

Outbreak of multidrug-resistant *Serratia marcescens* in a paediatric care unit of a tertiary care hospital in Hyderabad, Pakistan: A retrospective outbreak investigation

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ABSTRACT

Objective: This study investigates a recent outbreak of *S. marcescens* in a paediatric care unit of a tertiary care hospital in Hyderabad, Pakistan, highlighting the challenges of containing such infections.

Material and Methods: It is a retrospective analysis of cases identified through routine infection surveillance from 1st January to 31st January 2024. Clinical and demographic data were collected from medical records, laboratory reports, and infection control logs. A case was defined as a patient presenting with clinical signs of infection and *S. marcescens* growth in blood cultures. Environmental and staff screening for contamination was also conducted.

Results: Seven patients were identified with healthcare-associated infections caused by multidrug resistant *S. marcescens*. All patients had been hospitalized for more than 48 hours, with symptoms including fever and respiratory distress. Index case was a 3-month-old with pneumonia and had been transferred from another hospital. No *S. marcescens* was isolated from environmental swabs or staff screenings; however, other contaminants were identified. Following the outbreak's identification, targeted infection control measures such as enhanced surveillance, hand hygiene education, and disinfection protocol reviews were implemented, leading to a halt in new cases.

Conclusion: This occurrence emphasizes on the significant challenges posed by *S. marcescens* in paediatric care settings. The cessation of new cases following various measures underscores the importance of continuous surveillance, adherence to stringent infection control protocols, and staff education in preventing further upsurges.

Keywords: Outbreak, Paediatric critical unit, *Serratia marcescens*

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INTRODUCTION

Serratia marcescens is an emerging, opportunistic pathogen mainly associated with hospital-acquired infections. Outbreaks occur frequently, particularly in vulnerable populations such as neonates and children and difficult to manage [1]. Multiple sources of infection have been identified, including the hands of healthcare workers, infected neonates, and contaminated medical equipment [2]. In hospitalized adults, *S. marcescens* typically colonizes the respiratory and urinary tracts, while in neonatal intensive care units (NICUs), the gastrointestinal tract serves as a significant reservoir for cross-contamination [3].

Increased rates of multi-drug resistant *Serratia marcescens* leads to limited therapeutic options and

guarded prognosis [4]. The emergence of multidrug-resistant strains requires careful selection of antimicrobial therapy and continuous surveillance to track resistance patterns [5]. Epidemiological studies show various outbreaks of *S. marcescens* associated with factors such as contaminated intravenous fluids, respiratory devices, and inadequate compliance with hand hygiene protocols [2].

Outbreaks of multidrug-resistant *Serratia marcescens* in critical care units are uncommon but can lead to significant morbidity, particularly in resource-limited settings. An outbreak in a tertiary neonatal unit in eastern India involving six bloodstream infections, predominantly among premature infants with prior exposure to broad-spectrum antibiotics has been reported, which highlights the importance of early recognition and rigorous infection-control practices to mitigate similar outbreaks [6].

This study aims to provide a comprehensive overview of a recent outbreak of *S. marcescens* in paediatric care unit of a tertiary care hospital. We will describe the epidemiological characteristics of the outbreak, including patient demographics, clinical presentations, and outcomes. Additionally, we will discuss the investigative measures taken, infection

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control interventions implemented and the overall outcomes and impact on patient care within the unit. By sharing these insights, we hope to enhance understanding of *S. marcescens* in paediatric settings and suggest strategies for preventing future outbreaks. Furthermore, by documenting the clinical characteristics, temporal clustering, and response measures during the outbreak, this study not only provides regional outbreak data but also actionable lessons for clinicians, microbiologists, and infection control teams working in overcrowded and high-risk PICU environments.

MATERIAL AND METHODS

In this retrospective study, we have investigated an outbreak of *Serratia marcescens* in the paediatric care unit of a tertiary care hospital. The outbreak was identified through routine monthly infection surveillance grand round conducted from 1st January 2024 to 31st January 2024. Data were retrieved from patient medical records, laboratory reports, and weekly infection control logs. This study was conducted in the paediatric care unit and section of microbiology of Liaquat University of Medical and Health Sciences, a tertiary care facility located in Hyderabad, Pakistan. The unit is equipped with 50 beds and serves a diverse paediatric population, including infants, and children with various medical conditions.

A case of *Serratia marcescens* infection was defined as a patient in the paediatric care unit with clinical signs of infection (fever and respiratory distress) and *Serratia marcescens* isolated from blood culture.

Demographics, line list of clinical cases and compliance to infection control practices were analysed.

All the blood cultures that yielded the growth of *Serratia marcescens* were included. Isolates were identified using standard biochemicals and API 20 E (bioMérieux[®]) and susceptibility testing was performed using disk diffusion. Results of susceptibility testing were interpreted using breakpoints in CLSI M-100.

