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RESEARCH ARTICLE

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Point prevalence survey of antibiotics use among hospitalised neonates and children in Saudi Arabia: findings and implications

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ABSTRACT

Background: Neonates and children are more susceptible to a variety of infections, leading to frequent antibiotic prescriptions. However, the inappropriate use of antibiotics leads to antibiotic resistance and higher mortality rates. Therefore, this study aimed to determine the prevalence of antibiotic use, and current antibiotic prescribing practices among neonates and children admitted in the selected hospitals of Saudi Arabia.

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Methods: A cross-sectional study was conducted from September to November 2023 to assess the prevalence of antibiotic use, and the current antibiotic prescribing practices across six hospitals of Saudi Arabia.
Results: The study included 499 children and neonates, with 94.6% receiving antibiotic prescriptions. The most frequently prescribed antibiotic class was third-generation cephalosporin (31.5%), with ceftriaxone being the most commonly prescribed antibiotic (15%). The majority of patients were prescribed one antibiotic (81.4%), and the intravenous route (96.4%) was the primary route for administration. The majority of patients were prescribed antibiotics empirically (69.7%), and community-acquired infections (64.2%) were the most common type of infection for antibiotic prescription. Similarly, sepsis (39.2%) was the most common indication for antibiotics, and the majority of prescribed antibiotics (61.7%) belonged to the 'Watch' category as per WHO AWaRe classification.
Conclusion: Our study revealed excessive antibiotic consumption in neonates and children, therefore quality improvement programmes including antimicrobial stewardship programmes are urgently needed to address ongoing issues.

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KEYWORDS Antibiotics; children; point prevalence survey; Saudi Arabia; antimicrobial resistance; AWaRe classification

Background

Since the discovery of penicillins in 1940, antibiotics have emerged as an effective treatment option for a wide range of bacterial infections (Gaynes, 2017; Lobanovska & Pilla, 2017). Antibiotics not only play a crucial role in saving countless lives worldwide but also play a valuable role in advancing standards in medicine and surgery (Ventola, 2015). Similarly, antibiotics have proved to be beneficial in treating infections associated with chronic diseases such as cancers, end-stage renal diseases, diabetes millets, and rheumatoid arthritis, as well as complex surgeries i.e. joint replacements, cardiac surgeries, and organ transplants (Akbari et al., 2017; Aslam et al., 2018; Bazaid et al., 2022; Chan et al., 2020; Thomas & Vassilopoulos, 2020).

Infections caused by bacteria resistant to current antibiotics are spreading rapidly, thereby posing a serious health concern (Prestinaci et al., 2015). Antimicrobial resistance (AMR) is among the top ten global health threats, which not only increases morbidity and mortality but also imposes a substantial burden on the healthcare system (Godman et al., 2021; *World Health Organization (WHO). Antimicrobial Resistance (AMR); World Health Organization: Geneva, Switzerland, 2020*). In 2019, AMR resulted in more than 4.95 million global deaths, of which 1.27 million deaths were directly attributed to AMR (Murray et al., 2022). Similarly, according to the estimates of the Centers for Disease Control and Prevention (CDC), AMR accounts for an annual loss of

55 billion dollars in the United States alone (Dadgostar, 2019). Therefore, failure to promptly address the alarmingly increasing issue of AMR, could lead to more than 10 million deaths, and a 3.8% reduction in Gross Domestic Product per country by the year 2050 (Laxminarayan et al., 2020; O'Neill, 2016; World Bank Group. Pulling Together to Beat Superbugs Knowledge and Implementation Gaps in Addressing Antimicrobial Resistance. 2019).

AMR is a natural phenomenon; however, its development is primarily driven by the misuse and overuse of antibiotics, along with poor infection prevention and control measures (Michael et al., 2014; Prestinaci et al., 2015; *World Health Organization (WHO). Antimicrobial Resistance (AMR); World Health Organization: Geneva, Switzerland, 2020*). Hospitalised patients are highly vulnerable to AMR due to the excessive and prolonged use of antibiotics (Walsh et al., 2023). It is estimated that a substantial percentage of antibiotics ranging from 20–50% are inappropriately prescribed within the hospital settings (Cooper et al., 2020; Mwita et al., 2021).

