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KNOWLEDGE, ATTITUDES, AND PRACTICES OF NURSES REGARDING ANTIBIOTIC STEWARDSHIP IN NORTH LEBANON: A CROSS-SECTIONAL STUDY

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KNOWLEDGE, ATTITUDES, AND PRACTICES OF NURSES REGARDING ANTIBIOTIC STEWARDSHIP IN NORTH LEBANON: A CROSS-SECTIONAL STUDY

Abstract

ABSTRACT: Background: Antimicrobial resistance is an urgent global issue. Several associations are supporting the implementation of antibiotic stewardship programs in all hospitals. This program is multidisciplinary in its nature however, nurses are often not included in the antibiotic stewardship team. The role of nurses in antibiotic stewardship needs further development, and additional information is needed regarding gaps in nurses' knowledge and attitudes toward antibiotic stewardship. Hence, this study was conducted to assess the knowledge, attitudes, and practices of nursing staff regarding antibiotic stewardship in North Lebanon and identify the barriers that prevent their participation. **Methods:** A descriptive cross-sectional study was performed using a self-administered questionnaire distributed to 120 nurses working in four hospitals in North Lebanon. The survey included 29 questions addressing (1) demographic and professional characteristics; (2) knowledge and attitude about antibiotic stewardship; (3) delivery of antimicrobials; (4) knowledge and attitude about antimicrobial use, (5) and knowledge and attitude about antimicrobial resistance. **Results:** In total, 100 staff nurses (33.3%) responded to the survey. 60% of the nurses were familiar with the term antibiotic stewardship and 57% received training in this subject, however, gaps in their knowledge were recorded. Almost all nurses (97%) believed they should be involved in antibiotic stewardship interventions. There was no association between years of experience or level of education with being familiar with ASP. **Conclusion:** This study showed that although many nurses are familiar with the term antibiotic stewardship, their overall knowledge of core elements and their potential roles in AS were limited. In addition, nurses stated that concerns over physician pushback and knowledge of antibiotics as barriers to their participation in the program. The results highlight the need for further education to fill the gaps in their knowledge.

Keywords

Antibiotic Resistance, Antimicrobial Stewardship, Attitude, Knowledge, Nurses, Nursing Staff

1. INTRODUCTION

Antimicrobial resistance (AMR) is a major public health challenge facing the world today and tomorrow, jeopardizing human and animal health, agriculture, and the economy (CDC, 2019a). As estimated by the Centers for Disease Control and Prevention (CDC), antibiotic-resistant organisms are responsible for more than 2.8 million infections in the United States of America (USA) leading to more than 35,000 deaths per year (CDC, 2019b). While, the mortality rate registered is lower in Europe (25,000 deaths per year) and higher in Asia (96,000 deaths per year) (Khan et al., 2016). According to the World Health Organization (WHO), antibiotic-resistant organisms lead to more than 700,000 deaths worldwide annually (Brinkmann & Kibuule, 2019).

To combat this urgent matter, several associations such as the CDC, The American Hospital Association, the Infectious Disease Society of America (IDSA), the WHO, and other professional societies and international organizations are recommending the implementation of antibiotic stewardship programs (ASP) in all healthcare facilities. The IDSA has emphasized the need for antibiotic stewardship (AS) to stop or reduce the development of AMR since 1997 and in 2007, it issued guidelines to promote the creation of stewardship teams (Monsees et al., 2018). AS is a global intervention defined as a combination of coordinated strategies and efforts to improve the use and prescribing of antibiotics by selecting the optimal antibiotic regimen, dose, route, and duration of therapy and limiting the unnecessary use of antibiotics (Hamdy et al., 2019; Merrill et al., 2019). ASP has a crucial role in conserving the efficiency of antibiotics for future generations (Abbas et al., 2018). This program aims at optimizing the use of antibiotics, improving antibiotic prescribing, quality of care, treatment of infections, and patient outcomes while reducing the development and emergence of resistant organisms (Ha et al., 2019). Additionally, it aims at decreasing unnecessary antibiotic use, health care costs, medication errors, hospital length of stay, adverse events, and *Clostridium difficile* infection (CDI) rates (CDC, 2019b). Interestingly, the implementation of ASPs in critical care units in nine countries from 1996 to 2010, showed a reduction of 11% to 38% in antibiotic use, a decrease in cost by \$5 to \$10 per patient per day, a reduction in the inappropriate use of antibiotics, duration of therapy, and the number of adverse events (CDDEP, 2015). A drug-oriented ASP intervention study done in Makassed General hospital in Beirut, Lebanon showed a 55% decrease in the use of tigecycline consumption levels after the implementation of ASP in 2016 (Moghnieh et al., 2020). Moreover, numerous studies, mostly from the USA, have shown that ASPs led to a reduction between 10% and 40% in antimicrobial use with \$200,000-\$900,000 of yearly savings (Hara, 2014).

