Expert Review of Anti-infective Therapy

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/ierz20

An assessment of the index of rational drug prescribing for severe acute respiratory infections among hospitalised children in Northern Nigeria: a retrospective study

Aliyu Sulaiman, Mohammad Alfa Isah & Abubakar Usman

To cite this article: Aliyu Sulaiman, Mohammad Alfa Isah & Abubakar Usman (09 Feb 2024): An assessment of the index of rational drug prescribing for severe acute respiratory infections among hospitalised children in Northern Nigeria: a retrospective study, Expert Review of Anti-infective Therapy, DOI: 10.1080/14787210.2024.2307913

To link to this article: https://doi.org/10.1080/14787210.2024.2307913

Published online: 09 Feb 2024.

EXPERT REVIEW OF ANTI-INFECTIVE THERAPY
https://doi.org/10.1080/14787210.2024.2307913

Taylor & Francis
Taylor & Francis Group

ORIGINAL RESEARCH

An assessment of the index of rational drug prescribing for severe acute respiratory infections among hospitalised children in Northern Nigeria: a retrospective study

Aliyu Sulaiman[a], Mohammad Alfa Isah[b] and Abubakar Usman[c]

[a]Pharmacy Department, Federal Medical Centre, Bida, Nigeria; [b]Hospital Management Board, Niger State Ministry of Health, Minna, Nigeria; [c]Department of Clinical Pharmacy and Practice, College of Pharmacy, QU Health, Qatar University, Doha, Qatar

ABSTRACT

Background: This study evaluated drug use pattern among hospitalized children with severe acute respiratory infection (SARI) in Nigeria.

Research design and methods: A retrospective assessment of prescribed medicines for children aged 13 years and below who were admitted and treated for SARI from 1 January 2016 to 31 December 2018 was conducted. The WHO prescribing indicators and the Index of Rational Drug Prescribing were used to evaluate prescriptions.

Results: A total of 259 patients were included, mostly diagnosed with bronchopneumonia (56%). A summary of WHO-core prescribing indicators showed the average number of drugs per encounter was 3.9, medicines prescribed by generic name was 82.1%, and an encounter with at least an antibiotic was 99.7%. The percentage of drugs prescribed from the Essential Medicine List for children was 79%. The most frequently prescribed pharmacological class of medicines was antibiotics (41.4%). Cephalosporins (40.0%), aminoglycosides (34.1%), and penicillins (21.5%) were the most commonly prescribed antibiotic classes. Gentamicin (34.1%) and cefuroxime (21.5%) were the most commonly prescribed antibiotics.

Conclusions: Drug prescribing for hospitalized children with SARI was suboptimal, especially with regard to polypharmacy, antibiotics, and injection use. Interventions to promote rational use of medicines including antimicrobial stewardship interventions are recommended.

ARTICLE HISTORY
Received 24 April 2023
Accepted 28 November 2023

KEYWORDS
Use of medicines; severe acute respiratory infections; children; WHO prescribing indicators; antibiotic prescribing

1. Introduction

Acute respiratory infections are common in children below the age of 5 years, and are associated with significant morbidity and mortality among hospitalized children [1–3]. Severe acute respiratory infection (SARI) is one of the most common childhood infectious diseases and a leading cause of hospitalization in children [4]. SARI is among the leading causes of hospitalization and deaths worldwide [5,6]. Of the estimated 7.6 million deaths in children younger than 5 years worldwide in 2010, infectious diseases alone accounted for 68%, with the largest percentage (18%) due to pneumonia [1,7]. Estimations in 2010 have shown that 11 million children aged less than 5 years were admitted for SARI in developing countries, with an estimated case fatality rate of 2.3%, compared to 0.6% in developed countries [8]. The etiology of SARI varies among patients and viral infections are the most common cause of SARI in children below the age of 15 years [9–12] including rhinovirus, respiratory syncytial virus, bocavirus, influenza viruses, adenoviruses, metapneumoviruses, and parainfluenza viruses [5,9–14]. The clinical manifestations of SARI include cough, fever ≥ 38°C, rhinorrhea, shortness of breath and vomiting [13,14]. Pediatric patients with confirmed viral infections have a low risk of secondary bacterial infections [4].

In Nigeria, the estimated median incidence of pneumonia in 2000 was 0.34 episodes per child year, which equates to 6.1 million new cases each year in under-five children [6]. SARI remains a major cause of mortality in under-five children in Nigeria, with pneumonia alone accounting for about 17% of mortality in this age group [1]. Indeed, of the top 10 countries with the highest pneumonia disease burden and mortality, Nigeria recorded more than 204,000 annual pneumonia deaths in children, ranking second only to the corresponding value recorded in India [6]. While SARI-related deaths vary widely between developed and developing countries, significantly higher mortality burdens are recorded in countries with inefficient health systems. Rational use of medicines, especially in children, is of paramount importance in order to achieve safe and effective treatment. When drugs are used inappropriately, the economic and clinical outcomes will be undesirable; leading to escalating cost of care, exacerbation of illness, antimicrobial resistance, and drug-related morbidity and mortality [15]. However, the pattern of drugs prescribed for children with SARI is often inappropriate.

