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Antimicrobial Resistance in ENT Infections: A Rising Threat in Bangladesh

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Abstract
Background: The rise of antimicrobial resistance stands in the way of proper ENT infections in parts of the world where resources are limited. Irrational antibiotic treatment in Bangladesh has increased antibiotic resistance among both community and hospital patients.
Objective: This study aims to determine the bacterial types, patterns of antibiotic resistance, and the risk factors involved in ENT diseases.
Methodology: The research enrolled 120 patients with ENT infections who had been admitted to a tertiary medical college hospital in a cross-sectional observational study. Samples from the cultures were tested with antibiotics to determine their resistance. Using SPSS version 25.0, data were examined, and conclusions were drawn at the statistical significance level of $p<0.05$.
Result: The most commonly isolated bacterium was Staphylococcus aureus (38.33%), while Pseudomonas aeruginosa came next (24.17%). Followed by Streptococcus pneumoniae (19.17%), Klebsiella pneumoniae (13.33%), and finally Escherichia coli (5%). Most *S. aureus* and K. pneumoniae isolates were highly resistant to amoxicillin (89.1% and 93.8%, respectively) and ceftriaxone, with the highest being 83.3%. Moderate resistance to meropenem was reported, ranging from 10.9% to 18.8%. Having taken antibiotics in the past (70.8%, p=0.002), incomplete the prescribed treatment (51.7%, p=0.01), and purchasing over-the-counter antibiotics (65%, $p<0.001$) were all associated with AMR.
Conclusion: Most ENT pathogens are now highly resistant due to an overuse of antibiotics. Stronger measures and tougher rules for prescribing medications are necessary to protect lives globally.

Keywords: Antimicrobial resistance, ENT infections, Bangladesh, antibiotic misuse, bacterial profile, drug resistance, cross-sectional study.

Introduction
Antimicrobial resistance (AMR) refers to the capability of any microorganism to resist the action of any drug substance that is designed to inhibit its growth or kill any microorganism [1]. WHO declared antimicrobial resistance a leading global threat to public health and development [2]. According to 2019 statistics, an estimated 4·95 million deaths occurred worldwide due to AMR, while 1·27 million deaths were the result of bacterial resistance only [3]. Antibiotic resistance can occur by three fundamental mechanisms: (1) enzymatic degradation of antibacterial drugs, (2) alteration of bacterial proteins that are antimicrobial targets, and (3) changes in membrane permeability to antibiotics [4]. The cause of antimicrobial resistance include lack of access to clean water, sanitation and hygiene (WASH) for both humans and animals; poor infection and disease prevention and control in homes, healthcare facilities and farms; poor access to quality and affordable vaccines, diagnostics and medicines; lack of awareness and knowledge; and lack of enforcement of relevant legislation [2]. Antimicrobial resistance is alarming to the Ear, nose, and throat (ENT) patients, as most of the ENT infections are caused by bacterial species such as *Staphylococcus aureus*, *Streptococcus sp.*, *Proteus sp.*, Haemophilus, and Escherichia coli [5]. The infection affects the victim's quality of life and leads to permanent impairments if it remains untreated [6]. A 2015 study in Bangladesh evaluated 3314 ENT patients in a six-month timeline at a single tertiary hospital in Bangladesh [7]. In Bangladesh, approximately 50% of patients are prescribed antibiotics, 25% were treated with more than one antibiotic, and 8.3% of patients are prescribed to antibiotic without any laboratory test [8]. ENT infections, including otitis media, sinusitis,

and tonsillitis, are common in low and Middle-Income countries (LMICs) like Bangladesh and are often managed with antibiotics, even without testing for pathogens. Excessive and irrational use of antibiotics causes bacterial resistance here. This study aims to evaluate the bacterial profile, resistance patterns, and the associated factors of antimicrobial resistance.

