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ORIGINAL RESEARCH

Knowledge, Attitude, and Practices of Mothers Working as Nurses Toward Multidrug-Resistant: Impact of an Educational Program in Neonatal Intensive Care Unit

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Objective: This study seeks to assess the influence of an educational program on enhancing the knowledge, attitudes, and practices of NICU nurses regarding MDROs.

Methodology: Quasi-experimental design that investigated the efficacy of an educational intervention in shaping the knowledge, attitudes, and practices of mothers working as nurses in NICU toward MDROs was used. A total of 168 nurses participated, divided into 84 intervention groups and 84 non-educational groups.

Results: The analysis of overall knowledge scores before and after the educational interventions revealed a significant improvement in post-education knowledge scores (Mean = 16.94) compared to pre-education scores (Mean = 12.9929; $t(83) = 40.119$, $p < 0.001$). Attitude scores exhibited a notable improvement post-education, with mean scores increasing from 46.64 in the pretest to 58.45 in the posttest. The total attitude shift was statistically significant ($t(83) = 104.23$, $p < 0.001$ 0). Regarding overall practice, the data suggests a positive impact of education on neonatal nurses' practices related to antibiotic usage ($t(3) = 149.31$, $p < 0.001$). A significant positive correlation was found between post-knowledge and post-attitude ($r = 0.251$, $p = 0.021$).

Conclusion: Based on the study findings, the MDROs educational program demonstrated its effectiveness in improving nurses' knowledge and attitudes toward MDROs, serving as a valuable educational resource for nurses. Given the increasing demand for nurses with MDROs knowledge, attitude, and practice in NICU, and considering the documented positive impact on protecting neonates from fatal infections, enhancing nurses' knowledge, attitudes, and practices toward MDROs has become imperative.

Keywords: MDROs, knowledge, attitude, practice, nurse

Introduction

The proliferation of multidrug-resistant bacteria (MDROs) in healthcare settings is problematic because infected neonates are harder to treat and have worse outcomes.[1] Neonates who contract MDROs have greater morbidity and mortality rates and are especially susceptible to chronic infections caused by MDROs.[2] Worldwide, an estimated 3 million cases of newborn sepsis are reported annually, with up to 570,000 sepsis-related deaths; a large number of these deaths are related to the ineffectiveness of the current antibiotics.[3] Antibiotics are administered to up to 40% of neonates admitted to neonatal intensive care unit (NICUs), and 90% of these patients are expected to be exposed to antibiotics during their stay in the unit.[4] Because there is a noticed or established requirement for experimental or particular treatment of MDR infections, several of these kinds of antibiotics are given without a prescription. Infection risk is significant for neonatal intensive care unit (NICU) admissions, particularly those born prematurely, for a variety of causes, such as immuno-compromised due to an underdeveloped immune response, prolonged hospital stays, and frequent application of invasive medical equipment and drugs.[5] Over the past two decades in patient care settings, some multidrug-resistant gram-

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negative bacteria have become much more common, particularly in neonatal and pediatric units.[6] Based on recent literature, neonates require exceptional care.[7] The NICU is the most therapeutic setting suitable for the care of neonates with critical conditions.[5] Antibiotics are the most routinely prescribed drugs in NICUs related to the high incidence of morbidity and mortality of newborns in NICUs, clinical symptoms of infection are still limited yield.[8] Antibiotics are essential in treating bacterial diseases that could cause severe medication reactions.[9] However, when antibiotics are overused, they contribute to MDROs which serve as an obstacle to risk neonates.[10] Antibiotic treatment duration is a major medical concern that depends on neonatologist suggestions, risks, and effects.[8]

The way mother working as healthcare workers behave may have an impact on how neonates are affected.[11] These nurses are the largest and the most important team of healthcare professionals who come into contact with people of all ages, including neonates.[12] They play an important part in disease prevention and control such as infectious diseases.[13] In a hospital, nurses are responsible for all antibiotic process. This vital behavior affects treatment success, the development of MDROs and the antibiotic contact between nurses and the environment.[14,15] For example, the disposal of unused IV antibiotics could violate the best practices or standards set by regulators. However, nurses disposed of antibiotics in hospital sinks.[16,17] The presence of these germs has been linked to infections related to the healthcare sector, as has the prevalence of MDROs in wastewater.[17,18] Antibiotic overuse contributes to MDROs and can act as a signal to neonates' elevated risk. In addition to the improper agent(s), the dose, frequency, and mode of administration, as well as the wrong culture collection of specimens and analysis norms increase multidrug resistance in clinical outcomes of high-risk neonates.[16,19] These nurses must enhance their communication skills with prescribers and pharmacists. According to Olans et al,[20] education was deemed necessary to promote knowledge regarding the link between antibiotic resistance and antibiotic use to practice the correct protocol for culture-taking, and to aid in communication, to enhance knowledge, attitude, and practice to prevent MDROs. In all healthcare setting nurses lack knowledge, attitudes, and best practices to deal with antibiotics regarding MDROs specifically and the corresponding infection control procedures.[16,21] Furthermore, endeavors to prevent infections caused by MDROs should encompass not only antibiotic usage and implementing measures to halt MDROs transmission but also enhancing our comprehension of MDROs transmission, particularly within hospital environments. A thorough examination of nurses' knowledge, attitudes, and practices regarding antibiotic prescription, usage, and resistance is imperative. Significantly, a substantial proportion of respondents recognizes antibiotic resistance as a notable public health issue in their context, yet disparities exist in knowledge and practices.

