A Stewardship-Guided Framework for Improving Antibiotics Use among Children with Acute Respiratory Tract Infections

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Abstract

Background: Most acute respiratory tract infections (ARTIs) in children are due to viral etiology; however, overprescribing of antibiotics for ARTIs is common. **Aim:** To develop a Stewardship-guided framework for improving antibiotics use among children with ARTIs. **Design:** A quasi-experimental design (pre-posttest) was utilized for this study. **Setting**: The Pediatric ward and the pediatric outpatient clinic in Menoufia University Hospital. **Sampling:** A convenient sample of 43 nurses and a purposive sample of 200 children and their parents were included. **Instruments:** Five instruments were utilized to get the data. I: Nurses structured interview questionnaire sheet. II: Observational checklist for nurses' antibiotic Stewardship activities. III: Children structured interview questionnaire sheet (children 9-11 years). IV: Children structured interview questionnaire sheet (children 12-15 years). V: Parents structured interview questionnaire sheet. **Results:** There was a significant improvement in nurses' knowledge and antibiotic Stewardship activities. There was a significant improvement in children' knowledge, beliefs and attitudes regarding antibiotic use. There was a significant decrease in parents' false knowledge/ information, negative attitude and practices regarding antibiotic use after implementation of the Stewardship-guided framework compared to preintervention. **Conclusion**: The Stewardship-guided framework was more successful on the posttest than on the pretest in improving nurses' knowledge and antibiotic stewardship activities as well as children' knowledge, beliefs and attitudes regarding antibiotic use, and parents' knowledge, attitudes and practices regarding antibiotic use. **Recommendation:** Nurses in collaboration with the health care team should integrate the Stewardship-guided framework in all pediatric units and outpatient clinics for improving antibiotic use among pediatric patients.

Keywords: A Stewardship-Guided Framework, Antibiotics Use among Children, Acute Respiratory Tract Infections

Introduction

Acute respiratory infections (ARIs) are a primary cause of morbidity and mortality in children worldwide. Every year, around 1.3 million children under the age of five die as a result of ARIs. ARIs account for one-third of all mortality in children under the age of five in low-income countries **(WHO, 2019).** ARIs account for almost 12 million hospital admissions in children under the age of five each year **(Nair et al., 2021).** ARIs include both upper and lower respiratory tract infections, with the common cold and influenza being the most common **(Pham et al. (2019).**

ARIs are caused by both viral and bacterial organisms. Viruses are the second leading cause of infant mortality worldwide, accounting for more than 80% of ARI in babies and children **(El Baroudy et al., 2018 & Ho et al., 2018).** In schools and nurseries, influenza and respiratory syncytial virus (RSV) are common viruses that can cause pediatric respiratory tract infections and outbreaks **(Mourya et al., 2019 & Çelik et al., 2020).**

Although the majority of RTIs are viral in nature, it is extremely common practice in pediatrics to prescribe antibiotics for those disorders. (**Fleming-Dutra et al., 2016 & Harnden et al., 2017**). Furthermore, a recent study found that even if RTIs are caused by bacteria, they are likely to resolve without the use of antibiotics (**Butler et al., 2019**). Antibiotic prescriptions that are unnecessary are the primary cause of antibiotic resistance (AMR) **(Al Sous et al., 2023).** AMR poses a challenge to the effective prevention and treatment of an increasing variety of diseases caused by bacteria,

parasites, viruses, and fungi **(Ayukekbong et al., 2017).** According to the World Health Organisation (WHO), AMR is one of the top ten worldwide public health problems facing humanity **(Walsh et al., 2023).** Without intervention, it is anticipated that global AMR fatalities could reach 10 million per year by 2050 **(Murray et al., 2022).**

Numerous studies have looked into the factors that contribute to antibiotic misuse. These factors include antibiotic knowledge, attitudes, and beliefs, behaviors, patient treatment satisfaction, patient-doctor communication, and patient experiences with antibiotics. Even after providing instruction, some physicians said that it was done at the parents' request **(Mitsi et al., 2015; Awad & Eltayeb, 2017; Al-Azzam et al., 2017; Palmer & Bauchner, 2022).**

Pediatricians and parents are both at accountable for the spread of AMR. Parental expectation to obtain antibiotics was discovered to be an important factor promoting antibiotic overuse **(Mangione-Smith et al., 2018)**. Previous research in the United States and the United Kingdom found that more than 30% of parents expected their kid with RTIs to be given antibiotics during the first visit to the pediatrician. The reasons were: the fear of contracting a severe infection that necessitates antibiotic therapy, the idea that antibiotics are the preferred treatment for RTIs because they relieve symptoms and decrease the duration of the sickness. **(Braun & Fowles, 2020 & Palmer & Bauchner, 2022).**

Additionally, it should be highlighted that the only significant predictor of the actual prescription of antibiotics for diseases with a suspected viral aetiology was physicians' opinions of parental expectations for antibiotics **(Mangione-Smith et al., 2018).** Doctors provided antibiotics 62% of the time when they believed a parent wanted them, compared to 7% of the time when they did not. Further, doctors were substantially more likely to diagnose a bacterial infection when they believed the parent desired an antibiotic (i.e., 70% vs. 31% of the time) **(Cockburn & Pit, 2020).**

Antibiotic Stewardship programs are among the efforts to decrease unnecessary antibiotic prescribing. The Centers for Disease Control and Prevention (CDC) has urged hospitals to implement antibiotic Stewardship programs **(Fridkin et al., 2014).** Antibiotic Stewardship is defined by the National Institute for Health and Care Excellence as coordinated, evidence-based strategies for optimizing antibiotic use. **(NICE, 2015).** Antibiotic stewardship is an endeavor to track antibiotic prescribing, enhance the appropriateness and minimize the negative consequences of antibiotic usage, reduce resistance, toxicity, and costs, and promote the selection of the best antibiotic regimen, dose, duration, and method of administration. **(Khan et al., 2020).** According to the antibiotic Stewardship principle, viral infections in both children and adults should not be treated with antibiotics. **(Kissler et al., 2021).**

Antibiotic stewardship is a cornerstone of efforts to improve antibiotic-related patient safety and slow the emergence of antibiotic resistance. It can be adopted in any health-care settings where antibiotics are dispensed. Antibiotic stewardship seeks to maximize the beneficial effects of antibiotic treatment while minimizing the harmful consequences on persons and communities **(Rhea et al., 2020).**

Nurses have a significant role in all aspects of patient care, such as assessment, diagnosis, prescribing, and developing patient-specific treatment plans. As a result, they can influence antibiotic use and prescribing rates at different stages of patient care **(Cals et al., 2022).** Nurses have an important multidisciplinary team role in most antibiotic stewardship activities, including advocacy, culture specimen monitoring, and intravenous to oral switch **(Carter et al., 2018).**

Nurse-led antibiotic stewardship was seen as an extension of nurses' roles as patient advocates. In July 2016, the American Nurses Association (ANA) and the Centres for Disease Control and Prevention (CDC) acknowledged that nurses play a vital role in antibiotic stewardship **(Olans et al., 2016).** Through antimicrobial Stewardship programmes, nurses are responsible for upholding antibiotic Stewardship standards in primary and

secondary care settings. They are essential in the preparation, administration, and prescribing of antibiotics, as well as the evaluation of their efficacy **(Ladenheim, 2018).**

Nurses have an important role in antibiotic stewardship because they spend more time with patients than other health professionals. Nurses are also experienced with patients' reactions to and comprehension of antibiotic treatment, which makes them an essential member of the multidisciplinary team. Furthermore, they are in control of the complete antibiotic delivery procedure, from dose through treatment continuation **(Olans et al., 2016; Dyar et al., 2017; Mula et al., 2018 & Mula, 2019).** Therefore, this study was conducted to develop a Stewardship-guided framework for improving antibiotics use among children with ARIs.