In Saudi Arabia, higher rates of AMR have been recorded including outbreaks of various infectious diseases. A study conducted in Riyadh revealed a considerable rate of AMR, showing low susceptibility of *Acinetobacter baumannii* to meropenem and imipenem i.e. 64% and 81.2% susceptibility in 2006, while 8.3% and 11% susceptibility in 2012, respectively (Al-Obeid et al., 2015). Other studies have also indicated that antibiotics are frequently and inappropriately prescribed to hospitalised patients with upper respiratory tract infections which rarely require antibiotics (Neyaz et al., 2011; Olwi & Olwi, 2021). Similarly, literature indicated that children are at a greater risk of developing bacterial infections, hence antibiotics are frequently prescribed and are considered as one of the common drugs prescribed to neonates and children (Woll et al., 2018; Youngster et al., 2017). One study conducted in Saudi Arabia found that 58.1% of children were inappropriately using antibiotics, 58.3% were using antibiotics without a prescription, and 51.2% were using two antibiotics at the same time (Almughais et al., 2023). Apart from that, Saudi Arabia serves as a focal point for the annual pilgrimage of approximately 2–3 million pilgrims for Hajj and Umrah (Taibah et al., 2020). This significant influx of travellers from around the world may consequently increase the risk of the spread of various infectious diseases including resistant bacteria. Therefore, this issue cannot be overlooked as it poses a significant health challenge in the form of the spread of AMR.

Following the goals of the WHO global action plan in combating AMR, Saudi Arabia developed its national action plan in 2017 (Ministry of Health. *Kingdom Saudi Arabia national action plan on combating antimicrobial resistance*; *World Health Organization (WHO). Global Action Plan on Antimicrobial Resistance*). Additionally, the WHO has devised a new.

methodology 'point prevalence survey (PPS)' to document the prevalence of antimicrobial use and patterns in hospital settings (*World Health*

Organization (WHO). Essential Medicines and Health Products. WHO Methodology for Point Prevalence Survey on Antibiotic Use in Hospitals. 2018). PPS is a proven, robust, and standardised methodology to acquire baseline information on antibiotic prescribing patterns in hospital settings in a specific time frame to develop future quality improvement programmes including antimicrobial stewardships (Rehman et al., 2018; Saleem et al., 2020; Versporten et al., 2018; *World Health Organization (WHO). Essential Medicines and Health Products. WHO Methodology for Point Prevalence Survey on Antibiotic Use in Hospitals. 2018*). Similarly, WHO has also introduced the AWaRe (Access, Watch, and Reserve) classification of antibiotics to promote its rational use and combat AMR (Hsia et al., 2019; Sharland et al., 2018).

Given the role of antibiotic prescribing patterns in hospital settings for developing quality improvement programmes including antimicrobial stewardship programmes. Most of the point prevalence studies reported from Saudi Arabia are predominantly conducted in adults (Al-Tawfiq & Al-Homoud, 2020; Al Matar et al., 2019; AlMahasnah et al., 2023; Haseeb et al., 2023; Haseeb et al., 2022). Therefore, this study aimed to conduct a PPS among neonates and children admitted to different hospitals in Saudi Arabia to determine the prevalence of antibiotic use, document antibiotic prescribing practices, and provide a standardised tool for hospitals to identify gaps and the need for quality improvement.

Methods

Study design and duration

A PPS that involved children and neonates was conducted from September to November 2023 across six government hospitals in Saudi Arabia. No formal sample size calculation was performed, rather a random convenient sampling technique was used for this study. The included hospitals were located in different cities of Saudi Arabia i.e. Makkah, Riyadh, Alkhobar, and the Southern region of Saudi Arabia.

Setting of study

The data was collected from paediatric wards during the study duration from all six hospitals selected for this study namely King Fahad Medical City (H1), King Fahad University Hospital (H2), Maternity and Children Hospital (H3), Al Yamamah Hospital (H4), Dr. Sulaiman Al Habib Rayan hospital (H5) and Armed Forces Hospital – Southern Region (H6).