There is also a notable inclination toward prescribing antibiotics in cases of doubt of infection. Concerns arise regarding the influence of patient demands, with a considerable percentage admitting to prescribing antibiotics due to patient insistence or to maintaining patient trust.[22] Inappropriate antibiotic usage is influenced by various factors that contribute to the misuse and overuse of these medications in addition to one significant factor that is physicians' nonadherence to treatment guidelines, which may stem from a lack of awareness or disregard for established protocols, so the nurse's role is to adhere to the physician to follow the protocol.[23] Additionally, insufficient knowledge of MDROs (nurses) plays a role in this global problem. Fear of clinical failure and external pressures, such as influence from patient demands for antibiotics regardless of necessity, also contribute to the problem. Furthermore, self-prescribing exacerbates the issue by bypassing professional medical guidance, and all of these challenges addressed by Malhotra et al[23] were found to contribute to antibiotic resistance. It is crucial to provide guidelines and timely, comprehensive information to address this concern and this needs an educational program.[24] Neonatal nurses need to feel confident in their practice, as a lack of understanding of MDROs can impact the quality of care, professional-patient relationships, and interprofessional interactions. In light of this, the author conducted this study to investigate the impact of educational programs on improving nurses' knowledge, attitude, and practice regarding antibiotic use and the prevention of antibiotic resistance.

Method

The quasi-experimental design was employed, deemed feasible for simulating real-world studies in neutral settings. Educators need to ascertain whether the intervention instigated a shift in outcomes, rather than delving into the causative factors behind the change.[25] This study used two groups, the first group was called the educational group, and the second group was called the non-educational group. The educational group was evaluated two times. Initially, nurses working in the Neonatal Intensive Care Unit (NICU) underwent assessment for their knowledge, attitudes, and practices concerning

MDROs (pre-test, X1). Subsequently, they were reassessed for knowledge and attitudes regarding MDROs immediately after receiving the educational intervention developed by the research team (post-test, X2), followed by an assessment of their practices through a self-reported questionnaire two weeks after the intervention. The non-educational group underwent two assessments of their knowledge, attitudes, and practices regarding MDROs. Firstly, nurses were evaluated (pre-test, X1), followed by a second evaluation without any intervention (post-test, X2). The educational group consisted of nurses from Al-Basheer Hospital. Control hospitals were Raya Hospital, Moath Bin Jabal Hospital, Rahma Hospital, and al-Abdali Hospital. The sample size for the two nonequivalent group pre-post design with a power level of 0.8, a significant alpha level of 0.05, and a moderate effect size of 0.25 based on G power was 80 participants. Adding a 15% attrition rate for 184 participants. A convenient sample technique was utilized to recruit the participants. A convenient sample technique was utilized to recruit the 184 participants. The criteria for eligibility were mothers who working as nurses in NICU and were able to participate in the study.

The instrument comprises four sections, including demographic data, nurses' knowledge of MDROs, nurses' attitudes toward MDROs, and nurses' practices regarding MDROs, all adapted from Lalithabai et al.[26] The demographic section encompasses gender, age, hospital of employment, education level, primary role, years of general experience, years of NICU experience, and completion of an antibiotic handling educational course within the last six months. The section on nurses' knowledge of MDROs, also adapted from Lalithabai et al,[26] comprises a self-descriptive scale consisting of 20 statements categorized into three groups: six statements regarding antibiotic information, six statements concerning antibiotic resistance, and eight statements addressing prevention of multidrug-resistant organisms. The scale demonstrated a Cronbach's Alpha of 0.65. Each statement is a multiple-choice question with four options, only one of which is correct. Scores below 10 (50%) are categorized as indicating "poor knowledge", scores between 10 (50%) and 15 (75%) indicate "good knowledge", and scores exceeding 15 (75%) indicate "excellent knowledge". The section on nurses' attitudes toward MDROs, also from Lalithabai et al,[26] comprises 15 items measured on a 5-point Likert scale. Scores below 30 (50%) indicate "poor attitude", scores between 30 (50%) and 42 (70%) indicate "moderate attitude", and scores exceeding 54 (90%) indicate "good attitudes". The reliability, assessed by Cronbach's alpha, was 0.7, and validity was confirmed by five experts.

