CASE SERIES

Reinforcing infection prevention practices: *Providencia stuartii* outbreak in ICU, an observational study

Pallavi Dhawan[1], Varsha Gupta[1], Preeti Chaudhary[1], Neelam Gulati[1], Anku Goel[1]

[1]Department of Microbiology, Government Medical College and Hospital, Chandigarh- 160030, India

Abstract

Gaps in infection control practices have long been significant contributors to healthcare-associated infections (HAIs). Both multidrug-resistant isolates and outbreaks caused by rarely reported bacterial species are increasingly being recognized adding to the concern. This study reports an outbreak of *Providencia stuartii* in a single Intensive Care Unit (ICU) of a tertiary care center. The reported observational study was initiated with the identification the index case of *Providencia stuartii* during routine HAI surveillance in an adult ICU. Subsequently, four additional cases with the same pathogen and susceptibility profile were detected in the same unit. Infection control practices were immediately reinforced, and environmental sampling taken from multiple sites of the concerned ICU was carried out to trace the source. Multiple interventions, including additional teaching sessions and audits, were implemented. *Providencia stuartii* was first isolated from the index case during routine surveillance and later from samples of four additional patients in the same ICU. The pathogen was identified in a total of eleven samples over three months, with all isolates showing identical susceptibility profiles. Although the source could not be determined despite extensive sampling, the implemented interventions, including enhanced teaching sessions and hand hygiene audits helped control the outbreak and strengthen infection control practices. The pathogen was transferred possibly due to the lapses in the infection control practices. Reinforcement of infection control measures, in addition to regular teaching sessions and audits for hand hygiene, played a major role in controlling the outbreak and further highlighted the importance for their periodic implementation to prevent such lapses.

Keywords: Hospital acquired infections, *Providencia stuartii*, intensive care unit, HAI surveillance, multi drug resistant organisms, hand hygiene, infection control practices, healthcare workers

Introduction

Infections caused by emerging and re-emerging infections have increasingly been recognized as significant contributors to the Healthcare Associated Infections (HAIs) [1]. These pathogens have the ability to colonize and survive in harsh environments, facilitating their spread part-icularly among immunocompromised and critically ill patients. *Providencia* species are increasingly being reported and recognized as important micro-organisms causing HAIs [2] Number of published studies have reported and identified *Providencia* species as potential nos-ocomial pathogens responsible for outbreaks [3] These are gram-negative bacteria capable of forming biofilms and causing device-associated infections, urinary tract infections (UTIs) being most common. Frequent contact among patients, residents, and healthcare workers, along with poor adherence to hand hygiene (HH) and infection prevention and control (IPC) practices, facilitates the transmission of such microbes and leads to outbreaks. Intensive Care Unit (ICU) settings are particularly vulnerable as mostly immunocompromised patients are admitted in intensive care. The best way to prevent such infections is through strict adherence to appropriate infection control practices, which requires continuous reinforcement through regular teaching sessions and audits. We report an outbreak of Multidrug-Resistant (MDR) *Providencia stuartii* in an adult ICU at our tertiary care institute. Despite extensive efforts, the source of the outbreak could not be identified. However, rigorous IPC measures successfully contained the outbreak within three months. The key factors that helped halt further transmission were repeated teaching sessions emphasizing proper IPC practices, regular audits to monitor healthcare worker compliance, and strict supervision of disinfection policy adherence.

Outbreak report

This cross-sectional observational study for over a period of three months was done in an adult ICU of a 1200-bedded tertiary care health facility of North India.

ICU setting

The adult ICU at our institute comprises 10 beds. The patient profile usually includes immuno-compromised individuals or those in critical conditions requiring ventilator support or invasive devices, making them highly susceptible to HAIs. As part of routine protocol, HAI surveillance is carried out for Ventilator-Associated Events (VAE), catheter-associated UTI (CAUTI), and Central Line-Associated Bloodstream Infections (CLAB SI) in reference with the National Healthcare Safety Network (NHSN) guidelines [4].

