

ORIGINAL ARTICLE

Emerging Infections by Pantoea species: A Potential Threat, Clinical Implication and Antibigram

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Abstract:

Background: *Pantoea* species, traditionally considered opportunistic pathogens, have emerged as significant causes of infections, particularly in neonatal and immune compromised populations. This study aims to investigate the prevalence, clinical impact, and antimicrobial resistance patterns of *Pantoea* species over a five-year period in a tertiary care center located in the Konkan region of the Western Ghats, Maharashtra. **Material and Methods:** Detailed records of 40 *Pantoea* isolates, primarily from blood cultures, were gathered from various clinical samples. The study assessed the yearly trend of *Pantoea* infections, identified associated risk factors, and outlined antimicrobial susceptibility profile. **Results:** The majority of isolates (87%) were from blood samples, with significant occurrences in neonates with underline predisposing factors like low birth weight, intrauterine growth retardation (IUGR), and meconium aspiration syndrome (MAS). The study observed a marked decrease in cases during the COVID-19 lockdown period (2020-2021), followed by a resurgence in 2022. Antimicrobial susceptibility testing revealed decreased sensitivity to third-generation cephalosporins Piperacillin Tazobactam, and Meropenem, indicating a trend towards multidrug resistance. **Conclusion:** The finding underscore the emerging threat of *Pantoea* infections and the need for vigilant antimicrobial stewardship. Monitoring environmental factors, such as the use of *Pantoea* species as biofertilizers and traditional practices like giving rice water to newborns, is crucial to prevent potential large-scale outbreaks. Futures sequencing based studies are recommended to gain a deeper understanding of the epidemiology and resistance mechanisms of *Pantoea* species in this region.

Keywords: Emerging *Pantoea* infections, Potential threat, Neonatal sepsis, Multidrug resistance, NICU infection, antibiogram

Introduction:

The *Pantoea* species are gram negative bacteria that belong to the Enterobacteriaceae family, they are

typically found in close proximity to plants, either as epiphytes or as pathogens. Since last decade, *Pantoea* species are re-emerging plant pathogens in various diseases affecting rice plants.^{1,2} The *Pantoea* have been isolated from a variety of soil and water environments.³ The *Pantoea* is a non-encapsulated, non-spore-forming anaerobic Gram-negative bacillus having 20 known species; some of them affect humans; the most common is *P.agglomerans*, previously known as *Enterobacter agglomerans* or *Erwinia herbicola*. In this modern era, the emergence of the *Pantoea* species is associated with various human infections (local as well as systemic type), e.g. septic arthritis, osteomyelitis, or synovitis, Endocarditis, endophthalmitis, wound super infection as well as bacterimia.^{4,5,6,7} Exposure to medical equipment or fluids contaminated with bacteria is known to be associated with hospital outbreaks. The Factory-contaminated screw caps of bottles of intra-venous fluids are a proven example of an epidemic in the United States back in 1970-1971 in infants and children.⁸ Ingestion of bacteria in food, direct penetration of human skin through micro trauma, and inhalation of organic dust are considered modes of transmission.⁹ IUGR, prolong rupture of membranes, Birth asphyxia, low birth weight, and meconium aspiration are important risk factors in neonates; they cause neonatal sepsis.^{10,11} In our remote rural area, characterized by heavy rainfall and rice paddy fields, this study was carried out to determine the emergence and current burden of this newer pathogen in the region.

Material and Methods:

The present study is retrospective observational study conducted during 2018 to 2022. Records of all The *Pantoea* species isolates from different clinical samples received from various wards are included in the study. The Records of samples with incomplete history, and reports having growth of probable contaminants like aerobic spore bearing bacilli were excluded. In addition, bacteria of the normal skin flora were considered pathogenic bacteria only if the same bacteria, has been recovered from 2 or more cultures samples with the same antibiotic-susceptibility patterns.

All the reports fulfilling the above eligibility criteria were studied for achieving above aims and

objective of this study. In these cases, samples were processed as per departmental standard operating procedures for sample processing. All clinical samples received from different departments were processed as per standard norms of bacteriological culture; these samples were cultured on Blood Agar, Mac-Conkey Agar & Chocolate agar respectively. Identification of *Pantoea* species was done by using Vitek-2 Compact system & antimicrobial susceptibility was done by manual Kirby Baur Disc diffusion method.

