

# Cardiac Implantable Electronic Device (CIED) Infections, Associated Risk Factors and Optimization in Reducing CIED Infections; An Experience of Tertiary Care Hospital of Pakistan

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## ABSTRACT

**Objective:** To determine the frequency of infections in cardiac implantable Electronic device patients, identify risk factors, and look for optimization in reducing Cardiac Implantable Electronic Device infections, with a resultant decrease in mortality and morbidity, decrease in hospital stay, and total expenditure.

**Study Design:** Cross-sectional study.

**Place and Duration of Study:** Electrophysiology Department of National Institute of Cardiovascular Diseases, Karachi Pakistan, from Jul 2019 to Jun 2020.

**Methodology:** The study was conducted on the patients with cardiac implantable devices. Adult patients of either gender with cardiac implantable Electronic device and infection were included. Epicardial leads and surgical site infections within six weeks were excluded.

**Results:** One thousand and forty-six (1046) patients were enrolled in the study. There were 596(57%) male patients. 385(36.8%) patients were implanted with single chamber pacemakers, 390(37.3%) with dual chamber pacemakers, 146(14%) single chamber ICD (implantable cardiac defibrillator), 67(6.4%) dual-chamber cardiac implantable Electronic device, 46(4.4%) CRT-D, 12(1.1%) TPM, 134(12.8%) Re-do, 114(10.9%), 114(10.9%) generator change, 20(1.9%) leads revision, 26(2.5%) patients had extraction. The rate of CIED infection was 34(2.1%). The association of the study parameters with infection rate revealed that type of device ( $p=0.002$ ), extraction, suture type, and post-procedure hematoma ( $p<0.001$ ) had a statistically significant relationship with infection rate.

**Conclusion:** The Cardiac Implantable Electronic Device infection rate was 2.1%. Hypertension and diabetes were common risk factors, and left ventricular dysfunction was common in high-energy devices with multiple leads and repeated procedures.

**Keywords:** Cardiac implantable devices, Risk Factors, Pakistan, Defibrillators.

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## INTRODUCTION

Patients gain significantly from devices (pacemakers, defibrillators, CRT) that reduce mortality and improve quality of life. PPMs, implantable cardioverter defibrillators (ICDs), and cardiac resynchronization therapy devices with and without defibrillator (CRTD/C RTP) are among the CIEDs that are used to treat patients with tachyarrhythmia, bradyarrhythmia, or severely reduced ejection fraction.<sup>1,2</sup>

Infection is a severe consequence of Cardiac Implantable Electronic Device (CIED) implantation, with significant morbidity and mortality.<sup>3</sup> Without treatment, mortality surpasses 66%, and even with competent care, 1-year mortality can be as high as 18% to 20%.<sup>4</sup> The usual hospital stay lasts about two weeks, and recent data shows that average hospitalization costs have risen to more than \$170,000 in the last

decade. As a result, it is critical to comprehend this complicated sickness, as well as its care and prevention.<sup>5</sup>

Many risk factors are known for infection of the device, such as multiple leads, diabetes, chronic steroid use, early re-intervention, post-operative hematoma, fever, respiratory and renal failure, including patient on hemodialysis, fever within the preceding twenty-four hours or general infection, similarly as use of a temporary pacing lead.<sup>6</sup>

Infection in a CIED that has been implanted permanently is a significant problem and is linked to a significant increase in mortality and in-hospital costs. Due to the lack of a thorough registry or mandated reporting, determining the exact incidence of CIED infection is difficult. It can happen as a surgical site infection or as late-onset lead endocarditis within the first year of implantation.<sup>7,8</sup> Although it is widely acknowledged that the rate of CIED infection is rising, published data are scarce on the risk-adjusted mortality and costs associated with CIED infection, as well

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as the link between these outcomes and different CIED types, particularly in Asian nations.<sup>9,10</sup> This study aimed to determine the frequency of infection and identify risk factors in CIED patients that could help reduce the burden with resultant decreased morbidity, in-stay, and total expenditure.

## METHODOLOGY

After Ethical Committee approval, the cross-sectional study was carried out at the Electrophysiology Department of the National Institute of Cardiovascular Disease (NICVD) Karachi, Pakistan, from July 2019 to June 2020. The National Institute of Cardiovascular Diseases is a publicly funded government-sector hospital where cardiac implantable devices are implanted free of cost. The sample size of 1046 patients was estimated using the WHO sample size calculator, with the reported infection prevalence of 2.8%.<sup>11</sup>

**Inclusion Criteria:** The study enrolled adult patients (18 years or older) of either gender with CIED.

**Exclusion Criteria:** Patients with Epicardial leads and surgical site infection within six weeks were excluded.

All the patients enrolled for CIED implantation from July 2019 to June 2020 were included in the study. Any missing information about patients was obtained through telephone calls after verbal informed consent. Patient demographic details and medical history were taken by using a predefined proforma. Data on factors affecting infection was obtained through the patient's history.

Statistical Package for Social Sciences (SPSS) version 25.0 was used for the data analysis. Quantitative variables were expressed as Mean±SD and qualitative variables were expressed as frequency and percentages. Chi-square test was applied to explore the inferential statistics. The *p*-value of ≤0.05 was considered statistically significant.