Study procedure

For this PPS data were collected by a team of investigators that comprised of health care professionals including physicians, clinical/hospital pharmacists, and nurses working in health care settings. In order to carry out the study in a very professional and appropriate manner the principal investigator provided a two-day training session to all the investigators involved in this study before commencing the survey regarding data collection. The team of investigators visited the selected hospitals to collect data on the predesigned data collection form at three levels, i.e. Section I, Section II, and Section III.

Section I of the data collection form. In this section of the data collection form, information about the hospitals was collected including the type of hospitals either government or private hospitals, secondary or tertiary healthcare settings, the number of functional beds in paediatric units, and the availability of antibiotics.

Section II of the data collection form. This section comprised information related to the children's ward, sub-wards, and the number of functional beds in each unit.

Section III of the data collection form. This section encompasses patient-related details, demographic characteristics such as gender, reasons for hospitalisation, diagnoses, and specifics of any surgical procedures performed during hospitalisation. It also includes information regarding antibiotic usage, whether for therapeutic or prophylactic purposes. Moreover, details about the type of prophylactic antibiotic used, whether for medical or surgical purposes, were documented. The route of administration for each prescribed antibiotic, along with its stop date/time, information regarding the quality of prescribing with regards to the presence or absence of guidelines, guideline concordance, and the rationale behind the antibiotic prescription as noted in patients' medical records, were recorded by the investigators. Additionally, this section involves information concerning the Anatomical Therapeutic Chemical Classification (ATC) (Tayebati et al., 2017) and the AWaRe classification of antibiotics developed by the WHO (Hsia et al., 2019).

Patients, clinicians, and health facility staff were not interviewed, only the investigation team was engaged to monitor records. They were only involved when retrieval of any missing record was deemed necessary.

Inclusion and exclusion criteria

The study's inclusion criteria encompassed children and neonates of all ages hospitalised before or at 08:00 am on the days of the PPS, regardless of whether they were receiving antibiotics. Additionally, eligible patients needed to have complete medical records and antibiotic therapy initiated by 08:00 am on the survey day. On the contrary, patients visiting emergency departments, outpatients for short visits, and individuals in nursing homes, rehabilitation centres, and psychiatric facilities were not included in this PPS. Moreover, patients whose antibiotics were prescribed after 8:00 am on the day of the survey were excluded from this study.

Data analysis

For data analysis, Statistical Package for the Social Sciences (SPPS) version 22® was used. Since the data comprised categorical variables, we presented it in terms of frequencies and percentages.

Ethical considerations

The study received ethics approval from the Institutional Review Board of the respective hospital. Patient data were treated confidentially, as they were extracted from medical records.

Results

The survey of antibiotic usage in a children's ward at 8:00 am included 499 children and neonates. Among the six selected hospitals, all the hospitals were secondary were secondary care hospitals except H1, which is a tertiary care hospital. Of these hospitals 436 (87.7%) patients were at Secondary care hospitals while 63 (12.6%) were at tertiary care hospitals. The majority (94.6%) of these patients were prescribed antibiotics at the time of the survey. A total of 63% of the doses of antibiotics adhered to the recommended antibiotic guidelines or indications. Out of the total patients, males accounted for the majority (57.1%) of the patients, and the majority (81.4%) received only one antibiotic, while the intravenous route was the primary route (96.4%) for administration. Medical subspecialty was predominant, with 52.3% of patients followed by ICU (42.4%). Community-acquired infections were the most common indication for antibiotic prescription in the patients. The majority of the patients (69.7%) were prescribed antibiotics empirically as compared to the targeted therapy (as shown in Table 1).

Figure 1, illustrates the indications for antibiotic prescriptions among patients. Sepsis emerged as the predominant indication across 3 hospitals i.e. H3, H4, and H5; while antibiotics prescribed for prophylaxis against medical issues ranked second most common across all hospitals. Conversely, the utilisation of antibiotics for indications like urinary tract, gastrointestinal, and skin/soft tissue infections was minimal (as shown in Figure 1).

Antibiotics prescribed according to the ATC class and subclass are shown in Table 2. Third-generation cephalosporins, carbapenems, and aminopenicillins were the most commonly prescribed classes of antibiotics. The top three most commonly prescribed antibiotics were ceftriaxone (n = 75), cefotaxime (n = 67), and meropenem (n = 66) (as shown in Table 2).

