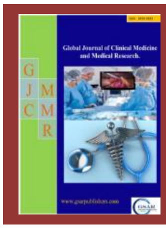

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The pattern of empirical and targeted antibiotic use in hospitalised pediatric patients at a tertiary health facility

By

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Abstract

Background: *Children in sub-Saharan Africa have high infection burden, leading to prevalent empirical antibiotic use, a driver for antibiotic resistance.*

Aim and objectives: *This study assessed outcomes of empirical and targeted antibiotic therapy on symptom resolution in hospitalised paediatric patients at Tamale Teaching Hospital (TTH).*

Methods: *A cross-sectional study assessed the proportion of empirical and targeted antibiotic use among paediatric patients with bacterial infections and treatment outcomes. Fisher's exact test was used to statistically analyse the data.*

Results: *The 371 participants were mostly males (62.0%), with a median age of 1.08 years (range 0.08-12 years). The prevalent infections were gastrointestinal infections (34.2%) and pneumonia (31.8%), with culture and sensitivity testing (CST) requests ($p<0.001$) being common in sepsis, UTIs, and CNS infections. The 640 antibiotics prescribed, mainly cephalosporins (47.8%) and penicillins (21.6%), consisted of 55.0% Access antibiotics and 45% Watch antibiotics. Overall, CST findings were used for targeted therapy in 4.9% of participants. The most prevalent bacterial isolates were Acinetobacter baumanni and Klebsiella pneumoniae, both of which are multidrug-resistant. At the end of antibiotic treatment, the proportion of patients who had symptom resolutioon was higher in those who received targeted therapy compared to those who received empiric antibiotic use, but this difference was not statistically significant.*

Conclusion: *Antimicrobial stewardship at TTH should emphasise the use of local antibiograms to optimise pharmacotherapy.*

Keywords: *empirical, targeted, AWaRe antibiotics, antibiotic resistance, culture and sensitivity test.*

Introduction

Antibiotic resistance (ABR) largely results from the misuse of antibiotics in humans and animals. Globally, sub-Saharan Africa has the highest death rate (23.7 per 100,000 people) attributable to ABR (Murray et al., 2022). The high burden of ABR-related outcomes in sub-Saharan Africa is mainly due to the high prevalence of infectious diseases within this population, which often leads to the use of antibiotics even for infections of non-bacterial origin. It is reported that children in this population experience infectious diseases more frequently than adults due to immature immune systems (Amponsah et al., 2021; Opare-Asamoah et al., 2021). Therefore, they are at a higher risk of infections requiring antibiotics. The high infection burden in children results in increased antibiotic use among this group, which is mostly empirical, without culture and sensitivity testing (Amponsah et al., 2021; Escadafal et al., 2020). However, most community-acquired infections (CAIs) are self-limiting and do not require antibiotic treatment (Sono et al., 2023; Lubanga et al., 2025).

In low- and middle-income countries (LMICs), including Ghana, most caregivers send their children to community pharmacies and over-the-counter (OTC) medicine outlets, due to their accessibility and relative affordability compared to going to clinics and hospitals, where suspected infections may be treated with affordable antimicrobials, mostly of the WHO *Access* antibiotic group (Ngyedu et al., 2023; Akpan et al., 2021; Bayot and Bragg, 2024). The children are later sent to health facilities in the case of treatment failure or worsening of symptoms, where higher antibiotics, mostly WHO *Watch* antibiotics, may be used without microbiological findings (Alavudeen et al., 2021). The prevalent practice of empirical antibiotic use is a major driver of ABR (Escadafal et al., 2020; Alavudeen et al., 2021; Shimelis et al., 2020; WHO, 2022).

