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Effect of Educational Program on Pediatric Nurses' Knowledge and Practice Regarding Combating Antimicrobial Resistance

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Abstract: Antimicrobial resistance (AMR) occurs when microorganisms such as bacteria, viruses, fungi and parasites change in ways that render the medications used to cure the infections they cause ineffective. Antimicrobial resistance is recognized as a global health and economic threat. It places extreme pressure on the effective prevention and treatment of an ever increasing range of infections potentially returning modern medicine to the pre-antibiotic era. Nursing has a key role in supporting efforts to reduce this threat as a central part of the health care and public health workforce. The present study aimed to evaluate the effect of educational program on pediatric nurses' knowledge and practice regarding combating antimicrobial résistance. A quasi-experimental design was utilized in this study conducted in Pediatric Hospitals affiliated to Cairo University Hospitals. A convenient sample consisted of 60 nurses from the previously mentioned setting were included. Tools of data collection included tool I: A structured interviewing questionnaire sheet to assess nurses' personal characteristics and tool II assessment sheet for nurses' knowledge and practice regarding AMR. Results showed highly statistical significant differences ($P<0.001$) concerning nurses' knowledge, practice pre/post implementation of the educational program and there was a positive correlation between total nurses' knowledge, practice regarding AMR post-implementation of the educational program ($P<0.001$). Conclusion: implementation of the educational program affect positively on nurses' knowledge and practice regarding AMR. Recommendation: providing nurses in pediatric hospitals with continuous educational program regarding AMR.

Key words: Nurses' Knowledge and Practice · Antimicrobial Resistance

INTRODUCTION

Antimicrobial resistance (AMR) is related specifically to common bacteria's resistance to antibiotics. Antimicrobial resistance is a wider term which combines bacteria's and other microbes', parasites', viruses' and fungi resistance to drugs to which it was originally responsive. Antibiotic use is considered as the main factor of antibiotic resistance [1, 2].

Inappropriate antibiotic use is one of the main factors that determined speedy development of antibiotic resistance. Incorrect prescribing of antimicrobials, fact that antibiotics are available over the counter and self-medication show that society is lacking general awareness about AMR and the risks it poses to the public [3].

In 2010, the Centers for Disease Control and Prevention launched Get Smart for Healthcare, a campaign focused on improving antibiotic use in inpatient health care facilities to prevent overuse of antimicrobials and promote the use of antimicrobial stewardship. The 2011 World Health Organization Day focused on international antimicrobial resistance. This World Health Organization campaign has drawn together agencies from all over the world to focus resources and combat the increase in antimicrobial resistance [3].

These organizations are drawing attention to the battles that practitioners face on a daily basis. This attention should be a call to action for insurance providers, national and state governments and hospital administrators to provide much needed resources to

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practitioners who incorporate stewardship practices into everyday patient care [3, 4].

In a study done by Laxminaryan [5] who reported that in developing countries, resistance is present due to a lack of basic healthcare and public health infrastructure, also limited access to clean drinking water and a huge deficit of trained healthcare providers. Another factor contributing to spreading resistance is non-therapeutic antibiotic use in animals, where antibiotics are being administered to pigs, cows and chickens in order to promote their growth and prevent possible infections. It is expected that the use of antibiotics in animals will increase up to 67 percent until 2030.

In the hospital, combating Antimicrobial resistance teams are charged with this important initiative. Combating antimicrobial resistance has been defined as "The optimal selection, dosage and duration of antimicrobial treatment that results in the best clinical outcome for the treatment or prevention of infection, with minimal toxicity to the patient and minimal impact on subsequent resistance.

According to American Nurses' Association [6] nursing is a widely described profession and, apart from providing medical care to patients, nurses are also responsible for providing health promotion, education and coordinating patient care in collaboration with a wide range of other healthcare professionals.

Nurses are in an ideal position in contributing to minimizing AMR by undertaking a role in combating AMR team as they can monitor, influence, guide and encourage the implementation of responsible antibiotic use. Nurses have an important role in regulating the use of antibiotics because they know how long treatments last, medication administration routes and timings, prescribing and monitoring of drugs. Nurses that are aware and recognize the importance of AMR can also contribute in reducing medication prescription errors by encouraging compliance with correct prescribing guidelines [7].

Health education means that knowledge and point of views are impacted through communication and this leads to increased well-being and prevention of diseases. Prevention includes medical interventions that are taken in order to reduce and avoid illnesses. Health protection defines protecting population's health through legislative, social or financial means [8].

Monsees *et al*. [9] emphasized the importance of an interdisciplinary team on AMR, but current practice focuses primarily on defining the role of infectious disease physicians and pharmacists; the role of inpatient staff nurses as AMR management is largely unexplored.

According to Edwards *et al*.[10] prescribing of antimicrobials is mostly delegated to doctors as they have more expertise in medicines but the reality very often is that antibiotics are being prescribed by junior doctors who are working in different areas and also need assistance from senior doctors in order to assign a proper treatment for a patient. Due to the high rotation of junior doctors within a ward, the information and knowledge about each patient's individual treatment is very often lost. This is why nurses who are the least transient medical professionals should be involved in antimicrobial management as they spend most of the time with a patient and they are in ideal position to collaborate with physicians and pharmacists due to the information they behold.

