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Eye, Ear, Nose, Throat or Mouth (Eent) Healthcare Associated Infections in A Tertiary Care Pediatric Icu

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ABSTRACT

Background: Healthcare-associated infections (HAIs) remain a major challenge in critical care settings, especially in pediatric intensive care units (PICUs). While a considerable body of literature has investigated respiratory, bloodstream, and urinary tract HAIs, limited attention has been paid to EENT (eye, ear, nose, throat or mouth) infections in children. EENT HAIs can lead to prolonged hospital stays, increased healthcare costs, and significant morbidity, warranting a focused exploration of their etiological agents, associated risk factors, and outcomes.

Methods: A prospective observational study was conducted from May 2023 to November 2024 in the PICU of Kalawati Saran Children's Hospital, New Delhi. One hundred and twenty-five (125) pediatric patients aged 1 month to 18 years, admitted for at least 48 hours, were screened for EENT HAIs. Microbiological investigations and antimicrobial susceptibility testing were carried out using standard culture methods and automated systems. Relevant risk factors, including demographic variables, comorbidities, and invasive procedures, were analyzed through univariate logistic regression.

Results: Of 125 enrolled cases, 11 developed EENT HAIs, yielding an infection rate of 8.8 per 100 admissions. Ear infections were predominantly caused by *Acinetobacter baumannii* and *Klebsiella pneumoniae*, while *Staphylococcus aureus* (MRSA) was isolated from nasal specimens. *Pseudomonas aeruginosa* was a frequent pathogen in throat infections. Susceptibility testing revealed significant resistance patterns, particularly among *Acinetobacter baumannii* and carbapenem-resistant Enterobacterales. Although 45.4% (n=5) of EENT HAI cases underwent invasive procedures, no single risk factor reached statistical significance ($p<0.05$). Five children required mechanical ventilation or central line placement; one case succumbed to multi-organ dysfunction.

Conclusion: EENT HAIs in PICUs, though less frequently reported than other HAIs, require heightened vigilance due to the involvement of multidrug-resistant organisms. Strict adherence to infection control protocols, judicious antimicrobial use, and prompt microbiological diagnosis are essential to improve outcomes.

Keywords: *EENT infections, healthcare-associated infections, pediatric intensive care unit, multidrug-resistant organisms, antimicrobial susceptibility*

1. INTRODUCTION

Healthcare-associated infections (HAIs) have long been recognized as a significant contributor to patient morbidity and mortality in hospitals worldwide [1]. Pediatric populations, especially those admitted to intensive care units, are particularly susceptible to such infections due to immature immune systems, underlying medical conditions, and the frequent necessity of invasive devices [2]. While respiratory, urinary, and bloodstream infections have garnered considerable research attention, there is a substantial knowledge gap regarding EENT (eye, ear, nose, throat or mouth) infections in critically ill children [3]. This gap is pertinent because anatomically contiguous structures of EENT regions can become entry points for opportunistic pathogens when mucosal integrity is compromised, such as via intubation, central line insertion, or mechanical ventilation [4].

The spectrum of microorganisms causing EENT HAIs includes Gram-negative bacilli (e.g., Pseudomonas aeruginosa, Acinetobacter baumannii, and various Enterobacterales) and Gram-positive cocci (e.g., Staphylococcus aureus), many of which exhibit multidrug resistance [5]. These multidrug-resistant organisms (MDROs) present a complex therapeutic challenge in pediatric intensive care settings, limiting the efficacy of standard empiric therapy. Early identification and

targeted management of EENT infections are crucial, given their potential to progress to systemic complications, such as sepsis, or to exacerbate existing comorbidities [6].

Notably, EENT infections in hospitalized children may manifest subtly, with non-specific clinical signs that can be overshadowed by more prominent systemic problems. For instance, an evolving otitis media in an intubated infant might be overlooked in the face of pre-existing respiratory distress and sedation. Such diagnostic challenges underscore the need for regular screening, standardized clinical protocols, and robust surveillance strategies [7]. Additionally, hospital-acquired organisms proliferate in environments with repeated antibiotic exposures and suboptimal infection control measures, heightening the risk for severe EENT HAIs and therapeutic failures.