The section on nurses' practices toward MDROs consists of 14 items divided into two categories: nine items on antimicrobial delivery practices adapted from El Baida & Mina (2022), consisting of nine yes/no questions, and one multiple-choice question. The Cronbach's Alpha for this section was 0.65. The second category comprises five items on advice given to patients regarding antimicrobial usage, adapted from Balliram et al,[27] assessed through yes/no questions. This instrument, developed by Balliram et al,[27] categorizes an overall practice score of less than or equal to 6 as indicating "poor practice" and a score exceeding 6 as indicating "good practice".

The educational program aimed to enrich the knowledge, attitude, and practices of nurses in preventing the harm caused by MDROs at al-Basheer Hospital. The program, integrated into the nurses' educational group, adopted the educational module from the Minnesota Department of Health (MDH) in the United States. This module defined antibiotic resistance, explained the development of antibiotic-resistant organisms, highlighted the impact on patients, families, and neonatal care facilities, and provided actionable steps to manage their development and spread. Guided by the WHO Curriculum Guide for Nurses on Antimicrobial Resistance and CDC recommendations, the program covered theoretical aspects such as distinguishing between antibiotic and antimicrobial resistance, inappropriate antibiotic prescription scenarios, antibiotic initiation, timeouts, allergy history, adverse effects, culture result reconciliation, the definition of antibiotic misuse, and associated complications.

The practical component encompassed infection control procedures in NICU, identification of broad-spectrum antibiotic use, recognizing opportunities for oral antibiotics over intravenous administration, observation and identification of potential adverse events, timing of administering antibiotics to high-risk neonates, ensuring cultures are obtained before starting antibiotics, promoting antibiotic time-outs, offering appropriate discharge assistance and follow-up instructions, antibiotic reconciliation, and educating caregivers. These educational sessions were conducted by the research assistant who hold a master degree in nursing and received a training about MDROs education using PowerPoint presentations in both English and Arabic languages, with distribution facilitated through the WhatsApp

application. The sessions were complemented with supporting videos to enhance the understanding of the presented material. The data collection was conducted between August 2023 to November 2023.

Data Analysis

The Statistical Package of Social Sciences (SPSS) version 28 was used, the data was checked before statistical analysis. The means, median, and standard deviation were used. Furthermore, the bivariate chi-square test was employed to compare the baseline and after education statements of the nurses in the educational and non-educational groups.

Ethical Considerations

This study was approved from Deanship of Research in Jordan University of Science and Technology IRB (348-2023). The written informed consent was signed from all participants in the study that informs them of all their rights and expectations from the study. The guidelines outlined in the Declaration of Helsinki were followed.

Results

Description of the Demographic Differences Between the Two Group

Table 1 presents a comparison of socio-demographic and professional characteristics between the educational and non-educational groups according to the hospital name. The distribution of participants across hospitals shows significant differences (X2 = 168.00, df = 4, $p < 0.001$).

Table 1 Comparison of the Nurses' Socio-Demographic and Professional Characteristics Between the Two Groups of Nurses. N=168

Variable	Category	Educational group n (%)	Control group n (%)	X^2	df	P-value
Hospital Name	Rahma Hospital Albasheer Hospital Raya Hospital Moath Bin Jabal Hospital Al-Abdali Hospital	0(0.00) 84(100.00) 0(0.00) 0(0.00) 0(0.00)	39(100.00) 0(0.00) 15(100.00) 7(100.00) 23(100.00)	168.00	4	**0.00**
Gender	Females	84(50.00)	84(50.00)			
Age	20–30y 31–40y More than 40 y	46(66.67) 31(41.33) 7(29.17)	23(33.33) 44(58.67) 17(70.8)	13.329	2	**0.001**
Educational	Diploma Bachelors Postgraduate	0(0.00) 78(54.17) 6(33.33)	6(100.00) 66(45.83) 12(66.67)	8.829a	2	**0.012**
Experience Year	Less than 5 years 5–10 years 11–15 years More than 15 years	23(57.50) 39(60.94) 12(46.15) 10(26.32)	17(42.50) 25(39.06) 14(53.85) 28(73.68)	12.347a	3	**0.006**
Experience ICU	Less than 5 years 5–10 years 11–15 years More than 15 years	41(62.12) 29(48.33) 5(23.81) 9(42.86)	25(37.88) 31(51.67) 16(76.19) 12(57.14)	9.610a	3	**0.022**
Primary Role	Registered Nurse Practical Nurse	84(51.23) 0(0.00)	79(48.77) 6(100.00)	2.716a	1	0.099
Educational Course	No Yes	78(51.66) 6(35.29)	73(48.34) 11(64.71)	1.570a	1	0.21