The World Health Organization (WHO) in collaboration with the International Network of Rational Use of Drugs (INRUD) developed a set of standardized drug use indicators to evaluate drug use practices at health-care facilities [15]. The indicators were initially developed for use in outpatient settings in primary-level facilities. However, the

CONTACT Abubakar Usman pharmumma2@gmail.com Department of Clinical Pharmacy and Practice, College of Pharmacy, QU Health, Qatar University, P.O. Box: 2713, Doha, Qatar

indicators have also been used for inpatient settings of tertiary hospitals [16–18]. The indicators called 'core drug use indicators' are classified into prescribing, patient-care, and facility-specific indicators. The prescribing indicators are useful in identifying problems in general prescribing. They include the following: Average number of drugs per encounter which measures the degree of polypharmacy; percentage of drugs prescribed by generic name which measures the cost-effectiveness of a health system to procure and use drugs; the percentage of encounters with an antibiotic prescribed which measures the overall use of commonly overused and costly forms of drug therapy; percentage of encounters with injection prescribed which measures the level of use of very important but commonly overused and costly forms of drug therapy; and the percentage of drugs prescribed from the national essential medicines list which measures the degree to which practices conform to a national drug policy [15]. There are limited data available on drug use assessment among children with SARI in northern Nigeria. Such assessments will be used to optimize therapy for the children with acute severe infections, educate health workers on rational drug use, and also help policymakers have some information that can help in the future review and implementation of policies related to drug prescribing for severe acute respiratory infections in the country. The objectives of this study were to evaluate drug use pattern among hospitalized children diagnosed with SARI in a tertiary hospital in northern Nigeria using WHO prescribing indicators. In addition, the study evaluated the pattern of antibiotic use among hospitalized patients with SARI.

2. Methods

2.1. Study design

This was a retrospective study conducted to assess prescribed medicines for children aged 13 years and below who were admitted and treated for any form of SARI at a tertiary hospital in North Central, Nigeria.

2.2. Study setting

The study was conducted in a tertiary hospital located in [anonymized] North Central, Nigeria. The hospital is a 200-bed capacity health facility and serves as a main referral public health facility. The hospital provides a range of services including medical, surgical, nursing, pharmacy, laboratory, radiology, and physiotherapy. This study was conducted in the pediatric inpatient units, which include pediatrics medical ward and neonatal intensive care unit.

2.3. Study population

The study included health records of pediatrics in-patients who were admitted and treated as a case of SARI in the center.

2.3.1. Inclusion criteria

(1) Hospitalized children aged 13 years and below who were admitted and treated for SARI.
(2) Those hospitalized from January 1, 2016, to December 31, 2018.
(3) Those with records of medication prescription during hospitalization.
(4) Cases that meet the case definition of SARI – patient who presented with complaints of fever or history of fever and cough, both occurring in less than ten (10) days and were admitted and treated as acute respiratory infections.

2.3.2. Exclusion criteria

(1) Those with missing data in their medical records.

2.3.3 Sample size determination

The sample size was determined by sample size proportions using Cochrane formula. A total of 789 patients had visited the emergency pediatric unit (EPU) and/or pediatric ward during the period under review from 1 January 2016 to 31 December 2018 for SARI. Using a 95% confidence interval, the required sample size was calculated as 259 hospitalized pediatric patients.

2.5. Sampling method

The hospital reference number of all the cases that meet the case definition of SARI is recorded in no particular order and assigned study number from 1 to 789. Systematic random sampling was used to select 259 folders using sampling interval of three (3). The first folder was selected by means of random numbers. One random number was selected from a piece of random numbers 1–4, and the random number picked was used to select the first folder with the corresponding study number. Subsequently, other folders were selected using a sampling interval of three (3) until 259 folders were selected.

2.6. Data collection

Relevant data was extracted from patient's health record and entered into the WHO prescribing indicator form. The information collected included patient's demographics (age, sex, and body weight), the diagnosis, names of medicines prescribed, dose, route, frequency, duration of treatment, number of drugs per encounter, number of drugs prescribed by generic name, number of drugs prescribed from essential medicine list for children, encounter with antibiotics (yes/no) and encounter with injections (yes/no). A prescription for any form of SARI from multiple prescriptions in the case note was recorded. Thus, if the initial prescription is continued, it is recorded as the same prescription for a given duration. The addition of another drug or change of drug from the existing regimen was recorded as a separate prescription (encounter).

2.7. Data analysis

The data obtained were collated, coded, and entered into Microsoft excel which was then imported into the Statistical Package for Social Sciences (SPSS) version 20 for analysis. A descriptive statistical analysis was carried out, and the results on all categorical variables were expressed as frequencies and percentages. The continuous measurements are presented as Mean ± SD (Min-Max). Drugs were classified into therapeutic classes using the Anatomical Therapeutic Chemical Classification System with Defined Daily Doses (ATC/DDD) Classification. The data was subsequently described using WHO-core prescribing indicators [19]. This includes the average number of drugs per encounter which was calculated by dividing the total number of drugs prescribed by the total number of eligible encounters, percentage of drugs prescribed by generic name was determined by dividing the number of drugs prescribed by generic names by the total number of drugs prescribed, multiplied by 100, percentage of encounter with antibiotics and injections was calculated by dividing the number of patients encounter with antibiotics or injections prescribed by the total number of eligible prescriptions, multiplied by 100, respectively, and the percentage of drugs prescribed from the Essential Medicine List for children (EMLc) was determined by the number of drugs prescribed from the EMLc divided by total number of drugs prescribed, multiplied by 100.

