Effect of an Educational Program on Nurses' performance regarding Antibiotics Stewardship among High-risk Neonates

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Abstract

Background: Antibiotic stewardship is the optimum selection of antimicrobial therapy that results in the best clinical outcome for the management/ prevention of infection, with slight toxicity and minimal influence on subsequent resistance. **The aim of the study was** to assess the effect of an educational program on nurses' performance regarding antibiotic stewardship among high-risk neonates. **Design:** A quasi-experimental (pre & post-test) design used. **Settings:** This study was performed at Neonatal Intensive Care Units and Neonatal Surgical Intensive Care Unit of Benha Specialized Pediatric Hospital in Benha city. **Sample**: A purposive sample of 80 nurses and a purposive sample of 74 high-risk neonates at the previously mentioned settings. **Tools of data collection:** Four data collection tools were utilized, a structured interviewing questionnaire, nurses' practices observational checklists, nurses' attitudes sheet, and High-risk Neonates' Medical Record. **Results:** The current study demonstrated that most studied nurses (88.8%, 83.8% respectively) had a satisfactory level of knowledge and proficient level of practices after applying the educational program as compared to (8.8%, 17.5% respectively) before implementation. **Conclusion**: Based on the findings of the current study, studied- nurses had a satisfactory level of understanding, attitudes, and proficient level of practices after implementation of the educational program as compared to pre-program implementation with a statistically important improvement. **Recommendations:** The study suggest the application of traditional and online in-service training in NICUs for nurses with consistent revising of their knowledge and practices concerning antibiotic stewardship program for high-risk neonates in all NICUs.

Keywords: Antibiotic Stewardship, Nurses' Performance and High-Risk Neonates

Introduction

In neonatal intensive care units (NICUs), a high incidence of morbidity and mortality results from infection and sepsis, but clinical manifestations of infection are still restricted. Antibiotics are the commonly recommended medications in the NICUs. Determining the duration of antibiotic therapy is a widespread medical problem based on neonatologist decisions, risks, and advantages. Clinical organization reduces antibiotic resistance development and improves high-risk neonates' outcomes, and accessibility for appropriate checking of neonates' condition to classify the diagnosis ***(Tolia, Desai & Qin, 2017).***

Antibiotic stewardship is a procedure dedicated to administering antibiotics merely when required and, when antibiotics are thought crucial, encouraging the use of proper agents, dosage, frequency, and the method of treatment. Antibiotic stewardship is required to improve clinical outcomes while minimizing the unexpected consequences of antibiotic use (***Gerber et al., 2021)***. The overuse of antibiotics supports antibiotic resistance, which is a warning to high-risk neonates. The antibiotic stewardship program is a practice excited to prescribe the antibiotics only when crucial and encouraging the usage of a suitable agent(s), dose, frequency, and method of administration to enhance high-risk neonates' clinical consequences, whereas diminishing unintentional costs of antibiotic usage ***(American Academy of Pediatrics, 2018).***

Antimicrobial stewardship refers to the complicated approach which includes policies, guidelines, surveillance, prevalence reports, education, and audit of practice, that healthcare organizations have adopted to optimize prescribing. Basically, antimicrobial stewardship advocates the use of the extremely suitable antibiotic in the context of the presenting clinical condition and specific high-risk neonates. Effective antimicrobial stewardship programs

depend on coordination and collaboration between healthcare professionals to ensure consistency in approach, shared knowledge, and widespread distribution of practice (***Gerber et al., 2021).***

The antibiotic stewardship (AS) denotes approaches that boundary the usage of antibiotics to the lowest possible required spectrum and occurrence in situations for which antibiotics are suggested ***(Center for Disease Control and Prevention CDC, 2017***). A widespread awareness among nurses in NICUs is that AS is a challenge to be addressed by prescribing health care workers (nurse) or pharmacologists. Since AS has an impact on all settings of outpatients, inpatients, and long-term treatment. Nurses throughout the health care field have a chance to perform a significant role in AS ***(Manning, Pfeiffer & Larson, 2016 & Olans, Olans & DeMaria et al., 2016).***

Antimicrobial stewardship programs can address inconsistency and improve clinical outcomes for high-risk neonates. The antibiotic stewardship in NICUs was encouraging for the reason of signs and symptoms of neonatal sepsis and the suboptimal blood amount gathered for blood culture ***(Nash, Simmons, Bhagat & Bartlett, 2014).***

Nurses have a vital role in antibiotic stewardship and are actively involved in stewardship interventions. They provide continuousness of care to high-risk neonates and can be vital in safeguarding those endeavors of care that are conducted and redirected daily ***(Olans, Olans, & DeMaria. 2016, Monsees, Popejoy, Jackson, Lee & Goldman. 2018).***

Moreover, nurses can assist with improving high-risk neonates' and guardians' concerns about antibiotics usage. More guidance on precise illustrations of stewardship efforts is required. The team of stewardship can also work as a channel between the microbiology laboratory team and pediatrician by instructing health care workers (nurses) about suitable culture specimen gathering and analysis norms as well as an understanding of the antibiogram ***(Avdic & Carroll, 2014 & Monsees, Tamma, Cosgrove, Miller & Fabre, 2019).***

The improvement and broadcasting of institutional standards for diagnosing and treating frequent infectious diseases are considered a crucial function of stewardship courses. The antibiotic rules for high-risk neonates may be established to target common suggestions for antibiotic use, for example, community-acquired pneumonia, urinary tract infections, hospital-associated pneumonia, ventilator-associated pneumonia, skin and soft tissue infections, abdominal infections, and neonatal sepsis. These suggestions exemplify most of the antibiotic usage in nearly all health care settings (***Astorga et al, 2019).***