Nurses' Knowledges of MDROs

The *t*-test did not show a significantly difference between educational and non-educational groups (t = −1.439, df = 167, p = 0.152) during pre-test period. They were similar in knowledge and participants demonstrated relatively low levels of knowledge. The *t*-test revealed a significant improvement in post-education knowledge scores (M = 16.94) compared to pre-education scores (M=12.9929 (t = 40.119, df = 83, p <0.001). This means educational programs effectively enhance nurses' knowledge of various antibiotic resistance concepts. Following the educational intervention, participants in the educational group exhibited substantial improvements in accurately defining antibiotics, identifying side effects, grasping antibiotic resistance, and understanding appropriate antibiotic usage. The remarkable enhancement in overall knowledge underscores the efficacy of the educational program in enriching participants' understanding of critical antibiotic-related concepts. The findings revealed a significant increase in nurses' responses in the educational group across all items except two (items 6 and 14). For further insights into the comparison of nurses' knowledge-related questions between the pretest and post-test in the educational group, see Table 2.

Nurses' Attitudes Towards MDROs

The overall mean attitude scores for both groups suggest no significant difference between the educational (46.64) and non-educational groups (46.32). This indicates that there is no significant difference between both groups in attitude before applying to educational program groups (t = 104, df = 167, p = 0.56). The *t*-test to compare the means of attitude between pre-education and post-education. The overall attitude scores indicate a noteworthy improvement post-education, with the mean scores increasing from pretest 46.64 to posttest 58.45. The total attitude shift is statistically significant (t = 104.23, df = 83, p < 0.001). See Table 3

Nurses' Practice Toward MDROs

The chi-square test was conducted to compare the practice in the pretest and post-test for the educational group items and also between two groups at baseline. The *t*-test was used to compare the mean score between two groups. The overall practice data suggest that education has positively influenced neonatal nurses' practices related to antibiotic usage with mean before education 11 and 12.7 (p = 0.38, t = 149.11) after education. For more details about the comparison of nurses' questions of practice at the Pre-Posttest of the educational group in Table 4.

Correlation Between Nurses' Knowledge, Attitudes, and Practice Toward MDROs

There is a significant correlation between post-knowledge and post-attitude (r = 0.251, p = 0.021), suggesting that as post-education knowledge increases, post-education attitude tends to be enhanced. This finding could imply that learning more about antibiotics and resistance is related to a more critical or cautious attitude in some circumstances. See Table 5

Discussion

To best of our knowledge, this is one of the few studies that conducted in Jordan that aims to determine the impact of educational program on improving knowledge, attitude, and practice among nurses in NICU. Our study showed that the intervention group was statistically significant in the post-test in attitude and nurse knowledge with positive changes in neonatal nursing practice toward MDROs before and after the educational interventions, and there was a notable improvement in overall knowledge scores, indicating a significant increase in post-education knowledge compared to pre-education scores. Likewise, the overall attitude scores showed a significant enhancement post-education, with mean scores increasing from the pretest to the posttest. Additionally, concerning overall practice, the data suggest that education has positively impacted neonatal nurses' practices regarding antibiotic usage, as evidenced by the mean scores before and after education. Similarly, three studies conducted in Asia to examine the result of an educational program on nurses' attitudes, knowledge, and practice toward the MDROs.[28–30]

Firstly, Lim and Bang[29] in South Korea, findings demonstrated that NICU nurses' knowledge and practice regarding MDROs infection management had improved as a result of their participation in the educational program. This study highlights the importance of education and training in improving infection prevention practices between health

Table 2 Comparison of Nurses' Knowledge Toward Antibiotic Use and Prevention of Antibiotic Resistance in the Pre-Post Educational Time