Index of Rational Drug Prescribing (IRDP) was used to determine the extent to which the prescriptions met the ideal standards of rational prescribing. IRDP consists of five indices derived from the WHO prescribing indicators mentioned above. This index system was developed to measure the performance of healthcare system in terms of drug utilization [20]. It has been used to describe prescribing patterns for children in China [21], India [18], and Nigeria [16]. The WHO prescribing indicators were assigned an optimal index score of one such that the closer to one the calculated index is, the more rational prescribing is assumed to be. The index of polypharmacy was estimated by the percentage of non-polypharmacy prescriptions, with prescriptions containing three medicines or fewer considered as non-polypharmacy. The generic name index and essential medicine index were measured by the percentage of drugs prescribed by generic name and from EMLc, respectively. For the calculation of rational antibiotic and injection safety indices, the following formula was used [18];

$$Index = \frac{\text{Optimal value}}{\text{Observed value}}$$

The IRDP, which has an optimal maximum value of five, was then calculated by adding the five corresponding indices obtained from the results.

3. Results

3.1. Demographic and clinical characteristics of the patients

Of the 259 children included in this analysis, 147 (56.8%) were for males and 112 (43.2%) for females. The majority of the children were infants (57.1%), followed by toddlers and preschool children up to 5 years of age (38.2%). Overall, the mean body weight was 8.2 ± 3.4 kg. A total of 1148 prescribed medications were reviewed from 259 patients who were diagnosed and treated for SARI in the hospital within the study period. A change in the prescription order was required in 34 cases bringing the total number of prescriptions reviewed to 293 prescriptions. Bronchopneumonia was the most common diagnosis among the patients accounting for 56%, followed by unspecified SARI (18.5%) and pharyngotonsillitis (8.9%). Pharyngitis and tonsillitis constitute 5% each of the diagnosis. Table 1 summarizes the demographic and clinical characteristics of the children included in this study.

Table 1. Demographic and clinical characteristics of the patients.

Variable	Frequency	Percentage
Age in years		
<1	148	57.1
1–5	99	38.2
6–10	11	4.2
>10	1	0.4
Sex		
Male	147	56.8
Female	112	43.2
Mean weight (SD)	8.2 ± 3.4	
Diagnosis		
Bronchopneumonia	145	56.0
Lobar pneumonia	5	1.9
Bronchiolitis	9	3.5
Viral croup	3	1.2
Tonsillitis	13	5.0
Pharyngitis	13	5.0
Pharyngotonsillitis	23	8.9
Unspecified ARI	48	18.5

SD: standard deviation; ARI: acute respiratory infection.

3.2. Core prescribing indicators for hospitalized paediatric patients with severe acute respiratory infections

The number of medications per prescription varied among the patients with more than one-thirds (37.9%) receiving four medications per prescription. This was followed by three (26.3%), five (18.1%), two (7.8%), and six (7.8%) medications per prescription. The average number of medicine per prescriptions was 3.9 (SD = 1.1), and the percentage of medicines prescribed by generic name was 82.1%. Less than eighty percent (79%) of the medications were prescribed from the Essential Medicine List for children, and about 99.3% and 99.7% of the prescriptions had at least an injection and antibiotics prescribed, respectively. Table 2 describes the core prescribing indicators for the treatment of SARI among the patients.

3.3. Index of rational drug prescribing (IRDP) among hospitalized severe acute respiratory infections patients

The IRDP as calculated from the component indices in this study was 2.36 which indicates a poor index of rational drug prescribing in pediatric patients with SARI. Injection use, antibiotic prescribing, and polypharmacy had the lowest

Table 2. The core prescribing indicators for the treatment of SARI among the patients.

Prescribing indicator	Value for the hospital	Reference value
Average number of medicines per encounter, (mean ± SD)	3.9 ± 1.1	1.6–1.8
Number of medicines prescribed by generic name, n (%)	942 (82.1)	100.0
Encounter with an antibiotics prescribed, n (%)	292 (99.7)	20.0–25.4
Encounter with an injection prescribed, n (%)	291 (99.3)	10.1–17.0
Percentage of medicines prescribed from EMLc, n (%)	907 (79.0)	100.0

SD: standard deviation; EMLc: essential medicine list for children. Reference values were based on WHO-core prescribing indicators [19].

index score of 0.1, 0.3, and 0.35, respectively, while generic prescribing had the highest index score (0.82). The generic prescribing and essential drug indices were good, while rational antibiotic prescribing and rational injection prescribing were poor. Table 3 depicts the IRDP obtained for the SARI patient prescriptions studied alongside the ideal standard.

Table 3. The calculated indices of rational drug prescribing for SARI patients along with the ideal standards.