Nurses and further health care specialists are requisite to motivate and adhere to rules that support the guideline of the prescriptive usage of antibiotics (***Fleming-Dutra et al., 2016)***. Health care professionals need to be educated regarding the misuse and /or overuse of antibiotics administration for widespread, and constraining infections that frequently do not need treatment **(Tartar, Abbas, Pires, Kraker, & Pittet, 2017).** Nurses need to educate others about full compliance with dosing treatments. Refusal of the complete routines of the antibiotics is a contributing issue in multidrug-resistant organisms' progress ***(Kardos, 2017).***

Nurses play a significant responsibility in health education and therefore, they are sources for AS. Nevertheless, nurses want to be reinforced in this informative role. Additionally, interdisciplinary colleagues need to assist and deliver resources for nurses' instruction particularly to support AS before nurses can participate efficiently. With the implementation of an educational program and assistance, nurses would then be encouraged to educate parents of high-risk neonates and educate health care workers concerning proper indications of antibiotics usage, and possible undesirable reactions (***Sumner et al***., ***2018).***

Nurses also are in a key position in contributing to the multidisciplinary management of antibiotics as they work at dissimilar levels within different health care settings. Nurses assess medications charts and administer medications so they can directly contribute towards contesting antimicrobial resistance ***(Eileen et al., 2018 & Monsees, Popejoy, Jackson, Lee, & Goldman, (2018).***

Significance of the Study:

The Centers for Disease Control and Prevention (CDC) reported that antibiotic-resistant microbes cause approximately 3 million infections and about 35 000 deaths each year in the United States. Antibiotics are often utilized in inpatient and outpatient pediatric settings, with a considerable amount of antibiotic use, deliberated unnecessary ***(CDC, 2019).***

Nurses must be accountable for providing high-quality, safe, evidence-based care for high-risk neonates to reduce the occurrence of antibiotic resistance (***Monsees* et al., 2019**).

Recent studies have shed light on nurses' perceptions of their potential involvement regarding stewardship efforts in NICUs, their supposed limitations to accomplish their role as stewards, and recommendations to overcome these limitations. When nurse stewardship role and confidence were observed, nurses influenced a high degree of confidence with certain practices assessing for an adverse drug reaction, obtaining cultures prior to antimicrobial beginning, participating in family education, and notifying providers of dosing errors. On the other hand, nurses were less self-confident or unenthusiastic to perform a 48-hour antimicrobial time out ***(Monsees, Popejoy, Jackson, Lee, & Goldman, 2018).***

As a neonatal intensive care nurse, the researchers noted several nurses' denial of antibiotic stewardship. Ineffective prohibition of this noncompliance may increase morbidity and mortality among high-risk neonates (***Center for Disease Control and Prevention, 2017***). Even though the field of antibiotic stewardship has make considerable improvements over the preceding period, remarkable knowledge gaps remain (***Olans, Olans, & DeMaria, 2016***). Henceforward, the researchers observed this as an urgent to develop educational program for nurses concerning antibiotic stewardship among high-risk neonates built on the recognized requirements and observation to enhance their knowledge and improve their practices.

Aim of the Study:

The aim of the study was to assess the effect of educational program on nurses' performance regarding antibiotic stewardship among high-risk neonates through:

1- Assessing nurses' knowledge, attitude and practices concerning antibiotic stewardship among high-risk neonates
2- Designing and applying educational program built on studied nurses' real needs regarding antibiotic stewardship among high-risk neonates.
3- Evaluating the effect of educational program on studied nurses' knowledge, attitude, and practices regarding antibiotic stewardship among high-risk neonates.

Research Hypothesis:

1- There will be a considerable difference between nurses' knowledge, and attitude results of pre-test and post-test regarding antibiotic stewardship among high-risk neonates.
2- There will be a meaningful difference between pre and post-test of studied nurses' practices concerning antibiotic stewardship among high-risk neonates.
3- There will be a considerable correlation between studied nurses' knowledge and practice results after program implementation.

Operational definition:

The antibiotic stewardship is defined as a procedure dedicated to administering antibiotics merely when required and, when antibiotics are thought crucial, encouraging the use of proper agents, dosage, frequency, and the method of treatment. Antibiotic stewardship is required to improve clinical outcomes while minimizing the unexpected consequences of antibiotic use (***Gerber et al., 2021).*** **In current study**, the antibiotic Stewardship refers to nurses' practices regarding appropriate preparation, administration, early recognition of side effects and allergic reaction that can occur because of intravenous antibiotic administration for high-risk neonates. It also improves their quality of care and safety.

Subjects and Methods

Research design:

A quasi-experimental (pre and post-test) design was employed to carry out this study. Quasi-experimental studies have been generally accepted and utilized in the social

sciences numerous times ***(Bärnighausen et al., 2017).***

Research Settings:

This study was implemented at Neonatal Intensive Care Units (NICUs) and Surgical Neonatal Intensive Care Unit "SNICU" of Benha Specialized Pediatric Hospital affiliated to the Egyptian Ministry of Health and Population and Specialized Medical Centers at Benha City, Egypt, wherever this hospital is the maximum capacity of high-risk neonates. This hospital included one NICU on the third floor on building "A", and one Surgical Neonatal Intensive Care Unit "SNICU" on the third floor on building "B". The NICU on the third floor has two rooms, the 1st room had 32 incubators, and the 2nd room had 4 incubators. Building "B" contains two rooms on the third floor with 12 incubators.

Sampling:

A purposive sample of all available nurses (80) who are employed as full-time nursing care providers at the previously stated settings was included.

- A purposive sample of high-risk neonates who take up the antibiotics drugs was included in this study from the previously mentioned settings; the total number of them was 74. They were selected corresponding to the following inclusion criteria:

Inclusion criteria:

- High-risk neonates take antibiotic drugs.
- High-risk neonates from both genders.