In 2014, the CDC developed Core Elements of Hospital Antibiotic Stewardship Programs later updated in 2019, to assist hospitals in implementing an ASP. It summarizes seven core elements needed to achieve a successful ASP. These elements can be applied in all hospitals, regardless of their size. The Core Elements include hospital leadership commitment, accountability, pharmacy (drug) expertise, action, tracking, reporting, and education (CDC, 2019b).

A successful ASP requires a multidisciplinary, integrative approach as recommended by the CDC. Traditionally, recognized core members of ASP include physicians, pharmacists, infection preventionists, microbiologists, and administrators. Nurses, however, have not been formally integrated into the AS team and there are limited efforts to engage them in such teams (Abbas et al., 2018). Several associations, such as the CDC, the American Nurse Association (ANA), the National Quality Forum, the American Academy of Nursing, and the National Institute of Nursing Research advocated for including nurses in AS seeing as they can improve AS activities due to their fundamental role and involvement in the process of antibiotic use and antibiotic management (Ha et al., 2019). Nurses work at multiple levels within the clinical setting, playing a key role in patient safety and have the most consistent presence as patient advocates (Edwards et al., 2011). Therefore, it is imperative to integrate nurses into ASPs officially and educate them about it rather than labeling them as mere participants in the program. This will allow nurses to collaborate and contribute effectively to the main goals of ASP and make them understand that they are critical to the success of this program (Ha et al., 2019). Moreover, increasing nurses' awareness and training in ASPs will likely improve the antimicrobial administration (Edwards et al., 2011). An evaluation of bedside nurse driven AS

rounds in a hospital in the USA showed a significant reduction in antibiotic use with a decrease in the length of stay and CDI rates (Ha et al., 2019).

Despite the nurses' role being highlighted by the CDC and other associations as part of the AS team and other efforts made to engage nurses in AS, they have not yet been formally included in the structure of AS (Olans et al., 2016). Nurses can make significant contributions in AS and in reducing AR. They perform various functions related to antibiotics and which are an integral part of AS. Nurses, however, are often not familiar with the term AS because AS training usually does not incorporate nurses in education programs (Abbas et al., 2018). Moreover, there is limited data regarding the gaps in nurses' knowledge and attitude regarding AS. Not much research has been carried out in this domain and till now no such study has been conducted in Lebanon. Therefore, the purpose of this study is to assess the nurses' knowledge, attitudes, and practices regarding AS in four private hospitals in North Lebanon. Also, this study aims at measuring the nurses' willingness to be engaged in AS activities and identify the barriers that prevent them from participating.

2. METHODOLOGY

2.1 Data Collection

A descriptive cross-sectional research design was carried out in four private hospitals located in North Lebanon, three hospitals in Tripoli and one hospital in Zgharta. A valid and reliable self-administered questionnaire composed of 29 questions (with sub-questions resulting in 39 items) adapted from previous studies (Abbas et al., 2018; Gillespie et al., 2013; Merrill et al., 2019; Monsees et al., 2018) was distributed to nurses to assess their knowledge, attitude and practices (KAP) regarding AS. The questionnaire was composed of five parts: i) demographics consisting of 7 items and assessed using nominal and ratio scale, ii) knowledge and attitude about AS consisting of 10 items and assessed using dichotomous, Likert and nominal scales, iii) delivery of antimicrobials consisting of 9 items and assessed using dichotomous and nominal scales, iv) knowledge and attitude about antimicrobial use consisting of 5 items assessed using Likert scale and finally v) knowledge and attitude about AR consisting of 8 items and assessed using Likert scale. The questionnaire was available in English, Arabic and French. The instrument was reviewed for its content validity by four experts in the field of infection control and nursing, it was also tested for internal consistency (reliability) by Cronbach's Alpha test and a score of 0.65 was obtained. The study included all nurses who were willing to participate in the study with the exclusion of nursing students using simple random sampling. A total of 314 nurses were invited to participate in this study. A total of 100 surveys were collected resulting in an overall 33.3% response rate. The data was collected over a period of 3 months. Filling the questionnaire required about 15 minutes.

2.2 Statistical Analysis

Statistical analysis was performed using SPSS version 24 for windows software. Chi-Square test was carried out to evaluate the association between socio-demographic data and knowledge regarding AS. Linear regression test was conducted to detect the predictors of knowledge and attitudes towards AS. All statistical tests were considered statistically significant at a p-value of ≤ 0.05 .

2.3 Ethics Statement

Ethical approval from the hospitals was obtained by signing a permission form. This work was submitted to the University Institutional Review Board IRB for ethical approval (2020-H-0118-HS-M-0431). Verbal consent was obtained from nurses who were willing to participate, and anonymity was preserved.