Prescribing indicators	Obtained index	Optimal index	Comment
Non-polypharmacy	0.35	1	Fair
Generic prescribing	0.82	1	Good
Rational antibiotic prescribing	0.3	1	Poor
Rational injection prescribing	0.1	1	Poor
Essential drug index	0.79	1	Good
Total	**2.36**	**5**	**Poor**

3.4. Therapeutic classifications of medicines prescribed for severe acute respiratory infections in the facility

Of the 1148 medications prescribed among 259 patients, antibiotics (41.4%), intravenous fluids (20.9%), vitamins and minerals (15.4%), and analgesics (9.1) were the most common medications prescribed among hospitalized children diagnosed with SARI. A total of 475 antibiotics were prescribed to the patients, and the average number of antibiotics per prescription was 1.6 ± 0.53. Majority (58.4%) of the prescriptions had 2 antibiotics, while 39.2% prescriptions contained only one antibiotic. Only 0.3% of the prescriptions had no antibiotics prescribed. Cephalosporins (40.0%), aminoglycosides (34.1%), penicillins (21.5%), and macrolides (2.6%) were the most common classes of antibiotics prescribed among pediatric patients diagnosed with SARI. Overall, gentamicin (34.1%), cefuroxime (21.5%), ceftriaxone (18.3%), amoxicillin-clavulanic acid (17.3%), amoxicillin (3.0%), erythromycin (1.9%), and azithromycin (0.6%) were the most common antibiotics prescribed among the patients. Table 4 shows the classes and types of antibiotics prescribed among hospitalized pediatric patients diagnosed with severe acute respiratory infections

3.5. Antibiotics combination used among hospitalized paediatric patients with severe acute respiratory infections

About 60.5% of the prescriptions contained at least two antibiotics including 58.4% with two antibiotics per prescription and 2.1% with three antibiotics per prescription. Combinations of cephalosporins and aminoglycosides (60.4%), penicillins and aminoglycosides (28.8%), macrolides and aminoglycosides (2.7%), and penicillins and cephalosporins (2.2%) were the most common combinations among dual antibiotic prescriptions. In triple antibiotic therapy, the combinations of cephalosporins, aminoglycosides, and macrolides (2.4%) were the most common. Table 5 shows the distribution of antibiotic combinations used among hospitalized pediatric patients with severe acute respiratory infections.

4. Discussions

The current study evaluated the drug use and the pattern of antibiotic use among hospitalized children diagnosed with SARI. Overall, the index of rational drug prescribing among the patients was poor with poor rating in the rational antibiotic prescribing, and rational injection prescribing domains. However, generic prescribing and essential drug index domains were good. There was a high rate of antibiotic prescribing among the patients, with the majority of the prescriptions involving a combination of antibiotics. WHO-Core prescribing indicators provide an insight into the prescribing

Table 4. Antibiotic use among children hospitalized patients with severe acute respiratory infections.

Variable	Frequency	Percentage
Prevalence of antibiotic prescription	292	99.7
Number of antibiotics per prescription		
0	1	0.3
1	115	39.2
2	171	58.4
3	6	2.1
Classes of antibiotics prescribed ($n = 475$)		
Cephalosporins	190	40
Aminoglycosides	162	34.1
Penicillins	102	21.5
Macrolides	12	2.6
Quinolones	3	0.6
Chloramphenicols	3	0.6
Nitroimidazole	2	0.4
Sulphonamides	1	0.2
Antibiotics prescribed ($n = 475$)		
Gentamicin	162	34.1
Cefuroxime	102	21.5
Ceftriaxone	87	18.3
Amoxicillin-clavulanic acid	82	17.3
Amoxicillin	14	3.0
Erythromycin	9	1.9
Azithromycin	3	0.6
Chloramphenicol	3	0.6
Crystalline-penicillin	3	0.6
Ampicillin-sulbactam	3	0.6
Ciprofloxacin	2	0.4
Metronidazole	2	0.4
Ceftazidime	1	0.2
Co-trimoxazole	1	0.2
Levofloxacin	1	0.2

Table 5. Antibiotic combinations prescribed among hospitalized pediatric patients with severe acute respiratory infections.

Antibiotic combinations prescribed	Frequency ($n = 177$)	(%)
Dual antibiotic combinations		
Cefuroxime + gentamicin	87	49.1
Amoxicillin-clavulanic acid + gentamicin	43	24.3
Ceftriaxone + gentamicin	20	11.3
Amoxicillin + gentamicin	8	4.5
Amoxicillin + ceftriaxone	4	2.2
Erythromycin + gentamicin	3	1.6
Azithromycin + gentamicin	2	1.1
Crystalline-penicillin + chloramphenicol	2	1.1
Metronidazole + erythromycin	1	0.6
Levofloxacin + erythromycin	1	0.6
Triple antibiotic combinations		
Erythromycin + gentamicin + cefuroxime	2	1.2
Erythromycin + gentamicin + ceftriaxone	1	0.6
Azithromycin + gentamicin + cefuroxime	1	0.6
Azithromycin + crystalline-penicillin + ceftriaxone	1	0.6
Co-trimoxazole + gentamicin + ceftriaxone	1	0.6

practice in any health-care facility. The average number of drugs per prescription is an index that provides useful information about the extent of polypharmacy in a facility [15]. More than half of the prescriptions studied contained at least four drugs per encounter; this is an evidence of polypharmacy practice among the pediatric prescribers in the facility. Furthermore, the average number of 3.9 drugs per prescription, being higher than the reference standard of 1.6 to 1.8 is additional evidence of polypharmacy practice in the health-care facility studied [15]. Previous studies among pediatric patients also reported similar high values [16,17]. A much higher value of 5.8–7.9 for average number of drugs per encounter was reported in some studies on drug use pattern in health-care facilities [22–24]. In addition, high rate of medication prescription has been previously reported among older adults in northern Nigeria and this increases the risk of inappropriate prescription [25]. Polypharmacy practice, if not addressed, can lead to increased risk of drug–drug interaction, adverse drug reactions, increased healthcare cost, dispensing errors, reduced medication compliance, and poor quality of life in patients [26]. Therefore, the prescribers should ensure that patients receive drugs appropriate to their clinical needs at the lowest cost using evidence-based practice, while pharmacists should be trained to identify potential and actual drug therapy problems arising from polypharmacy practice.