Data collection tools:

Tool one: A structured Interviewing Questionnaire:

It was developed by the researchers in the Arabic language after reviewing the related literature to assess nurses' knowledge regarding antibiotic stewardship among high-risk neonates. It included two primary sections which are:

Section I: Attributes of studied nurses such as age, gender, level of education, years of experience. Additionally, attending any previous education programs about antibiotic stewardship.

Section II: Nurses' knowledge concerning antibiotic stewardship among high-risk neonates. It comprised of 18 closed-ended questions connected to the definition of antimicrobial, definition of antimicrobial resistance, the difference between the antibiotic and antimicrobial resistance, indications where the antibiotics are inappropriately prescribed, the antibiotic initiation, the antibiotic time outs, dose reduction, allergy history, reconciliation culture results, adverse effects, the importance of obtaining culture and sensitivity, broad-spectrum antibiotics, does antibiotic resistance is a natural and/or acquired problem, the most common antibiotic agents prescribed for high-risk neonates, the definition of antibiotics misuse, complications of antibiotic mistreatment, intervention when skipping doses of antibiotics, furthermore, the role of poor infection control in hospitals in spreading of antimicrobial resistance. In addition to 6 questions related to antimicrobial stewardship, drug resistance, and microbial resistance.

The multiple-choice questions are assessed against a model key answer as (1 point) for a correct reply and (0) for an incorrect reply or don't know. The scoring of closed-ended questions was giving a grade (1) for accurate and full response, (0) for the incomplete reply, or do not know. The total count varied from 0-24. Then, the overall knowledge results were transformed into percentages and categorized as 80%, and more than were regarded as a satisfactory level of knowledge; a score of less than 80% was regarded as an unsatisfactory level of knowledge.

Tool two: Nurses' Practices observational checklists:

It was adopted from **the Center for Disease Control and Prevention (CDC, 2017)** to assess nurses' practices concerning antibiotic stewardship. It involves of 9 procedures as follows; recognizing the usage of broad-spectrum antibiotics, recognizing chances for substituting intravenous to oral antibiotics, observing, and recognizing possible adverse events, time of administrating antibiotics to high-risk neonates, declaring cultures are attained before taking antibiotics, facilitating antibiotic time-out, appropriate discharge advice and instructions in the follow-up settings, antibiotics reconciliation, and caregivers' education.

Scoring system for nurses' practices:

The total steps for practices were (87 steps). Every nurse was noted during every procedure utilizing nurses' observational checklists. Every accurately done step was given a score (1) and (0) for each inaccurately done or not done step. The total practices score was translated into percentage and was classified as a score of 85% and more was reflected competent practices, while less than 85% was judged incompetent practices**.**

Tool three: Nurses' attitude towards antibiotic stewardship among high-risk neonates:

It was adopted from ***Abera, Kibret& Mulu, (2014) and Cotta, (2014)*** after permission to assess nurses' attitudes regarding antibiotic stewardship among high-risk neonates. It involves 13 statements as follows; Do nurses know what antibiotic stewardship means, Does nurses notice that work nurses on his/her unit function as antibiotic stewards, staff nurses need to be elaborated in the antibiotic stewardship, assessing allergic history, assuring blood/ urine cultures are obtained, evaluating continuous antibiotic usage and performing 48-hours' time outs, assessing for a history of adverse drug reactions, reviewing microbiology laboratory results to the antibiotic orders, identifying the incorrect antibiotic dose, notifying the providers of incorrect antibiotic dose, evaluating for probable adverse effects associated with antibiotics, collaborating with other health care providers about IV/PO transitions and educating parents about the importance of taking antibiotics.

Scoring system for nurses' attitudes:

The nurses' attitudes were assessed by utilizing a 5-point Likert scale varying from 1 "strongly disagree" to 5 "strongly agree". The maximum score for attitudes was (65). The total score was transformed into percentage and was classified as the following: -

- 80% and more considered strongly agree.
- 60% to less than 80% considered agree.
- 40% to less than 60% considered neutral.
- 20% to less than 40% considered disagree.
- Less than 20% considered strongly disagree.

Tool four: High-risk neonates' Medical Record:

It was comprised of two-fold main sections as follows:

Section 1: Physical characteristics of high-risk neonates which include age, gestational age, gender, birth weight, and current weight.

Section 2: Involved health data of high-risk neonates such as medical/surgical diagnosis, indications of antibiotics administration, duration of antibiotics administration, route of administration, long-term complications, and blood and/ or urine cultures.

Validity of data collection tools:

The researchers promise that items of the tools of data collection adequately offered what is hypothetical to be measured "face validity" by a jury of five specialists comprising four assistant professors of pediatric nursing from the Faculty of Nursing, Menoufia, and Benha Universities, and one professor of microbiology Faculty of medicine, Benha University to test the precision of data collection tools, application, completeness, easiness, and applicability. All modifications of data collection tools created correspond to the jury committee reports about the precision of sentences, the relevance of the contents, and the progression of items. The jury committee approved the contents of data collection tools.

The reliability of data collection tools was completed by applying Cronbach's alpha test. The consistency score was 0.85 for the structured interviewing questionnaire, 0.81 for nurses' practices observational checklists, and 0.79 for nurses' attitudes.

Ethical considerations:

Written approval was obtained from the ethical research committee of the Faculty of Nursing, Banha University. Verbal and written consent were taken from the studied nurses. They were informed that their participation in the present study was voluntary, every nurse was notified about the kind of the study, its aim, and the collected data were confidential. Each nurse can leave the study at any time without any justifications. The nurses were told that all taken information would not be involved in any work appraisal.

Pilot study:

A pilot study was conducted on 10% of studied samples (8 nurses and 7 high-risk neonates) during April 2020 to assess the possibility of implementing the study, simplicity, fairness, pertinency, and required period for collecting information. Consequently, the required adjustments are done in the form of editing, and the addition or exclusion of certain statements. The pilot study was omitted from the definite study sample.