Significance of the study

Acute respiratory tract infections (ARTIs) are a major public health concern for children. According to the World Health Organization (WHO), 1.9 million children die each year as a result of ARTI complications **(Mulholland, 2018).** In Egypt, Pneumonia and other acute respiratory infections are responsible for 10% of children deaths under the age of five **(Fadl et al., 2020).** Egypt Evidence-based Surveillance (EBS) Systems discovered high rates of school absenteeism with ARTIs symptoms among primary and preparatory school students in various Egyptian governorates in October 2022. Furthermore, ARI surveillance identified an increase in the circulation of influenza and respiratory syncytial virus (RSV) among outpatients and inpatients. The Ministry of Health and Population (MOHP) of Egypt reported a rise in the rate of RSV from 15% in 2020 to 70% in 2021 in late November 2022 **(Kandeel et al., 2023 & Fahim et al., 2023).** ARTIs comprise nearly 75% of all antibiotic prescriptions; nonetheless, improper antibiotic prescribing in children is widespread. Antibiotic overuse in the treatment of ARIs is exacerbated by the worrying rise of AMR (**Saunders, 2020**). AMR is a severe public health problem that is expected to result in 10 million annual fatalities and a $100 trillion financial loss by 2050 (**Manesh & Varghese, 2021)**. Parents and children' knowledge, attitudes and practices significantly influence antibiotic use. Nurses are also in a special position to affect antibiotic use by participating in a variety of antibiotic-related activities such as ensuring optimum administration of drugs, tracking the safety and effectiveness of ongoing therapy, and instructing patients as well as their families about appropriate antibiotic use in order to decrease AMR **(Carter et al., 2018).**

Aim of study

To develop a Stewardship-guided framework for improving antibiotics use among children with acute respiratory tract infections (ARTIs).

Hypotheses

The following research hypotheses were developed to achieve the goal of this study:

1- Implementation of the Stewardship-guided framework is expected to improve nurses' knowledge and antibiotic stewardship activities on posttest than on pretest.

2- Implementation of the Stewardship-guided framework is expected to improve children' knowledge, beliefs and attitudes regarding antibiotic use on posttest than on pretest.

3- Implementation of the Stewardship-guided framework is expected to improve parents' knowledge, attitudes and practices regarding antibiotic use on posttest than on pretest.

Method

Research design:

For this study, a quasi-experimental design (pre-posttest) was used.

Research setting:

- This study was carried out in Menoufia University Hospital's pediatric ward and outpatient clinic in Shebin El-Koom City, Menoufia Governorate, Egypt.

Sampling:

- The current study included a convenient sample of 43 nurses working in the pediatric ward and the pediatric outpatient clinic.

- A purposive sample of 200 children and their parents were included. Children

whose age ranged between 9-15 years old and diagnosed with acute respiratory infections were included. The sample was calculated according to the following equation:

$$n = [DEFF*NP(1-p)]/[d^2/Z^21-\alpha/2*(N-1)+p*(1-p)]$$

n = [DEFF*Np(1-p)]/ [(d2/Z21-α/2*(N-1) + p*(1-p)]

DEFF (Design effect) = 1
N (population) = 500
p (Hypothesized %) = 10%+/-5
d (tolerated margin of error) = 0.05
Z (level of confidence) = 1.96
α (Alpha)= 0.05
n *= [1*250*10%+/-5 (1-10%+/-5)/ [(0.05)2/ (1.96)2*
1-0.05(250-1) + 10%+/-5 (1-10%+/-5)]*
n= 200

Therefore, a sample size of 200 children would be required for the research.

Instruments:

- To fulfil the study's goal, researchers collected data using five instruments.

Instrument one: Nurses Structured Interview Questionnaire sheet. It was developed by the researchers after reviewing relevant literature (Olans et al., 2016; Carter et al., 2018; Ladenheim et al., 2021 & Mula et al., 2021) to evaluate the nurses' comprehension of antibiotics, antimicrobial resistance (AMR) and antibiotic Stewardship. This instrument included four parts:

Part one: Characteristic of studied nurses. It involved questions about nurses' age, sex, educational level, years of experience, place of work and attending any education programs.

Part two: Nurses' knowledge about antibiotics, antimicrobial resistance (AMR) and antibiotic Stewardship. It included 20 questions. Questions about antibiotic included **seven questions (**if antibiotics are safe drugs, if broad spectrum antibiotics are more appropriate for managing respiratory tract infections, if antibiotics are ineffective for treating fever, if antibiotics are not intended to kill all bacteria in the body etc.), **eight questions** about antimicrobial resistance (AMR) such as if bacteria are capable of becoming resistant to antibiotics, if overuse of antibiotics lead to AMR, if taking antimicrobial agents correctly could lower the risk of resistance developing, if antibiotics should be withdrawn quickly when the patient is clinically improved in order to reduce the possibility of resistance etc. and **five questions** about the meaning, principal and 4 core elements of the antibiotic Stewardship, 4 moments of antibiotic decision making, and whether nurses have a role to play in antibiotic Stewardship. Scoring for these items was 1 for correct answers and 0 for incorrect and uncertain answers.

Instrument two: Observational checklist for nurses' antibiotic Stewardship activities. It was developed by the researchers after reviewing related literature (Olans et al., 2016 & Carter et al., 2018) to assess nurses' practices regarding antibiotic stewardship activities. It involved two parts:

Part one: Nurses' in- patient antibiotic Stewardship activities. It divided into four sections:

- ***Section A:*** **Patient admission**. It included five activities to be performed on patient admission which were triage and proper isolation, getting an accurate allergy history, acquiring early and suitable cultures, reviewing drug reconciliation reports, and administering antibiotics on time.

- ***Section B:*** **Daily clinical progress monitoring.** It included three activities which were monitoring progress of patients and reporting, preliminary micro findings and antibiotic modification, and delivering prescribed antibiotic dosing without intensification.

- ***Section C:*** **Patient safety and quality monitoring**. It contained four activities to ensure which were evaluating for adverse reactions, assessing for changes in the patient's health, taking the most recent culture report and antibiotic modification, and discovering antibiotic resistance.

- ***Section D:*** **Clinical progress tasks and patient education.** It involved two activities

which were shifting antibiotics from intravenous (IV) to per mouth (PO), and teaching about outpatient antibiotic therapy.

Scoring for these items was 1 for done activities and 0 for not done activities.

Part two: Nurses' out- patient antibiotic Stewardship activities. It included six activities to be performed which were checking the physician order for antibiotic name, dose, and route, taking allergy history, making sensitivity test, administering it, assessing for any adverse effects and educate patients. Scoring for these items was 1 for done activities and 0 for not done ones.

Instrument three: Children structured interview questionnaire (children 9-11 years). It was created by the researcher after reviewing relevant literature **(Lecky et al., 2010 & Appiah et al., 2021)** to assess children' knowledge, beliefs and attitudes regarding antibiotic use. This instrument was divided into four parts:

Part one: Demographic characteristics of studied children. It included questions about age, gender and diagnosis.

Part two: Children' knowledge related to microbes, spread of infection, treatment and prevention of infection. It comprised of 31 closed- ended Questions divided into three subparts: 1) Children' knowledge related to microbes, **thirteen questions** such as if a microbe cannot be seen this mean that it does not exist, all bacteria are dangerous, microbes exist in heated water, inside our mouths, on our hands, on animals, some microbes are capable of making us get ill, etc. 2) children' knowledge about spread of infection, it included **eleven questions** such as whether bad microbes are transmitted from touching someone's hands, from meat that is still raw, from meat that is well-cooked, people must wash their hands prior to eating, following a bath, before assisting with a meal, once contacting pets, cleansing with soap and water gets rid of more microbes than the water solely etc. 3) children' knowledge about treatment and prevention of infection , it included **seven questions** of whether antibiotics: destroy bacteria; destroy viruses; cure any disease; eliminate our good bacteria; help with cough; most colds and coughs improve without antibiotics; and immunizations assist in safe guarding individuals from some microorganisms. Scoring for all items of children' knowledge was 1 for correct answers and 0 for incorrect and uncertain answers.