3. RESULTS

3.1 Socio-Demographic Characteristics

As detailed in Table 1, the majority of the respondents were females (74%) and aged 20-30 years (49%). In addition, 71% of the participants were registered nurses with 5-10 years of experience working in the general ward (32%).

Table 1: Socio-Demographic characteristics

Characteristic	Number	Percentage (%)
Age		
20-30	49	49
31-40	39	39
Older than 40	12	12
Gender		
Male	26	26
Female	74	74
Level of education		
Diploma	24	24
Technical	31	31
Bachelors	26	26
Postgraduate Degree (Masters or higher)	19	19
Years of experience		
Less than 5 years	22	22
5-10 years	38	38
11-15 years	27	27
More than 15 years	13	13
Years of service at the same facility		
Less than 5 years	35	35
5-10 years	48	48
11-15 years	11	11
More than 15 years	6	6
Primary role		
Registered Nurse	71	71
Practical Nurse	11	11
Head Nurse	9	9
Educator	3	3
Manager	2	2
Other	4	4
Primary Specialty		
General Ward	32	32
ICU	27	27
Cardiology	7	7
Dialysis	6	6
Emergency	11	11
Oncology/Hematology	2	2
Obstetrics & Gynecology	13	13
Pediatrics	1	1
Surgical Services	1	1

3.2 Knowledge Regarding Antibiotic Stewardship

Regarding the level of knowledge, the findings showed that most of the participants (60%) were familiar with the term AS, 57% received training on stewardship programs, and 56% reported having an ASP at their facility. In addition, 65% of the nurses agreed that appointing a single physician leader is a core element of AS, while 76% of the nurses reported that dedicating necessary resources is not a core element. Moreover, almost all (98%) of the participating nurses reported that physicians are the most important participants in an ASP, followed by nurses where 89% of the participants agreed on their involvement. As for the nurse's role in ASP, the participants indicated various opinions, and it was noteworthy that 73% reported the important role of nurses in assessing the need for continued antibiotic therapy and daily progress monitoring and 75% reported that transitioning antibiotics from intravenous to oral therapy is not a potential role of nurses in AS (Table 2).

Table 2: Knowledge regarding antibiotic stewardship

Item	Yes	No
Are you familiar with the term “Antibiotic Stewardship”?	60 (60%)	40(40%)
Did you receive any training or education about Antibiotic Stewardship?	57 (57%)	43(43%)
Are you aware if an Antibiotic Stewardship Program exists at your facility?	56 (56%)	44 (44%)
What are the Core Elements of Antibiotic Stewardship Program?		
Dedicating necessary resources	24 (24%)	76 (76%)
Appointing a single physician leader	65 (65%)	35 (35%)
Appointing a single pharmacist leader	36 (36%)	64 (64%)
Implementing at least one recommended action such as antibiotic time out	29 (29%)	71 (71%)
Monitoring antibiotic prescribing and resistance patterns	50 (50%)	50 (50%)
Reporting information regularly on antibiotic use and resistance patterns	45 (45%)	55 (55%)
Educating staff members about resistance and optimal prescribing	44 (44%)	56 (56%)
In your opinion, who are the potential participants in Antibiotic Stewardship Program?		
Physicians/Clinicians	98 (98%)	2 (2%)
Pharmacist	61 (61%)	39 (39%)
Laboratory Staff	34 (34%)	66 (66%)
Nurses	89 (89%)	11 (11%)
Information Technology Staff	22 (22%)	78 (78%)
Infection Control Nurse/ Officer	45 (45%)	55 (55%)
Infectious Disease Specialist	49 (49%)	51 (51%)
Hospital Epidemiologist	42 (42%)	58 (58%)
Quality Improvement Staff	32 (32%)	68 (68%)
What are the potential roles of nursing staff in Antibiotic Stewardship?		
Admitting and triaging of patients	55 (55%)	45 (45%)
Assessing for the history of adverse drug reactions	48 (48%)	52 (52%)
Assessing for the history of allergy	46 (46%)	54 (54%)
Assessing the need for continued antibiotic therapy and daily progress monitoring	73 (73%)	27 (27%)
Educating patient and family about antibiotic use	57 (57%)	43 (43%)
Obtaining cultures before antibiotic administration	57 (57%)	43 (43%)
Reviewing stop dates for antibiotics, ensuring antibiotic durations and indications are recorded in discharge paperwork	56 (56%)	44 (44%)
Reviewing flags for multidrug-resistant bacteria colonization and placing in isolation when appropriate	36 (36%)	64 (64%)
Reviewing final cultures and discussing antibiotic de-escalation with treating physician	43 (43%)	57 (57%)
Transitioning antibiotics from intravenous to oral therapy	25 (25%)	75 (75%)
Notifying the provider of wrong antibiotic doses	39 (39%)	61 (61%)
Timely initiation of antibiotics if indicated	48 (48%)	52 (52%)

3.3 Attitudes Regarding Antibiotic Stewardship

Regarding attitudes, the participants had averagely rated attitudes towards AS. 42% of the nurses were neutral towards participation in the program, 42% reported that they would likely participate in AS. In addition, 30% of the nurses reported that the existence of such a program is important at their healthcare facility. Moreover, 29% of the participating nurses agree to perceive that staff nurse on their unit functions as antibiotic stewards. As for the barriers to the ASP, 48% of the nurses perceived concerns over physician pushback and knowledge of antibiotics as an important barrier (**Table 3**).