Index case and case series

During routine HAI surveillance, *Providencia* species was isolated from the urine sample of a catheterized patient (index case) admitted on bed no. 9 in the adult ICU. Two days later, blood culture from the central line of the same patient also grew *Providencia* spp. Antimicrobial Susceptibility Testing (AST) of both isolates showed susceptibility to imipenem, piperacillin tazobactam, and amikacin, and resistance to cotrimoxazole, tetracycline, ceftazidime, cefepime, and ciprofloxacin. Within 10 days, the same organism i.e. *Providencia* spp. was isolated from a pus sample of another patient (case 2) on bed no. 1, who had previously occupied bed no. 10. Subsequently, it was detected in urine and tracheal aspirate samples of a third patient (case 3) on the adjacent bed (bed no. 2). One month later, *Providencia* spp. was isolated from another patient also, (case 4) admitted on bed no. 9 (the previous bed of the index case) and from the urine sample of another patient on bed no. 10 (case 5). The susceptibility profiles of all isolates were identical to that of the index case. The identified index case was a 48-year-old male diagnosed with aspiration pneumonia and Guillain –Barré Syndrome (GBS). The patient had a urinary catheter, central line, and nasogastric tube in situ. He was admitted for three months and was receiving injectable amikacin (750 mg once daily), cefepime (1.5 g twice daily), colistin (2 IU twice daily), and linezolid (600 mg twice daily). After isolation of *Providencia* spp. from the urine sample, the treatment was modified to intravenous piperacillin-tazobactam (4.5 g twice daily) and colistin was discontinued. However, the patient succumbed to his illness. All the other patients with *Providencia* infection were treated with amikacin and piperacillin-tazobactam and they responded favourably. Species-level identification of every isolate was done using Matrix-assisted Laser

Desorption /Ionization–Time of Flight Mass Spectrometry (MALDI-TOF MS). A log score > 2 was obtained for *Providencia stuartii* in all 11 isolates. All isolates were MDR organisms and exhibited identical susceptibility patterns.

Actions taken and root cause analysis

Providencia stuartii was first isolated from the index case and subsequently from various clinical samples of four other patients in the same ICU. The organism was reported a total of 11 times over a period of three months. All isolates exhibited identical antimicrobial susceptibility profiles. Table 1 presents the details of *Providencia stuartii* isolates obtained from ICU patients. Isolation of this rare organism from two initial patients raised concern for the Hospital Infection Control (HIC) team. Hand Hygiene (HH) practices and cleaning and disinfection protocols were immediately reinforced in the ICU. This incident occurred during the COVID-19 pandemic, a period when the fear of viral spread was high and misuse of Personal Protective Equipment (PPE), gloves, and gowns was common, likely compromising infection control practices. Analysis of the root cause for the outbreak revealed that case 2 (bed no. 1) had been shifted from bed no. 10, which was adjacent to bed no. 9 (index case). Furthermore, the same attendant was responsible for patients on beds 1 and 2. The concerned staff received on-site education regarding hand hygiene and IPC measures. Disinfection protocols were meticulously followed, further reinforcement of infection control practices among all the Healthcare Workers (HCWs) was ensured. Repeated education sessions were conducted, and the frequency of Hand Hygiene (HH) audits was increased to ensure compliance. Before admitting new patients to beds 1, 2, 9, and 10, all bedding materials—including mattresses, sheets, pillows, and covers—were replaced, and the beds were disinfected. All potential routes of transmission were addressed through targeted corrective and preventive measures.

Environmental assessment

Swab sampling from the ICU environment was undertaken for the possible identification of the source of infection and eliminate potential reservoirs of transmission. Multiple rounds of sampling were performed by the HIC team. Swabs were collected from sterilized patient-care equipment, equipment screens and monitors, high-touch surfaces, and various disinfectant and solution containers, including distilled water, chlorhexidine, alcohol-based solutions, povidone-iodine, and chlorhexidine mouthwash. Samples were also collected from heparin vials, drinking and tap water, respiratory equipment surfaces and filters, cleaning devices and carts, medical equipment (e.g., thoracic drainage aspirators, ECG machines, portable X-ray units, cassettes, ECMO water heaters), haemodialysis units, patient surroundings, and also the bare hands of ICU staff. A total of 273 environmental swab samples were analysed over a three-month period. The first round of sampling was done within one week of isolating *Providencia* spp. from two ICU patients. None of the environmental samples yielded *Providencia* spp. Seven additional rounds of environmental sampling were subsequently conducted, but the source of contamination could not be identified. Though the environmental cultures were negative, still multiple infection control measures were initiated. Following these interventions, *Providencia stuartii* was no longer isolated from any patient samples in the concerned ICU after the treatment of case 4.