Items	Answer	Pre-Education n=84	Post-Education n=84	X^2	df	P-value
1. An antibiotic is a medication that kills or slows down the growth of bacteria.	Incorrect	31(96.88)	1(3.13)	34.74	1	≤**.001**
	Correct	53(38.97)	83(61.03)			
2. Antibiotics can have side effects, like allergic reactions and diarrhea.	Incorrect	35(100.00)	0(0.00)	44.21	1	≤**.001**
	Correct	49(36.84)	84(63.16)			
3. The common side effects of antibiotics are rash, nausea, vomiting, and diarrhea.	Incorrect	52(98.11)	1(1.89)	71.69	1	≤**.001**
	Correct	32(27.83)	83(72.17)			
4. The microorganism that can be killed by antibiotics is normal and infectious flora.	Incorrect	65(98.48)	1(1.52)	102.2	1	≤**.001**
	Correct	19(18.63)	83(81.37)			
5. The effectiveness of antibiotics will be reduced if the full course is not completed.	Incorrect	17(100.00)	0(0.00)	18.91	1	≤**.001**
	Correct	67(44.37)	84(55.63)			
6. Nosocomial infection is the type of infection acquired in the healthcare setting.	Incorrect	2(100.00)	0(0.00)	2.02	1	**0.155**
	Correct	82(49.40)	84(50.60)			
7. Antibiotic resistance is defined as bacteria changes in a way that reduces or eliminates the effectiveness of antibiotics.	Incorrect	54(100.00)	0(0.00)	79.57	1	≤**.001**
	Correct	30(26.32)	84(73.68)			
8. Developing new generations of antibiotics is not considered a cause of antibiotic resistance.	Incorrect	22(88.00)	3(0.00)	16.96	1	≤**.001**
	Correct	62(43.36)	81(56.64)			
9. Antibiotic resistance can affect any age group.	Incorrect	47(100.00)	0(0.00)	65.25	1	≤**.001**
	Correct	37(30.58)	84(69.42)			
10. Overuse of antibiotics is the most important factor leading to antibiotic resistance around the world.	Incorrect	4(100.00)	0(0.00)	4.09	1	**0.04**
	Correct	80(48.78)	84(51.22)			**3**
11. Infections caused by antibiotic resistance are difficult and sometimes impossible to treat	Incorrect	42(100.00)	0(0.00)	56	1	≤**.001**
	Correct	42(33.33)	84(66.67)			
12. Antibiotic resistance spread through animal and human	Incorrect	60(100.00)	0(0.00)		1	≤**.001**
	Correct	24(22.22)	84(77.78)			
13. Treating a viral infection with an antibiotic is an example of the improper use of antibiotic therapy.	Incorrect	30(100.00)	0(0.00)	36.52	1	≤**.001**
	Correct	54(39.13)	84(60.87)			
14. Effective handwashing is the most important procedure for the prevention of infection from microorganisms.	Incorrect	3(100.00)	0(0.00)	3.06	1	**0.08**
	Correct	81(49.09)	84(50.91)			
15. Immunization and infection prevention is considered the most important factor in preventing antibiotic resistance.	Incorrect	63(100.00)	0(0.00)	100.8	1	≤**.001**
	Correct	21(20.00)	84(80.00)			
16. The antibiotic stewardship program aims to improve the use of antibiotics and prevent antibiotic resistance.	Incorrect	35(100.00)	0(0.00)	44.21	1	≤**.001**
	Correct	49(36.84)	84(63.16)			
17. Antibiotic therapy should be started ideally when there is a positive microbiological result.	Incorrect	4(100.00)	0(0.00)	4.09	1	**0.043**
	Correct	80(48.78)	84(51.22)			

18. A patient expressing that antibiotics can be taken when symptoms are gone indicates a lack of knowledge	Incorrect	9(100.00)	0(0.00)	9.50	1	**0.002**
	Correct	75(47.17)	84(52.83)			
19. Implementing infection prevention and control practices is the key action that a nurse should take to prevent resistant infections and their spread.	Incorrect	13(100.00)	0(0.00)	14.09	1	≤**.001**
	Correct	71(45.81)	84(54.19)			
20.Prospective audits, formulary restrictions, and preauthorization and guidelines, and clinical pathways are considered antibiotic stewardship strategies to combat antibiotic resistance.	Incorrect	5(100.00)	0(0.00)	5.15	1	**0.023**
	Correct	79(48.47)	84(51.53)			
Overall, Knowledge, Mean (SD)		**12.8929**	**16.9405**	**40.11**	**83**	≤**.001**

Note: Bold number means significant value.

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Table 3 Comparison of Nurses' Attitudes Toward Antibiotic Resistance in the Post-Pre-Educational Time