Table 3: Attitudes regarding antibiotic stewardship

Item	N	%
How likely are you to participate in Antibiotic Stewardship Program?		
Extremely Unlikely	2	2
Unlikely	7	7
Neutral	42	42
Likely	42	42
Extremely Likely	7	7
To what extent do you think it is important to have an antibiotic stewardship program in your healthcare facility?		
Extremely Unimportant	1	1
Not Important	34	34
Neutral	35	35
Important	30	30
Extremely Important	1	1
Do you perceive that staff nurse on your unit function as antibiotic stewards?		
Strongly Disagree	1	1
Disagree	36	36
Uncertain	28	28
Agree	29	29
Strongly Agree	6	6
What are the barriers to nursing participation in Antibiotic Stewardship?	Yes	No
Time Constraint	46 (46%)	54 (54%)
Concerns over physician pushback	48 (48%)	52 (52%)
Scope of practice concerns	31 (31%)	69 (69%)
Knowledge of microbiology	42 (42%)	58 (58%)
Knowledge of antibiotics	48 (48%)	52 (52%)

3.4 Antimicrobial Delivery Practices

Regarding delivery practices, the results showed that the nurses had good practices regarding the dissemination of antibiotics. Almost all (98%) indicated that they know the indications for antibiotic prescribing. The majority (80%) of the participants ask physicians about the antibiotic being given. In addition, the participants showed that they usually question the physician about the choice (83%), dose (93%), route (90%), and duration (96%) of the antibiotic prescribed. It is noteworthy to indicate that 59% of the nurses reported that they have given an antibiotic they thought was inappropriate, while 97% feel that nurses should be involved in interventions aimed to improve antibiotic use (**Table 4**).

Table 4: Antimicrobial delivery practices

Item	Yes	No
When giving a patient an antibiotic, do you know WHY he or she is receiving the antibiotic?	98 (98%)	2 (2%)
If you have a question about the antibiotic being given, whom do you ask?		
Charge Nurse	35 (35%)	65 (65%)
Infectious Disease	32 (32%)	68 (68%)
Another staff nurse	13 (13%)	87 (87%)
Primary Medical Team	17 (17%)	83 (83%)
Physician	80 (80%)	20 (20%)
No one	0 (0%)	100 (100%)
Have you questioned a physician about the CHOICE of antibiotic for a patient?	83 (83%)	17 (17%)
Have you questioned a physician about the DOSE of antibiotic for a patient?	93 (93%)	7 (7%)
Have you questioned a physician about the ROUTE of antibiotic for a patient?	90 (90%)	10 (10%)
Have you questioned a physician about the DURATION of antibiotic for a patient?	96 (96 %)	4 (4%)
Have you ever given an antibiotic you thought was inappropriate?	59 (59%)	41 (41%)
Would you feel comfortable raising concerns to the treatment team about the antibiotic(s) a patient is getting?	77 (77%)	23 (23%)
Do you think nurses should be involved in interventions aimed to improve antibiotic use?	97 (97%)	3 (3%)

3.5 Knowledge and Attitude about Antimicrobial Use

In terms of knowledge and attitude about antimicrobial use, the nurses had good knowledge regarding antibiotic use: 93% of them agreed that misuse of antibiotics can cause harm, and 92% recognized that knowledge of antibiotics is important in their job. In addition, 95% stated that they would like more education on the appropriate use of antibiotics, and 83% agreed that it is their responsibility as nurses to ensure appropriate antibiotic use in their healthcare facilities. Moreover, 46% agreed that antibiotics are overused at their facility (Table 5).