HH auditing

HH auditing is a routine component of our infection control program. The HH audit is done using a direct observation method adapted and modified, based on the World Health Organization (WHO) hand hygiene audit tool via the Ibhar HH audit application. HH complete adherence rate, partial adherence rate, and total adherence rate (complete + partial) was determined. Profession-specific (e.g., doctors, nurses, others) and moment-specific, both HH adherence rates were calculated for all WHO-defined HH moment. The initial HH audit showed complete adherence, partial adherence, and total adherence rates of 13.1%, 41.2%, and 54.3%, respectively. Moment-specific observations revealed lower compliance during WHO Moments 1 and 5 (i.e., before touching a patient and after touching a patient's surroundings), at 38.9% and 35.5%, respectively. After reinforcement of HH practices and repeated training sessions, the adherence rates improved significantly over a three-month period. Complete Adherence (HHCAR) increased from 13.1% to 38.2%, Partial Adherence (HHPAR) from 41.2% to 47.4%, and Total Adherence (HHTAR) from 54.3% to 85.6%. Profession-specific HH adherence was initially below 25% among attendants and allied staff, which subsequently improved to approximately 50%. Moment-specific HH adherence for Moments 1 and 5 also increased to around 60% after interventions.

Hypothesis

The following possibilities were hypothesized as contributing factors to the outbreak:

Providencia spp. is known to colonize the intestinal

Table 1: Timeline of the isolation of Providencia stuartii from the ICU patients

Sequence of reports	Sample type	Bed No. (as per figure 1)	Isolate
Day 1	Urine	9 (Index case)	*Providencia stuartii*
Day 3	Blood	9 (Index case)	*Providencia stuartii*
Day 8	Urine	10 (Case 2)	*Providencia stuartii*
Day 12	Pus (Bed sore)	1(earlier on bed 10) (Case 2)	*Providencia stuartii*
Day 17	Urine	2 (Case 3)	*Providencia stuartii*
Day 19	Tracheal aspirate	2 (Case 3)	*Providencia stuartii*
Day 20	Tracheal aspirate	1(earlier on bed 10) (Case 2)	*Providencia stuartii*
Day 21	Tracheal aspirate	1(earlier on bed 10) (Case 2)	*Providencia stuartii*
Day 43	Urine	10 (Case 4)	*Providencia stuartii*
Day 48	Urine	9 (next patient) (Case 5)	*Providencia stuartii*
Day 50	Pus	9 (next patient) (Case 5)	*Providencia stuartii*

tract and can intermittently inhabit the periurethral region, leading to catheter contamination, biofilm formation, and infection spread particularly in immunocompromised patients. The index case had GBS and his initial treatment included colistin, to which *Providencia* spp. is intrinsically resistant. This likely facilitated colonization and persistence.

Gaps in practices for infection control, including infrequent change of PPE and gloves, may have a significant role in the spread of infection.

Although environmental cultures were negative, transmission via environmental reservoirs could not be completely ruled out. Ultimately, strengthening IPC measures, reinforcing disinfection protocols, and improving HH compliance appeared to have contained the outbreak.

It was therefore hypothesized that the index patient on bed no. 9, being immunocompromised and receiving colistin, became colonized with *Providencia* spp. in the periurethral region, leading to CAUTI and CLABSI. The organism likely spread from the index case (bed no. 9) to case 2 (bed no. 10), who was later shifted to bed no. 1. Transmission to case 3 (bed no. 2) may have occurred through a healthcare worker who attended both patients. Subsequently, the same organism i.e. *Providencia* spp. was again isolated from a patient occupying bed no. 9, the original bed of the index case. The mattresses and linens of all patients infected with *Providencia* spp. were replaced, and strict practices to control infection were enforced. Follow-up surveillance of ICU samples over the next month showed no isolation of *Providencia* spp. after three months of continued intervention and assessment.

Discussion

A study reported by the WHO across 22 countries reported that although approximately 60–70% of countries have IPC guidelines and training programs but auditing and monitoring are conducted annually in fewer than 30% of these countries only [5]. Outbreaks caused by rare and resistant organisms in hospital settings have become an increasing concern. Recently, various MDR organisms and their spread within hospital environments have been reported. The transmission of Methicillin-Resistant *Staphylococcus Aureus* (MRSA) between patients and their surroundings has been documented in teaching hospitals in the United Kingdom and hospitals including nursing homes in the United States [6, 7]. The isolate in our study was also multidrug-resistant, as defined by the Centers for Disease Control and Prevention (CDC).