All the equipment and furniture of paediatric critical care unit were swabbed and air sampling of the room affected was performed. In addition, staff hands were screened for any infected skin lesions by a dermatologist and hand swabs were also obtained.

Descriptive statistics were used to summarize demographic and clinical characteristics of the affected patients. Odds ratio was calculated to assess the association of central venous catheter use and mortality.

This study was approved by the institutional ethical review committee (LUMHS/ REC/-465) and all the patient information was kept confidential.

RESULTS

The outbreak was identified through routine monthly infection surveillance conducted from 1st January 2024 to 31st January 2024. Data were collected from medical records, laboratory reports and infection control logs. Index case was identified as a case with *Serratia marcescens* pneumonia, who had been transferred from another health facility. Other patients who were recovering, developed new symptoms and deteriorated clinically. Blood cultures sent yielded the growth of *Serratia marcescens*. The demographics and clinical information of all cases are included in Table-I. The median age group was pediatric, with 3 infants and 4 older children. Pneumonia and gastroenteritis were the most common diagnoses (28.6% each). The overall case fatality rate was 14.3% (1/7). Central venous catheter use was observed in 2 patients (28.6%), both of whom required respiratory support. Mortality among exposed patients was 50% (1/2), compared to 0% in non-exposed patients. Thus, the crude relative risk and odds ratio were incalculable due to zero events in the unexposed group. After continuity correction, the odds ratio was estimated at 11, suggesting a strong association between invasive device use and mortality. However, Fisher's exact test showed no statistically significant association between central line use and mortality ($P= 1.0$), likely reflecting the small sample size despite a high estimated odds ratio.

A total of 3290 blood cultures were received in the month of January 2024 out of which 623 were received from pediatric critical care unit. 7/623 blood cultures were positive for multidrug-resistant *Serratia marcescens*. All these patients were recovering and then developed new fever and respiratory distress. All patients had been hospitalized for over 48 hours, classifying the cases as healthcare-associated infections.

All the isolates had the same susceptibility pattern and were multidrug-resistant, with susceptibility only to meropenem, piperacillin-tazobactam and ciprofloxacin. Environmental swabs, air sampling plates and staff hand swabs yielded no growth of *Serratia marcescens*. However, other environmental contaminants such as *Coagulase negative staphylococci* and *Bacillus* species were isolated.

The closely spaced admissions and on beds in the same room highlight a possible outbreak scenario within the healthcare setting (Figure-I). The development of new symptoms after admission and recovery indicates potential exposure to *Serratia marcescens* during the hospital stay. Also, the consistent isolation of *Serratia marcescens* from blood cultures reinforces the likelihood of these infections being healthcare associated. All cases were discharged following treatment, emphasizing the importance of monitoring and management in a healthcare setting.

Following identification of the outbreak, a multidisciplinary infection control team implemented

targeted interventions, which included enhanced surveillance for new cases, reinforcement of hand hygiene practices and education for staff and caregivers, review and improvement of disinfection protocols for medical equipment and environmental surfaces and strict adherence to them and isolation of affected patients to prevent further transmission.

Following the targeted infection control strategies, no further cases were identified. A review of infection control protocols is essential to prevent further outbreaks. Also implementing enhanced surveillance for HAIs in similar patient populations can help detect and mitigate future risks.

Table-I: Demographics, clinical information and outcomes of patients with *Serratia marcescens* bacteremia.

Patient ID	Age/Gender	Presenting Complaints	Primary diagnosis	New symptoms	Central lines	Respiratory support	Outcome
Case 1	3 months/ Female	Fever, respiratory distress	Pneumonia	Worsening of symptoms	Yes	Yes	Expired
Case 2	4 years/ Male	Fever, Diarrhoea, Vomiting	Enteric fever	New fever, dyspnoea	No	No	Discharged
Case 3	6 months/ Female	Vomiting, Diarrhoea	Acute gastroenteritis	New fever, dyspnoea	No	No	Discharged
Case 4	2 years/ Male	Vomiting, Diarrhoea	Acute Gastroenteritis	New fever, dyspnoea	No	No	Discharged
Case 5	4 months/ Female	Respiratory Distress	Pneumonia	New fever, Dyspnoea	Yes	Yes	Discharged
Case 6	6 years/ Male	Fever, Lower abdominal pain, burning micturition	Pyelonephritis	New fever, Dyspnoea	No	No	Discharged
Case 7	4 years/ Male	Fever, headache, seizures	Cerebral malaria	New fever, Dyspnoea	No	No	Discharged