Part three: Children' beliefs regarding antibiotic use. It contained **4 statements** of whether they believe that remaining antibiotics are safe to keep at home in case they are needed in the future; if it is beneficial to be able to obtain antibiotics from friends or relatives without first consulting a doctor; if it is beneficial to be able to obtain antibiotics from the pharmacy without first consulting a doctor; and if a skin injury can be treated promptly by sprinkling antibiotic powder on the wound. Scoring for these items was 1 for correct beliefs and 0 for wrong beliefs.

Part four: Children 'attitudes regarding antibiotic use. It contained **3 statements** of whether the child seems better following a half of the antibiotic treatment, he or she is going to discontinue them; if the child has a skin reaction while using an antibiotic, he or she is unlikely to use that exact antibiotic another time; and if he or she receives a left-over antibiotic from a friend or family member who he or she trusts, he or she will take it. Scoring for these items was 1 for positive attitudes and 0 for negative attitudes.

Instrument four: Children structured interview questionnaire (children 12-15 years). It was developed by the investigators after reading the associated literature **(Lecky et al., 2010 & Appiah et al., 2021)** to assess children' knowledge, beliefs, and attitudes regarding antibiotic use. This instrument was divided into four parts:

Part one: Demographic characteristics of studied children. It included questions about age, gender and diagnosis.

Part two: Children' knowledge related to microbes, spread of infection and treatment and prevention of infection. It included 33 questions divided into three subparts: 1) Children' knowledge related microbes, it included fourteen questions such as if there are a greater number of harmful microbes than beneficial microbes, viruses and bacteria are identical in size, bacteria that always exist in the skin and the gut are beneficial for being healthy, viruses are unable to reproduce by their own, microbes may result in food poisoning, etc. 2) Children' knowledge about spread of infection, it compromised of ten questions such as whether hygiene is unable to avoid infections; microbes are not transmitted by sneezing or coughing; sneezing into tissues or the sleeves ceases greater microorganisms disseminating compared to sneezing to a hand, etc. 3) children' knowledge about treatment and prevention of infection, it compromised of nine questions such as if there is a vaccine for the common cold; antibiotics are not killing our beneficial bacteria if taken frequently, antibiotics are unlikely to have an effect in the future if used frequently or inappropriately, etc. Scoring for all items of children' knowledge was 1 for correct answers and 0 for incorrect and uncertain answers.

Part three and part four are the same as that of children aged 9-11 years**.**

Instrument five: Parents structured interview questionnaire. It was adapted by **Alsuhaibani et al., 2019** to assess parent' knowledge, attitudes and practices concerning the use of antibiotics in ARTIs. This instrument was divided into four parts:

Part one: Characteristics of studied parents. It contained questions about parents' age, gender, educational level, family income level, residency and sources of information about antibiotics.

Part two: Parents' knowledge about antibiotic use in ARTIs. It contained seven questions about whether use of antibiotics can contribute to the prevention of complications associated with ARTIs, if appropriate use of antibiotics can reduce their effectiveness and result in antibiotic - resistant bacteria; if children with ARTIs symptoms improve faster when given antibiotics; if most of the ARTIs are not caused by viruses and therefore antibiotics should be given; if antibiotics are best given to every child who has a high temperature; if scientists will be able to develop novel antibiotics for antibiotic-resistant bacteria; and if antibiotics have no side effects. Scoring system ranged between uncertain (1) to strongly agree (5). Higher scores indicated misunderstanding while lower scores indicated good understanding.

Part three: Parents' attitudes toward antibiotic use in ARTIs. It compromised of seven questions such as if URTIs may be treated with no antibiotics; if they re-use remaining antibiotics when the same ARTI symptoms arise; if they change pediatricians as a result of recommending antibiotics at each visit; for not offering antibiotics; and if they utilize antibiotics heavily in unneeded cases. Scoring system ranged between uncertain (1) to strongly agree (5). Higher scores indicated negative attitudes while lower scores indicated positive attitudes.

Part four: Parents' practices regarding antibiotic use. It included ten questions about how often they requested an antibiotic from the pediatrician for ARTIs during their visit; or through phone; how often they purchased antibiotics and gave it to the child without consulting a pediatrician; how often they gave the child antibiotics because relatives or colleagues has recommended it; because pharmacist recommended it; because there was no time to visit a pediatrician; or because it has been described previously, etc. Responses ranged from never (1) to always (5). Higher scores indicated wrong practices while lower scores indicated correct practices.

Reliability:

The reliability of the four instruments was examined using Cronbach co-efficiency Alpha to find out the extent to which the tool's elements were related to one another. The

estimated reliability of instruments one, two, three, four and five was 0.95, 0.89, 0.91, 0.85 and 0.90 consequently. As a result, it is possible to conclude that the tool is highly reliable.

Validity:

A panel of experts comprised of one professors of pediatric medicine, two professors of pediatric nursing, and two professors of community health nursing assessed data gathering instruments. Modifications were made in response to their insightful comments, such as changing some terms to reflect the most appropriate interpretation for a phrase that was unclear. Questionnaires were adjusted based on words clarity, uniformity, and adequacy of content, item sequence, correctness, and relevancy.

Pilot study:

It was conducted on 20 children, their parents, and 5 nurses (10% of the sample) following the development of the instruments and prior to the start of data collection to assess the accessibility, feasibility, and to anticipate the time needed to fill out the instruments. No essential changes were made. As a result, the study was incorporated in the overall sample.

Ethical Consideration:

- Official approval was acquired from the Ethical Research Committee of Faculty of Nursing, Menoufia University (Code No. 874).
- A written permission was obtained from nurses, parents, and children to participate in the study.
- An initial meeting was conducted to tell participants (nurses, parents, and children) about the study's objective and benefits. Researchers highlighted that participating in the study was totally optional and that individuals were able to opt out at any time without repercussions.

Procedure:

- Prior to gathering data, written approval to conduct the study was obtained from the director of the Menoufia University Hospital after submitting a formal letter from the faculty of nursing dean at Menoufia University outlining the objectives of the study and the procedures for gathering data. Data for this study were collected over a 6-month period, beginning on October, 2022, and concluding on March, 2023.
- Researchers began their work by reviewing the Stewardship guidelines from Agency for Healthcare Research and Quality and Johns Hopkins. Therefore, get insight understanding to design the Stewardship-guided framework for improving antibiotics use among children with Respiratory tract infections.
- The Stewardship-guided framework is based on the following guidelines:

a. The principles of the Stewardship-guided framework are accurately identifying patients who require antibiotic therapy, using local and regional antibiograms, avoiding therapy with overlapping activity, administering the appropriate dose and duration of drug, reviewing the results of cultures and adjusting antibiotics, observing for toxicity and modifying therapy as needed, and discontinuing therapy as soon as indicated by culture findings.

b. The core elements of outpatient Stewardship program are commitment, action for policy and practice, tracking and reporting, and education and expertise. The pediatric nurse was responsible for educating parents and children on appropriate antibiotic use and providing the required educational resources.

c. For the inpatient pediatric units, the pediatric nurse can keep patients from obtaining unnecessary antibiotic treatment by implementing the role of four moments of antibiotics decision making:

   - Does the patient have an infection that necessitates the use of antibiotics?
   - Have proper cultures been ordered prior to the administration of antibiotics? What kind of empirical therapy should be started?

- It's been a day or more. Can antibiotics be discontinued? Is it possible to narrow the scope of therapy? Is it possible to switch from IV to oral therapy?
- How long will antibiotic medication be required for the patient's diagnosis?
- What duration of antibiotic therapy is needed for the patient's diagnosis?

- Researchers started implementing the Stewardship-Guided Framework into action by assessing the nurses' knowledge regarding antibiotics; antimicrobial resistance and antibiotic stewardship using instrument one (part two). Also, nurses' antibiotic stewardship activities were assessed using instrument two. Parents' knowledge, attitudes and practices regarding antibiotic use were assessed using instrument three. Moreover, children' knowledge, beliefs and attitudes regarding antibiotic use were assessed using instrument four and five (pretest). The collected data were used as a basis for comparing pre and post Stewardship-guided framework.