Providencia species are commonly associated with CAUTIs, particularly in elderly patients with long-term indwelling urinary catheters [8]. Biofilm formation on the surface of indwelling catheters facilitates bacterial persistence and infection. Furthermore, the urease-producing property of *Providencia* allows these organisms to thrive, often causing severe infections [9]. Biofilm-forming bacteria such as *Proteus* spp. and *Pseudomonas aeruginosa* are globally recognized as major contributors to HAIs. *Providencia* spp. is intrinsically resistant to colistin, which facilitates colonization and persistence in ICU patients receiving this antibiotic. Colistin use has been linked to the emergence of hospital-acquired, Intrinsically colistin-Resistant Enterobacteriaceae (IRCE) [10]. Several outbreaks caused by *Providencia* species have been documented. Saida *et al*. (2008) reported a *P. stuartii* outbreak in a burn unit over four months, with tracheal aspirators identified as the source [11]. A Tunisian study recovered *P. stuartii* from eight colonized patients and environmental samples, although only one patient developed disease [12].

P. stuartii outbreak in our hospital ICU was hypothesized to have resulted from inappropriate infection control practices. Outbreaks associated with improper use of personal PPE, gloves, and gowns have been previously reported [13]. During our outbreak, similar lapses were observed likely influenced by the post-COVID-19 period, when staff routinely wore gowns and gloves, making frequent changes between patient interactions impractical. Studies from the United States have documented the transfer of Gram-Negative Bacilli (GNB), including MDR *Acinetobacter baumannii*, MDR *Pseudomonas* spp., and *Klebsiella pneumoniae*, from infected patients to gloves, gowns, and hands of HCWs [14]. The transfer of microorganisms between patients via HCWs' hands and reused medical devices has been repeatedly reported in the literature, dating back to the pioneering work of Ignaz Semmelweis (1818– 1865), the father of infection control [15]. These outbreaks highlight persistent gaps in IPC programs at both national and facility levels, particularly in Low- and Middle-Income Countries (LMICs). However, such outbreaks can be effectively prevented and controlled through appropriate IPC interventions. According to WHO, key IPC components include structured programs, guidelines, strategies, training, auditing, and monitoring, supported by adequate staffing and infrastructure. At our facility, IPC guidelines and strategies exist, and periodic training is provided. The staff are not overworked, and facilities are adequate; however, consistent monitoring and auditing were lacking, and infection control personnel were insufficient. These shortcomings likely contributed to the observed IPC gaps. Integration of all IPC components is essential for effective infection prevention in any healthcare facility. Early, targeted interventions addressing standard precautions are crucial for preventing and controlling outbreaks. Although environmental sampling did not reveal any association, the spread of infection through the environment cannot be completely excluded. Despite not isolating *Providencia* spp. from the environment or HCWs, the implementation of stringent infection control measures including reinforcement of HH, correct PPE use, regular HH audits, and meticulous disinfection procedures—over a two-month period effectively contained the outbreak. Continuous reinforcement of ongoing IPC programs is necessary to prevent future lapses. Species-level identification of *Providencia* strains was performed using MALDI-TOF MS, with all isolates showing identical susceptibility profiles. However, variations in sequence types cannot be excluded. Advanced molecular techniques such as multilocus sequence typing or whole-genome sequencing could not be performed due to financial constraints, which is a limitation of this study.

Conclusion

It was concluded that understanding the dynamics of pathogen transmission among patients and healthcare workers is crucial for designing effective infection control policies and for containing inadvertent outbreaks. This reinforces the principle that, regardless of the type of infection, the golden rule for patient safety is the consistent adherence to appropriate infection control practices. Equally important are their regular reinforcement, continuous monitoring, and systematic auditing to strengthen and sustain these practices in routine healthcare settings.