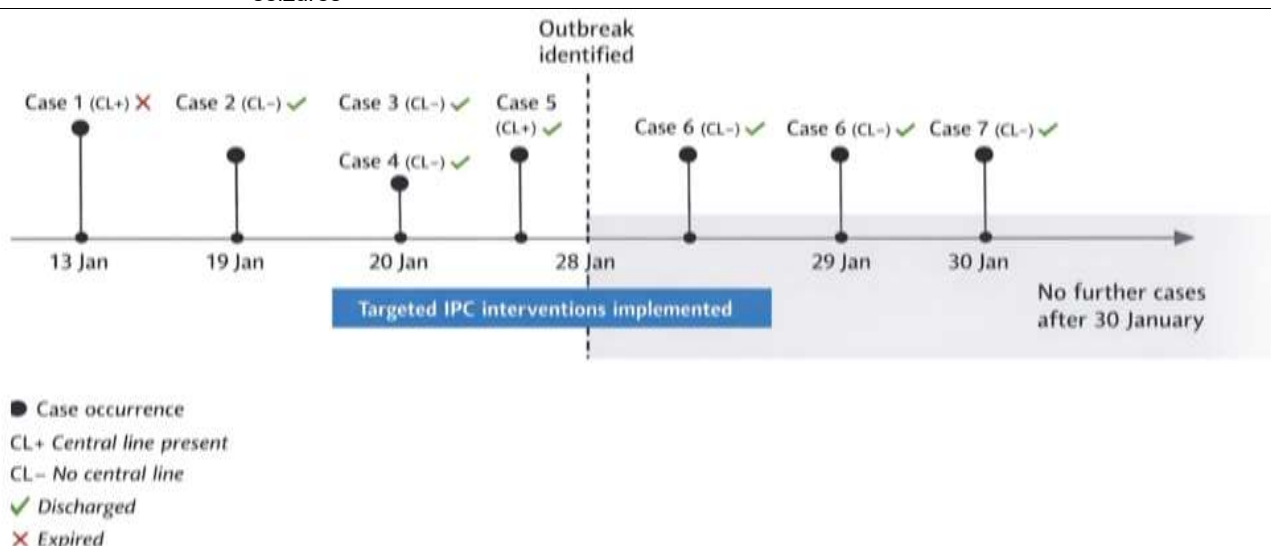


Figure-I: Timeline of healthcare associated infections (HAIs).

DISCUSSION

This outbreak of *Serratia marcescens* in the paediatric care unit shows the significant challenges

public healthcare facilities face in containing health care associated infections, particularly among susceptible populations like children and neonates.

The symptoms observed, primarily fever and respiratory distress, are common manifestations of severe infections in paediatric patients, stressing the need of early identification and management of such outbreaks [7,8]. The index case, a 3-month-old infant with pneumonia, exemplifies the clinical severity of infections caused by *S. marcescens* and the urgent need for effective outbreak management protocols.

The demographic data analysed shows diverse age range and clinical presentations of the affected children, which suggests that *S. marcescens* infection is not restricted to one age group or specific disease, but it may infect especially those who undergo invasive procedures or require prolonged hospitalization [9].

All the cases had been hospitalized for more than 48 hours before new symptom onset, hence highlighting the alarming issue of healthcare associated infection in a paediatric critical care unit. Literature also supports that *S. marcescens* is frequently associated with HAIs within critical care particularly in neonatal and paediatric units [10].

The timeline analysis reveals a closely spaced admission pattern and admission of all patients in a single bay, managed by the same staff, which suggests the possibility of cross-contamination within the unit. The development of new symptoms in recovering patients raises concerns about intra-hospital transmission, which is consistent with findings from other studies that conclude it to be because of lack of compliance of infection control practices [10]. The close monitoring of admissions and patient movements within the unit, education of staff and surveillance of compliance to infection control practices is essential to prevent such occurrences.

The microbiological analysis revealed that 7 out of 623 blood cultures from the paediatric care unit were positive for multidrug-resistant *S. marcescens*. The emergence of multidrug resistant strains is particularly alarming, as it limits treatment options and leads to poor outcomes, emphasizing the need for consistent surveillance and robust antimicrobial stewardship program [11,12].

The absence of *S. marcescens* growth in environmental swabs and staff screening suggests that the staff was not colonized, the equipment and other environmental resources were not contaminated. The source of infection identified was lack of adherence to infection control practices by the staff responsible for the bay. Other studies have documented direct patient-to-patient contact, lack of

hand hygiene or contaminated medical equipment as potential sources of pathogens, urging the need for rigorous and correct sterilization and disinfection protocols [13,14]. Also, continuous education and training on proper hand hygiene and infection control protocols are essential. Literature shows that compliance with these protocols directly correlates with reduced rates of HAIs [14]. Regular reinforcement sessions can further enhance staff adherence to infection control practices [15].