Nurses are in a key position in contributing to multidisciplinary management of antibiotics as they work at different levels within health care settings and also are main patient's carers that are always present. Nurses review medication charts and administer medications so they can directly contribute towards combating AMR [10].

Monsees *et al*. [9] focused consideration to empower and educate staff nurses in antimicrobial management is needed to strengthen collaboration and build an interprofessional stewardship workforce and concluded that further exploration on the integration and measurement of nursing participation is needed to accelerate this important patient safety initiative.

Significance of the Study: Historically, guidelines for developing and implementing AMR largely recognized the need for an interdisciplinary team, including physicians, pharmacists, infection preventionists, microbiologists and others. However, nurses have been frequently missing from mention in these publications. Fortunately, in recent years, the dialogue surrounding antibiotic stewardship has evolved to include nurses. Evidence of this can be found in guidance documents from the US Centers for Disease Control and Prevention, National Quality Forum and American Nurses Association [11] in which nurses are acknowledged as key contributors to these efforts. Although this recognition is a step in the right direction, studies to demonstrate specifically how nurses can actively participate in antibiotic stewardship and quantify impact are limited.

Antimicrobial resistance is not a recent phenomenon, but it is a critical health issue today. However, in Egypt there are many challenges have been identified concerning AMR including; limited awareness,

unauthorized irrational public use of antibiotics, shortage of component microbiology laboratories, poor surveillance data on antibiotic use and resistance, lack of combating Antimicrobial resistance programs in health care settings, inadequate knowledge of health-care providers leading to prescription of antibiotics and poor infection control in some healthcare settings can greatly increase the spread of drug-resistant infections [12, 13]. Therefore, the present study aimed to evaluate nurses' knowledge and practice regarding AMR through implementation of an educational program for them, to improve their knowledge and practice. Moreover, providing recommendations that reflected in pediatric nursing education, practice and research.

Aim of the Study: The current research study aimed to evaluate the effect of an educational program on pediatric nurses' knowledge and practice regarding combating AMR.

This Aim Is Achieved Through:

- Assessing nurses' knowledge and practice regarding AMR.
- Designing and implementing educational program regarding AMR based on level of nurses' knowledge and practice.
- Evaluating the effect of the educational program on nurses' knowledge and practice regarding AMR.

Hypothesis: The researchers hypothesized that the nurses who received the educational program regarding combating AMR would expect to gain high score of knowledge and practice in post test more than before

MATERIAL AND METHODS

Research Design: One group pre/ post test, quasi-experimental design was utilized to fulfill the aim of this study.

Setting: The present study was carried out at Pediatric Hospitals affiliated to Cairo University Hospitals.

Sample: A convenient sample of available nurses (60 nurses) who worked at the previously mentioned setting was included in the current study regardless of their educational level, age and years of experience.

Tools of Data Collection: Two tools were designed by the researchers and used for data collection.

Tool (I): A self-administered questionnaire which was developed by the researchers in Arabic language after reviewing of related literature. It includes nurses' demographic characteristics, such as; age, level of education, job, years of experience and attending training programs regarding AMR.

Tool (2): Knowledge and practice assessment questionnaire of the studied nurses regarding AMR. This part was used before and after implementation of the educational program (pre/post test format), it included 26 multiple choice and yes/no questions, such as; meaning of AMR, AMR is an important and serious global public health issue, AMR problem is growing from indiscriminate use of antimicrobial drugs, …etc.

Education Program: Included illustrated Arabic booklet about AMR for nurses. The program was adapted by the researchers after reviewing the literature review and related researches, global action plan on antimicrobial resistance [2, 13].

It includes

- Antimicrobial resistance definition
- The difference between antibiotic and antimicrobial resistance
- Causes of antibiotic resistances and antimicrobial resistance:
- Risk factors for development of AMR.
- Role of the nurse in combating AMR.

Scoring System: A correct answer was scored "one" and the incorrect "Zero". The score was calculated by adding the scores for the correct answers. The total possible score ranged from 0 to 26, these scores were summed and converted into a percentage; the nurses' total knowledge was classified into: satisfactory $\geq$ 75 % (19.5 marks or more) and unsatisfactory < 75% (Less than 19.5 marks).

Tools Validity and Reliability: Tools were reviewed by a panel of three experts in the field of pediatric nursing and two in infection control staff from hospitals to test its content validity. Modifications were done accordingly based on their judgment. Reliability was done by Cronbach's Alpha coefficient test which revealed that each of tools consisted of relatively homogenous items as indicated by the moderate to high reliability (Internal consistency) of each tool (knowledge = 0.92, practice= 0.83).

Ethical Considerations: Each nurse in the study was informed about the nature and benefits of the study then; oral consent was obtained before starting the data collection. Strict confidentiality was ensured throughout the study process. The studied nurses were assured that all data was used only for research purpose and each nurse was informed of the rights to refuse or withdraw at any time with no consequences.