Table 5: Knowledge and Attitude about Antimicrobial Use

Item	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The misuse of antibiotics can cause harm.	2 (2%)	3(3%)	2 (2%)	39 (39%)	54 (54%)
Strong knowledge of antibiotics is important in my job.	2 (2%)	2 (2%)	4 (4%)	47 (47%)	45 (45%)
I would like more education on the appropriate use of antibiotics	2 (2%)	0 (0%)	3(3%)	55 (55%)	40 (40%)
Antibiotics are overused at my healthcare facility.	4 (4%)	29 (29%)	21 (21%)	31 (31%)	15 (15%)
It is my responsibility to ensure appropriate antibiotic use in my healthcare facility.	3 (3%)	3 (3%)	11 (1%)	55 (55%)	28 (28%)

3.6 Knowledge and Attitude about Antimicrobial Resistance

Regarding the knowledge and attitudes of nurses towards antimicrobial resistance, the majority agreed that inappropriate use of antibiotics causes resistance, and that prescribing broad-spectrum antibiotics increases the risk of AR. In addition, 80% of the participants argued that the incidence of antibiotic-resistant organisms can be reduced by changing antibiotic prescribing patterns, and 61% admitted that AR is a significant problem in their healthcare facility. Notably, the majority (80%) of the participants rated the emerging AR as an urgent problem that needs to be tackled. Further details are described in **Table 6**.

Table 6: Knowledge and Attitude about Antimicrobial Resistance

Item	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Inappropriate use of antibiotics causes resistance.	1 (1%)	6 (6%)	5 (5%)	48 (48%)	40 (40%)
Prescribing broad-spectrum antibiotics increases the risk of antibiotic resistance.	1 (1%)	10 (10%)	9 (9%)	51 (51%)	29 (29%)
The incidence of antibiotic-resistant organisms can be reduced by changing antibiotic prescribing patterns.	1 (1%)	9 (9%)	10 (10%)	57 (57%)	23 (23%)
The development of new antibiotics will help to combat current resistance trends.	0 (0%)	6 (6%)	21 (21%)	52 (52%)	21 (21%)
Antibiotic resistance is a significant problem in my healthcare facility.	4 (4%)	23 (23%)	12 (12%)	42 (42%)	19 (19%)
I am interested in the current status of antibiotic resistance in my healthcare facility.	3 (3%)	6 (6%)	13 (13%)	60 (60%)	18 (18%)
Assessment and documentation of allergies are important to ensure appropriate antibiotic use.	2 (2%)	2 (2%)	3(3%)	62 (62%)	31 (31%)
	Extremely Non-urgent	Non-urgent	Neutral	Urgent	Extremely Urgent
Rank the magnitude of emerging antibiotic resistance as a healthcare problem	4 (4%)	0 (0%)	16 (16%)	43 (43%)	37 (37%)

3.7 Association between Socio-Demographic Data and Knowledge regarding Antibiotic Stewardship

The Chi-Square results showed that there was a significant association between gender, level of education, experience, and years of working at the same facility with some of the elements yet there was no association at the level of age. There was an association between years of working at the facility and educating staff about resistance and optimal prescribing. Similarly, no association was observed between level of education and reporting information on antibiotic use and resistance patterns. The results are delineated in **Table 7**.

Table 7: Association between socio-demographic data and knowledge regarding AS. Chi-Square test, * p<0.05.

Item	Age	Gender	Level of Education	Years of Experience	Years of working at the same facility
Are you familiar with the term “Antibiotic Stewardship”?	0.52	0.03	0.06	0.33	0.35
Did you receive any training or education about Antibiotic Stewardship?	0.86	0.44	0.46	0.08	0.51
Are you aware if an Antibiotic Stewardship Program exists at your facility?	0.42	0.01	0.01	0.17	0.38
What are the Core Elements of Antibiotic Stewardship Program?					
Dedicating necessary resources	0.61	0.50	0.23	0.30	0.45
Appointing a single physician leader	0.73	0.31	0.05	0.55	0.75
Appointing a single pharmacist leader	0.91	0.11	0.24	0.23	0.39
Implementing at least one recommended action such as antibiotic time out	0.85	0.43	0.00	0.02	0.09
Monitoring antibiotic prescribing and resistance patterns	0.56	0.64	0.11	0.44	0.01
Reporting information regularly on antibiotic use and resistance patterns	0.92	0.00	0.01	0.28	0.29
Educating staff members about resistance and optimal prescribing	0.22	0.11	0.18	0.28	0.00
In your opinion, who are the potential participants in Antibiotic Stewardship Program?					
Physicians/Clinicians	0.17	0.39	0.63	0.75	0.92
Pharmacist	0.87	0.23	0.01	0.16	0.28
Laboratory Staff	0.73	0.17	0.16	0.19	0.26
Nurses	0.36	0.17	0.30	0.42	0.45
Information Technology Staff	0.69	0.34	0.02	0.13	0.29
Infection Control Nurse/Officer	0.44	0.09	0.11	0.25	0.29
Infectious Disease Specialist	0.66	0.21	0.68	0.43	0.35
Hospital Epidemiologist	0.76	0.37	0.30	0.75	0.59
Quality Improvement Staff	0.66	0.10	0.21	0.32	0.24
What are the potential roles of nursing staff in Antibiotic Stewardship?					
Admitting and triaging of patients	0.12	0.43	0.30	0.03	0.10
Assessing for the history of adverse drug reactions	0.19	0.11	0.02	0.14	0.01
Assessing for the history of allergy	0.12	0.07	0.03	0.04	0.09
Assessing the need for continued antibiotic therapy and daily progress	0.94	0.60	0.26	0.07	0.12