Procedures of data collection:

Preparatory phase:

The researchers revised the previous, current, local, and international concerning literature regarding the present study utilizing textbooks, articles, journals, periodicals, and websites. This publication empowered the researchers to be aware of the studied research and directed them for designing data collection tools.

Fieldwork:

Before data collection, written permission to carry out the study was obtained from Hospital Managers and Head of NICUs and SNICU through submission of an official letter released from the Dean of Benha Faculty of Nursing. The purpose and results of the study were clarified. Also, the study was harmless. The fieldwork was achieved from the beginning of June 2020 to the end of November 2020 (6 months). The researchers were available three days per week (Sunday, Tuesday, and Wednesday) in the morning and afternoon shifts by rotation in the previously mentioned settings.

The implementation of the study: The educational program was implemented through the following phases:

Assessment and planning phase:

Initially, the researchers talk to nurses in the study settings in the morning and afternoon shifts to provide them a brief idea regarding the present study and its purpose.

The average number of studied nurses who were assessed ranged from 7-10 nurses per week. The tools used for collecting data were used as pre and post-program **(Tool I, II, & III)**. The structured interviewing questionnaire was completed by the nurses by interviewing each nurse individually to take in their characteristics and to assess their knowledge regarding antibiotics resistance and antibiotic stewardship among high-risk neonates **(Tool I)**. The average time required for filling out the questionnaire was around 25-40 minutes. Then, the researchers observed nurses' practices through using nurses' observational checklists **(Tool II).** The average time needed for nurses' practices observation was around 30-45 minutes. Also, nurses' attitudes regarding antibiotic resistance and antibiotic stewardship among high-risk neonates were evaluated **(Tool III).** Finally, high-risk neonates were assessed by utilizing high-risk neonates' medical records **(Tool IV).**

Implementing phase:

The antibiotic stewardship educational program was applied at the previously mentioned study settings in three weeks and one week for pre-test and post-test for each group of nurses (10 groups). It was implemented across 9 sessions (3 sessions for theory and 6 sessions for practices), The duration of each session was one hour with a break. In addition, one week for pre-test and an extra one for post-test. Studied nurses were distributed into 10 groups, 7-10 nurses in every group. These sessions have lasted for 9 hours (4 hours for theory & 5 hours for practice). The theoretical and practical parts were provided through direct face-to-face learning. The researchers initiated each meeting with a revision of the previous one.

At the beginning of the first session, the researchers offer a summary regarding the antibiotic stewardship educational program. Also, it's goal and specific objectives are clarified.

The theoretical part was provided in 3 sessions about; the definition of antibiotic stewardship, antimicrobial, antimicrobial resistance, the difference between the antibiotic and antimicrobial resistance, indications where the antibiotics are inappropriately prescribed, the antibiotic initiation, the antibiotic time outs, , allergy history, reconciliation culture results, adverse effects, the importance of obtaining culture and sensitivity, broad-spectrum antibiotics, , the most common antibiotic agents prescribed for high-risk neonates, the definition of antibiotics misuse,

complications of antibiotic mistreatment, intervention when skipping doses of antibiotics, furthermore, the role of poor infection control in hospitals in spreading of antimicrobial resistance.

The practical part was implemented in 6 sessions and covers; procedures of infection control in NICUs ,recognizing the usage of broad-spectrum antibiotics, recognizing chances for substituting intravenous to oral antibiotics, observing, and recognizing possible adverse events, time of administrating antibiotics to high-risk neonates, declaring cultures are attained before taking antibiotics, facilitating antibiotic time-out, appropriate discharge advice and instructions in the follow-up settings, antibiotics reconciliation, and caregivers' education.

Easy Arabic words are utilized to match the nurses' level of education. At the end of each session, any nurses' inquiries are considered to correct any misunderstanding or confusion, and re-demonstration of practical procedures was performed.

Numerous teaching and learning approaches are worked for the application of antibiotic stewardship educational program, such as; simple lectures, brainstorming, small group discussion, role-playing, demonstration, and re-demonstration utilizing real items for practice. Proper audio-visual supplies were utilized to help proper understanding of the subject matter of the antibiotic stewardship educational program. Nurses were encouraged, motivated to collaborate, and participate enthusiastically in all phases of the present study by positive reinforcement and giving some rewards.

Evaluation phase:

After the accomplishment of the educational program, the post-test was performed for all studied nurses in NICUs and SICU to evaluate the effect of the educational program on nurses' performance regarding antibiotic stewardship among high-risk neonates **(using tool I, II, & III).**

Statistical analysis

The gathered data were reviewed, arranged, charted, and analyzed by applying SPSS (Statistical Package for the Social Science Software) statistical package version 22. Mean and Standard deviation (X ± SD) were used for numerical data (Quantitative data) and analyzed by using t-test for normally distributed variables, while qualitative data was itemized as frequency and proportion and chi-square, while t-test was used as a parametric test of significance for comparison of two samples means. Pearson correlation test (r) was employed to determine the association between quantitative variables. P-value at 0.05 used to ascertain significance considering:

- P-value > 0.05 to be statistically insignificant.
- P-value ≤ 0.05 to be statistically significant
- P-value ≤ 0.001 to be highly statistically significant.

Results:

Table (1) illustrates characteristics of the studied nurses, wherever there is slightly more than two-thirds of the studied nurses' ages were between 20 to less than 30 years and the mean age was 26.84 + 4.36 years. Most of them were females (88.8%) and 77.5% had a diploma of secondary nursing school and slightly more than half of them (52.5%) have from 1 to less than 5 years of experience, while no one joined training programs regarding antibiotic stewardship.