The *Pantoea* species isolated from different clinical samples were tested for antimicrobial susceptibility towards following drugs using Kirby Bauer disc diffusion method on Mueller Hinton agar. Antimicrobial agents evaluated against Gram Negative organism (*Pantoea* species) Ampicillin (AMP), Amikacin (AK), ceftazidime (CAZ), ceftazidime/clavulanic acid (CAC), Cefoperazone (CPZ), Cefoperazone-sulbactam (CFS), Gentamycin (GEN), Piperacillin/tazobactam (PTZ), Trimethoprim/ sulfamethoxazole (TMP/SMX), Levofloxacin (LE). For urinary isolates antimicrobial agents like Norfloxacin (NX) Nitrofurantoin (NIT) & Fosfomycin (FO) additionally tested as per Clinical and Laboratory Standards Institute (CLSI) guideline.

Results:

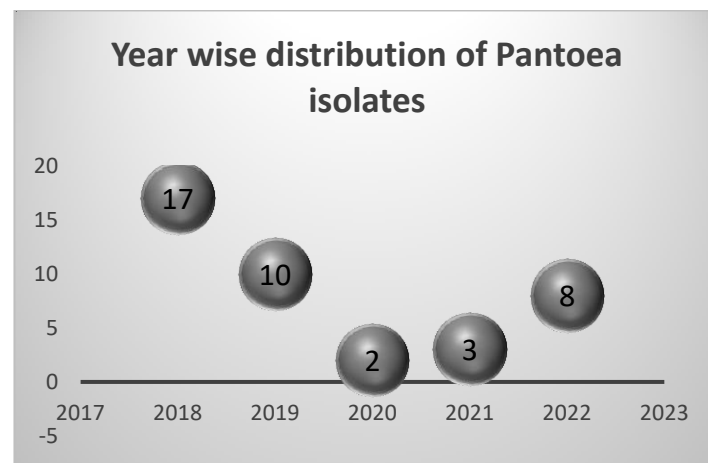
A total of 40 *Pantoea* species were isolated from 3845 various clinical samples processed over a period of 5 years. Among these 40 isolates, 87% were recovered from blood cultures, most of which were sent from the Neonatal Intensive Care Unit (NICU) (see below

TABLE 1: OVERALL SUMMARY OF STUDY	
Number of <i>Pantoea</i> isolates	40
In Male	24
In Female	16
AGE GROUPS	
Adults (>19 Years)	4
Adolescent (10-19 years)	1
Under 5 children's	1
Neonate	34
NEONATES (N=34) TYPE OF BIRTH	
Full term delivery	7
Preterm delivery	20
Twin deliveries	7
SAMPLE WISE DISTRIBUTION OF PANTOEA SPECIES	
Sample	Number of <i>Pantoea</i> species isolated
BLOOD	35
URINE	2
CEREBROSPINAL FLUID	1
SPUTUM	1
PUS (Suture site)	1

WARD/ICU/OPD WISE DISTRIBUTION OF PANTOEA SPECIES	
WARD/ICU/OPD	Number of <i>Pantoea</i> species isolated
NICU	34
PICU	2
OBGY	2
MICU	1
FMW	1

NICU (neonatal intensive care unit). MICU (medicine intensive care unit), PICU (Paediatric intensive care unit), female medicine ward (FMW) OBGY (Obstetric gynaecology)

Chart no 1: Year wise isolation trend of *Pantoea* species



As a tertiary care center located in a remote and rural area, most patients were referred from public and private healthcare facilities due to conditions such as intrauterine growth retardation (IUGR), meconium aspiration syndrome, or low birth weight. Therefore, the source of *Pantoea* infection cannot be ruled out in these cases. The maximum number of isolates was reported in 2018, but the number drastically fell in 2019. During the COVID-19 lockdown (2020 and 2021), fewer cases were reported, but by November 2022, *Pantoea* infections began re-emerging. (Chart no1)

Chart No2: Cumulative antibiogram showing percentage susceptibility pattern

When the cumulative antibiogram of the isolates was analyzed, it was found that most isolates showed decreased susceptibility to many commonly used antibiotics such as Ampicillin (63%), Ceftazidime (53%), Cefoperazone (65%) and Gentamicin (70%). Additionally, there was increased resistance to higher antimicrobial agents like Piperacillin-Tazobactam and Meropenem (see chart. 2). In this study, only 2 urinary isolates of *Pantoea* were reported, which showed good susceptibility to Nitrofurantoin and Fosfomycin.