Items	Category	Pre-Education n=84	Post-Education n=84	X^2	df	P-value
1. The antibiotic can be taken for the flu to get better quickly	Strongly Agree Agree Neutral Disagree Strongly Disagree	6(100.00) 25(100.00) 5(100.00) 26(100.00) 22(20.75)	0(0.00) 0(0.00) 0(0.00) 0(0.00) 84(79.25)	98.264a	4	≤**.001**
2. Antibiotics can be taken without a prescription	Strongly Agree Agree Neutral Disagree Strongly Disagree	0(0.00) 11(100.00) 6(100.00) 46(100.00) 21(20.00)	0(0.00) 0(0.00) 0(0.00) 0(0.00) 84(80.00)	100.800a	3	≤**.001**
3. Instructions are read and understood before taking antibiotics	Strongly Agree Agree Neutral Disagree Strongly Disagree	23(21.90) 58(96.67) 2(100.00) 1(100.00) 0(0.00)	82(78.10) 2(3.33) 0(0.00) 0(0.00) 0(0.00)	88.419a	3	≤**.001**
4. Antibiotics can be kept in stock to be used whenever feeling sick.	Strongly Agree Agree Neutral Disagree Strongly Disagree	2(40.00) 20(100.00) 8(100.00) 35(89.74) 19(19.79)	3(60.00) 0(0.00) 0(0.00) 4(10.26) 77(80.21)	87.883a	4	≤**.001** ≤**.001**
5. Participation in infection control activities helps in minimizing the spread of antimicrobial resistance.	Strongly Agree Agree Neutral Disagree Strongly Disagree	20(19.23) 61(100.00) 3(100.00) 0(0.00) 0(0.00)	84() 0(0.00) 0(0.00) 0(0.00) 0(0.00)	103.385a	2	≤**.001**
6. Reporting and escalating issues related to the misuse of antibiotics is the responsibility of a nurse.	Strongly Agree Agree Neutral Disagree Strongly Disagree	3(7.89) 50(50.51) 16(100.00) 12(100.00) 3(100.00)	35(92.11) 49(49.49) 0(0.00) 0(0.00) 0(0.00)	57.957a	4	≤**.001**

7. Advising patients to complete the prescribed antibiotic course even if they feel better quickly is necessary.	Strongly Agree Agree Neutral Disagree Strongly Disagree	25(23.58) 59(95.16) 0(0.00) 0(0.00) 0(0.00)	81(76.42) 3(4.84) 0(0.00) 0(0.00) 0(0.00)	80.166a	1	≤**.001**
8. Participation in special training on antibiotic resistance is recommended for all healthcare professionals.	Strongly Agree Agree Neutral Disagree Strongly Disagree	22(21.36) 61(95.31) 1(100.00) 0(0.00) 0(0.00)	81(78.64) 3(4.69) 0(0.00) 0(0.00) 0(0.00)	87.359a	2	≤**.001**
9. Advising other healthcare professionals in the appropriate use of antibiotics is important.	Strongly agree Agree Neutral Disagree Strongly Disagree	20(19.42) 63(98.44) 1(100.00) 0(0.00) 0(0.00)	3(80.58) 1(1.56) 0(0.00) 0(0.00) 0(0.00)	99.596a	2	≤**.001**
10. Playing an active role in educating patients and families on the risk of antibiotic resistance is the responsibility of a nurse.	Strongly agree Agree Neutral Disagree Strongly Disagree	6(9.38) 48(64.86) 20(100.00) 10(100.00) 0(0.00)	58(90.63) 26(35.14) 0(0.00) 0(0.00) 0(0.00)	78.791a	3	≤**.001**
11. Active contribution to institutional policies and guidelines which aim to control antibiotic resistance is the responsibility of a nurse.	Strongly Agree Agree Neutral Disagree Strongly Disagree	3(5.00) 58(68.24) 13(100.00) 10(100.00) 0(0.00)	57(95.00) 27(31.76) 0(0.00) 0(0.00) 0(0.00)	82.906a	3	≤**.001**
12. Advocating the use of new generations of antibiotics that can fight diseases more effectively with caution.	Strongly Agree Agree Neutral Disagree Strongly Disagree	8(8.99) 62(95.38) 9(100.00) 4(100.00) 1(100.00)	81(91.01) 3(4.62) 0(0.00) 0(0.00) 0(0.00)	127.430a	4	≤**.001**
Overall Attitude, Mean (SD)		46.64	8.45	t= 104.23	83	≤**.001**

Note: Bold number means significant value.

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Table 4 Comparison of Nurse's Practice Questions in the Post-Pre-Education Time