The index of generic prescribing in this study was 0.82 (82%). Though, less than the WHO reference standard, it is still an encouraging indicator when compared to other similar studies. A study of outpatient children prescriptions in India revealed that only 7.4% of the prescribed drugs were written by generic names [27], while in Nigeria, Abdu-Aguye *et al.* reported that only 57% of the prescribed drugs were written in their generics [28]. The relatively high index of generic prescribing observed in this study could be attributed to better utilization of WHO essential drug list for children, since the facility had no essential drug list at the time of study. This may also suggest minimal influence of pharmaceutical sales representatives who indulge in vigorous product promotion to influence the prescribing habits of doctors. There is, however, a need to improve in order to meet the WHO 100% requirement of generic prescribing since generic prescribing has been known to be much simpler and cheaper than medicines prescribed with brand names, as well as reduce dispensing errors caused by misidentification of prescribed drugs [29,30]. However, the percentage of drugs prescribed from essential medicine list was 79%. EDL is a continuously updated list of drugs that are chosen based on the health-care needs of the majority of the population. The drugs on the list are safe, efficacious, affordable, accessible, and widely available as generics [31]. It is then safe to say that the higher the essential drug index, the more rational the prescribing pattern in a facility. Prescribing from EDL has witnessed tremendous progress in the past decade ever since the adoption and implementation of the WHO essential medicine program in many African countries. The relatively high index of essential drug and generic prescribing observed in this study is quite commendable and should further be encouraged. This trend implies that the doctors in this facility are very much aware and are implementing, to a certain level, WHO's essential medicine program.

The finding that about 99.7% of the prescriptions surveyed contained at least one antibiotic paints an unpleasant picture of antibiotics use in this facility. Globally, there is an increase in the inappropriate use of antibiotics and that calls for urgent interventions to address misuse of antibiotics. A previous study conducted in Northern Nigeria demonstrated a high rate of antibiotic use among hospitalized pediatric patients [32]. Similarly, a study conducted among inpatient children in South-Eastern Nigeria revealed that 86.6% of the prescriptions contained at least one antibiotic [23]. Studies conducted in Ethiopia (77.3%) [33] and India (79%) showed high rates of antibiotic use in pediatrics prescriptions [27]. However, the rate of antibiotic prescriptions in the current study is higher than the rate of antibiotic prescriptions reported in a previous Malaysia study [34]. The high rate of antibiotic prescribing could be due to non-adherence to prescribing guidelines, lack of knowledge among prescribers, and the misperception about the use of antibiotics for the management of viral infections [35]. Even though the disease condition studied was acute respiratory infections in severe form, which will presumably warrant the use of antibiotics, available evidence showed that viruses are the major cause of SARI [36–38]. This implies that the high rate of antibiotic prescription indicates a high rate of antibiotic misuse and this appears to have become a common trend in developing countries as observed in previous studies [18]. The inappropriate use of antibiotics among children with ARI is a global problem, as evident in studies from Indonesia [39], Malaysia [34], Jordan [40] and Saudi Arabia [41,42].

About two-thirds of the prescriptions among the patients contained two or more antibiotics. This is consistent with the finding of a previous multicentre study conducted among inpatients in Northern Nigeria [32]. Evidence has shown that an increasing number of antibiotic prescription is an independent predictors of redundant antibiotic prescription [32]. Redundant antibiotic combinations were observed in the current study such as the combination of cephalosporin and penicillin, although, the duration of the redundant antibiotic therapy was not evaluated. Previous Nigerian studies have demonstrated the prescription of redundant antibiotic combinations among hospitalized patients [32,43]. This highlights an important opportunity for hospital pharmacists to implement antimicrobial stewardship interventions in Nigeria. A previous study from Nigeria showed that pharmacist-led antimicrobial stewardship interventions successfully reduced redundant antibiotic combination among patients who had obstetrics and gynecology surgeries [44]. Available evidence has demonstrated that hospital pharmacists have limited participation in antimicrobial stewardship programs in Nigerian tertiary hospitals [45] and was due to lack of knowledge and training in antimicrobial stewardship [46]. Therefore, training of practicing pharmacists and future pharmacists is recommended to improve pharmacists' involvement in antimicrobial stewardship activities [47,48].

More worrisome in this case, are the classes of antibiotics prescribed among the patients. While the WHO had recommended the use of parenteral amoxicillin (or penicillin) and gentamicin as a first-line treatment for children (2–59 months old) with severe pneumonia [49], this combination was written only in 2.7% of the prescriptions that contained antibiotics. Ceftriaxone, a third-generation cephalosporin, which is only recommended as a second-line treatment in children with severe pneumonia who failed first-line treatment was prescribed in up to 30% of the prescriptions. This departure from the recommended treatment guideline for severe acute respiratory infections in the studied facility may be because of variance in etiological agents of pneumonia in Nigeria and that of other parts of world [50] or the health status of the children at the time of their admission. In addition, the high rate of broad spectrum antibiotic use among the patients raises concern about the emergence of antimicrobial resistance. Therefore, antimicrobial stewardship interventions are recommended to promote rationale use of antibiotics with respiratory tract infections.