Item	Age	Gender	Level of Education	Years of Experience	Years of working at the same facility
monitoring					
Educating patient and family about antibiotic use	0.68	0.70	0.51	0.95	0.06
Obtaining cultures before antibiotic administration	0.90	0.47	0.69	0.70	0.45
Reviewing stop dates for antibiotics, ensuring antibiotic durations and indications are recorded in discharge paperwork	0.68	0.22	0.04	0.35	0.57
Reviewing flags for multidrug-resistant bacteria colonization and placing in isolation when appropriate	0.68	0.26	0.24	0.17	0.05
Reviewing final cultures and discussing antibiotic de-escalation with treating physician	0.93	0.01	0.09	0.55	0.48
Transitioning antibiotics from intravenous to oral therapy	0.71	0.14	0.04	0.07	0.33
Notifying the provider of wrong antibiotic doses	0.97	0.31	0.56	0.88	0.22
Timely initiation of antibiotics if indicated	0.77	0.25	0.24	0.93	0.02

3.8 Association between Socio-Demographic Data and Practices of Antibiotic Delivery

When evaluating the association between socio-demographic data and practices of antibiotic delivery, results showed a significant association between years of working at the same facility and knowing the indications for antibiotic prescribing, asking a charge nurse for questions about the antibiotic prescribed, and feeling comfortable raising concerns to the treatment team about the antibiotics prescribed. In addition, there was a significant association between questioning the physician about the duration of antibiotic therapy and age and years of experience. Further, there was an association between the level of education and giving and an inappropriate antibiotic. There was no association at the level of gender (**Table 8**).

Table 8: Association between socio-demographic data and practices of antibiotic delivery. Chi-Square test, * $p \leq 0.05$.

Item	Age	Gender	Level of Education	Years of Experience	Years of working at the same facility
When giving a patient an antibiotic, do you know WHY he or she is receiving the antibiotic?	0.17	0.54	0.12	0.13	0.05
If you have a question about the antibiotic being given, whom do you ask?					
Charge Nurse	0.73	0.25	0.22	0.08	0.04
Infectious Disease	0.48	0.14	0.29	0.94	0.84
Another staff nurse	0.07	0.67	0.93	0.08	0.10
Primary Medical Team	0.17	0.53	0.37	0.43	0.06
Physician	0.95	0.64	0.69	0.77	0.65

Item	Age	Gender	Level of Education	Years of Experience	Years of working at the same facility
No one	-	-	-	-	-
Have you questioned a physician about the CHOICE of antibiotic for a patient?	0.20	0.29	0.56	0.21	0.37
Have you questioned a physician about the DOSE of antibiotic for a patient?	0.37	0.41	0.65	0.57	0.67
Have you questioned a physician about the ROUTE of antibiotic for a patient?	0.67	0.51	0.41	0.35	0.17
Have you questioned a physician about the DURATION of antibiotic for a patient?	0.02	0.22	0.98	0.05	0.37
Have you ever given an antibiotic you thought was inappropriate?	0.70	0.09	0.01	0.17	0.89
Would you feel comfortable raising concerns to the treatment team about the antibiotic(s) a patient is getting?	0.13	0.99	0.85	0.99	0.01
Do you think nurses should be involved in interventions aimed to improve antibiotic use?	0.19	0.59	0.74	0.40	0.86

3.9 Descriptive Statistics of Knowledge, Attitude, and Practice Scores

The percentage ASP scores were grouped into good (scores between 80 and 100%), average (scores between 50 and 79%) and poor (scores less than 50%) according to a similar study (Ogoina et al., 2021). Descriptive statistics of knowledge, attitudes, and practice scores are summarized in **Table 9**. Of the 100 participants in the study, 43% had average score and 57% had poor scores regarding knowledge of ASP. Moreover, 100% had poor scores regarding the attitude and practice towards ASP. None of the participants had good knowledge, attitude, and practices of ASP.

Table 9: Descriptive statistics of knowledge, attitudes, and practice scores

	Number of Items	Mean (SD)	Range	Good Score (%)	Average Score (%)	Poor Score (%)
AS Knowledge Score	6	46.79±7.98	31-57	0	43%	57%
AS Attitude Score	4	17.31±2.28	13-23	0	0	100%
AS Practice Score	9	19.3±1.83	15-24	0	0	100%

3.10 Predictors of Knowledge and Attitudes Towards Antibiotic Stewardship

In order to detect the predictors of knowledge and attitudes towards AS, a linear regression test has been carried. The total score for knowledge and attitudes has been taken as a dependent variable and multiple other variables have been tested to be predictive of knowledge such as demographic factors (gender, age, level of education, years of experience, etc.). The results of the linear regression analysis showed that the years of experience and years of working at the same facility are significant predictors of knowledge and attitudes towards AS; a p-value of ($p < 0.001$) was recorded for both variables (**Table**

10). In addition, the results showed a positive correlation between years of working at the facility and knowledge and attitudes towards AS ($B=4.392$). However, years of experience were found to be negatively correlated with knowledge and attitudes towards AS ($B=-5.529$). No correlation was observed with age, gender, level of education and primary role.

