate to buy the same antibiotics that cured the same symptoms before.

Assessing the respondents' knowledge on the indication of antibiotics on different diseases revealed that most respondents believe antibiotics are useful to treat urinary tract infection (99%), followed by skin or wound infection (89%). However, only a few respondents' aware antibiotics can treat gonorrhea (29%). Alternatively, 20% of the respondents having a misconception those antibiotics are useful to treat malaria. A major proportion of the respondents were familiar with the antibiotics-related terms such as AR (100%), drug resistance (95%), antibiotic-resistant bacteria (95%), and antimicrobial resistance (87%). However, the terms "superbugs" and "AMR" were less well known among the respondents (64% and 52%, respectively). The details are presented in Table 3.

Table 2: Antibiotic use among the respondents (n=98).

S.No	Question	Frequency	Percentage (%)
1	When did you last take antibiotics?		
	a. In the last month	9	9.18
	b. In the last 6 months	27	27.55
	c. In the last year	14	14.29
	d. More than a year ago	26	26.53
	e. Never	2	2.04
2	On that occasion, did you get the antibiotics (or a prescription for them) from a doctor or Healthcare professionals?		
	a. Yes	91	92.86
	b. No	4	4.08
3	On that occasion, did you get advice from a doctor, nurse, or pharmacist on how to take them?		
	a. Yes, I received advice on how to take them	81	82.65
	b. No	10	10.2
4	On that occasion, where did you get the antibiotics?		
	a. Medical store or pharmacy	95	96.94
	b. Stall or hawker	0	0
	c. The internet	0	0
	d. Friend or family member	0	0
	e. I had them saved up from a previous time	0	0
f. Somewhere/someone else	2	2.04	

Assessment on the source they used to hear the terminology related to AR, many answered they obtained information from the pharmacist (44%), 32% from other sources and 31% from media. The details are presented in Table 4. Most of the study population were aware of the deteriorating problem of various infections becoming resistant to antibiotics treatment and agreed that this problem could put medical procedures at risk (98%), and bacteria that are resistant to antibiotics are very difficult to treat (96%). However, more than one-quarter of the total study population (29%) did not know that bacteria that are resistant to antibiotics could be spread from one person to another. The details are demonstrated in Table 5.

The respondents' perception of antibiotics and its resistance was analyzed using a 5-point Likert scale with the responses ranges from agree strongly to disagree strongly. The responses such as agree strongly and agree slightly were computed to get Net Positive Responses (NPR), whereas the responses neither agree nor disagree, disagree slightly, disagree strongly were combined to get the Net Other Responses (NOR). The positive response rate was calculated by dividing the NPR by the total responses and multiplied by 100.

Most of the respondents believed doctors should prescribe antibiotics when the patients need antibiotics (96%), and they also agreed they need to make sure their children are vaccinated up to date (90%). Most of the respondents stated it is everyone's responsibility to use antibiotics appropriately (88%). The details are presented in Table 6 and 7. A Cronbach's α was calculated to check the reliability and reproducibility of the items presented in the study questionnaire. The mean value of Cronbach's α was found to be 0.773, which was ranged from 0.478 to 0.821 across all the items of the questionnaire. It evident that the items of the study questionnaire were more reliable to check the intended objectives of the research among the study population.

Discussion

The study on assessment of pharmacy students' knowledge, attitude, perception, and practice towards antibiotics and its resistance received an overall response rate of 74.8%, which is higher than the previous study conducted by Sakeena et al. [17] where they obtained

Table 3: Knowledge of antibiotics among the respondents (n=98).