The current study demonstrated that the most frequently prescribed classes of antibiotics were cephalosporins, aminoglycosides, and penicillins. Similarly, another Nigerian study demonstrated that cephalosporins, β-Lactam penicillins, and aminoglycosides were the most common antibiotics prescribed [23]. The results of the current study are consistent with the findings from previous studies conducted in Saudi Arabia, where cephalosporins, penicillins, and macrolides were the most common antibiotics prescribed among pediatric inpatients [41]. Another study in a pediatric hospital in Nepal also showed that cephalosporins were the most frequently prescribed antibiotics, followed by penicillins and aminoglycosides [51]. The high rate of broad spectrum antibiotic use among hospitalized children increases the risk of antimicrobial resistance. The excessive and inappropriate use of third-generation cephalosporins is a precursor for the emergence of extended-spectrum beta-lactamase producing Enterobacteriaceae, which is associated with a high mortality rate [52]. Therefore, prescribers and pharmacists should be educated about the rationale use of antibiotics to improve clinical outcomes and prevent adverse events such as resistance and *Clostridium difficile* infection.

This study has a number of limitations that should be considered when interpreting the findings. First, the study was conducted in a single hospital, and the findings may not be generalizable. Secondly, the data was collected through the review of retrospective data, and this may introduce assessment bias. Third, the study did not evaluate the appropriateness of the antibiotic prescriptions and the factors associated with inappropriate antibiotic use. Fourth, laboratory parameters and co-morbidities among the patients were not assessed. Fifthly, WHO indicators were used to assess the rational use of medicines despite being very old and newer indicators are available from the Centers for Disease Control and Prevention. Therefore, future studies should address these limitations.

5. Conclusion

Drug prescribing among hospitalized pediatric patients diagnosed with SARI is far from being rational, especially with regard to polypharmacy, injection, and antibiotics use. However, prescribing within the WHO essential drug list for children and generic prescribing were considerate. There was a high rate of antibiotic use with frequent use of a broad spectrum and a combination of antibiotics. Therefore, prescribers should be trained on the rational use of medicines in children, and antimicrobial stewardship program should be implemented to improve antibiotic use and clinical outcomes among hospitalized pediatric patients diagnosed with severe acute respiratory infections.

Acknowledgments

Open Access funding provided by the Qatar National Library.

Funding

This paper was not funded.

Declaration of interest

The authors have no relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript. This includes employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties.

Reviewer disclosures

Peer reviewers on this manuscript have no relevant financial or other relationships to disclose.

Ethics statement

The study protocol was reviewed and approved by the Health Research and Ethics Review Committee of the Federal Medical Centre, Bida with reference number FCMB/HCS/HREC/APPR/Vol. 1/18/19. All methods were carried out in accordance with relevant guidelines and regulations. The need for written informed consent was waived by the Health Research and Ethics Review Committee of Federal Medical Center Bida due to the retrospective nature of the study. The confidentiality of the participants' data was ensured by assigning study numbers to each folder such that the identity of the patients was not revealed.

Data availability statement

All data generated or analyzed during this study are included in this published article.

Author contribution statement

All authors made substantial contributions to the conception and design of the study and interpreting the findings. All authors were involved in writing the article and revised it for intellectual content.