Table 10: Predictors of knowledge and attitudes towards antibiotic stewardship

	B	Std. Error	T	P-value
Age, years	2.47	1.542	1.602	0.113
Gender	-2.106	1.638	-1.286	0.202
Level of education	-0.768	0.655	-1.173	0.244
Years of experience	-5.529	1.338	-4.131	0.000
Years of working at the same facility	4.392	1.065	4.122	0.000
Primary role	-0.555	0.556	-0.998	0.321

4. DISCUSSION

The present research is among the first studies conducted in Lebanon, particularly North Lebanon to comprehensively evaluate knowledge, attitudes, and practices regarding antibiotic stewardship among nurses.

It was remarkable that more than half of the participants reported being familiar with the term AS. This was similar to several studies including a study conducted in a pediatric hospital in the USA (Monsees et al., 2018), and a study conducted in Richmond, Virginia (Abbas et al., 2018). However, our findings were inconsistent with a Scottish study where only a few of the respondents were familiar with the term (McGregor et al., 2015) a multisite study that reported the non-familiarity of nurses with the phrase AS (Greendyke et al., 2016), and another study conducted in Utah where the majority of the nurses reported being unfamiliar with the term or didn't understand it (Merrill et al., 2019). This inconsistency could be explained by the difference in socio-demographic characteristics. In addition, most of the nurses in this study stated that they have received previous training in AS, which explains the familiarity of most nurses with the term.

In this study, the knowledge of nurses regarding AS including its core elements and potential participants and roles were assessed. When evaluating the knowledge of nurses regarding CDC core elements of ASP, gaps in their knowledge were evident. Nurses considered that appointing a single physician leader is a core element of AS while the majority agreed that the other elements were not within AS. This is inconsistent with a study that showed a high percentage of the nurses were able to correctly identify more than one core element (Abbas et al., 2018). Also, the vast majority of our participants believed that physicians, nurses, and pharmacists are potential participants in AS which is consistent with what nurses in Richmond, Virginia chose (Abbas et al., 2018), and with other studies that reported that nurses agreed that their involvement is crucial in AS (Carter et al., 2018; Monsees et al., 2018). Therefore, healthcare facilities should focus on their education and competencies to act as frontline stewards.

Moreover, nurses had a humble confidence in their potential roles in AS. Compared to the study done in Virginia, nurses had much better knowledge regarding their potential roles in AS than nurses in this study (Abbas et al., 2018). It is noteworthy that activities that required nurses' interaction with the physician or treating team were not favored as potential roles for nurses in ASPs which is similar to nurses' behavior in another study (Abbas et al., 2018). Nurses' modest confidence in their potential roles draws attention as these roles serve to shorten the patient's hospital stay, promote optimal therapy while reducing the duration of antibiotic therapy. According to a cross-sectional study conducted in the USA, infection control leaders perceived that the role of nurses in ASP is not well defined. Policies and procedures clearly defining their roles must be created which will aid nurses in defining their roles and identifying knowledge gaps, and this will help nurses adopt greater roles in ASP (Manning et al., 2018).

Additionally, the findings showed a significant association between level of education, years of experience and years of working at the same facility with some of the elements of knowledge regarding AS. For instance, there was an association between years of experience in the workplace at the facility and educating other staff about resistance and prescribing. Also, there was an association between level of education and years of experience with assessing the history of allergy before administering antibiotics. In addition, years of experience and years of working at the same facility were significant predictors of knowledge and attitude towards AS. Nurses' level of education, years of experience, and years of serving at the same facility influence their level of expertise and their knowledge. This provides them with the fluidity and flexibility to perform complex functions in their profession and integrate theoretical knowledge with actual procedures. Furthermore, it affects their critical thinking and their skills and consequently their clinical judgment (Mchugh & Lake, 2010).

This inconsistency in the nurses' knowledge about AS despite respondents stating that they are familiar with AS and received training on the topic, might be because nurses are often not integrated into the AS team and hence their roles are not clearly defined (Monsees et al., 2018). Moreover, a study conducted in two academic hospitals in New York City suggested that nurses' knowledge gaps regarding AS are likely attributable to the education gaps in both pre and post-licensure (Carter et al., 2018). Therefore, the CDC and the Joint Commission stress on the need to define nurses' role in AS and integrate them into this approach. Allowing nurses to be involved in stewardship rounds, educating them about the goals of AS, microbiology, and antibiotics can help increase their knowledge about the topic (Abbas et al., 2018). A pre and post-course survey showed that nurses' knowledge regarding ASP increased comparably after they completed online education modules (Wilson et al., 2017). Besides, nurses need further education on AS especially at the site of work. This can be accomplished by developing action-oriented, evidence-based materials and making them available to nurses in their work environments in order to expand their knowledge concerning their responsibilities and roles in AS (Carter et al., 2018).