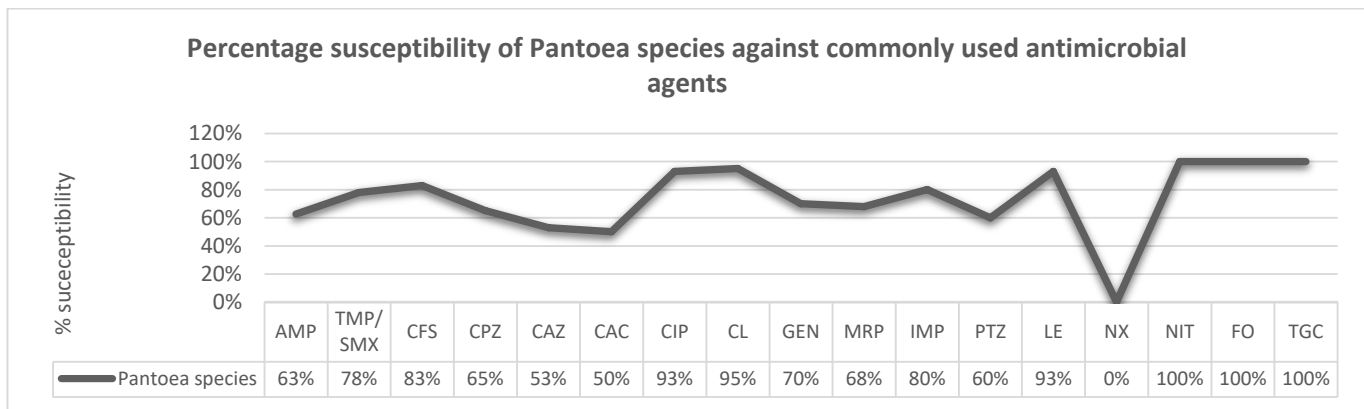


Table 2 A: SUMMERY OF DIFFERENT CASE REPORTS OF PANTOEA SPECIES (In India)

YEAR	Place of study	No. of cases reported	Sample	Ward/ICU	Age group	Source of infection	Ref
2012	Madurai, Tamil Nadu	1	Superficial corneal foreign body	Eye Hospital	Adult	ocular trauma with a rice husk	15
2012	Pune, Maharashtra	1	Synovial fluid	Ortho ward	Adult	History of Road traffic accident	16
2012	New Delhi	1	Tissue (Muscle cyst)	Male surgery ward	Adult	Thorn Prick	17
	Indore, Madhya Pradesh	2	Blood	NICU	Neonate	Not known	18
2014	Odisha	5	Blood	NICU	Neonate	Not known	19
2015	Odisha	1	Blood	NICU	Neonate	Not known	20
2018	Bathinda, Panjab	1	Endotracheal secretion	MICU	Adult	Intubation? Ventilator	21
2019	Karamsad, Gujarat	1	Blood	MICU	Adult	Central Venous Catheter	22
2022	Gondia, Maharashtra	1	Urine	Female Medicine	Adult	Not known	23

Table 2 B: SUMMERY OF DIFFERENT CASE REPORTS OF PANTOEA SPECIES Outside India

Year	Place of study	No. of cases reported	Sample	Ward/ICU	Age group	Source of infection	Ref
2004	Malaysia	6	Blood	NICU	Neonates (6)	Contaminated parenteral nutrition	24
2006	Malaysia	8	Blood	NICU	Neonates(8)	Infected parenteral nutrition solutions.	25
2008	Catanzaro (Italy)	6	Blood	ncology ward (5), ICU (1)	Adult (6)	Not known	26
2011	Naples, Italy	19	Blood	Medicine (5), Paediatric oncology (4), surgery (8), Nephrology (1), Haematology (1)	Adults (15), Paediatric (4)	Contaminated Total parenteral nutrition Bags	27
2016	Morocco	11	Blood	NICU	Neonates(11)	Not known	28
2018	Nepal	2	1 CSF, 1 Blood	NICU (1), PICU (1)	Neonate, child	Not known	29

2019	Georgia	1	Skin punch biopsy	OPD	Adult	Not known	30
2022	Lisbon, PRT	3	Ascitic fluid	Indoor Patients (IPD)	Adult	Environmental factor (injury during gardening, Local contamination of catheter)	31
2022	China	1	Blood	ICU	Adult	Not known	32
2023	Italy	19	Blood	Wards oncology, Paediatric, Medicine	children's (05), adults (14)	Central venous line, respiratory tract, Intra-abdominal cavity etc	33
2024	Georgia	1	Skin, genital ulcer	Skin OPD	Adults (1)	Not known, gardening	34

Discussion:

The *Pantoea* species is an opportunistic pathogen that usually does not affect healthy individuals. Infections caused by this pathogen have been reported in various parts of the world (refer to Table 2A&B). It is isolated from different samples, including sterile samples (blood, urine, synovial fluid, cerebrospinal fluid, and ascitic fluid) as well as unsterile samples (pus, infected tissue, and sputum). Therefore, *Pantoea* species infections are often not mono-microbial.