S.No	Question	Frequency	Percentage (%)
1	When do you think you should/ you stop taking antibiotics once you have begun treatment?		
	a. When you feel better	2	2
	b. When you have taken all the antibiotics as directed (CR)	96	98
	c. Do not know	0	0
2	“It’s okay to use antibiotics that were given to a friend or family member, as long as they were used to treat the same illness”		
	a. True	1	1
	b. False (CR)	96	98
	c. Do not know	1	1
3	“It’s okay to buy the same antibiotics, or request these from a doctor, if you’re sick and they helped you get better when you had the same symptoms before”		
	a. True	2	2.04
	b. False (CR)	93	94.9
	c. Do not know	3	3.06
4	Do you think these conditions can be treated with antibiotics?		
	a. HIV/AIDS	8	8.16
	b. Gonorrhoea (CR)	28	28.57
	c. Bladder infection or Urinary Tract Infection (UTI) (CR)	97	98.98
	d. Diarrhoea (CR)	12	12.24
	e. Cold and flu	15	15.31
	f. Fever	19	19.39
	g. Malaria	20	20.41
	h. Measles	7	7.14
	i. Skin or wound infection (CR)	87	88.78
	j. Sore throat (CR)	28	28.57
	k. Body aches	0	0
	l. Headaches	0	0
5	Have you heard of any of the following terms?		
	a. Antibiotic resistance	98	100
	b. Superbugs	63	64.29
	c. Antimicrobial resistance	85	86.73
	d. AMR	51	52.04
	e. Drug resistance	93	94.9
	f. Antibiotic-resistant bacteria	92	94.9

CR: Correct Response or Answer

Table 4: Knowledge of medical terminologies of antibiotics resistance (n=98).

S. No	Where did you hear the following terms related to antibiotics and its resistance?						
	Question/ Options	Doctor or nurse n (%)	Pharmacist n (%)	Family member or friend (including on social media) n (%)	Media (newspaper, TV, radio) n (%)	Specific campaign n (%)	Other n (%)
1.	Antibiotic resistance	26 (26.53)	55 (56.12)	16 (16.33)	38 (38.78)	21 (21.43)	40 (40.82)
2.	Superbugs	5 (5.10)	20 (20.40)	9 (9.18)	33 (33.67)	7 (7.14)	19 (19.39)
3.	Antimicrobial resistance	20 (20.41)	46 (46.94)	9 (9.18)	30 (30.61)	15 (15.31)	38 (38.78)
4.	AMR	9 (9.18)	25 (25.51)	4 (4.08)	13 (13.27)	8 (8.16)	14 (14.29)
5.	Drug resistance	27 (27.55)	58 (59.18)	12 (12.24)	35 (35.71)	19 (19.39)	36 (36.73)
6.	Antibiotic-resistant bacteria	22 (22.45)	54 (55.10)	10 (10.20)	33 (33.67)	17 (17.35)	40 (40.82)
	Average (%)	18.54	43.88	10.2	30.95	14.8	31.81

Table 5: Knowledge of antibiotics and resistance among the respondents (n=98).

S.No	Question	True n(%)	False n(%)	X ²	p
1.	Antibiotic resistance occurs when your body becomes resistant to antibiotics and they no longer work as well. (T)	75 (76.53)	23 (23.47)	0.68	0.38
2.	Many infections are becoming increasingly resistant to treatment by antibiotics. (T)	96 (97.96)	2 (2.04)	0.68	0.00*
3.	If bacteria are resistant to antibiotics, it can be very difficult or impossible to treat the infections they cause. (T)	94 (95.92)	4 (4.08)	0.68	0.00*
4.	Antibiotic resistance is an issue that could affect me or my family. (T)	91 (92.86)	7 (7.14)	0.68	0.00*
5.	Antibiotic resistance is an issue in other countries but not here. (F)	2 (2.04)	96 (97.96)	0.84	0.00*
6.	Antibiotic resistance is only a problem for people who take antibiotics regularly. (F)	18 (18.37)	80 (81.63)	0.84	0.14
7.	Bacteria which are resistant to antibiotics can be spread from person to person. (T)	70 (71.43)	28 (28.57)	0.68	0.78
8.	Antibiotic-resistant infections could make medical procedures like surgery, organ transplants and cancer treatment much more dangerous. (T)	96 (97.96)	2 (2.04)	0.68	0.00*

T: Correct Answer

*Statistically significant

Table 6: Knowledge of actions that would help address the problems of antibiotics resistance (n=98).