Table (2) reveals a statistically significant difference between studied nurses' total knowledge regarding antibiotics on pre-and post-program (p-value was 0.00**).

Table (3) discloses that there were statistically significant variations between the studied nurses' total knowledge regarding antibiotic stewardship on pre-and post-program implementation (p-value was 0.00**).

Figure (1) This figure demonstrates that 88.8% of the studied nurses have acceptable knowledge about antibiotic stewardship post-program compared to 8.8% of them pre-program

Table (4) clarifies that studies-nurses have competent practices post-program regarding antibiotic stewardship. This table also, shows that there are statistically significant differences between studied nurses' practices scores regarding all items on pre-and post-program application (P<0.001).

Figure (2) describes that 70.0% of studies nurses having positive attitudes (5.0% strongly agree and 65.0% agree) post-program implementation compared to 9.0% pre-program implementation. This figure also shows that there

was a statistically significant difference between studied nurses ' attitudes score concerning all items pre-and post-program (P<0.001).

Table (5) displays that the total studied nurses' knowledge was unsatisfactory with a percentage of 91.2% on pre-program. However, the total studied nurses' knowledge post-program was satisfactory with a percentage of 88.8%. Regarding their total practices, 83.8% of them were proficient post- program matched with 17.5% pre-program.

Table (6) demonstrates that there was a positive correlation between total studied nurses' knowledge and total nurses' practices post-program (r = 0.868, p < 0.000).

Table (7) describes that the mean age of high-risk neonates was 14.82 ± 1.76 days, while the mean gestational age was 32.48±2.46 weeks. Regarding gender, 59.5% were males, and 44.6% and 50.0% their weight ranged from 2000 to less than 2500 grams respectively. Regarding birth weight and current weight respectively, the mean birth weight was 2140±126.42 grams, while the mean current weight was 2170±302.76 grams.

Table (8) shows that 64.9% of high-risk neonates had respiratory system disorders. 46.0% of high-risk neonates take antibiotics for treatment of infection, while 51.4 % have the antibiotics for more than 15 days and most of them take antibiotics by IV administration. Also, 94.6% of them had no complications and 81.1% had no urine or blood cultures.

Table (1): Distribution of studied nurses according to their characteristics

Items	Study sample	
	No	%
Age in years		
- 20 - < 30	54	67.5
- 30 - < 40	25	31.2
- ≥ 40	1	1.3
X ±SD: 26.84 ± 4.36		
Gender:		
- Male	9	11.2
- Female	71	88.8
Level of education		
- Diploma of secondary nursing school	62	77.5
- Technical Institute of nursing	7	8.8
- Bachelor of nursing science	11	13.8
Years of experience		
- <1year	0	0.0
- 1 - < 5 years	42	52.5
- 5 - < 10 years	22	27.5
- ≥ 10 years	16	20.0
X±SD= 4.72 ±2.18		
Attending previous training courses regarding antibiotic stewardship		
- Yes	0	00.0
- No	80	100,0

Table (2): Distribution of studied nurses according to their knowledge regarding antibiotic pre-and post-program

Items of Knowledge	Pre-program				Post-program				x^2	P-value
	Satisfactory		Unsatisfactory		Satisfactory		Unsatisfactory			
	No	%	No	%	No	%	No	%		
Definition of antimicrobial	11	13.8	69	86.2	73	91.2	7	8.8	13.11	0.001
Definition of antimicrobial resistance	9	11.2	71	88.8	65	81.2	15	18.8	20.42	0.001
Difference between antibiotic and antimicrobial resistance	7	8.8	73	91.2	71	88.8	9	11.2	18.11	0.001
Indications of antibiotics	18	22.5	62	77.5	71	88.8	9	11.2	24.04	0.001
The antibiotic initiation	15	18.8	65	81.2	70	87.5	10	12.5		
The antibiotic time outs	19	23.7	61	76.3	69	86.2	11	13.8	17.19	0.000
Dose reduction	15	18.8	65	81.2	68	85.0	12	15.0	26.08	0.001
Allergy history	18	22.5	62	77.5	70	87.5	10	12.5	12.74	0.001
Reconciling culture results	7	8.8	73	91.2	58	72.5	22	27.5	22.16	0.00
Adverse effects	11	13.8	69	86.2	66	82.5	14	17.5	11.55	0.001
Importance for obtaining culture and sensitivity	9	11.2	71	88.8	68	85.0	12	15.0	24.04	0.001
Broad-spectrum antibiotics are a safer choice than extremely selective the antibiotics	10	12.5	70	87.5	66	82.5	14	17.5	14.04	0.001
Antibiotic resistance is a natural/acquired problem	9	11.2	71	88.8	70	87.5	10	12.5	18.18	0.001
The most common antibiotic agents prescribed for high-risk neonates	22	27.5	58	72.5	69	86.2	11	13.8	20.04	0.001
Definition of antibiotics misuse	9	11.2	71	88.8	58	72.5	22	27.5	20.11	0.001
The complications of antibiotic misuse.	12	15.0	68	85.0	69	86.2	11	13.8	16.19	0.000
Intervention when skipping doses of antibiotics.	14	17.5	66	82.5	69	86.2	11	13.8	24.04	0.001
Role of poor infection control in hospitals in spreading antimicrobial resistance.	11	13.8	69	86.2	68	85.0	12	15.0	19.04	0.001
Total	**9**	**11.2**	**71**	**88.8**	**70**	**87.5**	**10**	**12.5**	**19.47**	**0.001**

Table (3): Distribution of studied nurses according to their knowledge concerning antibiotic stewardship on pre-and post-program