- Researchers arranged two educational sessions for nurses to improve their knowledge and activities toward antibiotic stewardship. Each session included 4-5 nurses and lasted for 45-90 minutes. Educational materials included power point presentation, explanatory booklets, small group discussion, brainstorming and feedback. Antibiotics, antimicrobial resistance, and antibiotic stewardship were all topics covered in the first session. The second session focused on the activities that nurses must perform in the ward or outpatient clinic to improve antibiotic use. Sessions were conducted at the educational room in the pediatric ward and at the waiting area of the outpatient clinic.

- Health educational sessions also were provided by the researchers among studied children and their parents. For parents, health education sessions included interactive training sessions, booklets, and printed or electronic educational materials. Each session included 2-4 parents and lasted for 30-45 minutes. Parents whose children were hospitalized in the pediatric ward received two health education sessions. Sessions were conducted at the educational room in the pediatric ward. The first session was about general knowledge related to microorganisms, the spread of infection, and the prevention of infection. The second session was about the rational use of antibiotics for ARTIs.

- On the other hand, parents whose children visited the pediatric outpatient clinic received one health education session that lasted for 60-90 minutes. The session was conducted at the waiting area of the outpatient clinic and included all of the previously mentioned information.

- For children, health education sessions included use of colored booklets contained draw pictures and some stories about microorganisms, the spread of infection, the prevention of infection, antibiotic use, misuse, and antimicrobial resistance (AMR).

- Immediately after the implementation of the Stewardship-guided framework, the researchers reassessed the parents' knowledge, attitudes and practices regarding antibiotic use using instrument three, children' knowledge, beliefs and attitudes regarding antibiotic also assessed using instrument four and five (posttest).

- After a week of the implementation of the Stewardship-guided framework, the researchers reassessed the nurses' knowledge regarding antibiotics, antimicrobial resistance and antibiotic stewardship using instrument one (part two). In addition, nurses' antibiotic stewardship activities were assessed using instrument two.

Statistical Analysis:

- Data was input and analyzed using SPSS (Statistical Package for Social Science) version 22. Graphics were done using Excel program. Quantitative data were presented by mean (X) and standard deviation (SD). It was analyzed using student t- test for comparison between two means. Qualitative data were presented in the form of frequency distribution tables, number and

percentage. A highly statistically significant difference was considered if P-value < 0.001.

Results

Table 1 represents that the mean age of the studied nurses was 26.72 ± 4.24 and the vast majority of them (86.0%) were females. More than two-thirds (62.8%) graduated from the technical nursing institute and more than half (51.2%) had 1-5 years of experience. Also, more than three quarters (76.7%) were working in the pediatric ward. Concerning attending educational programs related to improving antibiotic use in children with ARTIs, none of them attended any previous educational programs.

Figure 1 clarifies that half of the studied children were 9-11 years and half were 12-15 years old.

Figure 2 represents that more than half of the studied children (55%) were males

Figure 3 illustrates that more than two thirds of the studied children (68%) had upper respiratory tract infections (URTIs).

Table 2 shows that the mean age of the studied parents was 28.40 ± 4.06. More than two- thirds (71.0%) were females. Additionally, less than half of studied fathers (43.1%) and more than half of studied mothers (58.5%) had secondary education. Also, about more than half (56.0%) had average income. Added to that, more than half (54.0%) were rural residents.

Figure 4 clarifies that more than one third of parents (35%) had taken their information about antibiotics use from friends, 25.5% from the internet, 24% from mass media, only 9.5% from doctors and 6% from radio.

Table 3 illustrates that nurses had a better understanding about antibiotics, antibiotic resistance and antibiotic stewardship on posttest than on pretest. Therefore, there were statistically significant variations in nurses' knowledge at 1% level of statistical significance on pre and posttests.

Table 4 illustrates that there was a significant improvement in nurses' in-patient antibiotic stewardship activities on posttest than on pretest. Therefore, there were statistically significant differences in nurses' in-patient antibiotic Stewardship activities at 1% level of statistical significance on pre and posttests.

Table 5 illustrates that there was a noticeable improvement in nurses' out-patient antibiotic Stewardship activities on posttest than on pretest. Therefore, there were statistically significant differences in nurses' out-patient antibiotic Stewardship activities at 1% level of statistical significance on pre and posttests.

Table 6 represents that there was a significant improvement in knowledge of children aged 9-11 years regarding microbes, methods of spread of infection and related treatments and prevention. Also, there was a noticeable improvement in children' beliefs and attitudes regarding antibiotic use on posttest than on pretest. Therefore, there were significant statistical variations in parents' knowledge, beliefs and attitudes at 1% level of statistical significance on pre and posttests.

Table 7 represents that there was a substantial rise in knowledge of children aged 12-15 years regarding microbes, methods of spread of infection and related treatments and prevention. Also, there was a noticeable improvement in children' beliefs and attitudes regarding antibiotics use on posttest than on pretest. Therefore, on pre and posttests, there were substantial statistically variances in parents' knowledge, beliefs and attitudes at 1% level of statistical significance.

Table 8 illustrates there was a considerable reduction in parents' misunderstanding, negative attitude and wrong practices following the implementation of the Stewardship-guided framework compared to pre intervention. As a result, statistically significant variance existed in parents' knowledge, attitudes and practices at 1% level of statistical significance on pre and posttests.

Table 9 clarifies a significant correlation between children' total knowledge, beliefs and attitudes regarding antibiotic use and their age and sex

Table 10 reflects a significant correlation between children' total beliefs and attitudes regarding antibiotic use and their total knowledge

Table 11 shows a significant correlation between parents' attitudes and practices regarding antibiotic use and their total knowledge.

Table 12 illustrates a significant correlation between nurses' antibiotic stewardship activities their total knowledge regarding antibiotic use.

Table (1): Characteristics of studies nurses (n=43).

Characteristics of studies nurses	No. (n=43)	%
Age (M±SD)	26.72 ± 4.24	
Sex		
Male	6	14.0
Female	37	86.0
Educational level		
Diploma	10	23.3
Nursing technician	27	62.8
Bachelor	6	14.0
Years of experience		
< 1year	6	14.0
1-5 years	22	51.2
6-10 years	15	34.9
Place of work		
Pediatric ward	33	76.7
Pediatric outpatient clinic	10	23.3
Attending any educational programs regarding improving antibiotic use in children with ARTIs	0	0.0

Note: (ARTIs): Acute respiratory tract infections

Figure (1): Age of studied children.

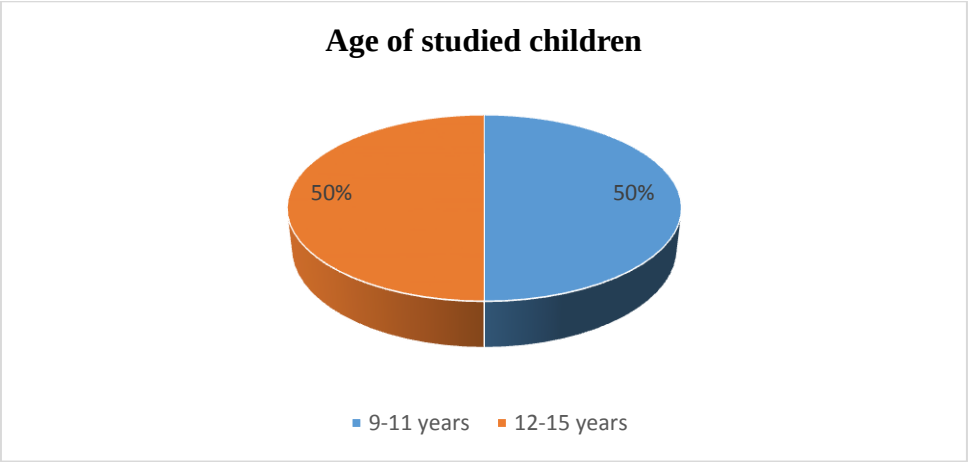

Figure (2): Sex of studied children.