Pilot Study: A pilot study was carried out on 10% of nurses to assess; the tools clarity, objectivity and feasibility. As well to estimate the time needed for data collection. Those nurses in the pilot study were not included in the main study sample since some modifications were done.

Field Work: A written official letter was obtained from heads of the pediatric University hospitals in order to obtain their approval for conduction of the research after explaining its purpose. At the time of data collection a verbal agreement was taken from every participant in the study after clear and proper explanation of the study purpose and its importance for pediatric patients. The study was carried out through four phases: assessment, planning, implementation and evaluation. These phases were carried out from beginning of March 2017 to the end of September 2017, covering along a period of six months. The previous mentioned settings were visited by the researchers two days/week from 9.00 am to 2.00 pm during morning shift.

Assessment Phase: Upon securing official permissions to conduct the study, the researchers approached and interviewed each nurse individually, explained the purpose and procedures of the study and asked for her participation. Upon consent to participate, the nurse was handed the self-administered questionnaire to assess nurses' personal characteristics and knowledge regarding AMR and asked to fill it. The data obtained during this phase constituted the baseline to evaluate the effect of the educational program. Average time for the completion of each participant interview was around 30-45 minutes. A number of interviewed nurses/week ranged from 10-12nurses.

Planning and Implementation Phase: Based on the needs identified in the assessment phase from the nurses and in view of the related literature, the researchers developed educational program about AMR in a simple Arabic language to suit nurses' different level of education. It emphasized the areas of lack of nurses' knowledge about AMR, such as meaning of AMR, causes, risk factors, signs and symptoms, role of the nurse in AMR and prevention. The educational program distributed to each nurse. The participants divided into five groups each group composed of 10-12 nurses according to their work schedule. Duration of this stage took one month, the total number of sessions was 6 sessions for each group, one session/day through two days/week during the morning shift., the duration of each session was one-hour lecture to provide participants with sufficient information. The education package involved the use of a slideshow presentation and discussion and encouraged participants to ask questions during the session The researchers explained to the nurses how to use it throughout setting directions including; 1. Each part should be read carefully and did not cancel any page in the program. 2. Nurses can return to the researchers in order to clarify the vague points and answer any questions via telephone numbers and meeting the nurses in their work place.

Evaluation Phase: After two months from the distribution of the educational program to the all nurses, the effect of the program was evaluated by using the same format of pre-test to constitute the post-test.

Statistical Analysis: Data were verified prior to computerized entry. The Statistical Package for Social Sciences (SPSS version 20.0) was used for that purpose, followed by data analysis and tabulation. Descriptive statistics were applied (e.g., mean, standard deviation, frequency and percentages). Test of significance (Chi-square and independent t test) were used to test the homogeneity of the outcome variables between the groups and to test the study hypothesis. Pearson correlation coefficients were used. A statistically significant difference was considered at P-value $P \leq 0.05$ and a highly statistically significant difference was considered at p-value $P \leq 0.001$.

RESULTS

Table (1) describes personnel characteristics of the studied nurses where more than one third of nurses (36.7%) their age ranged between 20 < 25 years old with mean age of 23.58±5.31 years. Regarding nurses' qualifications it was found that, more than one third of them (40.0%) had technical nursing institute and nursing bachelor and 31.7% of the studied nurses had less than two years of experience in pediatric units.

Table 1: Frequency and percentage distribution of the studied nurses according to their personnel characteristics (n=60)

	Frequency	
	The studied nurses (n=60)	
Items	No	%
-Age (years):		
18 <20	19	31.7
20 <25	22	36.7
25 <30	10	16.7
30 <37	9	15.0
mean	18-37	
	23.58±5.31	
-Education qualification:		
Nursing diploma	1	1.7
Nursing institute	24	40.0
Nursing bachelor	24	40.0
Postgraduates	11	18.3
- Post graduate levels:		
Diploma	3	27.3
Master	3	27.3
Doctorate	5	45.4
* Years of experience in pediatric units:		
< 2	19	31.7
2< 5	17	28.3
5<10	15	25.0
≥ 10	9	15.7

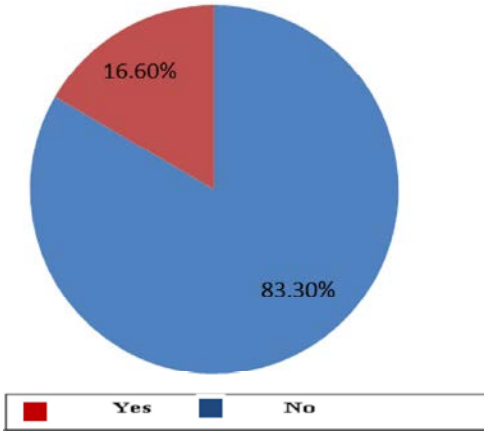

Fig. 1: Distribution of studied nurses according to their attending training courses regarding AMR (n=60)

Fig. 1 Clarifies that, more than three quarters of the studied nurses (83.3%) hadn't attended training courses related to AMR.