The retrospective design utilized in this study illustrates the critical role of surveillance in detecting and managing outbreaks. Regular infection surveillance not only helps in timely detection of clusters of infections but also allows for prompt interventions, resulting in lesser morbidity and mortality. Enhanced surveillance measures should be a priority in high-risk units to pre-emptively identify and manage potential outbreaks [16].

Following the outbreak identification, a series of targeted infection control strategies were implemented, including enhanced surveillance, reinforcement of hand hygiene practices, and staff education. These interventions are vital in preventing further transmission and highlight the significance of a multidisciplinary approach to infection control in healthcare settings [17]. The successful cessation of new cases following these interventions supports the efficacy of prompt infection control measures in mitigating the transmission of multidrug-resistant organisms.

Continuous monitoring of resistance trends among nosocomial pathogens can provide information on emerging resistance [18]. There is not much local published data, except 7-year study published in Rawalpindi, one-fourth of the isolates included, were resistant to last resort antibiotics and an outbreak at critical cardiac unit in Karachi, with carbapenem resistant isolates, highlighting the emerging resistance and importance of reporting of regional data [7, 19]. The incorporation of newer and latest technology, such as real-time monitoring systems for environmental contamination and pathogen identification, can strengthen surveillance efforts and may aid in management of such outbreak situations. Developing and validating national or institutional paediatric-specific infection prevention guidelines can significantly improve patient outcomes.

One of the major limitations of this study is the absence of genomic characterization of the isolates, which was not feasible in our resource-limited setting. Nevertheless, the uniform antimicrobial susceptibility

patterns observed, together with the clustering of cases within a single bay, are strongly suggestive of an outbreak.

The significance of this *Serratia marcescens* outbreak to resource-limited settings lies in the multiple challenges posed by constrained diagnostic and infection-control capacities. Limited access to advanced microbiological tools, such as genomic sequencing or rapid diagnostic testing, can delay confirmation of transmission pathways and hinder timely outbreak containment. Additionally, shortages of trained staff, inconsistent availability of personal protective equipment, and barriers to optimal hand-hygiene practices further compromise effective infection prevention. In paediatric critical care units, where vulnerable patients are at heightened risk, these constraints underscore the urgent need for strengthened basic infection-prevention measures, targeted surveillance, and feasible, low-cost strategies to detect and control outbreaks promptly.

A major strength of this study is that it provides context specific evidence from a resource limited Paediatric Intensive Care Unit (PICU) in Pakistan, a setting from which outbreak data are scarce and underreported. The study adds to the limited body of literature on *Serratia marcescens* outbreaks from low- and middle-income countries, where healthcare-associated infection dynamics, limited infrastructure, and infection prevention challenges differ substantially from those in high income settings.

Another notable feature of this study is successful identification, management, and complete containment of the outbreak using targeted infection prevention and control (IPC) measures, despite the absence of advanced molecular tools. The cessation of new cases following implementation of these interventions highlights the effectiveness of basic, feasible IPC strategies, such as reinforcement of hand hygiene, environmental cleaning, cohorting, and adherence to aseptic practices, thus demonstrating the practical value of conventional microbiology, clinical surveillance, and epidemiological linkage in outbreak investigations where genomic analysis is not readily available. This reflects real world conditions in many hospitals across Pakistan and similar settings, enhancing the generalizability and applicability of the findings.

CONCLUSION

In summary, the outbreak of *Serratia marcescens* in the paediatric care unit serves as a crucial study for understanding and addressing the challenges posed by opportunistic pathogens in critical care units. The

findings presented emphasizes the importance of rigorous infection control measures, effective surveillance, and ongoing staff education. By enhancing our understanding of *S. marcescens* resistance patterns and trends, we can improve our strategies for preventing similar outbreaks in the future, ensuring better outcomes.

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CONFLICT OF INTEREST

None

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Declared none

AUTHORS CONTRIBUTION

Yusra Shafquat: Substantial contributions to study design, acquisition of data, manuscript drafting, reviewing critically for intellectual contents, final approval, accountable for all aspects of publication.

Riyasat Ahmed Memon: Substantial contributions to acquisition of data, manuscript drafting, reviewing critically for intellectual contents, final approval, accountable for all aspects of publication.

Muhammad Rahil Khan: Manuscript drafting, reviewing critically for intellectual contents, final approval, accountable for all aspects of publication.

Ikram Din Ujjan: Reviewing critically for intellectual contents, final approval, accountable for all aspects of publication.

Abid Hussain Chang: Substantial contributions to acquisition of data, final approval, accountable for all aspects of publication.

Faisal Imran: Manuscript drafting, reviewing critically for intellectual contents, final approval, accountable for all aspects of publication.

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