Due to differences in the availability of diagnostic tools across regions and health facilities (i.e., from the primary health facilities to the quaternary health facilities) (Shimelis et al., 2020), empiric use of antibiotics is mostly recommended based on clinical signs and symptoms (Opare-Asamoah et al., 2021; WHO, 2022). Nevertheless, antimicrobial stewardship (AMS) programmes recommended the empirical use of antibiotics backed by antibiograms or targeted antibiotic use supported by culture and sensitivity testing (Pauwels et al., 2025; Opare-Asamoah et al., 2023). However, irrational use of antibiotics, a common occurrence in hospitals, is a global public health problem (Garcia-Vello et al., 2020), where antibiotics are used in low-risk patients with mild infections that do not need antibiotic treatment (Opare-Asamoah et al., 2023; WHO, 2022). Patients with mild infections mostly do well upon receiving symptomatic management. In addressing the global threat posed by antimicrobial resistance (AMR), the WHO AWaRe antibiotic classification requires that *Watch* antibiotics become the primary focus of AMS programs as first-line options for patients with more severe clinical cases or for infections where the causative pathogens are more likely to resist *Access* antibiotics, such as upper urinary tract infections (UTIs) (WHO, 2022).

The propensity to use antibiotics more in children is due to associating fever in children mostly with bacterial infections, which is a major contributory factor for the development and spread of ABR (Escadafal et al., 2020; Shimelis et al., 2020; Amaha et al., 2019). There is reported resistance of clinical bacterial isolates to commonly used antibiotics in Ghana (Labi et al., 2021), which calls for antibiotic use backed by culture susceptibility findings. However, there is a paucity of literature on antibiotic use in children, backed by an antibiogram and microbiological susceptibility findings for empirical and targeted antibiotics use in northern Ghana. This study, therefore, assessed empirical and targeted antibiotic use in hospitalised paediatric patients at the pediatric wards of Tamale Teaching Hospital (TTH), the only referral health facility in northern Ghana.

Materials and Methods

This cross-sectional study was carried out at the Tamale Teaching Hospital's (TTH) Paediatrics and Child Health Department. TTH is the only tertiary referral facility in northern Ghana and a training centre for health training institutions that offer courses in medical laboratory, pharmacy, medicine, and nursing. Children between the ages of one month and 12 years who were admitted to the pediatric wards between January and June 2022 made up the study population.

The study included patients who had bacterial infections, with either normal white blood cell counts and low neutrophil counts, or axillary temperatures of 36.5°C or greater than 37.5°C, and raised white blood cells and neutrophils. Patients on prescribed drugs for tuberculosis and those without a diagnosis of bacterial infection were not included. Additionally, in order to provide for standardisation and comparability among study participants, patients utilising topical antibiotics were excluded due to the potential confounding effects of systemic antibiotics on the treatment.

A sample size of 385 was estimated using Cochran's formula (Snedecor and Cochran, 1989), assuming a normal distribution score of 1.96 at 95% confidence level, 50% prevalence of antibiotics use in children, and 5% margin of error. For contingency, a 5% adjustment was made in the calculated sample, which brought the minimum of children recruited to 405.

Electronic medical records of 1560 hospitalised pediatric patients during the study period were reviewed, and 371 of them who met the inclusion criteria within the study period were recruited into the study. Data was extracted using a self-designed, pre-tested case report form that was verified by a consultant paediatrician. Sex, age, weight, axillary temperature at admission, white blood cell and neutrophil counts, diagnosis, pattern of antibiotic usage, culture and sensitivity testing (CST) findings backing targeted antibiotic use, and treatment outcomes were among the clinical data retrieved. Symptom resolution was assessed by the principal investigator and two specialist paediatric pharmacists stationed at the paediatric department of TTH using the patients' clinical presentation before admission and before discharge.

SPSS version 26 (IBM, Chicago, Illinois, USA) was used to analyse the data. For continuous data, the mean with standard deviation or median with limits, where applicable, were recorded; for categorical variables, the frequency and percentages were reported. Fisher's exact test was used to test the association between study variables where appropriate. Associations were considered statistically significant with a P-value < 0.05.