The WHO AWaRe classifies antibiotics into three stewardship groups: 'Access', 'Watch', and 'Reserve' to emphasise the importance of their

Table 1. General characteristics of surveyed patients.

	H1 (*n*)	H2 (*n*)	H3 (*n*)	H4 (*n*)	H5 (*n*)	H6 (*n*)	Total *n* (%)
Total patients in children ward at 8:00 am	64	99	138	83	54	61	499 (100)
No. of patients using antimicrobials on the day of survey							
No antibiotics	9	14	1	3	0	0	27 (5.4)
Yes antibiotics	55	85	137	80	54	61	472 (94.6)
Gender							
Male	40	56	79	44	34	32	285 (57.1)
Female	24	43	59	39	20	29	214 (42.9)
Age							
Neonates (0–28 days)	18	11	18	13	8	0	68 (13.6)
Infants (29 days–1 year)	15	26	32	25	13	22	133 (26.7)
Young child (>1–5 years)	15	32	42	34	20	18	161 (32.3)
Child (>5–12 years)	16	30	46	11	13	21	137 (27.5)
No. of antibiotics per patient							
One antibiotic	33	84	75	80	51	61	384 (81.4)
Two antibiotics	19	1	61	0	3	0	84 (17.8)
Three antibiotics and more	3	0	1	0	0	0	4 (0.8)
Route of administration of antibiotics							
IV	50	77	137	77	54	60	455 (96.4)
Oral	5	8	0	3	0	1	17 (3.6)
Subspecialty							
Medical	9	45	63	60	9	61	247 (52.3)
Surgical	13	12	0	0	0	0	25 (5.3)
ICU	33	28	74	20	45	0	200 (42.4)
Indications							
Therapeutic	29	74	137	80	51	61	432 (91.5)
Prophylaxis	26	11	0	0	3	0	40 (8.5)
Indications for prophylaxis							
Medical	27	3	1	0	1	60	92 (77.3)
Surgical	15	9	0	0	3	0	27 (22.7)
Indication of infection							
Community-acquired	32	67	54	75	43	32	303 (64.2)
Hospital-acquired	23	18	83	5	11	29	169 (35.8)
Stop date							
No	13	31	0	36	30	0	110 (23.3)
Yes	40	55	137	45	24	61	362 (76.7)
Types of therapy							
Empirical	43	77	59	78	38	34	329 (69.7)
Targeted	11	8	79	2	16	27	143 (30.3)

IV: intravenous; ICU: intensive care unit, H1: King Fahad Medical City; H2: King Fahad University Hospital; H3: Maternity and Children Hospital; H4: Al Yamamah Hospital; H5: Dr. Sulaiman Al Habib Rayan hospital; H6: Armed Forces Hospital – Southern Region

optimal uses and potential for AMR. The distribution of antibiotics according to AWaRe classification and general characteristics of patients are shown in Table 3. Our study findings showed that the majority of the antibiotics were from the 'Watch' group as per WHO AWaRe classification.

Discussion

PPS plays a vital role in healthcare settings as they provide valuable insights into current patterns of antimicrobial use and adherence to prescribing guidelines (Pauwels et al., 2021; Saleem et al., 2020). These studies generate