Items of Knowledge	Pre-program				Post-program				x^2	P-value
	Satisfactory		Unsatisfactory		Satisfactory		Unsatisfactory			
	No	%	No	%	No	%	No	%		
Definition of antibiotic stewardship	18	22.5	62	77.5	73	91.2	7	8.8	22.16	0.00
Goals of antimicrobial stewardship	15	18.8	65	81.2	65	81.2	15	18.8	11.55	0.001
Unintended consequences of antimicrobial stewardship	19	23.7	61	76.3	71	88.8	9	11.2	24.04	0.001
Opportunities for implementing antimicrobial stewardship programs	15	18.8	65	81.2	71	88.8	9	11.2	14.04	0.001
Barriers of antimicrobial stewardship programs	18	22.5	62	77.5	70	87.5	10	12.5	18.18	0.001
Nurses' role in antimicrobial stewardship programs	10	12.5	70	87.5	69	86.2	11	13.8	20.04	0.001
Total	**7**	**8.8**	**73**	**91.2**	**69**	**86.2**	**11**	**13.8**	**21.07**	**0.001**

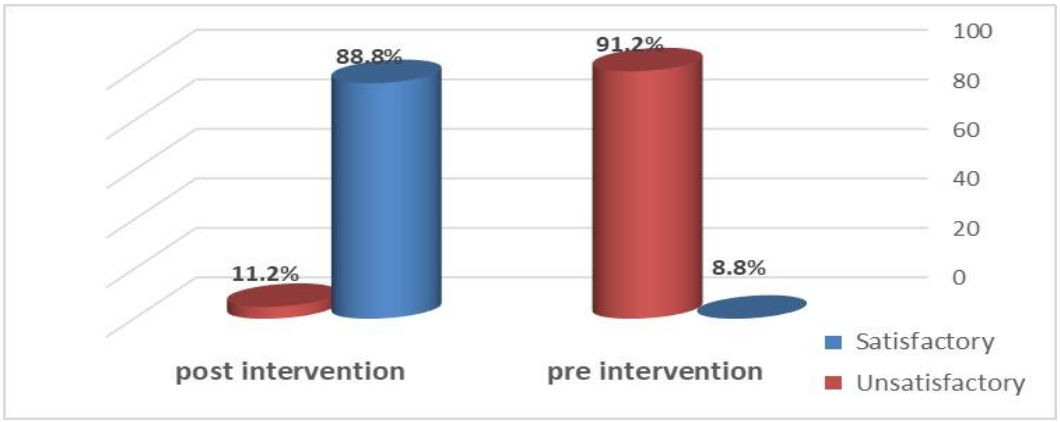

Figure (1): Percentage distribution of studied nurses' total knowledge concerning antibiotic stewardship on pre-and post-intervention

Table (4): Distribution of studied nurses according to their practices regarding antibiotics stewardship on pre-and post-program

Items of practices	Pre-program				Post-program				x^2	P-value
	Competent		Incompetent		Competent		Incompetent			
	No	%	No	%	No	%	No	%		
Identifying the application of broad-spectrum antibiotics	18	22.5	62	77.5	73	91.2	7	8.8	18.18	0.001
Identifying opportunities for transferring from intravenous to oral antibiotics	15	18.8	65	81.2	65	81.2	15	18.8	11.55	0.001
Monitoring and detecting possible adverse events	19	23.7	61	76.3	71	88.8	9	11.2	24.04	0.001
Timely administration of antibiotics to high-risk neonates	15	18.8	65	81.2	71	88.8	9	11.2	28.44	0.001
Assuring cultures are obtained before starting antibiotics	18	22.5	62	77.5	70	87.5	10	12.5	18.18	0.001
Facilitating antibiotic time-out	10	12.5	70	87.5	67	83.8	13	16.2	20.04	0.001
Suitable discharge instructions and follow up	13	16.2	67	83.8	65	81.2	15	18.8	22.16	0.00
The antibiotics reconciliation	11	13.8	69	86.2	73	91.2	7	8.8	14.04	0.001
Caregivers' education	18	22.5	62	77.5	67	83.8	13	16.2	19.18	0.001
Total	**14**	**17.5**	**66**	**82.5**	**67**	**83.8**	**13**	**16.2**	**16.37**	**0.001**

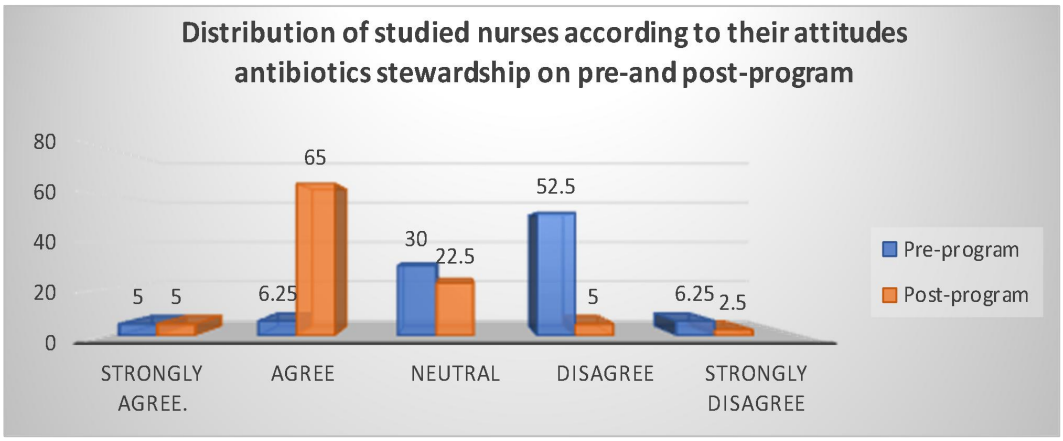

Figure (2): Distribution of studied nurses according to their attitudes concerning antibiotics stewardship on pre-and post-program

Table (5): Comparison of studied nurses' total knowledge and total practices concerning antibiotics stewardship pre-and post- program.