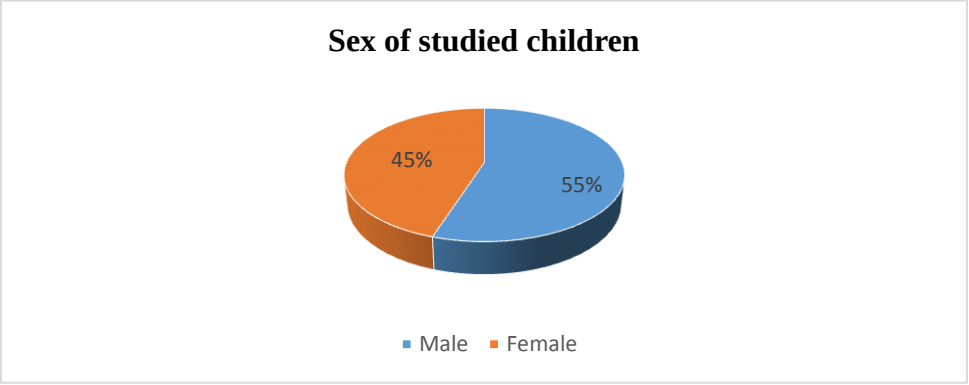

Figure (3): Diagnosis of studied children

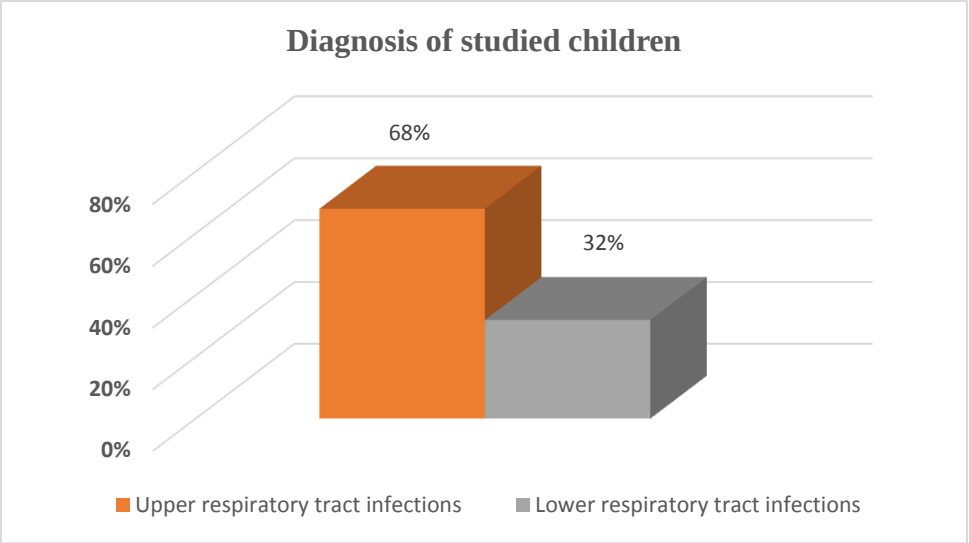

Table (2): Characteristics of studies parents (n= 200).

Characteristics of studies parents	No. (n= 200)	%
Age (M±SD)	28.40 ± 4.06	
Sex		
Male	58	29.0
Female	142	71.0
Educational level of fathers (n= 58)		
Primary education	15	25.9
Secondary education	25	43.1
University education	18	31.0
Educational level of mothers (n=142)		
Primary education	22	15.5
Secondary education	83	58.5
University education	37	26.1
Income level		
Low	56	28.0
Average	112	56.0
High	32	16.0
Residency		
Rural	108	54.0
Urban	92	46.0

Figure (4): Parents' sources of information about antibiotics.

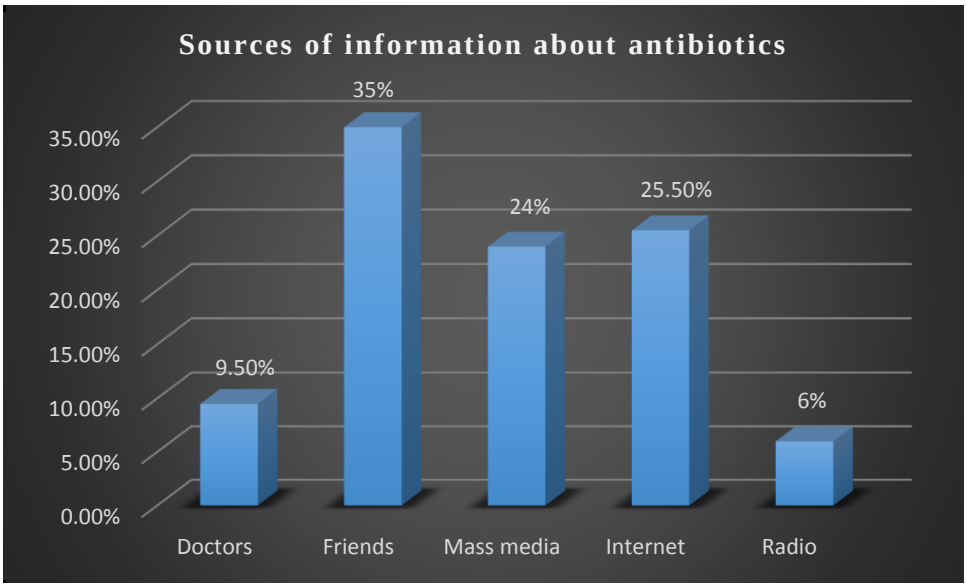

Table (3): Mean scores of nurses' knowledge regarding antibiotics, antibiotic resistance and antibiotic stewardship on pre and posttests (n= 43).

Variables	Pretest (M±SD)	Posttest (M±SD)	t test	P-value
Antibiotics	2.90 ± 2.07	6.04 ± 2.10	-6.978 HS	.000
Antibiotic resistance	2.95 ± 3.00	6.72 ± 2.82	-5.989 HS	.000
Antibiotic stewardship	0.00 ± 0.00	3.90 ± 1.715	-14.933 HS	.000
Total	5.86 ± 4.93	16.67 ± 6.35	-8.824 HS	.000

Note: (HS): High significant (p<.001)

Table (4): Mean scores of in-patient antibiotic Stewardship activities of nurses on pre and posttests (n=33).

In-patient nursing antibiotic Stewardship activities	Pretest (M±SD)	Posttest (M±SD)	t test	P-value
On patient admission	2.51 ± 1.03	4.30 ± 1.21	-6.447 HS	.000
Daily (24 h) clinical progress monitoring	2.00 ± 0.00	2.85 ± .36	-13.387 HS	.000
Patient safety & quality monitoring	1.00 ± 1.37	3.03 ± 1.65	-5.442 HS	.000
Clinical progress and patient education	1.00 ± 0.00	1.90 ± .29	-17.889 HS	.000
Total	6.51 ± 2.29	12.09 ± 3.35	-7.893 HS	.000

Note: (HS): High significant (p<.001)

Table (5): Mean scores of out-patient antibiotic Stewardship activities of nurses on pre and posttests (n=10).

Variables	Pretest (M±SD)	Posttest (M±SD)	t test	P-value
Out-patient nursing antibiotic Stewardship activities	2.40 ± 0.84	6.00 ± 0.00	-13.500 HS	.000

Note: (HS): High significant (p<.001)

Table (6): Mean scores of knowledge, beliefs and attitudes of children aged 9-11 years regarding antibiotic use on pre and post the Stewardship-guided framework (n=100).

Items	Pretest (M±SD)	Posttest (M±SD)	t test	P-value
Knowledge				
Introduction to microbes	3.28 ± 5.12	11.20 ± 4.33	-11.818 HS	.000
Spread of infection	3.38 ± 4.70	9.41 ± 3.72	-10.042 HS	.000
Treatment and prevention of infection	1.56 ± 2.66	5.94 ± 2.40	-12.218 HS	.000
Total knowledge	8.22 ± 12.27	26.55 ± 10.44	-11.375 HS	.000
Beliefs	1.16 ± 1.80	3.46 ± 1.35	-10.191 HS	.000
Attitudes	0.84 ± 1.31	2.61 ± 0.99	-10.733 HS	.000

Note: (HS): High significant (p<.001)

Table (7): Mean scores of knowledge, beliefs and attitudes of children aged 12-15 years regarding antibiotic use on pre and post the Stewardship-guided framework (n=100).