S.No	Item/ Response	Agree Strongly n (%)	Agree Slightly n (%)	Neither agree nor disagree n (%)	Disagree Slightly n (%)	Disagree Strongly n (%)
1	People should use antibiotics only when they are prescribed by a doctor or nurse	84 (85.71)	4 (4.08)	6 (6.12)	1 (1.02)	3 (3.06)
2	Farmers should give fewer antibiotics to food-producing animals	43 (43.88)	36 (36.73)	14 (14.29)	4 (4.08)	1 (1.02)
3	People should not keep antibiotics and use them later for other illnesses	80 (81.63)	13 (13.27)	0	0	5 (5.10)
4	Parents should make sure all of their children's vaccinations are up to date	88 (89.80)	5 (5.10)	4 (4.08)	0	1 (1.02)
5	People should wash their hands regularly	75 (76.53)	14 (14.29)	7 (7.14)	1 (1.02)	1 (1.02)
6	Doctors should only prescribe antibiotics when they are needed	94 (95.92)	2 (2.04)	0	0	2 (2.04)
7	Governments should reward the development of new antibiotics	58 (59.18)	24 (24.49)	14 (14.29)	0	2 (2.04)
8	Pharmaceutical companies should develop new antibiotics	60 (61.22)	24 (24.49)	14 (14.29)	0	0
9	Antibiotic resistance is one of the biggest problems the world faces	61 (62.24)	31 (31.63)	5 (5.10)	0	1
10	Medical experts will solve the problem of antibiotic resistance before it becomes too serious	19 (19.39)	35 (35.71)	32 (32.65)	11 (11.22)	1 (1.02)
11	Everyone needs to take responsibility for using antibiotics responsibly	86 (87.76)	11 (11.22)	0	0	1 (1.02)
12	There is not much people like me can do to stop antibiotic resistance	6 (6.12)	21 (21.42)	24 (24.49)	26 (26.53)	21 (21.43)
13	I am worried about the impact that antibiotic resistance will have on my health, and that of my family	49 (50.00)	35 (35.71)	13 (13.27)	1 (1.02)	0
14	I am not at risk of getting an antibiotic-resistant infection, as long as I take my antibiotics correctly.	12 (12.24)	26 (26.53)	25 (25.51)	16 (16.33)	19 (19.39)

Table 7: Comparison of responses of the respondents for the actions to address the problem of antibiotic resistance (n=98)

How much do you agree the following actions would help address the problem of antibiotic resistance?					
Item/ Response	NPR	NOR	X ²	p	PRR
People should use antibiotics only when they are prescribed by a doctor (T)	88	10	1.23	0.27	89.8
Farmers should give fewer antibiotics to food-producing animals (T)	79	19	0.01	0.93	80.6
People should not keep antibiotics and use them later for other illnesses (T)	93	5	2.8	0.09	94.9
Parents should make sure all of their children's vaccinations are up to date (T)	93	5	2.8	0.09	94.9
People should wash their hands regularly (T)	89	9	1.49	0.22	90.8
Doctors should only prescribe antibiotics when they are needed (T)	96	2	4.05	0.04*	98
Governments should reward the development of new antibiotics (T)	82	16	0.18	0.67	83.7
Pharmaceutical companies should develop new antibiotics (T)	84	14	0.43	0.51	85.7
Antibiotic resistance is one of the biggest problems the world faces (T)	92	6	2.43	0.12	93.9
Medical experts will solve the problem of antibiotic resistance before it becomes too serious (T)	54	44	7.49	0.01*	55.1
Everyone needs to take responsibility for using antibiotics responsibly (T)	97	1	4.51	0.03*	99
There is not much people like me can do to stop antibiotic resistance (F) -responses are reversed	27	71	33.5	0	72.5
I am worried about the impact that antibiotic resistance will have on my health, and that of my family (T)	84	14	0.43	0.51	85.7
I am not at risk of getting an antibiotic-resistant infection, as long as I take my antibiotics correctly. (T)	60	38	4.24	0.04*	61.2

a response rate of 69%. Among the study population, 73% were female which is consistent with a previous study done in Malaysia where the ratio of female to male was 67:33 among the pharmacy students in private universities in Malaysia [18]. In this study, all the study participants were aged between 19 and 24 years as this is the normal age range for final year pharmacy students in Malaysian undergraduate studies. Among the respondents, 92% were Chinese, four percent were Malay, one percent was Indian, and three percent were of other races. This result is consistent with the findings of a previous study where the percentage of races was 93% Chinese, five percent Malay and two percent Indian [18].