References

1. Boncea EE, Expert P, Honeyford K, Kinderlerer A, Mitchell C, Cookeet GS, *et al*. Association between intrahospital transfer and hospital-acquired infection in the elderly: A retrospective case-control study in a UK hospital network. *BMJ Qual Safe* 2021; 30(6): 457-466.
2. Ozalp, O, Ortakci B, Komec S, Gokce O, Alp E and Aydin O.A. Carbapenem-resistant Providencia spp.: the threat at the door. J Hosp Infect 2025; 163, 51-55.
3. Hadavand F, Naseri SR, Mardani M, Tabarsi P, Gachkar L, Shoaei SD, *et al*. An outbreak of Pan-drug resistant Providencia species in an intensive care unit: A case-series. *Arch Clin Infect Dis* 2024; 19(3): e145826.
4. HAI Checklists. National healthcare safety network. (NHSN) 2024 CDC. Accessed on 12th September 2025. Available at https://www.cdc.gov/nhsn/hai-checklists /index.html.
5. Moghnieh R, Al-Maani AS, Berro J, Ibrahim N, Attieh R, Abdallah D, *et. al*. Mapping of infection prevention and control education and training in some countries of the World Health Organization's Eastern Mediterranean Region: current situation and future needs. *Antimicrob Resist Infect Control* 2023; 12(1):90.
6. Mao YC, Chang CL, Huang YC, Sue LH, Lee CT. Laboratory investigation of a suspected outbreak caused by Providencia stuartii with intermediate resistance to imipenem at a long-term care facility. *J Microbiol Immunol Infect* 2018; 51(2):214-219.
7. Hofmaenner DA, Wendel Garcia PD, Duvnjak B, Chakrakodi B, Maier JD, Huber M, *et al*. Bacterial but no SARS-CoV-2 contamination after terminal disinfection of tertiary care intensive care units treating COVID-19 patients. Antimicrob Resist Infect Control 2021;10(1):11.
8. Malviya M, Kale-Pradhan P, Coyle M, Giuliano C, Johnson LB. Clinical and drug resistance characteristics of providencia infections. *Microorganisms* 2024; 12(10):2085.
9. Castro JE, Birnberg-Weiss F, Toloza MJ, Bertinat YA, Fuentes F, Peyloubet A, *et al*. Clinical isolates of Providencia rettgeri and Providencia Stuartii evades neutrophil-mediated killing by subverting neutrophil-extracellular traps. *Front Immunol* 2025; 16:1636387.
10. Samonis G, Korbila IP, Maraki S, Kofteridis D, Dimopoulou D, Gkogkozotou VK, et al. Trends of isolation of intrinsically resistant to colistin Entero-bacteriaceae and association with colistin use in a tertiary hospital. Eur J Clin Microbiol Infect Dis 2014; 33(9):1505-1510.
11. Saida NB, Thabet L, Messadi A, Bouselmi K, Turki A, Boukadida J. Clonality of Providencia stuartii isolates involved in outbreak that occurred in a burn unit. Burns J Int Soc Burn Inj 2008; 34(6):829-834.
12. Mnif B, Ktari S, Chaari A, Medhioub F, Rhimi F, Bouaziz M. Nosocomial dissemination of Providencia stuartii isolates carrying bla OXA-48, bla PER-1, bla CMY-4 and qnrA6 in a Tunisian hospital. J Antimicrob Chemother 2013; 68(2): 329-332.
13. Morgan DJ, Rogawski E, Thom KA, Johnson JK, Perencevich EN, Shardell M, et al. Transfer of multidrug-resistant bacteria to healthcare workers' gloves and gowns after patient contact increases with environmental contamination. Crit Care Med 2012; 40(4):1045-1051.
14. Rock C, Thom KA, Masnick M, Johnson JK, Harris AD, Morgan DJ. Frequency of Klebsiella pneumoniae carbapenemase (KPC) and non-KPC-producing Klebsiella contamination of healthcare workers and the environment. Infect Control Hosp Epidemiol Off J Soc Hosp Epidemiol Am 2014; 35(4):426-429.
15. Tyagi U, Barwal KC. Ignac Semmelweis—Father of Hand Hygiene. *Indian J Surg* 2020; 82(3):276–277.

***Author for Correspondence:**

Dr. Preeti Chaudhary, Department of Microbiology, Government Medical College and Hospital, Chandigarh, India Email: drpreeticthakur@gmail.com
Cell: 9501626331

How to cite this article:

Dhawan P, Gupta V, Chaudhary P, Gulati N, Goel. A. Reinforcing infection prevention practices: Providencia stuartii outbreak in ICU, an observational study. *J Krishna Inst Med Sci Univ* 2025; 14(4): 188-194

***Submitted:** 12-July-2025* ***Accepted:** 02-Sep-2025* ***Published:** 01-Oct-2025*