Table (2) shows the nurses' knowledge related to AMR, more than half of the studied nurses had unsatisfactory knowledge pre-implementing the program regarding definition of AMR and its importance (63.3% & 66.7%), respectively. Moreover, more than one third of the studied nurses had unsatisfactory knowledge pre-implementing the program regarding indiscrimination of antimicrobial use, diarrheal or flu like symptoms need short course of antibiotics, the relation between antibiotics cost & its efficacy, using of 2 or more antibiotics can control infection (43.3% & 41.7%), respectively. However, there were highly statistically significant differences between nurses' knowledge in pre and post-program implementation (P > 0.001).

Table (3) demonstrates lowest mean scores of nurses' knowledge related AMR during pre-program implementation, while in post-program implementation there were increasing in their mean score (47.60±3.48 &62.15±3.39 respectively) with highly statistical significant differences between pre/post program implementation (P ≤ 0.0001).

Table (4) reveals that, most of nurses had unsatisfactory practice regarding AMR in pre-program implementation. Meanwhile, they had satisfactory practice post-program implementation with highly statistically significant difference (P ≤)

Table (5) illustrates that; the majority of the studied nurses pre-program implementation was having lowest mean score of total practice (215.50 ± 20.03) related their practice regarding AMR. While, post-program implementation there were improvement in their total mean score (410.10 ±12.79) with paired test (62.531) with highly statistically significant differences (P < 0.0001).

Table (6) evidents that, there was a positive correlation with highly statistical significant difference between nurses' knowledge and their practice regarding AMR in pre and post-program implementation (P< 0.0001).

Table (7) clarifies that, there was statistically significant difference between nurses' knowledge regarding AMR in relation to their age and their educational qualification ($\mathbf{X^2}$ =11.669 & 12.119 respectively), (P ≤ 0.05).

It is evident from Table (8) that, there was statistically significant difference between nurses` practice in relation to their age and their experience years. ($\mathbf{X^2}$ = 9.908 and 13.143), respectively (P ≤ 0.05).

DISCUSSION

Containment of antimicrobial resistance requires change in the antimicrobial prescribing behavior of health worker. Nurses in hospitals play an important role in prevention of transmissions of resistant bacteria and

Table 2: Distribution of the studied nurses' knowledge related to AMR pre/post program implementation (n= 60)

Items	The studied nurses' knowledge					
	Pre-Program		Post-program			
	No.	%	No.	%	χ^2	P- value
AMR means that if they are taken too often, antimicrobials are less likely to work in the future:						
• Unsatisfactory	38	63.3	10	16.7	6.136	0.013*
• Satisfactory	22	36.7	50	83.3		
There is difference between antibiotic & antimicrobial resistance:					1.477	0.224
• Unsatisfactory	20	66.7	14	23.3		
• Satisfactory	40	33.3	46	76.7		
Indiscriminate antimicrobial use leads to the emergence of the growing problem of AMR:					6.420	0.011*
• Unsatisfactory	26	43.3	13	21.7		
• Satisfactory	34	56.7	47	78.3		
The efficacy of antibiotics used is better if they are newer and more costly:					10.506	0.0001**
• Unsatisfactory	25	41.7	9	15.0		
• Satisfactory	35	58.3	51	85.0		
Adverse effects of antimicrobials are reduced by using more than one antimicrobial at a time:					11.760	0.0001**
• Unsatisfactory	17	28.3	3	5.0		
• Satisfactory	43	71.7	58	95.0		
It is important to obtain culture and sensitivity report for antibiotic prescription:						
• Unsatisfactory	14	23.3	4	6.7	6.536	0.011*
• Satisfactory	46	76.7	56	93.3		
Large doses of antibiotics are better to use for quick action:						
• Unsatisfactory	20	33.3	14	23.3	1.477	0.224
• Satisfactory	40	66.7	46	76.7		
Short course of antibiotics is used in case of any diarrheal or flu like symptoms:					6.420	0.011*
• Unsatisfactory	26	43.3	13	21.7		
• Satisfactory	34	56.7	47	78.3		
Use of 2 or more type of antibiotics at a time is better choice to control infections:					10.506	0.0001**
• Unsatisfactory	25	41.7	9	15.0		
• Satisfactory	35	58.3	51	85.0		
Broad spectrum antibiotics is better choice than use highly selective antibiotics:					11.760	0.0001**
• Unsatisfactory	17	28.3	3	5.0		
• Satisfactory	43	71.7	58	95.0		
When child get fever, antibiotics help him to get better more quickly:						
• Unsatisfactory	14	23.3	4	6.7	6.536	0.011*
• Satisfactory	46	76.7	56	93.3		
Children with common cold symptoms need antibiotic treatment:					3.683	0.055
• Unsatisfactory	19	31.7	10	16.7		
• Satisfactory	41	68.3	50	83.3		
Whenever child takes antibiotics, he contributes to the development of antibiotic resistance:						
• Unsatisfactory	18	30.0	2	3.3	15.360	0.0001**
• Satisfactory	42	70.0	58	96.7		
Skipping of 1 or 2 doses does not contribute to development of antibiotic resistance:						
• Unsatisfactory	21	35.0	4	6.7	14.602	0.0001**
• Satisfactory	39	65.0	56	93.3		

