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Surveillance of nosocomial infections in kidney and liver transplant recipients in Rasht, Northern Iran

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ABSTRACT

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Solid organ transplant (SOT) recipients are at heightened risk of hospital-acquired infections (HAIs) due to immunosuppressive therapy and frequent exposure to invasive procedures. HAIs, particularly those caused by multidrug-resistant (MDR) organisms, remain a major source of morbidity, prolonged hospitalization, and mortality in this population. Despite the global significance of this issue, regional data on post-transplant HAIs and antimicrobial resistance in Northern Iran remain limited. This study aimed to investigate the prevalence, microbial etiology, and antibiotic resistance patterns of HAIs among kidney and liver transplant recipients at a tertiary referral hospital in Rasht, Iran. A retrospective cross-sectional study was conducted at Razi Hospital from March, 2018, to February, 2023. Clinical, microbiological, and demographic data were collected for transplant recipients diagnosed with HAIs ≥48 hours after hospital admission. Among 141 transplant recipients, 14 (9.9%) developed confirmed HAIs. urinary tract infections were the most prevalent (57.1%), followed by bloodstream infections (21.4%), ventilator-associated pneumonia (14.3%), and surgical site infections (7.1%). The most frequently isolated organism was *Escherichia coli* (42.9%), followed by *Staphylococcus* spp., *Acinetobacter* spp., *Citrobacter* spp., and *Klebsiella* spp. (each 14.3%). Antimicrobial susceptibility testing revealed diverse resistance patterns among the isolated organisms; however, the rates of drug resistance among Gram-negative bacteria was high. This study highlights a moderate prevalence of nosocomial infections among transplant recipients in Northern Iran, with Gram-negative MDR pathogens posing significant therapeutic challenges. These findings emphasize the need for enhanced infection control policies, continuous microbiological surveillance, and locally informed antimicrobial stewardship programs to improve outcomes in transplant populations.

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1. Introduction

Organ transplantation represents a life-saving therapeutic strategy for patients with end-stage organ failure. However, the lifelong immunosuppressive therapy required to prevent graft rejection places transplant recipients at significantly increased risk of infections, particularly hospital-acquired infections (HAIs) [1]. Among these, nosocomial infections are a leading cause of morbidity, prolonged hospitalization, graft dysfunction, and mortality in solid organ transplant (SOT) recipients [2].

These infections are commonly caused by opportunistic or multidrug-resistant (MDR) pathogens that take advantage of the weakened immune defenses of the host and the frequent use of invasive procedures [3,4].

Transplant recipients represent one of the most vulnerable populations to hospital-acquired infections (HAIs), with a strikingly high prevalence rate of 77%, the highest among all hospital wards globally. This elevated burden reflects the combined impact of intensive immunosuppression, complex medical care, and prolonged hospital stays [5].

The most frequent infection sites of HAIs include the respiratory tract, urinary tract, bloodstream, and surgical sites [6]. Gram-negative bacilli such as *Klebsiella pneumoniae*, *Acinetobacter baumannii*, and *Pseudomonas aeruginosa* are among the predominant etiologic agents, often displaying extensive resistance to first-line antibiotics [7]. The rise of MDR and extensively drug-resistant (XDR) organisms has further complicated the clinical management of infections in this population, limiting therapeutic options and increasing mortality risks [8].

Antimicrobial resistance (AMR) has become a pressing global health crisis, and its impact is especially critical in transplant settings. According to the global estimations, resistant infections cause more than a million deaths annually worldwide, and their burden is expected to rise if effective surveillance and stewardship strategies are not implemented [9,10].

In transplant recipients, MDR organisms have been associated with longer hospital stays, higher healthcare costs, and increased risk of graft loss and death [11,12]. This highlights the urgent need for regional surveillance studies that can inform empiric treatment guidelines and support targeted infection control policies.

Despite national and international efforts, there remains a lack of localized data on the epidemiology and resistance patterns of nosocomial infections in transplant patients, particularly in Northern Iran. Therefore, the present study aims to address this gap by conducting a five-year surveillance of nosocomial infections among transplant recipients. Such region-specific data support evidence-based decisions in both antimicrobial treatment and infection control.

2. Materials and Methods

2.1 Study design and setting

This study was designed as a retrospective cross-sectional study and was conducted at Razi hospital, located in Rasht, Northern Iran. The medical center serves as a major tertiary referral hospital in the region and provides transplant care, particularly for kidney and liver transplant recipients. Data were collected over a five-year period from March, 2018, to February, 2023. This study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Guilan University of Medical Sciences (approval ID: IR.GUMS.REC.1402.160). Patient confidentiality was preserved through anonymized data handling. As this was a retrospective study based on existing records, the need for informed consent was waived by the ethics board.