The assessment of the use of antibiotics among the study population revealed that 93% of the respondents purchased antibiotics with a prescription from a doctor. It contrasts with a survey done by Sakeena et al. [17] in that only 77% of the Sri Lankan students purchased antibiotics with doctor's prescription. This shows a better awareness of our respondents regarding the importance of buying antibiotics with a doctor's prescription. The contributing factor to the access to

antibiotics in both countries could be due to the different enforcement and control of medicines regulations. In Malaysia, antibiotics must be obtained by prescription instead of obtaining over the counter from pharmacies. In contrast, most of the pharmacies are managed by unqualified personnel in Sri Lanka [19]. A recent study conducted in Sri Lanka reported that antibiotics could also be obtained without prescriptions in a few districts of Sri Lanka [20]. Thus, every pharmacy personnel must undergo formal training in dispensing medicines and comply with laws related to the supply of medicines.

Besides, 93% of the study population received advice from healthcare professionals on the proper direction to take antibiotics. In contrast with a study done by Sakeena et al. [17] only 57% of the students claimed that they received advice from a healthcare professional on the correct way of taking antibiotics. This finding indicates that respondents in our study are more concerned about the correct direction of taking antibiotics compared to the previous study population.

Most of the respondents in this study heard the terms “antibiotic resistance” (100%), “antibiotic resistance bacteria” (95%), “drug-resistance” (95%), and “antimicrobial resistance” (87%). However, the terms “superbugs” (64%) and the widely used acronym “AMR” (52%) were less well-known by the pharmacy students. The respondents in this study demonstrated a higher knowledge than the participants of a previous study conducted by Sakeena et al. [21] regarding the terminology related to AR. The possible reason is these words are not commonly used in day-to-day practice or learning; therefore, it must be incorporated in their undergraduate curriculum to make them familiar with the common medical terminologies.

Consistent with a study conducted by Sakeena et al. [21] majorities of the students from both studies heard the terms related to AR from the pharmacist and media. This shows that pharmacists are playing a major role in educating the public on the knowledge of antibiotics and its resistance, at the same time, media gives a huge impact on creating awareness.

Moreover, many of the respondents understood that AR happens when the body is resistant to antibiotics and can no longer be effective. However, only a quarter of the Sri Lankan pharmacy students (28%) and half of the Australian pharmacy students (57%) understood how AR could occur [21,22]. The reason for better knowledge of AR among the current study students compared to students of other countries might be due to a stronger education imparted in our curriculum on the use of antibiotics and its resistance. Moreover, most of the respondents (94%) agreed that infections would become difficult or even impossible to treat if bacteria are resistant to antibiotics. This contrasts with a survey conducted by Sakeena et al. [17]. where a lower proportion of the students were aware of this consequence. This might be due to more extensive an aspect related to AMR was covered in the pharmacy curricula of the respondents’ university.

Furthermore, most of the respondents believed that the problem of AR is not only affecting other countries but also Malaysia. Consistent with another study carried out by Khan et al. [23] the majority of the senior pharmacy students agreed that AR is not only affecting other countries but affects their own country too. This implies that most of the final year pharmacy students in the current study are aware of the global as well as the local issue of AR.

On the other hand, 70% of the respondents understood that AR bacteria could spread from one person to another. In contrast to a survey, a lower number of pharmacy students (63%) were aware of the possibility of AR bacteria spread from one another [17]. Thus, this shows that the respondents in this study are having a better knowledge of the mechanism of AR but there are still some gaps that need immediate attention and improvement.

The assessment of knowledge on actions that would help to address the problems of AR shown, 90% of the participants stated parents should ensure all their children are vaccinated up to date. According to Andre et al. [24] vaccines may reduce the prevalence and prevent the development of antibiotics resistant strains. This positive result shows that our respondents are concerned about protecting the future generation from this life-threatening issue. Besides, most of the respondents (96%) strongly agreed that doctors should only prescribe antibiotics when patients are in need. According to a survey conducted by Halim et al. [25] half of the study population (50%) reported expecting doctors to prescribe antibiotics when they

were sick even it is not necessary. This shows that the current study respondents are more aware of the prescriber’s role and the doctor should only prescribe antibiotics when a patient needed to prevent the development of AR.