The Committee on Human Research Publication and Ethics at Kwame Nkrumah University of Science and Technology (KNUST) in Kumasi, Ghana, gave ethical approval for the study (CHRPE/AP/449/21). Every procedure has been completed in accordance with the 2013 Declaration of Helsinki's recommendations. Before their involvement in the study, all caregivers provided written or thumbprinted informed consent.

Results

Demographics of study participants

Of the 371 participants involved in the study, 62.0% (n=230) were males. About 41.2% (n=153) were less than 1 year old, and those between the ages of 1 and 3 years were 40.4% (n=150) with a median age of 1.08 years (range 0.08 to 12 years). The commonly diagnosed bacterial infections were gastrointestinal infections (34.2%, n=129), pneumonia (31.8%, n=118), and urinary tract infections (12.1%, n=45). The average length of hospital stay was 7.04 ± 4.57 days, with most patients (42.6%, n=158) staying between 4 and 6 days on admission (Table 1).

Pattern of antibiotic use

A total of 640 antibiotics were prescribed and administered to participants in this study. The common antibiotic classes prescribed were cephalosporins (47.8%, n=306) and penicillins (21.6%, n=138). Fifty-five percent (n=352) and 45.0% (n=288) of the prescribed antibiotics were in the *Access* and *Watch* categories of WHO's *AWaRe* classification of antibiotics, respectively (Table 2).

Table 1: Clinical characteristics of patients

Variables	**Category**	**N=371** **n (%)**
Sex	Male	230(62.0)
	Female	141(38.0)
Age (years)	Median (range)	1.08(0.08-12)
	<1	153(41.2)
	1-3	150(40.4)
	4-6	38(10.2)
	>6	30(8.1)
Bacterial infections	GI infection	129(34.7)
	Pneumonia	118(31.8)
	UTI	45(12.1)
	URTI	21(5.7)
	CNS infection	18(4.9)
	SST	11(3.0)
	infection	10(2.7)
	Sepsis	19(5.1)
	Others	
Duration of hospital stay (days)	Mean ± SD	7.04 ± 4.57
	1-3	64(17.3)
	4-6	158(42.6)
	7-9	84(22.6)
	10-12	25(6.7)
	>12	40(10.8)

n- number of patients; GI- gastrointestinal; UTI- urinary tract infections; URTI- upper respiratory tract infections; CNS- Central nervous system; SST- Skin and soft tissue; Others- Acute otitis media, bone and joint infections, bacteremia, and ear and nose infections

Culture and sensitivity testing request patterns

Of the 371 patients, 72.2% (n=268) were treated without a culture and sensitivity testing (CST) request. The CST request was predominant for sepsis (90%, n=9) and UTI (57.8%, n=26). There was an association (p <0.001) between the type of bacterial infection and the need for a culture request. For patients with CNS infections, the likelihood of CST being requested was 50% (n=9) (Table 3).

Common bacterial isolates from the clinical samples

Of the 103 participants for whom culture was requested, there were 31.1% (n=32) bacterial isolates, 1.9% (n=2) non-bacterial isolates (Candida albicans from urine samples), 40.8% (n=42) negative bacterial growth, and the reports of 26.2% (n=27) were not available for review. Of the 32 bacterial isolates from blood, urine, wound, and sputum samples, 59.4% (19) were Gram-negative organisms, with 40.6% (13) being Gram-positive organisms. The common bacterial isolates were *Acinetobacter baumanni* (n=5) and *Klebsiella pneumoniae* (n=5), followed by *Pseudomonas aeruginosa* (n=4) and *Enterococcus faecium* (n=4). *Micrococcus luteus* (n=2) and CoNS (n=3), which are regarded as typical contaminants, were among the isolates (Table 4).