References

1. Liu L, Johnson HL, Cousens S, et al. Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000. Lancet. 2012;379(9832):2151–61. doi: 10.1016/S0140-6736(12)60560-1
2. Liu L, Oza S, Hogan D, et al. Global, regional, and national causes of child mortality in 2000–13, with projections to inform post-2015 priorities: an updated systematic analysis. Lancet. 2015;385 (9966):430–40. doi: 10.1016/S0140-6736(14)61698-6
3. Williams BG, Gouws E, Boschi-Pinto C, et al. Estimates of world-wide distribution of child deaths from acute respiratory infections. Lancet Infect Dis. 2002;2(1):25–32. doi: 10.1016/S1473-3099(01) 00170-0
4. Byington CL, Enriquez FR, Hoff C, et al. Serious bacterial infections in febrile infants 1 to 90 days old with and without viral infections. Pediatrics. 2004;113(6):1662–6. doi: 10.1542/peds.113.6.1662
5. Rakocevic B, Grgurevic A, Trajkovic G, et al. Severe acute respiratory infection surveillance in Montenegro, 2014– 2017. Curr Med Res Opin. 2018;34(8):1513–7. doi: 10.1080/03007995.2018.1472558
6. Rudan I. Epidemiology and etiology of childhood pneumonia. Bullet World Health Organ. 2008;86(5):408–416. doi: 10.2471/BLT. 07.048769
7. Rudan I, O'brien KL, Nair H, et al. Epidemiology and etiology of childhood pneumonia in 2010: estimates of incidence, severe morbidity, mortality, underlying risk factors and causative pathogens for 192 countries. J Glob Health. 2013;3(1):1–14. doi: 10.7189/jogh.03.010401
8. Nair H, Simões EA, Rudan I, et al. Global and regional burden of hospital admissions for severe acute lower respiratory infections in young children in 2010: a systematic analysis. Lancet. 2013;381 (9875):1380–1390. doi: 10.1016/S0140-6736(12)61901-1
9. Wang Y, Zhu N, Li Y, et al. Metagenomic analysis of viral genetic diversity in respiratory samples from children with severe acute respiratory infection in China. Clin Microbiol Infect. 2016;22(5):. e458.1–.e458.9. doi: 10.1016/j.cmi.2016.01.006
10. Zhang C, Zhu N, Xie Z, et al. Viral etiology and clinical profiles of children with severe acute respiratory infections in China. PloS One. 2013;8(8):e72606. doi: 10.1371/journal.pone.0072606
11. Ouédraogo S, Traoré B, Nene Bi ZA, et al. Viral etiology of respiratory tract infections in children at the pediatric hospital in Ouagadougou (Burkina Faso). PLoS One. 2014;9(10):e110435. doi: 10.1371/journal.pone.0110435
12. Kenmoe S, Tchendjou P, Vernet MA, et al. Viral etiology of severe acute respiratory infections in hospitalized children in Cameroon, 2011–2013. Influenza Resp Viruses. 2016;10(5):386–393. doi: 10. 1111/irv.12391
13. Zhao Y, Lu R, Shen J, et al. Comparison of viral and epidemiological profiles of hospitalized children with severe acute respiratory infection in Beijing and Shanghai, China. BMC Infect Dis. 2019;19(1):1–8. doi: 10.1186/s12879-019-4385-5
14. Chittaganpitch M, Waicharoen S, Yingyong T, et al. Viral etiologies of influenza-like illness and severe acute respiratory infections in Thailand. Influenza Resp Viruses. 2018;12(4):482–489. doi: 10.1111/ irv.12554
15. World Health Organization. How to investigate drug use in health facilities: selected drug use indicators. World Health Org. 1993. [accessed 2024 Jan 21]. https://iris.who.int/bitstream/handle/ 10665/60519/WHO_DAP_93.1.pdf
16. Umar LW, Isah A, Musa S, et al. Prescribing pattern and antibiotic use for hospitalized children in a northern Nigerian teaching hospital. Ann Afr Med. 2018;17(1):26. doi: 10.4103/aam.aam_44_17
17. Cole CP, James PB, Kargbo AT. An evaluation of the prescribing patterns for under-five patients at a tertiary paediatric hospital in Sierra Leone. J Basic Clin Pharm. 2015;6(4):109. doi: 10.4103/0976-0105.168051
18. Atif M, Sarwar MR, Azeem M, et al. Assessment of WHO/INRUD core drug use indicators in two tertiary care hospitals of Bahawalpur, Punjab, Pakistan. J Pharm Policy Pract. 2016;9(1):1–8. doi: 10.1186/ s40545-016-0076-4
19. World Health Organization. Promoting rational use of medicines: core components. Geneva: World Health Organization; 2002.
20. Zhang Y, Zhi M. Index system, appraising method for comprehensive appraisal. J North Jiaotong Univ. 1995;19:393–400.
21. Dong L, Yan H, Wang D. Drug prescribing indicators in village health clinics across 10 provinces of Western China. Fam Pract. 2011;28(1):63–7. doi: 10.1093/fampra/cmq077
22. Adisa R, Fakeye TO, Aindero VO. Evaluation of prescription pattern and patients' opinion on healthcare practices in selected primary healthcare facilities in Ibadan, South-Western Nigeria. Afr H Sci. 2016;15(4):1318–1329. doi: 10.4314/ahs.v15i4.35
23. Anyanwu NC, Arigbe-Osula ME. Pattern of antibiotic use in a tertiary hospital in Nigeria. Eur J Hosp Pharm Sci Pract. 2012;19 (2):195.2–195. doi: 10.1136/ejhpharm-2012-000074.291
24. Babalola CP, Awoleye SA, Akinyemi JO, et al. Evaluation of prescription pattern in Osun state (Southwest) Nigeria. J Public Health Epidemiol. 2011;3(3):94–98.
25. Abubakar U, Tangiisuran B, Kolo M, et al. Prevalence and predictors of potentially inappropriate medication use among ambulatory older adults in Northern Nigeria. Drugs Ther Perspect. 2021;37 (2):94–99. doi: 10.1007/s40267-020-00800-3
26. Duerden M, Avery T, Payne R. Polypharmacy and medicines optimisation. Making it safe and sound. London: The King's Fund; 2013 Nov.
27. Pandey AA, Thakre SB, Bhatkule PR. Prescription analysis of pediatric outpatient practice in Nagpur city. Indian J Community Med. 2010;35(1):70. doi: 10.4103/0970-0218.62564
28. Abdu-Aguye SN, Haruna A, Shehu A, et al. An assessment of antimicrobial prescribing at a tertiary hospital in north-western Nigeria. Afr J Pharmacol Ther. 2016;5(4):229–234.
29. Balkrishnan R, Patel I. Medication error management around the globe: an overview. Indian J Pharm Sci. 2010;72(5):539. doi: 10. 4103/0250-474X.78518
30. World Health Organization. Guidance on the use of international nonproprietary names (INNs) for pharmaceutical substances. Geneva: World Health Organization; 2017.
31. Laing R, Waning B, Gray A, et al. 25 years of the WHO essential medicines lists: progress and challenges. Lancet. 2003;361 (9370):1723–9. doi: 10.1016/S0140-6736(03)13375-2
32. Abubakar U. Antibiotic use among hospitalized patients in northern Nigeria: a multicenter point-prevalence survey. BMC Infect Dis. 2020;20(1):1–9. doi: 10.1186/s12879-020-4815-4
33. Sebsibie G, Gultie T. Retrospective assessment of irrational use of antibiotics to children attending in Mekelle general hospital. Sci J Clin Med. 2014;3(3):46–51.
34. Tham DW, Abubakar U, Tangiisuran B. Prevalence and predictors of antibiotic use among children visiting the emergency department in a tertiary hospital in Malaysia. Eur J Pediatr. 2020;179(5):743–748. doi: 10.1007/s00431-019-03560-z
35. Abubakar U, Salman M. Antibiotic use among hospitalized patients in Africa: a systematic review of point prevalence studies. J Racial Ethn Health Disparities. 2023 May 8; 1–22. doi: 10.1007/s40615-023-01610-9
36. Simusika P, Bateman AC, Theo A, et al. Identification of viral and bacterial pathogens from hospitalized children with severe acute respiratory illness in Lusaka, Zambia, 2011–2012: a cross-sectional study. BMC Infect Dis. 2015;15(1):1–0. doi: 10.1186/s12879-015-0779-1
37. Obasi CN, Barrett B, Brown R, et al. Detection of viral and bacterial pathogens in acute respiratory infections. J Infect. 2014;68 (2):125–30. doi: 10.1016/j.jinf.2013.10.013