However, the respondents showed a lack of awareness of the roles of farmers, government, and pharmaceutical companies in curbing AR. According to WHO, the main contributing factor to AR is the misuse of antibiotics in livestock, aquaculture, and crops [12]. This will enable antibiotic-resistant bacteria to spread into the environment, food chain, and humans. Hence, farmers should ensure that antibiotics are given to animals only to treat infectious diseases. Therefore, these study respondents should be educated on the respective responsibilities of all different sectors rather than only healthcare in solving this problem as future pharmacists will play a vital role in educating the public regarding the danger of AR.

Moreover, 28% of respondents claimed that there are not many people like them can do to stop AR. According to WHO multi-country survey, more than half of the respondents (57%) feel there are not many HCPs to stop AR [12]. Thus, it is obvious that the pharmacy students from this study were having higher awareness that they play a role in solving this issue. However, interventions should be taken to ensure more people are clear about their responsibilities in solving the health issue.

Overall, this study found that final-year pharmacy students had a moderate to good attitude, knowledge, and perception of antibiotics and resistance. However, we have identified some educational gaps that will allow us to create more effective and targeted educational programs. The areas of improvement include the familiarity of the medical terms particularly superbug and AMR, lack of knowledge on the role of allied healthcare professionals, the appropriate selection of antibiotics, usage of antibiotics for food-producing animals, mechanism of AR, and the risk factors for getting AR.

In the healthcare field, we shall not compromise even a single mistake because every action we take is concerning the safety of the patient. It is important to raise the awareness of antibiotics during the degree courses since the pharmacy students are going to serve the community in near future and become the behavioral model for society. Having this in mind, implementation of a specific module and continuous professional education for the proper usage of antibiotics will make these future pharmacists better prepared for their decisive role in battling against AR.

Conclusion

The study concludes that final-year pharmacy students have a moderate to good understanding of many aspects of antibiotics and resistance. Despite their knowledge of antibiotics, their attitudes and perceptions of antibiotics use, and AR are not at an acceptable level and require immediate improvement. As the budding pharmacists going to take their active role as HCPs in near future, if it is not addressed now, it may bring adverse outcomes to the health of the people. A promising effect on antibiotics practice can be achieved in the future through the incorporation of essential components of antibiotics in their undergraduate and post-graduate academic curriculum.

Acknowledgment

The authors thank the management of International Medical University (IMU), Kuala Lumpur, Malaysia for providing the necessary support to carry out this research.