2.2 Study population

The study population included solid organ transplant recipients who were admitted to inpatient wards, including intensive care units (ICUs), during the study period. Eligible participants were: recipients of kidney or liver transplants, hospitalized for ≥48 hours post-transplantation [13], and diagnosed with nosocomial infection(s) based on clinical, laboratory, and microbiological evidence. Patients were excluded from the study if they had incomplete clinical or microbiological records. Data were extracted from hospital information systems, infection control surveillance logs, and microbiology laboratory records. A structured data collection form was used to retrieve clinical and demographic data.

2.3 Microbiological data

For each confirmed case of nosocomial infection, site of infection (urinary tract, bloodstream, surgical site, respiratory tract, others); isolated pathogens, identified using standard biochemical methods and antibiotic susceptibility testing results based on Clinical and Laboratory Standards Institute (CLSI) guidelines (2024 edition) were retrieved [14].

2.4 Statistical analysis

All data were entered into IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA) for analysis. Descriptive statistics were used to summarize demographic and clinical data. Categorical variables (e.g., sex, type of pathogen) were presented as frequencies and percentages. Continuous variables (e.g., age, hospital stay duration) were reported as means ± standard deviation (SD) or medians with interquartile ranges (IQRs) based on distribution.

3. Results

During the study period, a total of 141 solid organ transplant recipients were admitted to Razi hospital in Rasht, Iran. Among these, 14 patients developed confirmed nosocomial infections, yielding an overall infection prevalence of 9.9%. Categorized by transplant type, 10 out of 100 kidney transplant recipients (10%) and 4 out of 41 liver transplant recipients (9.75%) experienced hospital-acquired infections.

The mean age of infected patients was 42.78 ± 17.27 years, ranging from 16 to 68 years. The median age was calculated as 43.5 (24, 61) years. Among the 14 patients with infections, 8 were female (57.1%) and 6 were male (42.9%), indicating a slightly higher prevalence among female recipients.

Analysis of transplant type among infected individuals revealed that kidney transplant recipients accounted for the majority of infections. Specifically, 10 out of 14 infected patients (71.4%) had undergone kidney transplantation, while the remaining 4 patients (28.6%) had received liver grafts.

With respect to the clinical manifestation of nosocomial infections, urinary tract infections (UTIs) were the most common, diagnosed in 8 patients, accounting for 57.1% of all infection cases. Bloodstream infections (BSIs) were identified in 3 patients (21.4%), while ventilator-associated pneumonia (VAP) and surgical site infections (SSIs) were observed in 2 patients (14.3%) and 1 patient (7.1%), respectively.

The duration of hospitalization for patients with nosocomial infections varied considerably. The mean length of stay was 33.71 ± 21.71 days, while the shortest and longest durations recorded were 14 and 87 days, respectively. The median hospitalization time was 24 (18, 47) days, indicating a notable burden of prolonged inpatient care among this population.

Microbiological evaluation of the 14 infection cases demonstrated that *Escherichia coli* was the most frequently isolated pathogen, responsible for 6 infections (42.9%). Other causative organisms included *Staphylococcus* spp. in 2 cases (14.3%), *Acinetobacter* spp. in 2 cases (14.3%), *Citrobacter* spp. in 2 cases (14.3%), and *Klebsiella* spp. in 2 cases (14.3%). Overall, Gram-negative bacteria constituted the predominant group of pathogens.

Antimicrobial susceptibility testing revealed diverse resistance patterns among the isolated organisms (Table 1). *Staphylococcus* spp. exhibited complete (100%) resistance to trimethoprim-sulfamethoxazole (SXT), while maintaining full susceptibility to gentamicin, tetracycline, and cefoxitin. Moderate resistance (50%) was observed against clindamycin. In the case of *E. coli*, the highest resistance rate was also observed for SXT (83.3%), followed by cefixime (60%). Resistance to gentamicin, ciprofloxacin, and imipenem ranged between 20% and 25%, whereas no resistance was detected to amikacin or nitrofurantoin. *Acinetobacter* spp. demonstrated alarming resistance levels, with all isolates (100%) resistant to amikacin, imipenem, ceftazidime, SXT, and ciprofloxacin. However, only partial resistance (50%) was seen against gentamicin.

4. Discussion

This five-year surveillance study provides valuable insights into the epidemiology, microbiological profile, and antimicrobial resistance patterns of nosocomial infections among solid organ transplant recipients in Rasht, Northern Iran. Our findings underscore the continued threat posed by hospital-acquired infections in this vulnerable population and emphasize the urgent need for robust infection control and antimicrobial stewardship measures.