38. Assane D, Makhtar C, Abdoulaye D, et al. Viral and bacterial etiologies of acute respiratory infections among children under 5 years in Senegal. Microbiol Insights. 2018;11:1178636118758651. doi: 10.1177/1178636118758651
39. Alkaff RN, Kamigaki T, Saito M, et al. Use of antibiotics for common illnesses among children aged under 5 years in a rural community in Indonesia: a cross-sectional study. Trop Med Int Health. 2019;47(1):1–9. doi: 10.1186/s41182-019-0173-6
40. Ababneh MA, Al-Azzam SI, Ababneh R, et al. Antibiotic prescribing for acute respiratory infections in children in Jordan. Int Health. 2017;9(2):124–30. doi: 10.1093/inthealth/ihx003
41. Mohajer KA, Al-Yami SM, Al-Jeraisy MI, et al. Antibiotic prescribing in a pediatric emergency setting in central Saudi Arabia. Saudi Med J. 2011;32(2):197–8.
42. Al Munjem MF, Thabit AK, Rasool ST, et al. Prescription patterns and antibiotic resistance rates of respiratory tract infections in a Saudi tertiary medical centre. Saudi J Clin Pharm. 2022 Oct 1;1(4):128. doi: 10.4103/sjcp.sjcp_20_22
43. Abubakar U, Syed Sulaiman SA, Adesiyun AG. Utilization of surgical antibiotic prophylaxis for obstetrics and gynaecology surgeries in Northern Nigeria. Int J Clin Pharm. 2018;40(5):1037–1043. doi: 10.1007/s11096-018-0702-0
44. Abubakar U, Syed Sulaiman SA, Adesiyun AG, et al. Impact of pharmacist-led antibiotic stewardship interventions on compliance with surgical antibiotic prophylaxis in obstetric and gynecologic surgeries in Nigeria. PLoS One. 2019;14(3):e0213395. doi: 10.1371/journal.pone.0213395
45. Abubakar U, Tangiisuran B. Nationwide survey of pharmacists' involvement in antimicrobial stewardship programs in Nigerian tertiary hospitals. J Glob Antimicrob Resist. 2020;21:148–53. doi: 10.1016/j.jgar.2019.10.007
46. Abubakar U, Sha'aban A, Mohammed M, et al. Knowledge and self-reported confidence in antimicrobial stewardship programme among final year pharmacy undergraduate students in Malaysia and Nigeria. Pharm Educ. 2021;21:298–305. doi: 10.46542/pe.2021.211.298305
47. Abubakar U, Muhammad HT, Sulaiman SA, et al. Knowledge and self-confidence of antibiotic resistance, appropriate antibiotic therapy, and antibiotic stewardship among pharmacy undergraduate students in three Asian countries. Curr Pharm Teach Learn. 2020;12(3):265–273. doi: 10.1016/j.cptl.2019.12.002
48. Abubakar U. Practices and perceptions of Nigerian community pharmacists toward antimicrobial stewardship program. Int J Pharm Pharm Sci. 2020;37–42. doi: 10.22159/ijpps.2020v12i4.36505
49. World Health Organization. Revised WHO classification and treatment of childhood pneumonia at health facilities: evidence summaries. Geneva: World Health Organization; 2014.
50. Olowu A, Elusiyan JB, Esangbedo D, et al. Management of community acquired pneumonia (CAP) in children: clinical practice guidelines by the Paediatrics Association of Nigeria (PAN). Niger J Paediatr. 2015;42(4):283–92. doi: 10.4314/njp.v42i4.1
51. Palikhe N. Prescribing pattern of antibiotics in pediatric hospital of Kathmandu valley. J Nepal Health Res Counc. 2004;2(2): 31–36.
52. Abubakar U, Tangiisuran B, Elnaem MH, et al. Mortality and its predictors among hospitalized patients with infections due to extended spectrum beta-lactamase (ESBL) Enterobacteriaceae in Malaysia: a retrospective observational study. Future J Pharm Sci. 2022;8(1):17. doi: 10.1186/s43094-022-00406-8