Items	Answer	Pre-Education n=84	Post-Education n=84	X^2	df	P-value
1. When giving a patient an antibiotic, do you know WHY he or she is receiving the antibiotic?	No Yes	3(100.00) 81(49.09)	0(0.00) 84(50.91)	3.0 5	1	0.081
2. If you have a question about the antibiotic being given, whom do you ask?	a. Charge Nurse a. Another Staff Nurses a. Physician a. Primary Health Team a. No One	13(100.00) 0(0.00) 69(45.10) 2(100.00) 0(0.00)	0(0.00) 0(0.00) 84(54.90) 0(0.00) 0(0.00)	16.47	2	≤**.001**
3. Have you questioned a physician about the CHOICE of antibiotics for a patient?	No Yes	4(100.00) 80(48.78)	0(0.00) 84(51.22)	4.0 9	1	0.043
4. Have you questioned a physician about the DOSE of antibiotics for a patient?	No Yes	1(100.00) 83(49.70)	0(0.00) 84(50.30)	1.0 0	1	0.316
5. Have you questioned a physician about the ROUTE of antibiotics for a patient?	No Yes	3(100.00) 81(49.09)	0(0.00) 84(50.91)	3.0 5	1	0.081
6. Have you questioned a physician about the DURATION of antibiotics for a patient?	No Yes	13(100.00) 71(45.81)	0(0.00) 84(54.19)	14. 09	1	≤**.001**
7. Have you ever given an antibiotic you thought was inappropriate?	No Yes	46(35.38) 38(100.00)	84(64.62) 0(0.00)	49.10	1	≤**.001**
8. Would you feel comfortable raising concerns to the treatment team about the antibiotic(s) a patient is getting?	No Yes	3(100.00) 81(49.09)	0(0.00) 84(50.91)	3.0 5	1	0.081
9.Do you think nurses should be involved in interventions aimed to improve antibiotic use?	No Yes	0(0.00) 84(50.00)	0(0.00) 84(50.00)	-	-	-
What advice do you impart to patients on antimicrobial usage? (Discharge advice) (yes/no)						
10. The patient must complete the full course of antimicrobials for the recommended duration.	No Yes	0(0.00) 84(50.00)	0(0.00) 84(50.00)	-	-	-
11. The patient must take the antimicrobials at the correct time intervals.	No Yes	0(0.00) 84(50.00)	0(0.00) 84(50.00)	-	-	-
12.The patient should never share antimicrobial treatment with anyone	No Yes	1(100.00) 83(49.70)	0(0.00) 84(50.30)	1.0 0	1	0.316
13. The patient must not stop treatment even if they are feeling better after a few doses.	No Yes	2(100.00) 82(49.40)	0(0.00) 84(50.60)	2.0 2	1	0.155
14. The patient should dispose of antimicrobials appropriately	No Yes	2(100.00) 82(49.40)	0(0.00) 84(50.60)	2.0 2	1	0.155
Overall practice means (SD)		11.00	12.70	149.311	83	0.38

Note: bold number means significant value.

Table 5 Bivariate Pearson's Correlations Between Attitude, Knowledge, and Nurses' Practice Toward Antibiotic Use and Prevention of Antibiotics in the Intervention Group

Group	Test	Pre-Knowledge	Post-Knowledge	Pre-Attitude	Post-Attitude	Pre-Practice	Post-Practice
Pre-knowledge	Pearson Correlation Sig. (2-tailed)	1					
Post-knowledge	Pearson Correlation Sig. (2-tailed)	−0.053 0.632	1				
Pre-attitude	Pearson Correlation Sig. (2-tailed)	**0.369**** 0.001	0.221* 0.044	1			
Post-attitude	Pearson Correlation Sig. (2-tailed)	0.088 0.426	**0.251*** 0.021	0.099 0.373	1		
Pre- practice	Pearson Correlation Sig. (2-tailed)	−0.031 0.778	−0.036 0.746	−0.173 0.115	−0.209	1	
Post- practice	Pearson Correlation Sig. (2-tailed)	b	b	b	b	b	b

Notes: **Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). Bolded number means significant value. b Cannot be computed because at least one of the variables is constant.

professionals to stop and inhibit the growth of multidrug-resistant organisms. Secondly, Qadir et al[30] in Pakistan found a consistent decrease in rates for MDROs in 12 months following the intervention period. Third, Galal et al[28] in Cairo, found that the nurses' knowledge and attitudes about infection prevention significantly improved after the infection control program was provided by the hospital. Also, the knowledge among the nurses in the post-intervention phase on different types of nosocomial bacterial infections, infection risk classifications, infection control strategies, and different kinds of hand washing was significantly higher.

Two studies conducted in the United States for examining nurses' attitudes, knowledge, and practice related MDROs fields.[31,32] Firstly, Polisetty et al[31] showed that nurses had improved attitudes and beliefs toward antibiotic stewardship, they have a better understanding of the importance of the effects of antibiotic resistance and safe antibiotic use. Wilson et al[32] results demonstrated that the online course significantly improved nurses' knowledge and attitudes toward antimicrobial programs after the class, the mean knowledge scores rose from 75% to 86%.