Table 2: Continued

Items	The studied nurses' knowledge: Pre-Program No.	Pre-Program %	Post-program No.	Post-program %	χ^2	P- value
Antibiotics are safe drugs, hence it can be commonly used:					6.708	0.010*
• Unsatisfactory	20	33.3	8	13.3		
• Satisfactory	40	66.7	52	86.7		
Poor hand-washing in healthcare settings spread antimicrobial resistance:						
• Unsatisfactory	43	71.7	6	10.0	6.508	0.011*
• Satisfactory	17	28.3	54	90.0		
Poor infection control in hospitals spread antimicrobial resistance:						
• Unsatisfactory	19	31.7	11	18.3	2.844	0.092
• Satisfactory	41	68.3	49	81.7		
Sub-standard quality of antibiotics promotes antimicrobial resistance:						
• Unsatisfactory	16	26.7	12	20.0	0.745	0.388
• Satisfactory	44	73.3	48	80.0		
Prescribers' poor awareness promotes antimicrobial resistance:						
• Unsatisfactory	39	65.0	5	8.3	12.570	0.0001*
• Satisfactory	21	35.0	55	91.7		
Children poor adherence promotes antimicrobial resistance:						
• Unsatisfactory	23	38.3	1	1.7	25.208	0.0001*
• Satisfactory	37	61.7	59	98.3		

*Significant (P < 0.05) ** Highly significant (P < 0.001)

Table 3: Distribution of the studied nurses according to their total mean scores of knowledge related to AMR per/post program implementation (n=60)

Items	Mean scores of nurses' knowledge: Pre-program	Post-program	Paired t-test	P-value
Total knowledge score				
▪ Mean ± SD	47.60±3.48	62.15±3.39	31.593	0.0001**

** Highly significant (P < 0.001)

Table 4: Distribution of the studied nurses' practices related to AMR per/post program implementation (n=60)

Items	The studied nurses' practice (n=60): Pre-program No.	Pre-program %	Post-program No.	Post-program %	χ^2	P-value
- Choosing suitable antibiotic for an infectious disease						
▪ Unsatisfactory	50	83.3	1	1.7	82.654	0.0001*
▪ Satisfactory	10	16.7	59	98.3		
- Choosing appropriate dose of antibiotic						
▪ Unsatisfactory	59	98.3	15	25.0	68.316	0.0001*
▪ Satisfactory	1	1.7	45	75.0		
- Deciding the duration of antibiotic therapy:						
▪ Unsatisfactory	59	98.3	1	1.7	112.162	0.0001*
▪ Satisfactory	1	1.7	59	98.3		
- Choosing combination of antibiotics when necessary:						
▪ Unsatisfactory	42	70.0	1	1.7	69.016	0.0001*
▪ Satisfactory	18	30.0	59	98.3		
- Interpreting microbiological results:						
▪ Unsatisfactory	60	100	3	5.0	108.571	0.0001*
▪ Satisfactory	0	0	57	95.0		
- Making decision about correct diagnosis of infection:						
▪ Unsatisfactory	50	83.3	1	1.7	82.654	0.0001*
▪ Satisfactory	10	16.7	59	98.3		

Table 5: Total mean score of nurses' practice regarding AMR in pre/post-program implementation (n=60)

	Mean score of nurses' practice (n=60)			
Items	Pre-program	Post-program	Paired t-test	P-value
Total practice scores:			62.531	0.0001**
▪ Mean ± SD	215.50±20.03	410.10±12.79		

*Significant (P < 0.05) ** Highly significant (P < 0.001)

Table 6: Correlation between total nurses' knowledge and practice related to AMR in pediatric units (n=60)

	Total score of nurses' knowledge (n=60)			
	Pre-program		Post-program	
Variables	r	P	r	P
Total scores of nurses' practice	0.157	0.232	0.838	0.0001*

*Significant (P<0.05) r=Correlation Coefficient

Table 7: Relation between total nurses' knowledge regarding AMR and their demographic data post the program implementation (n=60)

	Total nurses' knowledge					
	Satisfactory		Unsatisfactory			
Variables	No.	%	No.	%	χ^2	P
Age (years):					11.669	0.009*
18-<20 ---- (19)	12	63.2	7	36.8		
20-<25 ---- (22)	5	22.7	17	77.3		
25-<30 ---- (10)	1	10.0	9	90.0		
30-37 ------ (9)	2	22.2	7	77.8		
Marital status:					2.700	0.100
- Single----- (30)	13	43.3	17	56.7		
- Married--- (30)	7	23.3	23	76.7		
Educational qualification:					12.119	0.007*
- Nursing diploma----- (1)	0	0.0	1	100		
- Nursing institute----- (24)	14	58.3	10	41.7		
- Nursing bachelor---- (24)	3	12.5	21	87.5		
- Postgraduates-------- (11)	3	27.3	8	72.7		
Post graduate Levels:					3.441	0.329
- Diploma----- (3)	2	66.7	1	33.3		
- Master------- (3)	0	0.0	3	100		
- Doctorate---- (5)	1	20.0	4	80.0		
Years of experience:					5.002	0.172
<2 ----- (19)	10	52.6	9	47.4		
2-<5 ----- (17)	5	29.4	12	70.6		
5-<10 ----- (15)	3	20.0	12	80.0		
≥10 ----- (9)	2	22.2	7	77.8		