Table 2: Antibiotic agents prescribed for the diagnosed infections

Variable	**Parameter**	**N=640** **n (%)**
Antibiotic class	Cephalosporins	306(47.8)
	Penicillins	138(21.6)
	Nitroimidazoles	58(9.1)
	Macrolides	51(7.9)
	Aminoglycosides	41(6.4)
	Fluoroquinolones	22(3.4)
	Lincosamides	17(2.7)
	Carbapenems	4(0.6)

	Others	3(0.5)
WHO AWaRe classification	Access	352(55.0)
	Watch	288(45.0)
	Reserve	-

AWaRe: A- Access, Wa- Watch, Re- Reserve

Table 3: Association between bacterial infections and culture requests

Bacterial infections	Culture request n (%)		*p*-value
	Yes	No	
GI	27(20.9)	102(79.1)	<0.001[a]
Pneumonia	20(16.9)	98(83.1)	
UTI	26(57.8)	19(42.2)	
URTI	4(19.0)	17(81.0)	
CNS	9(50.0)	9(50.0)	
SST	2(18.2)	9(81.8)	
Sepsis	9(90.0)	1(10.0)	
Others	6(31.6)	13(68.4)	
Total	103(27.8)	268(72.2)	

Fisher's exact test

Sensitivity pattern of clinical bacterial isolates

Staphylococcus aureus was susceptible to levofloxacin, clindamycin, and erythromycin, whilst *Moraxella catarrhalis* was susceptible to amoxicillin/clavulanic acid, ceftriaxone, and ciprofloxacin. *Klebsiella pneumoniae, Streptococcus pneumoniae,* CoNS, and *Citrobacter diversus* were susceptible to most of the antibiotics tested against them (Figure 1).

Resistance pattern of clinical bacterial isolates

Moraxella catarrhalis was not resistant to any of the antibiotics tested against it, whilst *Staphylococcus aureus* was resistant to amoxicillin/clavulanic acid and doxycycline. *Escherichia coli* was resistant to chloramphenicol and cefepime. *Klebsiella pneumoniae* was resistant to 10 antibiotics, which included amikacin, amoxicillin/clavulanic acid, and ceftriaxone. *Acinetobacter baumannii* was resistant to 8 antibiotics, which included ceftriaxone, meropenem, and levofloxacin. *Streptococcus viridans* isolate was resistant to amoxicillin/clavulanic acid, doxycycline, ampicillin, and levofloxacin. Multi-drug resistance was found with isolates of *Enterococcus faecium, Streptococcus viridans, Acinetobacter baumanni, Klebsiella pneumoniae,* and *Pseudomonas aeruginosa*, as they were resistant to antibiotics from at least three antibiotic classes (Figure 2).

Treatment outcomes of bacterial infections on symptom resolution

Overall, 4.9% (n=18) were treated with antibiotics based on CST findings, while 95.1% (n=353) were treated empirically without antibiogram data. Although a higher proportion of patients who received targeted antibiotic treatment had their symptoms resolve, a univariate analysis did not show that sex, age, type of treatment, and length of hospitalization had a statistically significant association with symptom resolution following antibiotic treatment (Table 5). A multivariate analysis accounting for other variables did not also show a statistically significant association with symptom resolution following antibiotic treatment (Table 6)

Table 4: Common bacterial isolates from the clinical samples

Bacterial isolates	Clinical samples				
	Blood	Urine	Wound	Sputum	Total
Staphylococcus aureus	1	-	-	-	1
Moraxella catarrhalis	-	-	-	1	1
Escherichia coli	-	1	-	-	1
Micrococcus luteus*	2	-	-	-	2
Streptococcus pneumoniae	1	-	-	2	3
	3	-	-	-	3
CoNS*	-	2	1	-	3
Citrobacter diversus	3	1	-	-	4
Pseudomonas aeruginosa	2	2	-	-	4
Enterococcus faecium	-	4	1	-	5
Acinetobacter baumanni	2	2	1	-	5
Klebsiella pneumoniae	14	12	3	3	32
Total					