Moreover, the results showed that concern over physician feedback is one of the barriers that prevent nurses from performing the recommended activities. This is consistent with what nurses chose as barriers to their participation in other studies recently conducted in the USA (Abbas et al., 2018; Hamdy et al., 2019). In addition, nurses chose a lack of knowledge in antibiotics as another barrier which is also similar to other studies conducted in the USA (Carter et al., 2018) (Monsees et al., 2018). Knowledge of key principles in microbiology and antibiotics and understanding the consequences of their inappropriate use are crucial to ensure proper management and prescribing of antibiotics (Edwards et al., 2011). When developing and implementing ASPs, obstacles and barriers that may prevent nurses from engaging in the program must be considered. This will ensure that nurses will truly have an impact on AS and be more effective, which in turn will produce more successful outcomes (Edwards et al., 2011).

It was noteworthy that a relatively high number of participants stated that they have previously disputed the choice, dose, route, or duration of the prescribed antibiotic which is consistent with a multisite study that reported a high percentage of nurses have previously questioned the prescribers about the antibiotic treatment (Greendyke et al., 2016). This could be explained by the fact that nurses in this study stated that they are comfortable raising concerns about the antibiotic being used. In addition, nurses, as promoters of appropriate antibiotic use, feel the need to speak up and raise concerns when they feel uncomfortable with the prescriber's decision regarding antibiotics (Hamdy et al., 2019).

It should be noted, however, that most nurses have given an antibiotic they thought was inappropriate despite feeling comfortable about questioning the physician regarding the prescribed antibiotic. This finding is concerning as it has a significant impact on patient safety. Inappropriate antibiotics can put the patient at an increased risk of infection or other adverse events such as allergic reactions. Additional data regarding the reason why nurses carry out such a behavior are needed to define better and develop solutions to address this issue (Merrill et al., 2019). Nurses' code of professional practice decrees a substantial role in patient advocacy which makes it mandatory for them to speak about patient safety concerns. It was encouraging that almost all nurses agreed that they should be involved in interventions aimed at improving antibiotic use which is similar to nurses beliefs in other studies (Carter et al., 2018; Merrill et al.,

2019). Nurses reasoned that their contribution to improving the use of antibiotics is an extension of their role as a patient supporter. In addition, they stated that since they are responsible for administering antibiotics and present constantly by the patient then it makes sense for them to be involved in such interventions (Carter et al., 2018).

Nurses showed efficient knowledge regarding antibiotic use and resistance. Interestingly, they expressed a desire to learn more about antibiotics as a high percentage of the respondents agreed that strong knowledge of antibiotics is important in their job and that they would like to acquire more education regarding antimicrobial use. These findings are consistent with nurse's assessment in other studies conducted in the USA (Greendyke et al., 2016; Hamdy et al., 2019; Merrill et al., 2019). This might be beneficial in filling their knowledge gaps regarding AS. With the appropriate training and education, nurses will be able to more effectively identify their roles and opportunities in AS and communicate these with the team (Merrill et al., 2019). In addition, nurses agreed on their responsibility to ensure appropriate antibiotic use in their healthcare facility and that they are interested in the status of AR in their healthcare facility. Therefore, health care facilities should implement training programs for nurses on patient safety alongside empowerment strategies to encourage them to speak up and integrate them into the ASP team. The main limitation of the present study is its cross-sectional design; therefore, no causal inference can be performed.

5. CONCLUSION

The purpose of this study was to evaluate the nurses' KAP regarding AS and to determine the barriers that prevent their participation. The study revealed that more than half of the nurses were familiar with the term AS. However, their overall knowledge of core elements and their potential roles in AS were limited. Nurses agreed that they should be involved in the program and expressed a desire to learn more about antibiotics as it is important for their job. The results highlight the need to provide education and knowledge to nursing staff about AS and engage them in AS teams and activities. Several associations state that the success of ASPs requires a multidisciplinary approach and that it is vital to integrate nurses in ASPs. Nurses already perform activities that overlap with AS roles and assist in improving antibiotic use. They are well qualified to play a major and crucial role and add range to this program. Despite this, efforts to engage them in ASPs remain limited. Future research is needed to explore the effect of education and the involvement of nurses in the ASP team on the knowledge and attitude of nurses regarding AS. Also, studies are needed to better understand the role of nurses in ASPs.

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