Table 8: Relation between total nurses' practice and their demographic data post the program implementation (N=60)

	Nurses' total practice regarding AMR (n=60)					
	Satisfactory		Unsatisfactory			
Variables	No.	%	No.	%	χ^2	P
Age (years):					9.908	0.019*
18-<20	14	73.7	5	26.3		
20-<25	21	95.5	1	4.5		
25-<30	7	70.0	3	30.0		
30-37	4	44.4	5	55.6		

Table 8: Continued

Variables	Nurses' total practice regarding AMR (n=60)					
	Satisfactory		Unsatisfactory			
	No.	%	No.	%	χ^2	P
Education qualification:						
- Nursing diploma	1	100	0	0		
- Nursing institute	20	83.3	4	16.7	3.994	0.262
- Nursing bachelor	19	79.2	5	20.8		
- Postgraduates	6	54.5	5	45.5		
Post graduate Levels:						
- Diploma	2	66.7	1	33.3		
- Master	2	66.7	1	33.3	4.769	0.190
- Doctorate	2	40.0	3	60.0		
Experience years:						
<2	14	73.7	5	26.3		
2-<5	15	88.2	2	11.8	13.143	0.004*
5-<10	14	93.3	1	6.7		
≥10	3	33.3	6	66.7		

*Significant (P < 0.05) ** Highly significant (P < 0.001)

promoting awareness on AMR for patients and communities. Thus, information on nurses' knowledge on AMR will permit the development of more effective interventions.

As regards nurses' training program, the current study findings revealed that two thirds of nurses did not attended training program about AMR. This result is congruent with Abera *et al.* [14] who studied knowledge and beliefs on AMR among physicians and nurses in hospitals in Amhara Region, Ethiopia and found that 49.3% of nurses replied that they had no up-to-date information about AMR. Regarding training need, 98% of nurses responded that they need further training on stewardship of antimicrobial resistance.

This can be explained by lack of program funding and staffing was underscored as the most important barriers to effective AMR program. Other barriers were lack of awareness by hospital leaders and opposition by prescribers.

Cotta *et al*. [15] conducted a study about attitudes towards combating antimicrobial resistance from a large private hospital in Australia, only a half of the respondents were willing to participate in any proposed AMR intervention; these results are perhaps reflective of significant disengagement (Either passive or active) to issues revolving around antimicrobial use among clinical stakeholders at the hospital. Employing subsequent qualitative methods in addition to these baseline quantitative data will likely shed more light on what factors are influential in this apparent lack of engagement, suggests that education linking antimicrobial prescribing and antimicrobial resistance will need to be a priority at the hospital.

These set of results are similar to previous studies [16, 17] which view that the most favored interventions are those that provide information and education rather than restrict prescribing behavior. It is not clear whether the overall low level of willingness to participate is reflective of either a perceived lack of time to contribute to a new intervention or an active refusal. The low level of experience with AMR suggests a degree of unfamiliarity with what it might entail.

On the other hand, a low proportion of nursing respondents were aware of AMR. This is an important consideration for implementers of AMR programs at the hospital as nursing staff are beginning to play an important role in AMR interventions, such as switching from intravenous to oral antimicrobial therapy [18].

In a recent qualitative study by Sutthiruk [16] using a semi-structured interview guide to facilitate 15 key stakeholder interviews and three focus group discussions were conducted in Bangkok, However, not all programs include nurses. The aim of this study was to explore the current and potential role of nurses in AMR along with investigating barriers to nurses' engagement in AMR in Thai acute care setting. Activities recognized as part of nurses' current role AMR program included: monitoring inappropriate antibiotic orders and adverse events; participating in antibiotic timeout and facilitating the switch from intravenous to oral therapy; providing leadership in infection prevention control and educating consumers.

The majority of participants agreed that improving antimicrobial prescribing would decrease AMR and should be a priority of hospital policy. Doctors were significantly less likely to agree with policies that limit antimicrobial prescribing ($p<0.001$) compared with nurses or pharmacists, recommending that a specialist team provide individualized antimicrobial prescribing advice ($P<0.01$) and that feedback improves antimicrobial selection ($p<0.001$). Nurses were less likely than other participants to agree that community antibiotic use ($p<0.001$) or patient pressure for antibiotics contributes to AMR ($p<0.001$). It was also noted that the results of the clinician survey identified that fewer nurses than doctors and pharmacists had heard of AMR terminology (10.9% vs.20.4% vs. 48.8%, $p<0.001$).