Items		Pre- program		Post- program		x^2	P-value
		No	%	No	%		
Knowledge	**Satisfactory**	**7**	**8.8**	71	88.8	21.07	0.001**
	Unsatisfactory	**73**	**91.2**	9	11.2		
Practices	**Competent**	**14**	**17.5**	**67**	**83.8**	**16.37**	0.001**
	Incompetent	**66**	**82.5**	**13**	**16.2**		

Table (6): Correlation between nurses' total knowledge and total practices concerning antibiotics stewardship post- program

Items	r	p-value
Knowledge	0.802	0.000**
Practices		

Table (7): Distribution of high-risk neonates according to their characteristics

Items	No (n=74)	% 100%
Age/days		
Less than 1 day	10	13.5
2->5	12	16.2
5->10	14	18.9
≥10	38	51.4
Mean ±SD 14.82±1.76		
Gestational age/weeks		
28->30	8	10.8
30->32	11	14.9
32->34	9	12.2
34->37	40	54.0
≥37	6	8.1
Mean ±SD 32.48±2.46		
Gender		
Male	44	59.5
Female	30	40.5
Birth weight/ grams		
Less than 1500	9	12.2
1500>2000	21	28.4
2000>2500	33	44.6
≥2500	11	14.8
Mean ±SD 2140±126.42		
Current weight/ grams		
Less than 1500	7	9.5
1500>2000	23	31.0
2000>2500	37	50.0
≥2500	7	9.5
Mean ±SD 2170±302.76		

Table (8): Distribution of high-risk neonates according to their medical data

Items	No	%
Medical/ surgical diagnosis		
Respiratory system disorders	48	64.9
C.V.S disorders	14	18.9
C.N.S disorders	2	2.7
Hematological disorders	5	6.7
Genitourinary disorders	2	2.7
G.I.T anomalies	3	4.1
Indications of antibiotics administration		
Infection	34	46.0
Surgery	30	40.5
For follow-up	10	13.5
Duration of antibiotic administration/ day		
Less than 5	10	13.5
5->10	12	16.2
10->15	14	18.9
≥15	38	51.4
Routes of administration		
IV	72	97.3
oral	2	2.7
Long term complications		
Yes	4	5.4
No	70	94.6
Blood and/ or urine cultures		
Yes	14	18.9
No	60	81.1

Discussion:

Nurses are considered important partners in antibiotic stewardship strategies and maybe vigorously incorporated into stewardship interventions ***(Olans, Olans, & DeMaria. 2016).*** Moreover, nurses offer continuity of care to patients and their families and can be crucial in confirming that objectives of care are implemented, and redirected daily ***(Monsees, Popejoy, Jackson, Lee & Goldman. 2018).***

Concerning the attributes of studied nurses, the results of the current study

demonstrated that the mean age of the studied nurses was 26.84 ± 4.36 years. This finding was agreed by **Said *et al.,(2019***) who found that "the mean age of studied nurses was 32 ± 2.7 years". Also, this finding in agreement with ***Mohammed et al., (2018)*** who stated that "less than half of the studied nurses their ages range from 30 to less than 40 years".

Regarding the sex of the studied nurses, the existing study determined that most of the studied nurses were females. **This can be attributed** to the study of nursing being limited to females only till a few years in the past in Egypt. Consequently, the career of nursing in Egypt was primarily feminine. In addition, this result was reinforced by ***Said et al., (2019***) who found that 91.4% of nurses were females. This also agreed with ***Said and Mohamed.,(2020)*** who found that 88.7% of nurses were females.

Concerning studied nurses' level of education, the current study showed that more than three-quarters of them had a diploma from secondary nursing school. This result was consistent with ***Mohammed et al., (2019)*** who reported that 52.7% of nurses have a technical institute of nursing "nursing technicians". This finding disagrees with ***Buraihi & Mohammed (2017)*** who revealed that the greatest numbers of the studied nurses are graduated from the technical nursing institute. In dissimilarity, ***Bakhshi, Montaseri, Edraki, Razavi & Haghpanah, (2018)*** clarified that most nurses in the NICU had a master's grade. **From the researchers' point of view**, this may be caused by the tendency of the hospital administration to engage the bachelor's

degree in critical areas in the initial stage of modification of the staff nurses in the NICU.

Concerning years of experience for examined nurses, the current study showed that somewhat more than half of nurses had one to less than five years of experience. This result was agreed with ***Aziz & Mansi, (2018)*** who mentioned that " half of the studied nurses had less than two years of experience in the pediatric nursing field and neonatal care unit". In addition, this finding is supported by ***Mohammed et al., (2019),*** who stated that "about half of studied nurses had fewer than five years of experience". **From the researchers' point of view**, the reductions in nurses' years of experience harm their performance regarding care provided for high-risk neonates.

As regards attendance of previous training courses regarding antibiotic stewardship program, the current study findings show that all studied nurses did not attend training programs about antibiotic stewardship. This finding is consistent with ***Abera et al***., ***(2014)*** who found that "approximately 50% of nurses responded that they had not up to date knowledge about AMR". These findings are also in line with the agreement with ***Cotta et al., (2014)*** who found that "13.0% only attended courses regarding AMR". This finding is also supported by ***Elsayed, Bayoumi, and Mahmoud, (2019)*** who found that 16.6% only attended training courses regarding AMR.

Regarding studied nurses ' knowledge about stewardship, the results of the current study found that the mainstream nurses have satisfactory knowledge about antibiotic stewardship post-program compared to the smaller percentage of them pre-program implementation, Also, there was a statistically significant difference between nurses' entire knowledge regarding antibiotic stewardship on pre and post-program implementation. These results were consistent with ***Elsayed, Bayoumi, and Mahmoud, (2019)***, who found that "more than half of studied nurses had satisfactory knowledge post-program implementation. However, more than one-third of studied nurses had unsatisfactory knowledge pre-program implementation. Therefore, there were statistically significant differences between the nurses' knowledge on pre and post-program implementation.