Methodology

A cross-sectional observational study took place at the Department of ENT and Head Neck surgery, Sir Salimullah Medical College Mitford Hospital, Dhaka, Bangladesh, from 1 Jan 2024 to 31 Dec 2024 This yearlong study included patients with some specific inclusion and exclusion criteria.

Inclusion criteria

- There is no age limit for this study.
- Confirmed case of ENT infections.
- Patients were willing to provide informed consent.

Exclusion criteria

- Viral/fungal infections confirmed by PCR or clinical assessments.
- Patients have a history of using long-term immunosuppressants.
- Incomplete medical record.

All selected patients underwent bacterial susceptibility and specificity tests. The data collection process was done with a questionnaire that included demographic data and laboratory data of patients. After a successful data collection, all data were analyzed by using MS Excel and SPSS version 25.0 software. A p-value<0.05 was considered significant at a 95% confidence interval.

Result

The cross-sectional observational study enrolled 120 patients with ear, nose, or throat infections. 56.7% male and 43.3% female participants took place in this study. The male-female ratio calculated for this study is 1.31:1.

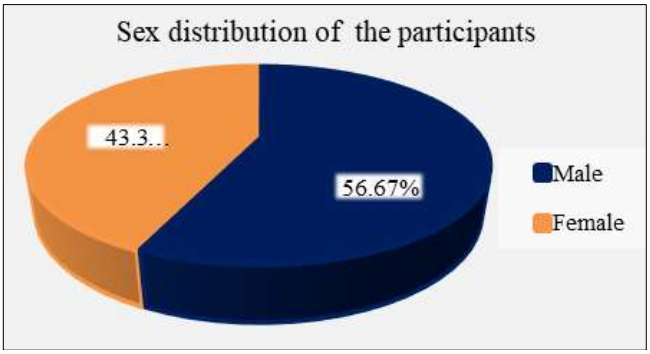

Fig 1: Pie chart showed demographic distribution of patients, sex (N=120)

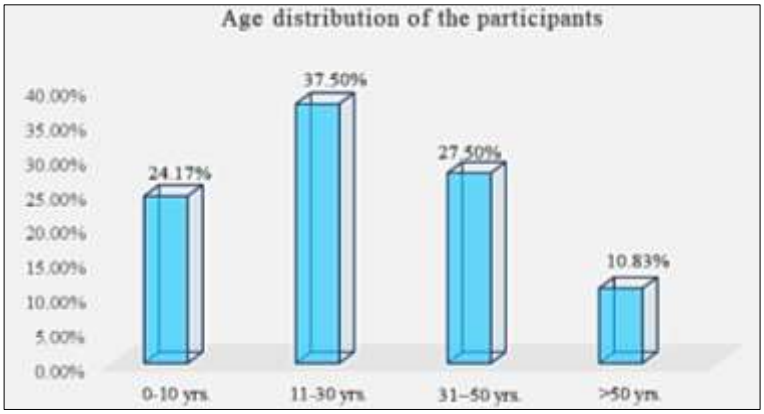

Fig 2: Column chart showed demographic distribution of patients, age (N=120)

Table 1: Demographic Characteristics (n=120)

Variable	Number	Percentage (%)
Gender		
- Male	68	56.67
- Female	52	43.33
Age Group (Years)		
0-10 Yrs.	29	24.17
11-30 Yrs.	45	37.50
31-50 Yrs.	33	27.50
>50 Yrs.	13	10.83
Mean Age ± SD	28.5 ± 15.2	-

According to Table 01 data, the cohort was predominantly male (56.7%), with adolescents/young adults carrying the largest infection burden (11-30 years, 36.7%). The average age (28.5 years) represents ENT infections in all age groups.