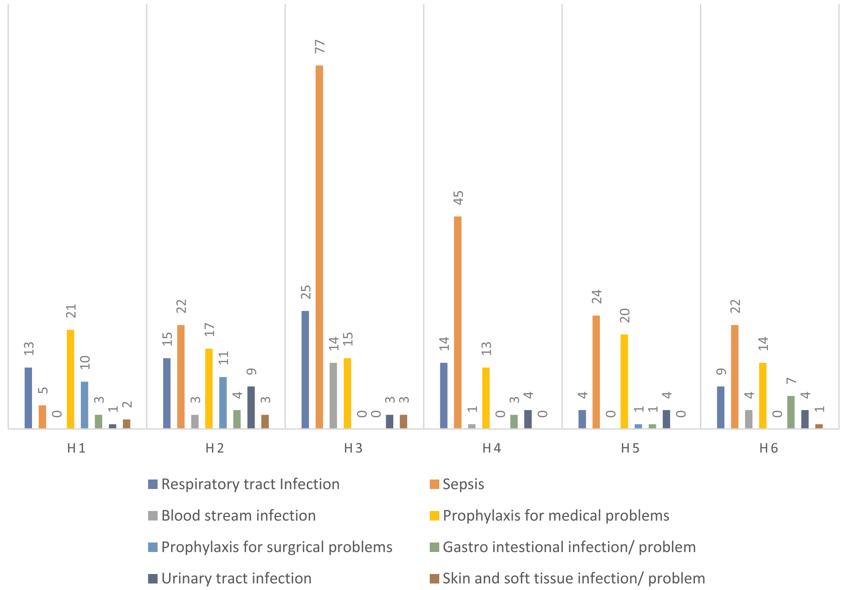

Figure 1. Comparison of antibiotic indication in different hospitals of the study.

scientific evidence that informs decision-making regarding the rational and appropriate use of antimicrobials for both treatment and prophylaxis at all levels of healthcare settings (Jing et al., 2024). Furthermore, these studies aid in designing targeted strategies to reduce the incidence of infectious diseases and plan for future prevention efforts by identifying areas for improvement and guiding the development of interventions, such as antimicrobial stewardship programmes, for optimising antibiotic use and combating AMR. Such studies are of utmost importance in countries including Saudi Arabia, where the burden of infectious diseases is constantly on the rise.

The findings from our PPS conducted in selected hospitals revealed a high prevalence of antibiotic usage among children and neonates, reaching 94.6%. In comparison to other studies, our results indicate a higher prevalence of antibiotic use, exceeding that of Botswana (70.6%) (Anand Paramadhas et al., 2019), Pakistan (75%) (Ambreen et al., 2023), Kenya (46%) (Omulo et al., 2022), Greece (40%) (Osowicki et al., 2015) and Australia (46%) (Gkentzi et al., 2019). Similarly, within our study, antibiotic usage was notably elevated in the medical subspecialty paediatric unit, at 52.3%, and in the ICU, at 42.4%. This contrasts with findings from other studies, where antibiotic utilisation was reported to be higher in the ICU, ranging from 99% (Ambreen et al., 2023), 62% (Prusakov et al., 2021), 78.5% (Wang et al., 2021). The heightened use of antibiotics among children and neonates in the ICU and medical subspecialty units may be attributed to the critical

Table 2. Details of prescribed antibiotics according to anatomical therapeutic chemical (ATC).

ATC class	Name of antibiotics (ATC code)	AWaRe Classification	Frequency (*n*)					
			H1	H2	H3	H4	H5	H6
First-generation cephalosporins	Cefazolin (J01DB04)	Access	9	8	0	0	1	0
Fourth-generation cephalosporins	Cefepime (J01DE01)	Watch	1	0	1	0	0	0
Third-generation cephalosporin	Ceftriaxone (J01DD04)	Watch	2	17	22	10	3	21
	Cefotaxime (J01DD01)	Watch	10	6	23	13	14	1
	Ceftazidime (J01DD02)	Watch	0	0	0	0	2	1
	Cefixime (J01DD08)	Watch	3	2	0	0	0	0
	Cefuroxime (J01DC02)	Watch	3	1	1	1	1	0
Carbapenems	Meropenem (J01DH02)	Watch	5	9	34	8	5	5
Aminopenicillins	Ampicillin (J01CA01)	Access	1	7	10	21	12	3
Piperacillin and enzyme inhibitor	Piperacillin + enzyme inhibitor (J01CR05)	Watch	5	1	20	1	1	2
Glycopeptide antibacterials	Vancomycin (J01XA01)	Watch	1	8	5	8	5	6
Aminoglycoside	Gentamycin (J01GB03)	Access	3	3	13	10	2	3
	Amikacin (S01AA21)	Access	1	0	3	0	0	6
Macrolides	Azithromycin (J01FA10)	Watch	0	6	0	4	1	3
Imidazole derivatives	Metronidazole (J01XD01)	Access	0	0	0	0	0	2
Amoxicillin and beta-lactamase inhibitor	Amoxicillin + beta-lactamase inhibitors (J01CR02)	Access	5	6	0	1	2	1
Lincosamides	Clindamycin (J01FF01)	Access	1	5	0	2	0	1
Sulfonamides and trimethoprim	Sulfamethoxazole + trimethoprim (J01EE01)	Access	1	5	3	0	4	0
Beta-lactamase resistant penicillins	Flucloxacillin (J01CF05)	Access	0	0	0	0	0	4
Fluoroquinolones	Ciprofloxacin (J01MA02)	Watch	0	2	1	0	0	1
Other antibacterials	Linezolid (J01XX08)	Reserve	2	0	0	1	2	1