Items	Pretest (M±SD)	Posttest (M±SD)	t test	P-value
Knowledge				
Introduction to microbes	5.12 ± 6.28	12.89 ± 3.60	-10.729 HS	.000
Spread of infection	4.66 ± 4.93	9.29 ± 2.43	-8.429 HS	.000
Treatment and prevention of infection	3.19 ± 4.06	8.37 ± 2.16	-11.256 HS	.000
Knowledge	12.97 ± 14.83	30.55 ± 8.17	-10.384 HS	.000
Beliefs	1.51 ± 1.93	3.67 ± 1.03	-9.860 HS	.000
Attitudes	1.17 ± 1.46	2.72 ± 0.86	-9.147 HS	.000

Note: (HS): High significant (p<.001)

Table (8): Mean scores of parents' knowledge, attitudes and practices regarding antibiotic use in RTIs on pre and post the Stewardship-guided framework.

Items	Pretest (M±SD)	Posttest (M±SD)	t test	P-value
Knowledge	26.9450 ± 6.75	17.28 ± 3.33	18.144 HS	.000
Attitudes	9.9500 ± 3.08	7.95 ± 1.34	8.414 HS	.000
Practices	37.8450 ± 6.86	21.50 ± 4.06	29.006 HS	.000

Note: (HS): High significant (p<.001)

Table (9): Correlation between children' total knowledge, beliefs and attitudes regarding antibiotic use and their age and sex

	Age		Sex	
	r	P- value	r	P- value
Total knowledge	.643**	.000	.552**	.000
Total beliefs	.587**	.000	.503**	.000
Total attitudes	.606**	.000	.522**	.000

** Correlation is significant at the 0.01 level (2-tailed)

Table (10): Correlation between children' total beliefs and attitudes regarding antibiotic use and their total knowledge.

	Total knowledge	
	R	P- value
Total beliefs	.913**	.000
Total attitudes	.918**	.000

** Correlation is significant at the 0.01 level (2-tailed)

Table (11): Correlation between parents' attitudes and practices regarding antibiotic use and their total knowledge.

	Total knowledge	
	r	P- value
Total attitudes	.722**	.000
Total practices	.236**	.000

** Correlation is significant at the 0.01 level (2-tailed)

Table (12): Correlation between nurses' antibiotic stewardship activities and their total knowledge.

	Total knowledge	
	R	**P- value**
Total in-patient nursing antibiotic stewardship activities	.682**	.000
Total out-patient nursing antibiotic stewardship activities	.973**	.000

** Correlation is significant at the 0.01 level (2-tailed)

Discussion

One of the main causes of morbidity in children is acute respiratory tract infections (ARTIs). It is also one of the most prevalent causes for children to seek outpatient care, which puts a tremendous strain on society and the healthcare system (**Uddin et al., 2021**). The extent of rational and irrational antibiotic usage, particularly in children, is endangering public health since antibiotic resistance is spreading globally. The entire impact of irrational antibiotic use impacts not just patients but also the population as a whole, resulting in an alarming crisis of antibiotic resistance (**King et al., 2020**). Therefore, the purpose of this study was to develop a Stewardship-guided framework for improving antibiotics use among children with ARTIs.

In relation to hypothesis one, the present research illustrated that nurses had lower level of knowledge regarding antibiotics, antimicrobial resistance (AMR) and antibiotic Stewardship on pretest than on posttest. This could be due to lack of educational programs provided to them relating to this subject. This outcome was in line with **MANE et al., (2021)** who mentioned that nurses and pharmacists had less knowledge regarding antimicrobials and AMR. In the same context, **Lalithabai et al., (2022)** who mentioned that nurses displayed moderate level of understanding of antibiotic resistance and a fair attitude towards its prevention.

The study also clarified that nurses had higher level of knowledge regarding antibiotics, antimicrobial resistance (AMR) and antibiotic Stewardship on posttest than on pretest. This might be because of the educational program provided to them by the researches which included use of effective teaching strategies. This outcome was in accordance with **Elsayed et al., (2019)** who concluded that implementation of the educational program had appositive effect on nurses' understanding and practice regarding AMR. This conclusion was consistent with the findings of **Fayed et al., 2022,** who discovered that after implementing the teaching program, the studied-nurses had a sufficient level of knowledge about antibiotics and antibiotic stewardship. In the same line, **Mittal et al., (2023)** who noted that the education program was very effective in educating nurses on important concerns relating to AMR and antibiotic stewardship.

In relation to hypothesis two, the present investigation revealed that children's understanding of microbes, ways of infection spread, treatment, and infection prevention improved significantly after the implementation of the Stewardship-guided framework compared to before intervention. This could be related to the attractive educational materials used with the children. Children' beliefs and attitudes about antibiotic use also improved. This could be because of the knowledge they acquired which in turn affected their beliefs and attitudes. These findings were aligned with **Lecky et al., (2020)** who stated that the e-Bug teaching pack resulted in a considerable increase in knowledge among students in regards to microbes, methods of spread of infection, treatments and prevention of infection.

This finding was congruent with the findings of **Appiah et al., (2021),** who discovered that public engagement initiatives involving picture painting and storytelling had a favorable effect on schoolchildren's knowledge, attitudes, and beliefs about antibiotic abuse and AMR. Furthermore, **Balachandran et al., (2023) found** that there was statistically significant variation in the knowledge, attitude, and behavior of study participants following the educational

intervention. The mean knowledge scores, the mean attitude and behavior score increased after intervention compared to baseline assessment. This could be related to interest of children to the importance of how to prevent diseases in order to maintain healthy for regular attendance to their schools without absenteeism and reduce cost and effort of their families when they are sick due to infections.

In relation to hypothesis three, the current investigation clarified that there was aconsiderable decrease in parents' misunderstanding, negative attitude and practices after implementation of the Stewardship-guided framework compared to pre intervention. This finding was consistent with **Abd El-Kader and Mohammed, (2021)** who reported a statistically significant difference in parental knowledge, attitude, and practices after the intervention and follow-up compared to before the intervention.

Also, this result was consistent with **Thong et al., (2021),** who stated that there was a substantial rise in participant perception of the use of antibiotics and the mean knowledge score on antibiotic use following the educational program ($p < 0.001$) compared to before intervention. This demonstrated that focused educational initiatives have been very successful in raising awareness of antibiotic use and resistance.

Additionally, this result was congruent with **Amin et al., (2022)** they found that participants showed sufficient good knowledge about antibiotic use and resistance with highest attitude score post intervention. Knowledge and attitudes toward antibiotic use and resistance had a significant impact on prescribing practice. In contrast, this finding was contradicted with **Alsuhaibani et al., (2019)** they reported that the vast majority of parents were educated but with poor attitude and practice. This contradiction was caused by parents in their research being uninformed of the indications and subsequent risks associated with utilizing over-the-counter antibiotics.

The present study revealed that there was a significant correlation between children' total beliefs and attitudes and their total knowledge. This finding was congruent with **Gahzi et al., (2022)** who reported that there was a significant association between students' knowledge on antibiotics usage and their attitudes. The students' knowledge regarding the use of antibiotics to treat upper respiratory tract infection was good and so on improved their beliefs and attitudes.

Moreover, this result was consistent with **Dopelt, Amar, Yonatan and Davidovitch, (2023)** who showed that there were positive and significant relationships between the levels of knowledge, beliefs and attitudes among the study participants. This indicated that a higher level of knowledge and awareness regarding the severity of antibiotic resistance was associated with improved beliefs and attitudes to reduce antibiotic misuse.

The current study showed that there was a significant correlation between parents' attitudes and practices and their total knowledge. This finding was in accordance with **Paredes et al., (2022)** who found that there was a strong significant evidence of a positive linear association between the knowledge and the attitudes scores among parents. For each increase in the score on knowledge, the scores on attitudes and practices increased. This demonstrated that improved parents' knowledge about antibiotics showed proper attitude and practices.