Given these complexities, systematic research focusing on the epidemiology, risk factors, and microbiological profiles of EENT HAIs is urgently needed. A clearer understanding could inform evidence-based preventive measures, rational antimicrobial usage, and improved stewardship initiatives, ultimately minimizing the incidence of such infections and associated morbidity. Furthermore, data from resource-limited settings, particularly in densely populated urban areas, are crucial to tailor interventions that address local microbial ecology and healthcare practices [1,4].

This study was thus designed to determine the incidence and etiological spectrum of EENT HAIs, assess antimicrobial susceptibility, explore risk factors, and evaluate the outcomes of infected pediatric patients. These objectives aimed to fill gaps in knowledge, optimize patient care, and form the basis for future prospective investigations. By enhancing recognition and management of these less-studied infections, pediatric care providers can minimize treatment delays, avert complications, and potentially reduce mortality among critically ill children.

2. MATERIALS AND METHODS

Study Design and Period

A prospective observational study was carried out from May 2023 to November 2024. The study site was the Pediatric Intensive Care Unit (PICU) of Kalawati Saran Children Hospital (KSCH), New Delhi, which is a leading tertiary care center for pediatric health services in North India.

Study Population and Sample Size

All children aged 1 month to 18 years who were admitted to the PICU and stayed for at least 48 hours were assessed for possible inclusion. Those with pre-existing EENT infections at the time of admission or those who died within 48 hours were excluded. A pilot survey indicated an approximate 9% prevalence of EENT HAIs in the PICU. Based on a 95% confidence interval and a margin of error of 5%, the calculated sample size was 125.

Inclusion and Exclusion Criteria

Inclusion Criteria:

Pediatric patients (1 month to 18 years) admitted to PICU for ≥48 hours.

Exclusion Criteria:

Evidence of EENT infection at admission.

Mortality within the first 48 hours.

Past history of neonatal sepsis.

Ethical Considerations

Approval was obtained from the Institutional Ethics Committee. Informed consent was sought from the parents or legal guardians of the participants. Patient anonymity was maintained, and the findings were shared with the treating physicians to guide clinical management.

Data Collection and Clinical Examination

A structured proforma captured patient demographics, antenatal/birth histories (if applicable), immunization status, prior hospitalizations, comorbid conditions, and relevant family histories. Baseline clinical examinations were performed within the first 24 hours to exclude any preexisting EENT infection. Subsequent examinations occurred after 48 hours, on day 5, and at intervals thereafter until discharge or death.

Sample Collection and Processing

Whenever EENT infection was suspected, appropriate specimens (e.g., deep nasal swabs, throat swabs, eye swabs, ear discharge swabs, and mouth swabs) were collected under aseptic conditions. Particular care was taken to avoid contamination. Samples were immediately transported to the microbiology laboratory. Standard protocols included:

Direct Microscopy: Wet mounts and Gram-stained smears were examined.

Culture: Inoculation on blood agar, MacConkey agar, chocolate agar, and subsequent overnight incubation.

Organism Identification: Conventional biochemical tests, matrix-assisted laser desorption/ionization time-of-flight (MALDI-TOF) mass spectrometry, and automated identification systems (e.g., Vitek 2).

Antimicrobial Susceptibility Testing: Performed using Vitek 2 automated systems, with interpretations aligned to Clinical Laboratory Standard Institute (CLSI) guidelines.

3. RESULTS

Overview of Study Population and Infection Rate

Of the 125 pediatric patients were enrolled during the study period. Following the defined eligibility criteria, 11 individuals (8.8% incidence rate) developed EENT healthcare-associated infections, translating to 8.8 cases per 100 admissions. The overall incidence density was approximately 72 days per 1000 patient-days.

General Findings

Within these 11 HAI cases, the largest proportion involved throat/mouth infections (n=7, 64%), while ear (n=3, 27%) and nose (n=1, 9%) infections constituted the remainder. Notably, no eye-related HAIs were detected in the study cohort. Most EENT HAIs arose in children under 6 years of age, reflecting the vulnerability of younger patients.

Invasive procedures were performed in five cases (45.4%), particularly central line cannulation and endotracheal intubation. The median time to develop an EENT HAI post-PICU admission ranged from 4 days to 24 days, with the majority manifesting in the first week. No single risk factor, including age, sex, immunization status, or the presence of invasive procedures, attained statistical significance on univariate analysis ($p<0.05$).

Microbial Isolates and Susceptibility Profiles

Table 1 summarizes the identified pathogens. *Acinetobacter baumannii*, *Klebsiella pneumoniae*, and *Escherichia coli* were frequent Gram-negative bacilli (GNB) isolated from ear and throat infections. One methicillin-resistant *Staphylococcus aureus* (MRSA) strain was obtained from a nasal swab.