Table 2: Bacterial isolation positivity (n=120)

Pathogen	Frequency	Percentage (%)	Gram-stain
Staphylococcus aureus	46	38.33	Gram-positive
Pseudomonas aeruginosa	29	24.17	Gram-negative
Streptococcus pneumoniae	23	19.17	Gram-positive
Klebsiella pneumoniae	16	13.33	Gram-negative
Escherichia coli	6	5	Gram-negative

Table 02 represents the bacterial isolation test positivity results, where the majority of the infections were caused by Staphylococcus aureus (38.33%), followed by Pseudomonas aeruginosa (24.17%), Streptococcus pneumoniae (19.17%), Klebsiella pneumoniae (13.33%), and Escherichia coli (5%). A total of 57.5% of infections encountered by gram-positive stains and 42.5% by gram-negative bacteria were found by this study.

Table 3: Antibiotic Resistance Rates Among Bacterial Isolates (n=120)

Antibiotic	*S. aureus* (n=46)	P. aeruginosa (n=29)	S. pneumoniae (n=23)	K. pneumoniae (n=16)	E. coli (n=6)
Amoxicillin	89.1%	89.7%	82.6%	93.8%	83.3%
Ciprofloxacin	67.4%	55.2%	60.9%	75.0%	66.7%
Ceftriaxone	73.9%	75.9%	69.6%	81.3%	83.3%
Azithromycin	78.3%	58.6%	73.9%	68.8%	66.7%
Meropenem	10.9%	17.2%	13.0%	18.8%	16.7%

Table 03 reveals that the resistance to medicines among ENT pathogens, where *Staphylococcus aureus* has 89.1% resistance to amoxicillin and 73.9% resistance to ceftriaxone. Resistance levels in *Klebsiella pneumoniae* isolates (13.3% of strains) were much higher, showing 93.8% resistance to amoxicillin and 81.3% to ceftriaxone. However, regarding resistance, the highest occurred in *K. pneumoniae* (18.8%), and emerging resistance in *E. coli* (16.7%) is concerning.

Table 4: Factors associated with antimicrobial resistance (n=120)

Factor	Cases	Percentage (%)	p-value
Prior antibiotic use (3 months)	85	70.8	0.002*
Incomplete treatment course	62	51.7	0.01*
OTC antibiotic purchase	78	65.0	<0.001*
Hospital-acquired infection	25	20.8	0.12

Table 04 found that several major practices were found to have strong links with antimicrobial resistance during the analysis. 70.8% of the patients had taken antibiotics in the previous 3 months (p=0.002) and 51.7% had not finished their antibiotic regimens (p=0.01). Disturbingly, 65% of participants managed to get antibiotics without a prescription by buying them somewhere over the counter (p<0.001). While a fifth of infections were acquired in the hospital, that was not found to be statistically significant (p=0.12) compared to other causes, implying community antibiotic misuse could be the main cause of resistance in ENT infections.