Concerning studied nurses' practices, they have competent practices post-program regarding antibiotic stewardship. Moreover, there was a statistically significant difference between studied nurses' practice grades concerning the entire items on pre-and post-program implementation. This result was strengthened by ***Sumner et al., (2018)*** who recommended that "nurses support antibiotic stewardship during admission process (drugs reconciliation, allergic history, the initiation), during hospital stay (reconciliation culture results, adverse events, dosage de-escalation), and upon discharge (instruction, outpatient management). At this time, there is a lack of evidence related to practices that facilitate nursing commitment as stewards (***Monsees, Goldman, & Popejoy, 2017).*** **In researchers point of view** , this can be rationalized as these results may be reflective of the significant detachment of concerns revolving around antimicrobial application between clinical participants in the hospital. Engaging in subsequent qualitative studies in adding to these quantitative studies will likely give more light on what reasons are significant in this apparent deficiency of engagement, it also proposed that education and research linking antimicrobial resistance will be essential to be an urgency the NICUs.

Regarding studied nurses' attitudes, the finding of this study describes that less than three-quarters of studies nurses have a positive attitude post-program implementation, compared to a minority of them pre-program. Moreover, there was a statistically significant difference between studied nurses' attitude results regarding all items pre-and post-implementing the program. These results were approved by ***Cotta et al. (2014),*** who mentioned that "only a half of the study subjects were prepared to contribute in any proposed AMR involvement".

Concerning nurses' role in AMR, the results were supported with ***Kandeel, Genedy, El-Refai, Funk and Talaat, (2015)*** in an Egyptian study about "The prevalence of hepatitis C virus infection in Egypt" The presence of intensive care units (ICUs) link nurses, who were accessible in the ICUs every day and were accountable for the Healthcare-Associated Infection (HAI) surveillance, was serious to the surveillance program. Surveillance data helped to notify representatives of the fact that HAIs and

antimicrobial resistance exemplify a true problem in Egypt, with a high responsibility on the Egyptian health care system. This is also supported by Padigos, Ritchie, and Lim (2018) in their study about "Nurses have a major role in antimicrobial stewardship". Additionally supported by Sutthiruk (2018) in a study about "The Current and Potential Role of Nurses in combating Antimicrobial resistance in a Thai Acute Care Setting" who stated that nurses have an vital role in antimicrobial stewardship. From the researchers' points of view that the obstacles to nurses taking a greater role in AMR may be attributed to lack of proper policies, clinical workload, and unsatisfactory knowledge regarding the antibiotic resistance and the antibiotic stewardship among high-risk neonates, and inadequate decision-support systems. Formal policies, the presence of decision-support systems, and identification of AMR nurse administrators are needed to promote, stimulate, and develop the role of nurses in AMR.

Concerning the correlation between studied nurses' total knowledge and total practices regarding antibiotic stewardship among high-risk neonates on pre-and post-program implementation, there was a positive correlation between nurses' total knowledge and total practices on post-program. **In the researchers' opinion**, this result may be interpreted as more time of education and clinical training may assist studied nurses to improve their awareness and develop their practices. This finding was on the same line with ***Safwat and khorais, (2018) and Mohamed and Said, (2020),*** who found that "there was a positive correlation between nurses' total knowledge scores and total practices scores on post-program implementation" ($p<0.001$).

Concerning the gestational age of studied high-risk neonates, the present study showed that more than half of studied neonates had a gestational age from 34->37 weeks with a mean of 32.48±2.46 weeks. This result supported by ***Mohamed and Said, (2020),*** who mentioned that "there were more than half of high-risk neonates had a gestational age from 34->37 weeks with a mean of 33.28±2.46 weeks". This result is also consistent with ***Mohammed et al., (2019),*** who showed that "81.8% of studied preterm infants their gestational age was between 32-≤36 weeks". **In the researchers' point of view**, It may be rationalized as high-risk neonates with gestational age ranging from 32-≤ 36 are at elevated risk of infection and require antibiotics administration.

The findings of the present study revealed that more than half of the studied high-risk neonates were males. This finding was supported by ***Mohammed et al., (2019)*** who found that "more than three-quarters of preterm infants were males". This result also was in line with ***Zhu et al., (2017),*** who revealed that "about two-thirds of preterm infants were males". Moreover, this finding conflicted with ***Sivanandan et al., (2018)*** who reported that" more than two-thirds of preterm neonates were females".

Concerning the medical and/ or surgical diagnosis of the studied high-risk neonates, this study revealed that about two-thirds of them had respiratory system disorders. This finding was supported by ***Elsobkey & Amer (2018),*** who presented that "most preterm infants had respiratory distress syndrome". This result also was in line with ***Mohamed and Said, (2020),*** who mentioned that "there were two-thirds of high-risk neonates had respiratory distress syndrome". **In the researchers' opinions**, this can be rationalized as the administration of antibiotics is the first line of medication required for these high-risk neonates.

Conclusion:

Based on the findings of the current study, it may be decided that the research hypotheses were accepted. Nurses who participated in the current study had a satisfactory level of understanding, attitudes, and proficient level of practices after implementation of educational program regarding antibiotic stewardship as compared to pre-program implementation with a statistically important improvement .

Recommendations:

Built on the conclusion of the current study, the following recommendations are suggested:

- Application of traditional and online in-service training in NICUs for nurses with consistent revising of their knowledge and practices concerning antibiotic stewardship program for high-risk neonates in all NICUs.
- Future research is recommended regarding the implementation of antibiotic stewardship (AS)

programs for different health problems of high-risk neonates in different health care settings.

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