CoNS- Coagulase Negative Staphylococcus; *- contaminants

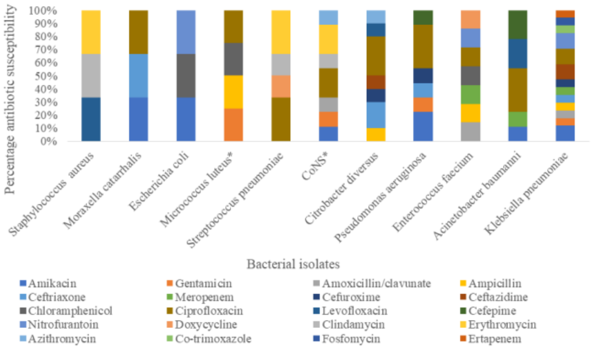

Figure 1: Antibiotic susceptibility pattern of clinical bacterial isolates

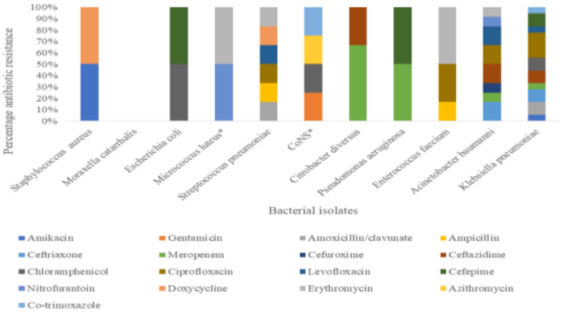

Figure 2: Antibiotic resistance pattern of bacterial isolates

Table 5: Patient variables and association with symptom resolution following antibiotic use

Variable	Symptom resolution, n (%)		*p*-value
	Yes	No	
Sex			
Male	231(92.6)	17(7.4)	0.087^{a}
Female	130(92.9)	10(7.1)	
Age			0.327^{b}
<1	142(92.8)	11(7.2)	
1-3	142(94.7)	8(5.3)	
4-6	33(86.8)	5(13.2)	
>6	27(90)	3(10)	
Type of treatment			0.083^{a}
Empiric	327(92.6)	26(7.4)	
Targeted	17(94.4)	1(5.6)	
Length of stay			0.728^{a}
1-3	59(92.2)	5(7.8)	
4-6	147(93)	11(7)	
7-9	79(94)	5(6)	
10-12	23(92)	2(8)	
>12	36(90)	4(10)	

^{a}Pearson Chi-square; ^{b}Fisher's exact test

Table 6: Logistic regression to adjust variables for potential confounders in symptom resolution

Variable	COR (95% CI)	AOR (95% CI)	*p*-vlaue
Sex			
Male	1	1	
Female	0.02(0.06-0.42)	0.94(0.41-2.16)	0.889
Age			
<1	1	1	
1-3	0.28(0.36-0.69)	0.7(0.18-2.69)	0.600
4-6	0.90(0.68-0.72)	0.51(0.13-2.07)	0.343
>6	0.15(0.30-0.78)	1.35(0.29-6.21)	0.703
Type of treatment			
Empriric	1		
Targeted	0.21(0.50-1.09)	1.65(0.20-13.86)	0.070
Length of stay			
1-3	1	1	
4-6	0.20(0.32-0.73)	0.73(0.18-3.01)	0.659
7-9	0.47(0.43-0.63)	0.65(0.19-2.24)	0.492
10-12	0.67(0.59-0.72)	0.56(0.14-2.28)	0.413
>12	0.05(0.20-0.92)	0.82(0.13-4.97)	0.825

COR- crude odds ratio; AOR- adjusted odds ratio; CI- confidence interval

Discussion

This study found that the use of CST to inform antibiotic therapy was low, and multidrug-resistant bacteria were being isolated from hospitalised paediatric patients. In this study, GI infection, pneumonia, and UTI were prevalent (Table 1). These findings were congruent with previous studies in Ethiopia (Girma et al., 2018) and in Ghana (Hogan et al, 20218), where GI infections, pneumonia, and UTIs were the prevalent CAIs resulting in hospitalisations. The similarity may be attributed to comparable socio-economic, environmental, and health-related factors in both Ghana and Ethiopia. This includes, but is not limited to, malnutrition, mostly in children under 5 years (Escadafal et al., 2020), limited access to healthcare and diagnostic facilities, inadequate access to safe drinking water, and widespread poverty, which collectively heighten the burden of childhood infections (WHO, 2022; Evans et al., 2021).