References

- Fair RJ, Tor Y. Antibiotics and bacterial resistance in the 21st century. *Perspect Medicin Chem.* 2014;6:25-64.
- Kapoor G, Saigal S, Elongavan A. Action and resistance mechanisms of antibiotics: A guide for clinicians. *J Anaesthesiol Clin Pharmacol.* 2017;33(3):300-5.
- Manohar P, Loh B, Athira S, Nachimuthu R, Hua X, Welburn SC, et al. Secondary bacterial infections during pulmonary viral disease: phage therapeutics as alternatives to antibiotics? *Front Microbiol.* 2020;11:1434.
- Malaysian Action Plan on Antimicrobial Resistance (MyAP-AMR) 2017-2021. Ministry of Health, Malaysia.
- Rather IA, Kim BC, Bajpai VK, Park YH. Self-medication and antibiotic resistance: Crisis, current challenges, and prevention. *Saudi J Biol Sci.* 2017;24(4):808-12.
- Manyi-Loh C, Mamphweli S, Meyer E, Okoh A. Antibiotic use in agriculture and its consequential resistance in environmental sources: potential public health implications. *Molecules.* 2018;23(4):795.
- Davey P, Marwick CA, Scott CL, Charani E, McNeil K, Brown E, et al. Interventions to improve antibiotic prescribing practices for hospital inpatients. *Cochrane Database Syst Rev.* 2017;2(2):CD003543.
- Majumder MAA, Rahman S, Cohall D, Bharatha A, Singh K, Haque M, et al. Antimicrobial stewardship: fighting antimicrobial resistance and protecting global public health. *Infect Drug Resist.* 2020;13:4713-38.
- Hassali M, Arief M, Saleem F, Khan M, Ahmad A, Mariam W, et al. Assessment of attitudes and practices of young Malaysian adults about antibiotics use: a cross-sectional study. *Pharm Pract.* 2017;15(2):929.
- Margaret JM, Bond CM. Public knowledge, attitudes and behaviour regarding antibiotics--a survey of patients in general practice. *European J Gen Pract.* 2003;(3):84-90.
- Bharath Kumar VD, Kalpana L. A comparative study to assess the awareness of antibiotic resistance amongst first and second year medical undergraduate students in a medical college. *Int J Basic Clin Pharmacol.* 2018;7(8):1567-71.
- WHO. Multi-country survey reveals widespread public misunderstanding about antibiotic resistance. Geneva: World Health Organisation. 2015.
- Dhingra S, Rahman NAA, Peile E, Rahman M, Sartelli M, Hassali MA, et al. Microbial resistance movements: an overview of global public health threats posed by antimicrobial resistance, and how best to counter. *Front Public Health.* 2020;8:535668.
- Elong Ekambi GA, Okalla Ebongue C, Penda IC, Nnanga Nga E, Mpondo Mpondo E, Eboumbou Moukoko CE. Knowledge, practices and attitudes on antibiotics use in Cameroon: Self-medication and prescription survey among children, adolescents and adults in private pharmacies. *PLoS One.* 2019;14(2):e0212875.
- Torres NF, Solomon VP, Middleton LE. Identifying the commonly used antibiotics for self-medication in urban Mozambique: a qualitative study. *BMJ Open.* 2020;10(12):e041323.
- Kotwani A, Joshi PC, Jhamb U, Holloway K. Prescriber and dispenser perceptions about antibiotic use in acute uncomplicated childhood diarrhea and upper respiratory tract infection in New Delhi: Qualitative study. *Indian J Pharmacol.* 2017;49(6):419-31.
- Takeena MHF, Bennett AA, Mohamed F, Herath H, Gawarammane I, McLachlan A. Investigating knowledge regarding antibiotics among pharmacy and allied health sciences students in a Sri Lankan university. *J Infect Dev Ctries.* 2018;12(9):726-32.
- Hasan S, Kwai CD, Ahmadi K, Se W, Hassali M, Hata E, et al. Influences on Malaysian pharmacy students' career preferences. *Am J Pharm Educ.* 2010;74(9):166.
- Takeena MHF, Bennett AA, McLachlan AJ. Non-prescription sales of antimicrobial agents at community pharmacies in developing countries: a systematic review. *Int J Antimicrob Agents.* 2018;52(6):771-82.
- Zawahir S, Lekamwasam S, Aslani P. Antibiotic dispensing practice in community pharmacies: A simulated client study. *Res Soc Admin Pharm.* 2019;15(5):584-90.
- Takeena MHF, Bennett AA, Jamshed S, Mohamed F, Herath DR, Gawarammana I, et al. Investigating knowledge regarding antibiotics and antimicrobial resistance among pharmacy students in Sri Lankan universities. *BMC Infect Dis.* 2018;18(1):209.
- Takeena MHF, Bennett AA, Carter SJ, McLachlan AJ. A comparative study regarding antibiotic consumption and knowledge of antimicrobial resistance among pharmacy students in Australia and Sri Lanka. *PLoS One.* 2019;14(3):e0213520.
- Hayat K, Jamshed S, Rosenthal M, Haq NU, Chang J, Rasool MF, et al. Understanding of pharmacy students towards antibiotic use, antibiotic resistance and antibiotic stewardship programs: a cross-sectional study from Punjab, Pakistan. *Antibiotics (Basel).* 2021;10(1):66.
- Andre FE, Booy R, Bock HL, Clemens J, Datta SK, John TJ, et al. Vaccination greatly reduces disease, disability, death and inequity worldwide. *Bull World Health Organ.* 2008;86(2):140-6.
- Halim NAAA, Chang CT, Chan HK, Hassali MA, Nouri A. Knowledge and attitudes concerning antibiotic use and resistance among the public in Pulau Pinang, Malaysia. *Malays J Med Sci.* 2018;25(6):141-7.