ATC Code: Anatomical Therapeutic Chemical; H1: King Fahad Medical City; H2: King Fahad University Hospital; H3: Maternity and Children Hospital; H4: Al Yamamah Hospital; H5: Dr. Sulaiman Al Habib Rayan hospital; H6: Armed Forces Hospital – Southern Region

health status of patients, the presence of severe infections, and concurrent medical conditions (Arif et al., 2021; Saleem et al., 2020).

In our study, (81.4%) of the patients received only one antibiotic, which is aligned with other studies that reported the use of one antibiotic in 54.6% (Levy Hara et al., 2022), 53% (Omulo et al., 2022), and 39.9% (Gandra et al., 2018). However, findings from Italy, showed higher percentages of children presented with two or more than two antibiotics on the day of PPS (Tersigni et al., 2019), 53.4% (Gandra et al., 2018). Our study showed that the majority of the antibiotics were prescribed as empirical therapy rather than targeted therapy and in our study 64.2% of the antibiotics were prescribed for community-acquired infections. The use of antibiotics in our study was empirical without results of microbiologic or other examinations to guide treatment, which is similar to the findings of another study (Horumpende et al., 2020). The most common indication of higher use of antibiotics in our study patients was sepsis followed by prophylaxis against medical problems. Our study

Table 3. Details of prescribed antibiotics according to WHO AWaRe classification.

	Access (*n*)	Watch (*n*)	Reserve (*n*)
Gender			
Male	100	172	4
Female	58	136	2
No. of antibiotics per patient			
One antibiotic	130	249	4
Two antibiotics	27	55	2
Three antibiotics and more	0	4	0
Route of administration of antibiotics			
IV	150	298	6
Oral	7	10	0
Subspecialty			
Medical	72	172	3
Surgical	18	7	0
ICU	67	129	3
Indications			
Therapeutic	133	293	5
Prophylaxis	24	15	1
Indications for prophylaxis			
Medical	33	57	2
Surgical	19	7	1
Indication of infection			
Community-acquired	102	196	4
Hospital-acquired	55	112	2
Types of therapy			
Empirical	115	210	3
Targeted	42	98	3
Hospitals			
H1	21	31	2
H2	33	52	0
H3	29	108	0
H4	34	45	1
H5	20	32	2
H6	20	40	1

findings were different from other studies in which the common indications for antibiotics prescription were respiratory, bloodstream infections, and prophylaxis use in medical illness and surgical processes (D'Amore et al., 2021; Zia Ul Mustafa et al., 2022a, 2022b). While other studies reported excessive use of antibiotics for prophylaxis for medical problems at 56.1% (Hufnagel et al., 2019), and 66% (Amadeo et al., 2010).

According to the ATC, third-generation cephalosporins, carbapenems, and aminopenicillins emerged as the most frequently utilised antibiotics among the patients in our study. Our findings are consistent with previous research, where third-generation cephalosporins (46.6%) were the primary antibiotics prescribed, followed by macrolides (20.5%) and penicillin/β-lactamase inhibitors (16.2%) (Wang et al., 2021). Similarly, in another study, amoxicillin/clavulanate was identified as the most commonly used antibiotic, followed by ceftriaxone, a third-generation cephalosporin (Omulo et al., 2022). However, another study indicated that the most common antibiotics prescribed were cefazolin and amoxicillin/clavulanate

(Nebot et al., 2022). A study from China documented that the top three antibiotics prescribed to neonates were meropenem (11.8%), penicillin G (10.8%), and latamoxef (9.9%) (Zhang et al., 2024); furthermore, third-generation cephalosporins (38.4%) were the predominant antibiotic class prescribed (Zhang et al., 2022).