The overall nosocomial infection rate of 9.9% observed in our study is relatively lower than infection rates reported globally, which often range from 15% to 60% depending on the type of organ transplanted, healthcare infrastructure, and local infection control practices [15,16].

While our lower rate may reflect effective infection prevention protocols, it is also possible that retrospective data collection led to underestimation due to missed or undocumented cases.

Table 1. The antibiotic susceptibility pattern of bacterial pathogens

Pathogen	Pattern	GEN	AMK	TET	FOX	CLI	SXT	IMP	CEF	CAZ	CFZ	CIP	NIT
Staphylococcus spp.	R	0	-	0	0	50	100	-	-	-	-	-	-
	I	0	-	0	0	0	0	-	-	-	-	-	-
	S	100	-	100	100	50	0	-	-	-	-	-	-
E. coli	R	20	0	-	-	-	83.3	25	60	-	-	20	0
	I	20	0	-	-	-	0	50	0	-	-	20	16.7
	S	60	100	-	-	-	16.7	25	40	-	-	60	83.3
Klebsiella spp.	R	50	50	-	-	-	-	50	100	100	100	50	-
	I	0	0	-	-	-	-	0	0	0	0	0	-
	S	50	50	-	-	-	-	50	0	0	0	50	-
Citrobacter spp.	R	0	0	-	-	-	100	50	100	100	-	100	-
	I	0	0	-	-	-	0	0	0	0	-	0	-
	S	100	100	-	-	-	0	50	0	0	-	0	-
Acinetobacter spp.	R	50	100	-	-	-	100	100	-	100	-	100	-
	I	0	0	-	-	-	0	0	-	0	-	0	-
	S	50	0	-	-	-	0	0	-	0	-	0	-

Abbreviations: Gentamicin (GEN), Amikacin (AMK), Tetracycline (TET), Cefoxitin (FOX), Imipenem (IMP), Cefixime (CEF), Ceftazidime (CAZ), Cefazolin (CFZ), Ciprofloxacin (CIP), Nitrofurantoin (NIT)

UTIs were the most common infection type, affecting 57.1% of patients with nosocomial infections. This is consistent with prior studies that have identified UTIs as the leading cause of infection in kidney transplant recipients, likely due to prolonged catheterization, anatomic abnormalities, and urological interventions [17,18]. BSIs and VAP followed in frequency, consistent with previously published literature [19-22].

The predominance of Gram-negative organisms, especially *E. coli*, as causative agents in this study is in agreement with several studies reporting similar trends in transplant recipients [23-28]. The high resistance of *E. coli* to SXT and cephalosporins observed in our study aligns with regional and global concerns about increasing antimicrobial resistance [23-25]. These resistance rates significantly challenge empirical treatment approaches and highlight the importance of local antibiogram-guided therapy. Of particular concern in our cohort was the detection of multidrug-resistant (MDR) organisms such as *Acinetobacter* spp., *Citrobacter* spp., and *Klebsiella* spp., which displayed extensive resistance to multiple antibiotic classes. For instance, *Acinetobacter* spp. isolates exhibited 100% resistance to amikacin, imipenem, ciprofloxacin, and ceftazidime, a pattern consistent with international reports of carbapenem-resistant *A. baumannii* in ICU settings [29-32]. Such resistance severely limits treatment options and contributes to prolonged hospital stays and increased mortality. Our study contributes valuable regional data to the limited body of literature on nosocomial infections in transplant recipients in Iran. The identification of common pathogens and their antimicrobial resistance profiles is essential for developing targeted antibiotic protocols, optimizing patient outcomes, and reducing the burden of drug-resistant infections. Despite its strengths, our study has several limitations. The retrospective design may have led to under-detection or misclassification of some infection episodes. Moreover, we also did not assess clinical outcomes such as graft loss or mortality, which would provide a more comprehensive understanding of the impact of HAIs. In conclusion, our findings reveal a moderate burden of nosocomial infections among transplant recipients at a tertiary care center in Northern Iran, predominantly caused by Gram-negative pathogens. The observed resistance patterns necessitate immediate attention to infection prevention strategies, continuous surveillance, and the implementation of evidence-based antibiotic stewardship to reduce the growing threat of antimicrobial resistance in transplant settings.

Authors' contributions

Study concept, design and supervision: PS, TY. Acquisition, analysis, or interpretation of data: MM. Drafting and critical revision of the manuscript: MM, PS, TY. All authors read and approved the final version of manuscript.

Conflict of interest

No potential conflict of interest was reported by the authors.

Ethical declarations

This study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Guilan University of Medical Sciences (approval ID: IR.GUMS.REC.1402.160). Patient confidentiality was preserved through anonymized data handling. As this was a retrospective study based on existing records, the need for informed consent was waived by the ethics board.

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