Researchers view that the barriers to nurses taking a larger role in AMR may be attributed to lack of formal policies, high clinical workload and lack of knowledge about antimicrobial prescribing and inadequate decision-support systems. Formal policies and identification of AMR nurse leaders are needed to promote and develop the role of nurses in AMR.

Regards to nurses' knowledge about AMR results was somewhat unexpected that more than half of the studied nurses had unsatisfactory knowledge pre-implementing the program regarding definition of AMR and its importance. Moreover, more than one third of the studied nurses had unsatisfactory knowledge pre-implementing the program regarding indiscrimination of antimicrobial use, diarrheal or flu like symptoms need short course of antibiotics, the relation between antibiotics cost & its efficacy, using of 2 or more antibiotics can control infection. However, there were highly statistically significant differences between nurses' knowledge in pre and post-program implementation.

Although the role of nursing in combat AMR has not been well developed, nurses are uniquely suited to implement successful measures at the point of care. The CDC [19] Core Elements for Hospital suggest that nurses be involved in these multidisciplinary efforts, yet do not elaborate on optimal nursing activities.

The current study results are in accordance with the findings of Manning *et al*. [20] and Olans *et al*. [21] who reported that a common perception among nurses is that AMR is a problem to be addressed by prescribing providers or pharmacists. In reality, because AMR affects all venues of patient care (Outpatient, inpatient and long-term care), nurses across the healthcare continuum have an opportunity to play an important role in AMR.

The results of the current study demonstrated that the majority of the studied nurses were having lowest total mean scores of knowledge and practice regarding AMR during pre-program implementation. While in post-program implementation there was improvement in their total mean scores with highly statistically significant differences between pre/post program implementation.

As mentioned by many authors there is limited published information about the role of nurses in antimicrobial resistance stewardship program (ASP) and no research studies published about the effect of the nurses' role in combating AMR. Moreover, the few articles indicate that nurses play an essential role in AMR, many nurses are currently performing activities and more education is needed for nurses and the multidisciplinary team to effectively collaborate to fully implement ASP in the acute care setting [10, 20, 21]. Manning *et al.* [20] outlined specific recommendations for action, practice, education, research and policy related to nurses' role in AMR. Many of these recommendations have yet to be implemented. For example, nurses at all levels across all clinical settings should receive education about AMR, partner with interdisciplinary teams, raise awareness and use evidence-based strategies such as antibiotic time outs and national awareness campaigns [19, 22].

In the same context an article by Padigos, Ritchie and Lim [17] reported that the need for further education of these roles among registered nurses in New Zealand. They also highlighted antimicrobial resistance in New Zealand and the need to address it in a multidisciplinary context, with nurses as advocates and leaders in preventing development and spread of AMR secondary to antibiotic overuse and poor infection control practices [10, 21].

Regarding nurses' role in AMR, an Egyptian study regarding National surveillance of health care-associated infections by Kandeel *et al*. [23] The presence of intensive care units (ICUs) link nurses, who were in the ICUs every day and were responsible for the Healthcare Associated Infection (HAI) surveillance, was critical to the surveillance program. Surveillance data helped to alert policymakers to the fact that HAIs and antimicrobial resistance represent a true problem in Egypt, with high burden on the Egyptian health care system. Strong political commitment was evidenced by a national launch of the HAI surveillance program in November 2015. As a result of the launch, increased awareness on the importance of surveillance and prevention of hospital infections was obvious. The future vision for national HAI surveillance is to implement the standardized approach until September 2018.

Many authors indicate that nurses are already performing many interventions in combating AMR but their efforts are not well understood or integrated across practice [21]. It is suggested that nurses support indirectly manage AMR during the admission process (Medication reconciliation, allergy history, antibiotic initiation), throughout the hospital stay (Reconciling culture results, dose de-escalation, adverse events) and upon discharge (Patient education, outpatient management) [20]. While it is recognized that staff nurses at the bedside are not prescribers of antibiotics, there remains a collaborative role with AMR similar to a number of other quality and safety initiatives such as decreasing healthcare acquired infections or pain management [10].

Researchers consider that there an important role for the infection control clinical nurse consultant and the bedside nurse on AMR teams. Institutional efforts to optimize antimicrobial use should concentrate on patient outcomes, have multidisciplinary support and use a combination of interventions and resources.

Gillespie *et al*. [18] found that involving nurses in education program led to an increase in combating antimicrobial resistance knowledge and the potential capacity to influence antibiotic management. There is agreement that AMR programs are essential; however, there is no consensus about the approach. They expected that the inclusion of nurses could have an effect on antimicrobial duration. The rationale behind this was that nurses spend more time with patients than professionals in any other discipline and also administer the antimicrobial drugs. Previous systematic plans to convert parenteral use to oral use have resulted in reduced length of stay, health care costs and potential complications. However, nursing knowledge of AMR and its association with antibiotic resistance significantly improved.