As far as antibiotic prescribing according to WHO AWaRe classification is concerned, the majority of antibiotics were prescribed from the 'Watch' group, followed by the 'Access' group. Higher use of antimicrobials in the watch group can be challenging as globally this group of antibiotics is most frequently prescribed both for therapeutic and prophylactic purposes (Pauwels et al., 2021). These findings are in contrast to the findings from studies conducted in Canada and South Africa, where most prescribed antibiotics belonged to the Access group (Nebot et al., 2022; Skosana et al., 2022). Another study indicated that, according to the WHO AWaRe classification, antibiotics were categorised as Access (14.5%), Watch (70.4%), and Reserve (1.5%) (Wang et al., 2021). Additionally, 80.4% of antibiotics were classified under the Watch group in a separate study (Zia Ul Mustafa et al., 2023). Key factors such as cultural practices and insufficient awareness, comprehension, and training regarding the issue of antimicrobial resistance are likely to exert significant influence on prescribing patterns (Touboul-Lundgren et al., 2015). Information regarding AWaRe classification must be communicated to all prescribers and posted on a wall to assist the prescribers. while doing prescriptions for antibiotics. Furthermore, a proper antimicrobial stewardship programme should be in place in relevant hospitals to give proper training to the prescribers to reduce the use of empirical antibiotics along with restriction to the use of broad-spectrum antibiotics to tackle the giant of antibiotic resistance.

In our study, the use of antibiotic prescription was higher in patients admitted to Medical and ICU, community-acquired infection, and empirical therapy. The possible reason for higher antibiotic usage among children and neonates in the ICU units may be attributed to the critical health status of patients, the presence of severe infections, and concurrent medical conditions (Arif et al., 2021; Saleem et al., 2020). In our study antibiotics were used empirically without confirming the results through culture & sensitivity testing. Our findings are in contrast to the findings from a study from the USA where the majority of the study population was prescribed antibiotics after consulting culture & sensitivity testing (Ho et al., 2018). The empirical use of antibiotics may also lead to antimicrobial resistance (Gupta et al., 2003; Muller-Pebody et al., 2011; Tripathi et al., 2012).

Strength and limitations

We are aware of several limitations associated with our survey. Firstly, we gathered data only from six hospitals in Saudi Arabia, therefore the finding of our study may not be generalised to the entire hospitalised neonates and children in the country. The strength of this study is that it is the first kind of study conducted among neonates and children in Saudi Arabia, we believe that our findings will provide robust information to the policymakers/ health authorities and healthcare providers to develop and implement effective paediatric antimicrobial stewardship programme through improved antibiotics prescribing guidelines.

Conclusions

This study demonstrates the high prevalence of antibiotic use among neonates and children admitted to the surveyed hospitals. Empirical use of antibiotics was frequent and a majority of the antibiotics were prescribed from the 'Watch' group. Hence, necessitates a robust mechanism and stringent antimicrobial stewardship programme for the appropriate use of antimicrobials among neonates and children in Saudi Arabia.

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Author contributions

Conceptualisation, HMA, MMF, MSA and MKA; methodology, HMA, MMF, MSA, TJA, AHN, KHH and HHH; software; AHN, KHH and HHH; validation: MDA, ASA and AAA; formal analysis: HHH, MDA, ASA, AAA, AAA and MKA; investigation: HMA, MMF, MSA and MKA; resources: HMA, MMF, MSA and MKA; data curation: HMA, MMF, MSA, TJA, AHN, KHH, HHH, MDA, ASA, AAA, AAA and MKA; writing – original draft preparation: MDA, ASA, AAA, AAA and MKA; writing – review and editing: MSA, TJA, AHN, KHH and HHH; visualisation: MDA, ASA, AAA, AAA and MKA; supervision: TJA, AHN, KHH and HHH; project administration: TJA, AHN, KHH and HHH and funding acquisition: HMA, MMF, MSA and MKA. All authors have read and agreed to the published version of the manuscript.

Data availability statement

Available on reasonable request from the corresponding authors.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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