Our study found that post-attitude, post-knowledge, and post-practice were found to be correlated to each other's. These results were similar to the studies in literature. Two studies conducted in Asia investigated the correlation between nurses' knowledge, practices, and attitudes in the field of neonatal MDROs.[33,34] They discovered that the majority of nurses reported adherence to preventive and control measures, exhibiting positive attitudes and practices. Additionally, a positive correlation was observed between attitude and practice. Nair et al[33] conducted research in India, where nurses' knowledge was found to be at 63.4%, attitude at 79.9%, and practice at 75.5%. However, a significant finding was the inconsistency between knowledge and practice, as participants demonstrated an understanding of appropriate antibiotic application attitudes but failed to translate this understanding into practice. In contrast, two studies in Asia regarding the relationship between neonatal nurses' knowledge, practices, and attitudes regarding MDROs.[13,26,35] Lalithabai et al[26] in Saudi Arabia found no statistically significant correlation between knowledge and attitude about MDROs, as well as a small relationship between the score for attitude and the overall knowledge score. Secondly, Hayat et al[35] in Pakistan found that although there was a lack of knowledge of MDROs the majority of nurses were seen to have a good attitude toward hospital-based MDROs. Moreover, two studies conducted in Africa regarding the relationship between the practices, attitudes, and knowledge of neonatal nurses towards MDROs.[36,37] Firstly, Sanneh et al[37] in Gambia found several of the nurses, who were shown to have less knowledge of antibiotic resistance while having a positive attitude and practice. Secondly, Dramowski et al[36] conducted a study in South Africa and found that there was a practice gap

between nurses' knowledge levels and the apparent increase in compliance across the reported research. The practical gap that requires being addressed to consistently stop the spread of infection in the setting of a pandemic is highlighted by the noted limitations in nurses' compliance and knowledge.

Our study found that the nurses in the intervention group had a significantly higher mean knowledge of antibiotic use at the post-intervention group score compared to the nurses who had not received the intervention course. Our results were improved in response to educational programs not related to any other factors. Similarly, Polisetty et al[31] in the United States showed that knowledge and attitude about medications and resistant antibiotics and demographic characteristics such as age, gender, and the number of years of experience are correlated. A study conducted in Western Europe in France by Vaillant et al[38] found five factors were strongly associated with more knowledge: being employed in a university hospital; age classes 26–35 years and 36–45 years; medical professional status, having experience in an intensive care unit and having received training in the management of antibiotic resistance. Additionally, Toska & Geitona[39] in Greece found a statistically significant connection among the nurses' gender, educational level, and age, as well as the kind of hospital and professional experience, and their assessments of MDROs and illogical prescriptions. The type of hospital was also linked to views of MDROs and antibiotic use for common children's illnesses. In contrast, four studies conducted in Asia regarding predictors of attitude, knowledge, and practices among neonatal nurses regarding the MDROs.[34,35,40,41] Firstly, Abuhammad et al[42] in Jordan found that the degree of knowledge was significantly related to the nurses' age, education, and number of years of experience. Secondly, a study in Pakistan by Hayat et al[35] found a significant correlation between age and years of experience and knowledge of antibiotic resistance. Thirdly, Zhou & Chen[34] in China found that knowledge regarding MDROs infection prevention and control was strongly connected positively with many parameters such as hospital grade, employment position, and emphasis on establishing and avoiding MDROs infections with the female gender. Similar factors, as well as regular supervision and training, were found to be connected to attitude.

These factors, as well as age group and employment as nosocomial infection control personnel, regular supervision, and the number of training sessions per year, were also associated with self-reported practice.[44–46] Additionally, there was a study conducted by Ogoina et al[43] in Africa in Nigeria that found that overall, there was a strong relationship between age, years of experience, and antibiotic resistance knowledge. Also, a study found that there were factors influencing practice including consistent medical staff turnover, an absence of "pediatric competent" nurses and doctors, lower senior healthcare coverage after hours, and time constraints in emergency departments. Many recent studies found that the appropriate practice regarding antibiotic use could decrease the MDRO problems specially in healthcare setting.

Implications

The results of this paper regarding the impacts of MRDOs education program provide neonatal mothers working as nurses with knowledge, attitude, and improve practice relying on evidence-based data as a basic core to implement high efficiency and quality of skills in clinical practice (providers cannot practice what they do not know) and reflect on the struggles of MDROs on neonates that are caused by malpractice, poor knowledge, negative attitude regarding the prevention of MDROs and prevent the consequences of problems that may lead to an increase in morbidity and mortality. These initiatives can be translated into neonatal nurses and lead to a fundamental change in the standard prevention of MDROs programs in Jordan by the integration of education into regular and daily basis treatment in NICU.

Conclusion

With an increasing need for neonatal nurse roles to avoid MDROs in neonates with serious medical conditions and the proven positive impact of MDROs programs on neonatal nurses, it became necessary to improve the nurses' knowledge, attitude, and practice regarding MDROs. It provides a good proof that the MDROs educational program is advantageous in enhancing nurse knowledge and attitudes toward MDROs prevention, as well as delivering an effective instructional program for nurses, based on the outcomes of this study.

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