In this study, over a period of 5 years, a total of 40 *Pantoea* species were isolated. This is one of the largest series of cases reported globally, following the 53 cases reported by Cruz AT et al. in 2007. *Pantoea* species are known to cause bloodstream infections in immunocompromised individuals and neonates. In our study, most of the isolates (87%) were from blood samples, which is significantly higher than the findings of Cruz AT et al. who observed that 43% of their isolates were from blood cultures (23 out of 53 isolates). In our study, the majority of *Pantoea* isolates were from the Neonatal Intensive Care Unit (NICU), involving preterm deliveries with low birth weight, intrauterine growth retardation (IUGR), or meconium aspiration syndrome (MAS) leading to birth asphyxia. These findings are similar to different studies those shown in Table 2 A and B.

As a tertiary care institute, most of the deliveries occurred in private or public healthcare setups, with patients referred to our institute due to risk factors like IUGR, MAS, and birth asphyxia. When analyzing the year-wise trend of *Pantoea* isolation, it was observed that the case count drastically decreased during the COVID-19 lockdown (2020 to 2021). This may be due to decreased referrals during that time.

In this study, out of 7 twin babies, 4 pairs (both the first and second babies) were infected with

Most of them had low birth weight, and twin pregnancy with IUGR/low birth weight emerged as an important risk factor in this study. One case of surgical site infection was also observed with *Pantoea* species isolated from pus at the suture site. Additionally, there was one case of meningitis, one case of pneumonia, and two cases of urinary tract infection (UTI) due to *Pantoea* species. Among these two UTI cases, one involved a patient with uncontrolled diabetes as an underlying risk factor, and the other involved a patient with carcinoma of the cervix with urinary retention; both patients were female.

When antimicrobial susceptibility against commonly used antibiotics was carried out, it was found that the isolates showed decreased sensitivity to third-generation cephalosporins, Piperacillin-Tazobactam, and Meropenem. Our findings are similar to some studies that observed multidrug-resistant strains in sepsis cases, such as the study by Gajdacs, M et.al & Legese, M.H. et al. in 2019, 2022 respectively.^{12,13} A single urinary isolate showed resistance to Norfloxacin, and Tigecycline was not tested for blood isolates as per CLSI 2022 norms.¹⁴

The analysis of antimicrobial susceptibility patterns revealed a concerning trend of decreased sensitivity to commonly used antibiotics, including third-generation cephalosporins, Piperacillin-Tazobactam, and Meropenem. This resistance pattern aligns with global reports of multidrug-resistant *Pantoea* strains, emphasizing the need for vigilant antimicrobial stewardship and tailored therapeutic strategies.

Conclusion:

This study highlights the emerging threat posed by *Pantoea* species, particularly in neonatal and immunocompromised populations. Over a five-year period, a significant number of *Pantoea* isolates were identified, predominantly from blood cultures in the NICU. The findings underscore the pathogen's ability to cause severe infections, including bloodstream

infections, meningitis, pneumonia, and urinary tract infections. The study highlighted key risk factors for *Pantoea* infections, such as low birth weight, intrauterine growth retardation, and twin pregnancies. This study also emphasizes monitoring environmental factors such as heavy rainfall, use of *Pantoea* species as biofertilizers, and traditional practices like giving newborns rice water is crucial to prevent larger outbreaks.

Limited data on the susceptibility patterns of *Pantoea*

species exists in the literature, highlighting the need for additional research to provide comprehensive overview of resistance trends. This knowledge would aid in selecting effective antimicrobial therapies and, ultimately, in reducing mortality from *Pantoea* infections

Sources of supports: Nil

Conflicts of Interest: Nil

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How to cite this article:

Yogendra P. Shelke, Amey Paranjape, Sumedh Sudhakar Lokapure, Prasanna Nakate, Suvarna Patil and Rasika Jadhav. Emerging Infections by Pantoea species: A Potential Threat, Clinical Implications and Antibiogram. *Walawalkar International Medical Journal* 2023; 10 (2):66-71 .<http://www.wimjournal.com>

Received date: 28/08/2024

Revised date: 08/10/2024

Accepted date: 09/10/2024