The present study illustrated that there was a significant correlation between nurses' antibiotic stewardship activities and their total knowledge. This result was agreed with **Herawati et al., (2021)** who reported that there was a significant positive correlation between nurses' knowledge and their practices. This indicated that increased knowledge about antibiotic stewardship affected positively on nurses' antibiotic use activities and behaviors.

Conclusion

- In light of this study's findings and the hypotheses, it was concluded that a Stewardship-guided framework was more successful on the posttest than on the pretest in improving nurses' knowledge and antibiotic stewardship activities as well as children' knowledge, beliefs and attitudes regarding antibiotic use, and parents'

knowledge, attitudes and practices regarding antibiotic use.

Recommendations

Based on the study's findings, the following suggestions can be made:

1- Nurses in collaboration with the health care team should integrate the Stewardship-guided framework in all pediatric units and outpatient clinics for improving antibiotic use among pediatric patients.

2- Teaching children regarding microbes, methods of spread of infection and treatment and prevention strategies to be involved in the school Curriculum.

3- More research with a larger sample size of children of different diagnosis requiring antibiotics is needed.

References

Abd El-Kader, R. G., & Mohammed, H. H. (2021). Effect of an Educational Intervention on Mothers' Knowledge, Attitude and Practice about Proper Antibiotic Use in a Selected Family Health Center. *The Malaysian Journal of Nursing (MJN)*, *12*(3), 16-23.

Al Sous, M. M. J., Al Houri, H. N., Safiah, M. H., Alazrak, S. O., & Akwan, R. R. (2023). Antibiotic prescription patterns for acute upper respiratory tract infections in an outpatient population with health insurance in Syria—a retrospective cross-sectional study. *IJID regions*, *7*, 66-71.

Al-Azzam, S. I., Al-Husein, B. A., Alzoubi, F., Masadeh, M. M., & Al-Horani, S. (2017). Self-medication with antibiotics in Jordanian population. *International journal of occupational medicine and environmental health*, *20*(4), 373.

Alsuhaibani, M. A., AlKheder, R. S., Alwanin, J. O., Alharbi, M. M., Alrasheedi, M. S., & Almousa, R. F. (2019). Parents awareness toward antibiotics use in upper respiratory tract infection in children in Al-Qassim region, Saudi Arabia. *Journal of Family Medicine and Primary Care*, *8*(2), 583.

Amin, M. T., Abd El Aty, M. A., Ahmed, S. M., Elsedfy, G. O., Hassanin, E. S., & El-Gazzar, A. F. (2022). Over prescription of antibiotics in children with acute upper respiratory tract infections: A study on the knowledge, attitude and practices of non-specialized physicians in Egypt. *PLoS One*, *17*(11), e0277308.

Appiah, B., Anum-Hagin, D., Gyansa-Luterrodt, M., Samman, E., Agyeman, F. K. A., Appiah, G., & Rene, A. (2021). Children against antibiotics misuse and antimicrobial resistance: assessing effectiveness of storytelling and picture drawing as public engagement approaches. *Wellcome Open Research*, *6*.

Awad, A. I., & Eltayeb, I. B. (2017). Self-medication practices with antibiotics and antimalarials among Sudanese undergraduate university students. *Annals of Pharmacotherapy*, *41*(7-8), 1249-1255.

Ayukekbong, J. A., Ntemgwa, M., & Atabe, A. N. (2017). The threat of antimicrobial resistance in developing countries: causes and control strategies. *Antimicrobial Resistance & Infection Control*, *6*(1), 1-8.

Balachandran, P., Ramanarayanan, V., & James, A. (2023). Effectiveness of an educational intervention in promoting antibiotic awareness among 8th to 10th grade students in Kerala, India. *Cumhuriyet Dental Journal*, *26*(2), 173-179.

Braun, B. L., & Fowles, J. B. (2020). Characteristics and experiences of parents and adults who want antibiotics for cold symptoms. *Archives of family Medicine*, *9*(7), 589.

Butler, C. C., Hood, K., Verheij, T., Little, P., Melbye, H., Nuttall, J., & Goossens, H. (2019). Variation in antibiotic prescribing and its impact on recovery in patients with acute cough in primary care: prospective study in 13 countries. *Bmj*, *338*.

Cals, J. W., Schot, M. J., de Jong, S. A., Dinant, G. J., & Hopstaken, R. M. (2022). Annals Journal Club: Point-of-Care C-

Reactive Protein Testing and Antibiotic Prescribing for Respiratory Tract Infections: A Randomized Controlled Trial. *Annals of Family Medicine*, *8*(2), 124.

Carter, E. J., Greendyke, W. G., Furuya, E. Y., Srinivasan, A., Shelley, A. N., Bothra, A., & Larson, E. L. (2018). Exploring the nurses' role in antibiotic stewardship: a multisite qualitative study of nurses and infection preventionists. *American journal of infection control*, *46*(5), 492-497.

Celik, I., Saatci, E., & Eyüboğlu, A. F. (2020). Emerging and reemerging respiratory viral infections up to Covid-19. *Turkish journal of medical sciences*, *50*(9), 557-562.

Cockburn, J., & Pit, S. (2020). Prescribing behaviour in clinical practice: patients' expectations and doctors' perceptions of patients' expectations—a questionnaire study. *Bmj*, *315*(7107), 520-523.

Dopelt, K., Amar, A., Yonatan, N., & Davidovitch, N. (2023). Knowledge, Attitudes, and Practices Regarding Antibiotic Use and Resistance: A Cross-Sectional Study among Students in Israel. *Antibiotics*, *12*(6), 1028.

Dyar, O. J., Huttner, B., Schouten, J., & Pulcini, C. (2017). What is antimicrobial stewardship? *Clinical microbiology and infection*, *23*(11), 793-798.

El Baroudy, N. R., El Refay, A. S., Hamid, T. A. A., Hassan, D. M., Soliman, M. S., & Sherif, L. (2018). Respiratory viruses and atypical bacteria co-infection in children with acute respiratory infection. *Open access Macedonian journal of medical sciences*, *6*(9), 1588.

Elsayed, A. I., Bayoumi, M. H., & Mahmoud, N. (2019). Effect of Educational Program on Pediatric Nurses' Knowledge and Practice Regarding Combating Antimicrobial Resistance.

Fahim, M., ElSood, H. A., AbdElGawad, B., Deghedy, O., Naguib, A., Roshdy, W. H., & Abdelghaffar, K. (2023). Adapting an integrated acute respiratory infections sentinel surveillance to the COVID-19 pandemic requirements, Egypt, 2020–2022. *Public Health in Practice*, *5*, 100358.

Fleming-Dutra, K. E., Hersh, A. L., Shapiro, D. J., Bartoces, M., Enns, E. A., File, T. M., & Hicks, L. A. (2016). Prevalence of inappropriate antibiotic prescriptions among US ambulatory care visits, 2010-2011. *Jama*, *315*(17), 1864-1873.

Fridkin, S., Baggs, J., Fagan, R., Magill, S., Pollack, L. A., Malpiedi, P., & Srinivasan, A. (2014). Vital signs: improving antibiotic use among hospitalized patients. *Morbidity and mortality weekly report*, *63*(9), 194.

Gahzi, H. F., Hasan, T. N., Rashed, F. H., Mahdi, K. S., Sami, F. A., Najm, L. A., & Abd, F. A. (2022). Students' Knowledge Regarding Antibiotic Usage for Children Upper Respiratory Tract Infections. *Unnes Journal of Public Health*, *11*(2), 154-159.

Harnden, A., Perera, R., Brueggemann, A. B., Mayon-White, R., Crook, D. W., Thomson, A., & Mant, D. (2017). Respiratory infections for which general practitioners consider prescribing an antibiotic: a prospective study. *Archives of disease in childhood*, *92*(7), 594-597.

Herawati, F., Jaelani, A. K., Wijono, H., Rahem, A., Yulia, R., Andrajati, R., & Soemantri, D. (2021). Antibiotic stewardship knowledge and belief differences among healthcare professionals in hospitals: A survey study. *Heliyon*, *7*(6).