In the current study, cephalosporins and penicillins were the commonly used classes of antibiotics (Table 2). The pattern of antibiotic use in this study was congruent with the highly used antibiotics globally (Amponsah et al., 2021; Labi et al., 2021). Moreover, with most of the commonly used cephalosporins and penicillins being *Watch* and *Access* antibiotics, respectively (Table 2), the trend of *Watch* and *Access* antibiotics use in this study was comparable to a similar study in Ghana (Amponsah et al., 2021), which reported 46.7% and 40.0% usage of *Watch* and *Access* antibiotics, respectively. *Watch* antibiotic use was also higher than reported in Finland (23.0%) but lower than reported in Iran (77.3%) (Hsia et al., 2019). However, at the time of the study, no patients used *Reserve* antibiotics, similar to studies in Ghana (Amponsah et al., 2021; Labi et al, 2018), although their availability was not assessed. The reason for the observed usage could be that these antibiotics are recommended by guidelines (WHO 2022; GSTG, 2017), as first- and second-line choices in the treatment of most bacterial infections in paediatrics (Opare-

Asamoah et al., 2021). With a target of using about 70% or more *Access* antibiotics (WHO 2022), the finding of this study, although higher than the 46.7% reported (Amponsah et al., 2021), still falls short of the WHO recommendation. Interventions such as facility-specific formularies considering the AWaRe classification and treatment guidelines that promote the use of *Access* antibiotics could be implemented to direct antibiotic use in hospitals in low-resource settings. Additionally, training clinicians and the use of information posters and fliers could also be provided to support appropriate prescribing and compliance with rational antibiotic use strategies (Hsia et al., 2019).

In the current study, a high proportion of the patients were treated empirically with antibiotics, including patients whose CST findings showed no bacterial growth. The reason for the high negative growth could be that often pediatric patients receive antibiotics days before culture samples are taken for CST (Alavudeen et al., 2021; WHO, 2022), which goes against good antimicrobial stewardship practices (Opare-Asamoah et al., 2021; Opare-Asamoah et al., 2023). The proportion of paediatric patients who had CST requested is, however, higher compared to a similar study in Ethiopia, where CST was not performed in any of the 822 patients reviewed (Demoz et al., 2020), and a 2.7% CST request as reported in Ghana (Amponsah et al., 2021). Since only a small proportion of the antibiotics used were targeted, the high empiric use of WHO *Watch* antibiotics, which in this study were cephalosporins, without antibiogram data, is problematic (Amponsah et al., 2021). The unaffordability of CST in resource-limited settings may have contributed to the low targeted use of antibiotics (Shimelis et al., 2020; Pauwels et al., 2025; Jima et al., 2025). Culture requests were highly associated with conditions such as UTIs, sepsis, and CNS infections (especially meningitis) (Table 3), possibly due to their high morbidity and mortality. It is therefore understandable that CST is prioritised for severe paediatric infections such as sepsis, UTIs, cellulitis, and meningitis, thus accounting for the low CST request for paediatric patients in this study.

There was a high prevalence of *Acinetobacter baumannii* and *Klebsiella pneumoniae* isolates from paediatric patients (Table 4), which are comparable to the leading pathogens for ABR-associated deaths as reported by a systematic review (Murray et al., 2022). Moreover, *Pseudomonas aeruginosa*, *Escherichia coli*, and *Staphylococcus aureus*, which are part of these six leading pathogens (Murray et al., 2022; CDC, 2022), were also among the isolates obtained in this study. The clinical isolates are among the WHO's list of critical priority pathogens for which new antibiotics are needed urgently for treatment, as they are now multidrug-resistant (MDR) (WHO, 2017). Consequently, MDR was observed with *Klebsiella pneumoniae*, *Acinetobacter baumanni*, *Enterococcus faecium*, *Streptococcus pneumoniae*, and CoNS in this study (Figure 2). These findings were typical of a study conducted across several hospitals in Ghana (Opintan et al., 2015).