Our study showed that following education, nurses were able to articulate the risks of treatment with intravenous antibiotic therapy and were aware of the benefits to actively promote switching to oral antibiotics. Involving nurses in AMR programs should be implemented and monitored to demonstrate an improvement in practice.

Finally the results illustrated that there was a positive correlation with highly statistical significant difference between nurses' knowledge and their practice regarding AMR in pre and post-program implementation. Based upon overview of the literature nursing staff are well suited to provide important AMR interventions directly at the point of care. The CDC [19] recommended that implementation of education of both patients and providers are key aspects of AMR. Nurses play an important role in health care education and thus are resources for AMR. However, nurses need to be supported in this educational role. Nurse leaders and interdisciplinary partners need to facilitate and provide resources for education of nursing staff specifically to support in combating AMR before nurses can effectively participate. Most effective changes happen when strong administrative support is generated throughout the organization. With education and support, staff nurses would then be empowered to educate patients and speak with providers about AMR, appropriate indications for antibiotic use and potential adverse reactions. To implement a program from the ground up, the following steps are recommended for nurse educators.

Olans *et al.* [21] in a review of 14 randomized controlled trials of inter professional collaboration among nurses and physicians; all but one reported at least one statistically significant improvement in patient outcomes following interventions that were based on interdisciplinary collaboration. Once nurses are educated about and integrated into, AMR stewardship program and empowered to participate fully in antimicrobial stewardship, research focused on their then recognized role could be performed to evaluate their impact to best enhance AMR performance. Education about combating antimicrobial resistance is important not only for physicians but for every healthcare discipline.

Concerning relationship between improvement of nurses' level of knowledge and their personal data there was statistically significant difference between nurses' knowledge and practice regarding AMR in relation to their age, years of experience and educational qualification.

In a study done by David *et al.* [26] in Pomona Valley Hospital Medical Center, rounds are led by the bedside nurse and performed twice weekly with attendance of an infectious diseases pharmacist, infection preventionists and critical care nurse practitioner. Recommendations from rounds are communicated to the appropriate provider by the bedside nurse. Compared with the pre-intervention period, the during-intervention period showed statistically significant reductions in antibiotic utilization and substantial reduction in unit length of stay and urinary catheter days was observed in the during-intervention period. Clinical outcomes are commensurate with recommendations made and corresponding acceptance rates. They concluded that bedside nurses can make substantial and direct contributions to combating AMR

and infection prevention outcomes when actively and adequately supported by a trained interdisciplinary team. These data support national guidance to include nurses in combating antimicrobial resistance efforts. Further study of strategies to engage bedside nurses in such activities is warranted.

In the same context in a recent multisite qualitative study of nurses and infection prevention's by Eileen *et al*. [24] to explore the nurses' role in AMR prevention, the authors reported that nurses appeared to be enthusiastic about participating in antibiotic stewardship program. Efforts to engage nurses should address knowledge needs and consider the contexts in which nurse-driven antibiotic stewardship occurs.

As was mentioned above, this results may be related to the fact that update ongoing education or skills days include nursing collaboration with pharmacy, laboratory and infection preventions to review basic microbiology, allergy basic drug classifications and their impact on AMR. In addition, new nurse orientation needs to be reviewed and revised to reflect AMR concepts.

The researchers of the current study view nurses as adult learners need to know how knowledge is applicable to their practice. When they realize the difference they are making with their recommendations in their patients' plan of care, the more value it brought to their personal practice, so collaborative efforts as continuous education is proved to be important and helpful for them.

National Institute for Health and Care Excellence [25] emphasized that efforts needed to comply with AMR recommendations and in consideration of best practice, nurse educators need to identify opportunities and provide the support and education required to enable staff nurses to participate in a meaningful way to promote better patient outcomes. For AMR program to be successful, nurse educators must champion staff nurses by providing adequate budget, education and time.

David *et al*. [26] and Sumner *et al.* [27] confirmed that nursing educators have a unique opportunity to help ensure the success of AMR program by empowering nurses. Educators can provide specific education and work with other leaders to develop, pilot and report on nursing activities. In addition, future research is needed to fully evaluate the impact of nursing involvement in ASP on patient outcomes.

Finally, the findings of the present study supported the research hypothesis that pediatric nurses who are exposed to education program about AMR will show high score of knowledge and practice post program than that before.

CONCLUSION

The current study concluded that nurses who received educational program as regards AMR showed a statistically significant improvement in nurses' knowledge and practice after implementation of the program than that before. There was a highly statistically significant positive correlation in nurses' knowledge and practice to their age, educational level and their years of experience.

Recommendations:

- Establishment of better-informed antimicrobial use policies and implementation of stricter infection control practices.
- Further researches for exploration the integration and measurement of nursing participation is needed to accelerate this important patient safety initiative.
- Focused consideration to empower and educate staff nurses in antimicrobial management is needed to strengthen collaboration and build an interprofessional stewardship workforce.
- Further investigation in order to understand how nurses can contribute to safe use of antimicrobial medicines and reduction in AMR.

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