Ho, N. T., Thompson, C., Van, H. M. T., Dung, N. T., My, P. T., Quang, V. M., & Baker, S. (2018). Retrospective analysis assessing the spatial and temporal distribution of paediatric acute respiratory tract infections in Ho Chi Minh City, Vietnam. *BMJ open*, *8*(1), e016349.

Kandeel, A., Fahim, M., Deghedy, O., Roshdy, W. H., Khalifa, M. K., Shesheny, R. E., & Abdelghaffar, K. (2023). Resurgence of influenza and respiratory syncytial virus in Egypt following two years of decline during the COVID-19 pandemic: outpatient clinic survey of infants and children, October 2022. *BMC Public Health*, *23*(1), 1067.

Khan, E. A., Raja, M. H., Chaudhry, S., Zahra, T., Naeem, S., & Anwar, M. (2020). Outcome of upper respiratory tract infections in healthy children: Antibiotic stewardship in treatment of acute upper respiratory tract infections. *Pakistan Journal of Medical Sciences*, *36*(4), 642.

King, L. M., Bartoces, M., Fleming-Dutra, K. E., Roberts, R. M., & Hicks, L. A. (2020). Changes in US outpatient antibiotic prescriptions from 2011–2016. *Clinical Infectious Diseases*, *70*(3), 370-377.

Kissler, S. M., Klevens, R. M., Barnett, M. L., & Grad, Y. H. (2021). Distinguishing the roles of antibiotic stewardship and reductions in outpatient visits in generating a 5-year decline in antibiotic prescribing. *Clinical Infectious Diseases*, *72*(9), 1568-1576.

Ladenheim, D. (2018). Role of nurses in supporting antimicrobial stewardship. *Nurs Stand*, *33*(6), 55-58.

Lalithabai, D. S., Hababeh, M. O., Wani, T. A., & Aboshaiqah, A. E. (2022). Knowledge, attitude and beliefs of nurses regarding antibiotic use and prevention of antibiotic resistance. *SAGE Open Nursing*, *8*, 23779608221076821.

Lecky, D. M., McNulty, C. A., Touboul, P., Herotova, T. K., Beneš, J., Dellamonica, P., & Campos, J. (2020). Evaluation of e-Bug, an educational pack, teaching about prudent antibiotic use and hygiene, in the Czech Republic, France and England. *Journal of Antimicrobial Chemotherapy*, *65*(12), 2674-2684.

Mane, A., Kamat, S., & Thanusubramanian, H. (2021). Knowledge, Attitude and Practices of Clinicians, Nurses and Pharmacists Regarding Antimicrobial Stewardship: A Five Center Survey from India. *Journal of Clinical & Diagnostic Research*, *15*(8).

Manesh, A., & Varghese, G. M. (2021). Rising antimicrobial resistance: an evolving epidemic in a pandemic. *The Lancet Microbe*, *2*(9), e419-e420.

Mangione-Smith, R., McGlynn, E. A., Elliott, M. N., McDonald, L., Franz, C. E., & Kravitz, R. L. (2018). Parent expectations for antibiotics, physician-parent communication, and satisfaction. *Archives of pediatrics & adolescent medicine*, *155*(7), 800-806.

Mitsi, G., Jelastopulu, E., Basiaris, H., Skoutelis, A., & Gogos, C. (2015). Patterns of antibiotic use among adults and parents in the community: a questionnaire-based survey in a Greek urban population. *International journal of antimicrobial agents*, *25*(5), 439-443.

Mittal, N., Deswal, H., Mittal, R., Sharma, S., & Kaushik, P. (2023). An educational program on antimicrobial resistance and stewardship for staff nurses in a public tertiary care hospital in India. *Infection, Disease & Health*.

Mourya, D. T., Yadav, P. D., Ullas, P. T., Bhardwaj, S. D., Sahay, R. R., Chadha, M. S., & Singh, S. K. (2019). Emerging/re-emerging viral diseases & new viruses on the Indian horizon. *The Indian journal of medical research*, *149*(4), 447.

Mula, C. (2019). The examination of nurses' adherence to the 'five rights' of antibiotic administration and factors influencing their practices: a mixed methods case study at a tertiary hospital, Malawi. *Malawi Medical Journal*, *31*(2), 126-132.

Mula, C. T., Middleton, L., Human, N., & Varga, C. (2018). Assessment of factors that influence timely administration of initial antibiotic dose using collaborative process mapping at a referral hospital in Malawi: a case study of pneumonia patients. *BMC Infectious Diseases*, *18*, 1-13.

Murray, C. J., Ikuta, K. S., Sharara, F., Swetschinski, L., Aguilar, G. R., Gray, A., & Tasak, N. (2022). Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. *The Lancet*, *399*(10325), 629-655.

Nair, H., Simões, E. A., Rudan, I., Gessner, B. D., Azziz-Baumgartner, E., Zhang, J. S. F., & Campbell, H. (2021). Global and regional burden of hospital admissions for severe acute lower respiratory infections in young children in 2010: a systematic analysis. *The Lancet*, *381*(9875), 1380-1390.

National Institute for Health and Care Excellence (2015) Antimicrobial Stewardship: Systems and Processes for Effective Antimicrobial Medicine Use. NICE guideline No. 15. NICE, London.

Olans, R. N., Olans, R. D., & DeMaria Jr, A. (2016). The critical role of the staff nurse in antimicrobial stewardship—unrecognized, but already there. *Clinical Infectious Diseases*, *62*(1), 84-89.

Palmer, D. A., & Bauchner, H. (2022). Parents' and physicians' views on antibiotics. *Pediatrics*, *99*(6), e6-e6.

Paredes, J. L., Navarro, R., Watanabe, T., Morán, F., Balmaceda, M. P., Reateguí, A., & Ochoa, T. J. (2022). Knowledge, attitudes and practices of parents towards antibiotic use in rural communities in Peru: a cross-sectional multicentre study. *BMC Public Health*, *22*(1), 459.

Pham, H., Rahman, A., Majidi, A., Waterhouse, M., & Neale, R. E. (2019). Acute respiratory tract infection and 25-hydroxyvitamin D concentration: a systematic review and meta-analysis. *International journal of environmental research and public health*, *16*(17), 3020.

Rhea, S., Jones, K., Endres-Dighe, S., Munoz, B., Weber, D. J., Hilscher, R., & CDC MInD-Healthcare Network. (2020). Modeling inpatient and outpatient antibiotic stewardship interventions to reduce the burden of Clostridioides difficile infection in a regional healthcare network. *PLoS One*, *15*(6), e0234031.

Saunders, B. I. (2020). Inappropriate Antibiotic Use: A Survey of Provider Prescribing Behaviors.

Thong, K. S., Chang, C. T., Lee, M., Lee, J. C. Y., Tan, H. S., & Shafie, A. A. (2021). Impact of targeted educational intervention towards public knowledge and perception of antibiotic use and resistance in the state of Perak, Malaysia. *Antimicrobial Resistance & Infection Control*, *10*, 1-9.

Uddin, T. M., Chakraborty, A. J., Khusro, A., Zidan, B. R. M., Mitra, S., Emran, T. B., & Koirala, N. (2021). Antibiotic resistance in microbes: History, mechanisms, therapeutic strategies and future prospects. *Journal of infection and public health*, *14*(12), 1750-1766.

Walsh, T. R., Gales, A. C., Laxminarayan, R., & Dodd, P. C. (2023). Antimicrobial Resistance: Addressing a Global Threat to Humanity. *Plos Medicine*, *20* (7), e1004264.

World Health Organization. (2019). Trends in maternal mortality 2000 to 2017: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division.

Zyoud, S. E. H., Abu Taha, A., Araj, K. F., Abahri, I. A., Sawalha, A. F., Sweileh, W. M., & Al-Jabi, S. W. (2015). Parental knowledge, attitudes and practices regarding antibiotic use for acute upper respiratory tract infections in children: a cross-sectional study in Palestine. *BMC pediatrics*, *15*(1), 1-9.