Discussion: Antimicrobial resistance is an emerging healthcare issue; ENT therapies sometimes fail and turn into a severe impairment due to the resistance of antibiotics in some cases [9]. The current study observed 120 patients suffering from ENT diseases and found that 56.67% of patients are male, with a male-female ratio of 1.31:1. A 2022 study shows a male-female ratio of 0.9:1, and females were slightly more prevalent (52.26%) among ENT disorders in their timeline [7]. On the contrary, Rahman MM *et al.*, 2024 found a male dominance (64%) in their study on ear and nasal diseases [10]. They agree with the age group finding of the current study by enrolling most of the cases from the 21-30 years of age group [10]. The current study did not limit patients by their age; the mean age calculated for this study was 28.5 ± 15.2 years, where most of the patients belong to the 11-30 years of age group (37.5%), followed by that indicated middle age patients are mostly victimized by ENT disorders. Al-Tulaibawi NAJ *et al.*, 2023 agree with all demographic findings of this study by including 58% of male participants and showing the incidence rate is more significant in patients aged 10-19 years (P≤ 0.05) [11]. *Staphylococcus aureus* is identified as the most common microorganism to induce ENT infections (38.33%), followed by *Pseudomonas aeruginosa* (24.17%), *Streptococcus pneumoniae* (19.17%), *Streptococcus pneumoniae* (13.33%), and *Escherichia coli* (5%). The current study reported that most of the ENT infections are caused by gram-positive bacteria (57.5%). Qurban R *et al.*, 2017 agree with the study by their findings with 51.7% of gram-positive bacteria [12]. A study on bacterial etiology shows that *Staphylococcus aureus* (27.9%), *Proteus sp.* (20.8%), *Streptococcus sp.* (10%), and *Pseudomonas sp.* (8.92%) were the main isolates for ear infections [13]. Another Bangladeshi study also shares similar findings with this study by reporting that the predominant bacterial isolates were *S. aureus* with 24.42% infection rates, followed by *Pseudomonas aeruginosa* (23.26%) [14]. Antibiotic resistance data represent an alarming condition. Amoxicillin, Ciprofloxacin, Ceftriaxone, and Azithromycin are the most resistant antibiotics against microorganisms. Although Meropenem resistance is quite low in comparison to other antibiotics, it is not negligible. 89.1% of *S. aureus*, 89.7% of *P. aeruginosa*, 82.6% of *K. pneumoniae, and* 93.8% of *E. coli* indicate resistance to Amoxicillin in this study. A previous study also shares a similar resistant pattern of Amoxicillin by 38.10% resisting *S. aureus*, 66.67% against *E. coli*, 75% resistance rate in *Pseudomonas sp.*, and *Klebsiella sp*. each [14]. Ciprofloxacin is another broad-spectrum antibiotic that shows resistance to *Salmonella typhi*, *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa* in a similar study [15]. Ceftriaxone is a potent antibiotic for UTI, but shows a concerning resistance against all strains in this study. Another Bangladeshi study stated that Ceftriaxone has 3% to 50% incompatibility to treat several infections, including ENT, UTI, and typhoid fevers [16]. Azithromycin is also reported to have high rates of resistance against *Salmonella Typhi* and *E. coli* by other studies [17]. Some Bangladeshi studies indicated that the Meropenem resistance rate in Bangladesh is 33% to 72% [18]. The study findings replicate the results of the current study. The prime cause of antibiotic resistance is previous antibiotic use (p=0.002), incomplete treatment course (p=0.01), and OTC antibiotic purchase (p<0.001). Over-the-counter (OTC) antibiotic purchase can be defined as the main cause of antibiotic resistance in this study. A Bangladeshi study found that 37.02% of antibiotic administration is without prescription [19]. In 2015, WHO also shared its concern on this issue and adopted a global action plan on antimicrobial resistance [20]. Misuse and overexposure to antibiotics, non-prescribed purchases, are the root cause of this burning healthcare issue [21]. Antimicrobial resistance is described as a catastrophic threat to animals and humans [22]. The majority of the ENT infections are caused by bacteria that can lead to chronic dysfunction or severity if the pattern remains unchanged.

Limitation: The single-centered study design is the main limitation of this study, which fails to combine the antimicrobial resistance of the country. Since the study was cross-sectional, it was not possible to determine cause and effect and testing for resistance mechanisms was not carried out.

Conclusion: This research points out that common infections of the ear, nose, and throat in Bangladesh are becoming more resistant to antimicrobial treatment. The most common organisms identified were *Staphylococcus aureus* and *Pseudomonas aeruginosa* and almost all of them were resistant to amoxicillin and ceftriaxone. Over-the-counter purchase of antibiotics and untreated illnesses added significantly to the rise of antibiotic-resistant bacteria. Based

on these findings, urgent promote stewardship should be taken to regulate antibiotic diagnosis and prescription rules more effectively and raise public knowledge.

Abbreviation
AMR: Antimicrobial Resistance
ENT: Ear, Nose and Throat
OTC: Over the counter
UTI: Urinary tract infection

Conflicts of Interest: The authors declare no conflicts of interest.

Author's Contribution: Not available

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