Table 1. Profile of Isolated Microorganisms from EENT HAIs

Pathogen	Number of Isolates	Causing
Acinetobacter baumannii	2	Ear EENT HAIs
Klebsiella pneumoniae	2	Ear EENT HAI & Throat/ Mouth EENT HAI
Klebsiella oxytoca	1	Throat/ Mouth EENT HAI
Citrobacter koseri	1	Ear EENT HAI
Escherichia coli	2	Throat/ Mouth EENT HAIs
Pseudomonas aeruginosa	1	Throat/ Mouth EENT HAI
Pseudomonas stutzeri	1	Throat/Mouth EENT HAI
Staphylococcus aureus (MRSA)	1	Nose EENT HAI

Multidrug resistance was conspicuous among *Acinetobacter baumannii* and carbapenem-resistant Enterobacterales. One isolate of *A. baumannii* was resistant to colistin. The single MRSA strain displayed susceptibility to teicoplanin, vancomycin, and linezolid but was resistant to clindamycin, erythromycin, ciprofloxacin, and tetracyclines.

Table 2 depicts the antimicrobial susceptibility of the Gram-negative isolates based on CLSI 2024 breakpoints. High levels of resistance were observed to third-generation cephalosporins and carbapenems among *E. coli*, *Klebsiella pneumoniae*, and *Acinetobacter baumannii*.

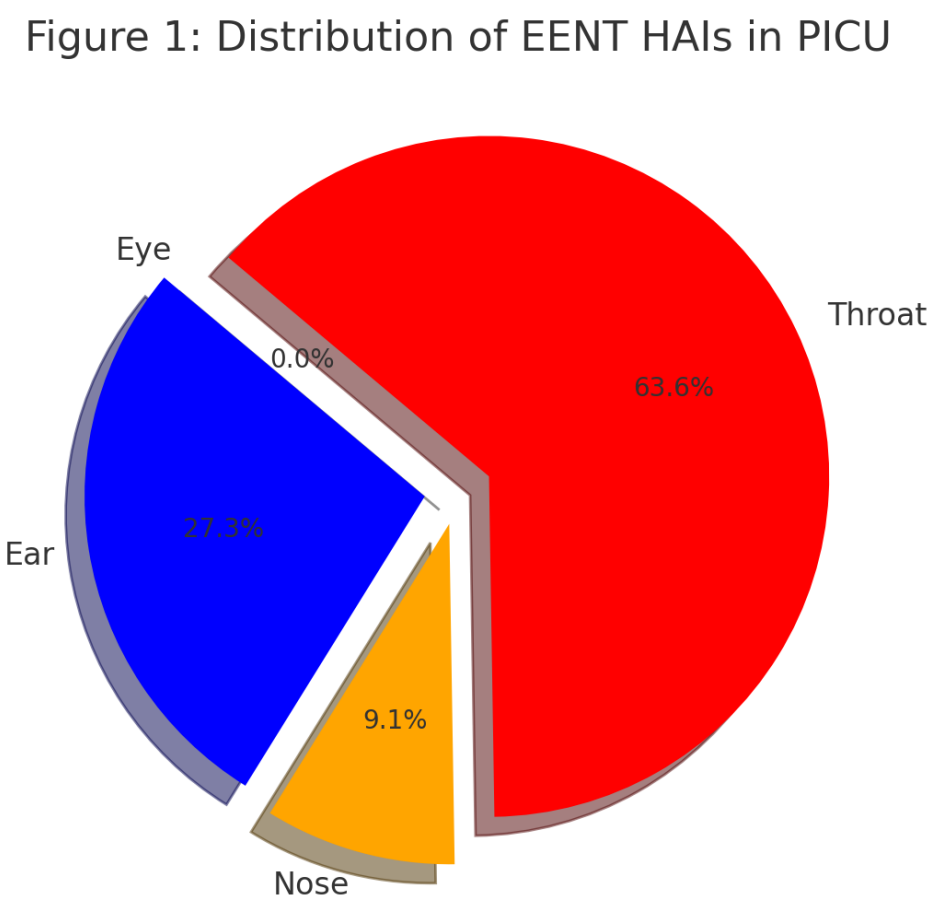
Table 2. Antimicrobial Susceptibility of Gram-Negative Bacilli from EENT HAIs as per CLSI 2024 guidelines

Antimicrobial	% Susceptibility in GNB Isolates
Cefepime	0–67%

Ceftazidime	0–100%* (for *Pseudomonas* only)
Piperacillin-Tazobactam	0–100%
Ciprofloxacin	0–100%
Amikacin	0–100%
Gentamicin	0–100%
Imipenem/Meropenem	0–100%
Trimethoprim-Sulfamethoxazole	0–100%
Colistin	50–100% (one *A. baumannii* colR)
*Susceptibility patterns varied among different genera; some columns reflect single-isolate data.	