These findings could be attributed to the high usage of these antibiotics, mostly empirically in clinical settings and also in community outlets (Ngyedu et al., 2023; Shimelis et al., 2020; Mokwele et al., 2022). These findings call for pragmatic antimicrobial and diagnostic stewardship programs that include routine surveillance of MDR organisms (CDC, 2022). *Klebsiella pneumoniae* isolates had a 50% susceptibility to amikacin, gentamicin, amoxicillin/clavulanic acid, ceftriaxone, meropenem, cefuroxime, ceftazidime, and ciprofloxacin (Figure 1). In a similar study, meropenem and amikacin were observed to be effective in 100% of cases of *Klebsiella pneumonia* (Alavudeen et al., 2021). Among the antibiotics, ciprofloxacin showed high resistance in the case of *Klebsiella pneumoniae* isolates. Concurrently, amikacin, meropenem, ciprofloxacin, levofloxacin, and cefepime were observed to be effective against 42.9% of *Acinetobacter baumannii* isolates. The susceptibility and resistance patterns of this study show that the prudent use of antibiotics can preserve their efficacy (Shimelis et al., 2020; Pauwels et al., 2025). It is therefore recommended that diagnostic stewardship and infection prevention and control measures be instituted in TTH to limit the emergence of ABR (Alavudeen et al., 2021).

Overall, less than 5% of patients were treated based on CST data, which was remarkable compared to a similar study conducted at a tertiary health facility in Ethiopia (Demoz et al., 2020), where CST was not performed in any patients. In patients who received targeted antibiotic therapy, the proportion of symptom resolution was higher than that of those who received empiric treatment, although this difference was not found to be statistically significant on both univariate and multivariate analysis. This outcome could have been affected by the relatively small number of patients who received targeted antibiotic treatment, late culture sampling, the prevalent empiric antibiotic use (Amponsah et al., 2022), and the MDR associated with some of the isolates (Labi et al., 2016; Osei et al., 2022). To this end, improved access to CST should be pursued, since it has the benefit of lowering unwarranted antibiotic use and healthcare costs (Labi et al., 2021). The cost of CST could be subsidised to improve its access (WHO, 2022; Pauwels et al., 2025).[12,13]

This study examines empiric and targeted antibiotic use in hospitalised pediatric patients at TTH, providing baseline data for antimicrobial stewardship. A key limitation is the small number of bacterial isolates due to limited CST, preventing generalisation of resistance patterns to the full study population.

Conclusion

This study provides evidence of the low CST-based treatment of pediatric infections at TTH, where most of the antibiotics were used empirically. The prevalent infections for which antibiotics are used in hospitalised paediatric patients include gastrointestinal infections, pneumonia, and urinary tract infections, for which cephalosporins and penicillins are the commonly used classes of antibiotics. CST requests were common for paediatric patients with UTIs, CNS infections, and sepsis. WHO *Access* and *Watch* antibiotic use constituted 55% and 45%, respectively. The most prevalent bacterial isolates were *Acinetobacter baumanni* and *Klebsiella* *pneumoniae*, both of which are multidrug-resistant, including other WHO high-priority pathogens. This study observed better treatment outcomes in patients with CST-backed antibiotic therapy. Overall, strengthening antimicrobial and diagnostic stewardship and developing an antibiogram to guide empirical antibiotic use at the hospital with a strong emphasis on the use of CST data to optimise pharmacotherapy of paediatric infections and thus control the emergence and spread of antimicrobial resistance cannot be overemphasised.

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Conflict of interest

The author(s) declare(s) that there is no conflict of interest.

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