Of the 11 children who developed EENT HAIs, one succumbed to multi-organ dysfunction secondary to underlying comorbidities and severe sepsis. One patient was discharged against medical advice, and nine patients had clinical improvement following specific interventions (appropriate antimicrobial therapy and supportive care). Among the survivors, four were discharged home directly from the PICU, whereas five were transferred to step-down wards for continued monitoring.

Figure 1 Distribution Of EENT HAIs In PICU



4. DISCUSSION

EENT healthcare-associated infections remain an under-explored domain in pediatric settings, even though similar invasive healthcare procedures and immunocompromised states predispose children to these infections [8]. The present study unveiled an 8.8% incidence of EENT HAIs among critically ill pediatric patients, which is comparable to or slightly higher than some previously reported data on ocular and otolaryngologic HAIs in neonates and young children [9]. The relatively high frequency of ear and throat involvement in this cohort likely arises from the substantial use of endotracheal tubes and nasogastric or orogastric interventions in the PICU [10].

The predominance of Gram-negative organisms such as *Acinetobacter baumannii*, *Klebsiella pneumoniae*, and *Escherichia coli* underscores the global trend of escalating antibiotic resistance among Enterobacterales and non-fermenters [11]. One of the most alarming findings in this study was the presence of a colistin-resistant *Acinetobacter baumannii* isolate, signifying the extreme end of the antibiotic resistance spectrum [12]. Indeed, the emergence of pan-resistant or nearly pan-resistant strains in resource-limited hospital settings has aggravated concerns regarding therapeutic options for vulnerable pediatric populations [13].

Although many of these infections were associated with invasive procedures—particularly endotracheal intubation—the univariate analysis did not yield a statistically significant association between any particular risk factor and EENT HAI occurrence. This outcome could be attributed to the modest sample size or the multifactorial nature of infection risk [14]. Routine prophylactic measures, including sterile insertion protocols for central lines and appropriate care of endotracheal tubes, remain integral to reducing EENT infection rates. Moreover, stringent hand hygiene, environmental disinfection, and contact isolation for colonized or infected patients are critical components of a multimodal infection control strategy [15].

From a management standpoint, early diagnosis facilitated by targeted microbiological investigations can significantly improve patient outcomes by optimizing antimicrobial therapy. Delayed or inappropriate antibiotic use in the setting of MDRO colonization can prolong hospital stays, elevate morbidity, and exacerbate resistance patterns across the institution. In light of these challenges, emphasis must be placed on antibiotic stewardship: prescribing shorter antibiotic courses when clinically feasible, utilizing narrow-spectrum agents guided by susceptibility data, and minimizing prophylactic regimens unless strictly indicated.

In conclusion, EENT HAIs in the PICU setting pose a tangible threat to pediatric patient safety. The interplay between procedural invasions and multidrug-resistant pathogens demands a holistic infection control approach, encompassing comprehensive microbiological surveillance, strict adherence to aseptic protocols, and evidence-based antimicrobial stewardship. Future studies with larger populations and multicenter collaboration could enhance the generalizability of these findings and refine strategies to mitigate EENT HAIs in critically ill pediatric populations.

5. CONCLUSION

This prospective study highlights the significance of EENT healthcare-associated infections in a pediatric ICU environment, revealing both a notable burden and a concerning level of multidrug resistance. Although no single risk factor independently predicted infection, invasive procedures and younger age groups were more frequently affected. Prompt laboratory diagnosis, strict aseptic practices, and vigilant antibiotic stewardship are pivotal for controlling these HAIs and curtailing the spread of resistant microorganisms. Future research should delve into improved preventive measures, advanced diagnostic modalities, and refined treatment approaches to minimize EENT HAIs and enhance clinical outcomes in pediatric intensive care settings.

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