## RESULTS:

One thousand forty-six patients were recruited, including 596(57%) male and 450(43%) female patients. Of the total, 284(27.2%) patients had diabetes mellitus, 371(35.5%) had HTN, 113(10.8%) were smokers, 16(1.5%) had chronic kidney disease, 182(17.4%) had left ventricular dysfunction, and 230(22%) patients had cardiomyopathy. 385(36.8%) patients were implanted with single chamber pacemaker, 390(37.3%) with dual chamber pacemaker, 146(14%) with single chamber implantable cardiac defibrillator (SICD), 67(6.4%) with dual chamber implantable cardiac defibrillator (DICD,

46(4.4%) with Cardiac resynchronisation therapy (CRT-D), 12(1.1%) patients with temporary pacemaker (TPM), 134(12.8%) Re-do, 114(10.9%) with Generator change, 20(1.9%) with leads revision, 26(2.5%) patients with extraction.

One hundred sixty-nine (16.2%) patients had ≤40% Ejection Fraction, 39(3.7%) had 40 to 60% Ejection Fraction, 838(80.1%) had ≥60% Ejection Fraction. 73(7%) were given absorbable suture type while 30(2.9%) were given non-absorbable. 11(1.1%) developed a post-procedure hematoma. 281(26.9%) patients were given Aspirin, 76(7.3%) used Clopidogrel, 10(1%) were given Warfarin and 16(1.5%) were given Rivaroxaban. Table summarises the results of the association of the baseline characteristics with infection rate. It was revealed that the device (*p*=0.002), extraction, suture type, and post-procedure hematoma (*p*<0.001) had a statistically significant relationship with infection rate in our study population.

## DISCUSSION

This study was conducted to determine the infection frequency and identification of associated risk factors in CIED patients in Pakistan. Our population had a CIED infection rate of 2.1%. Other epidemiological studies with long-term follow-up have estimated cumulative rates per patient or device and reported infection rates of 2.2 per cent and 1.6 per cent, respectively.<sup>11</sup>

Patients and healthcare systems pay a high price for CIED infections, which should be avoided wherever possible. Staphylococcus aureus is the most common pathogen.<sup>12</sup> Diabetes, renal and heart failure, corticosteroid use, oral anti-coagulation, fever within 24 hours of the procedure and leucocytosis, pacemaker versus implantable cardioverter defibrillator, especially in the case of Staphylococcus aureus bacteraemia, lack of antibiotic prophylaxis, and postoperative haematoma and other wound complications are the most important risk factors for CIED infections.<sup>13</sup> Prior procedures and CIED infections, the number of leads used, the use of Povidone-Iodine versus Chlorhexidine-Alcohol, and centres and operators with small implants are also risk factors to consider.<sup>14</sup>

The infection rate was almost three times higher following CIED replacement than after the first CIED implantation. In a prior study, the incidence of infection was 4.82/1,000 after the initial pacemaker was implanted and 12.12/1,000 after the pacemaker was replaced.<sup>15</sup> The significantly increased risk of

## Cardiac Implantable Electronic Device

**Table: Association of Study Parameters with Infection Rate (n=1046)**

Study Parameters	Infection Rate		p -value
	Yes n(%)	No n(%)	
<b>Gender</b>			
Male	19 (3.2)	577 (96.8)	0.896
Female	15 (3.3)	435 (96.7)	
<b>Co-morbid conditions</b>			
Diabetes Mellitus	10 (3.5)	274 (96.5)	0.763
Hypertension	14 (3.8)	357 (96.2)	0.479
Smokers	4 (3.5)	109 (96.5)	0.854
Chronic kidney disease	1 (6.3)	15 (93.7)	0.495
Left ventricular dysfunction	9 (4.9)	173 (95.1)	0.156
Cardiomyopathy	7 (3)	223 (97)	0.841
<b>Type of Device</b>			
Single Chamber Pacemaker	5 (1.3)	380 (98.7)	0.002*
Dual Chamber Pacemaker	22 (5.6)	368 (94.4)	
Single Chamber ICD	1 (0.7)	45 (99.3)	
Dual Chamber ICD	2 (3)	65 (97)	
CRT-D	4 (8.7)	42 (91.3)	
CRT-P	-	12 (100)	
TPM	16 (2.6)	603 (97.4)	0.144
Re-do	3 (2.2)	131 (97.8)	0.479
Generator change	1 (0.9)	113 (99.1)	0.13
Leads revision	2 (10)	18 (90)	0.086
Extraction	11 (42.3)	15 (57.7)	<0.001*
<b>Ejection fraction (EF)</b>			
≤ 40%	5 (3)	165 (97)	0.785
40 to 60%	2 (5.1)	37 (94.9)	
≥ 60%	27 (3.)	811 (96.8)	
<b>Suture Type</b>			
Absorbable	6 (8.2)	67 (91.8)	<0.001*
Non absorbable	7 (23.3)	23 (76.7)	
Not recorded	21 (2.2)	922 (97.8)	
Post procedure hematoma	6 (54.5)	5 (45.5)	<0.001*
<b>Medications</b>			
Aspirin	6 (2.1)	275 (97.9)	0.218
Clopidogrel	5 (6.6)	71 (93.4)	0.089
Warfarin	-	10 (100)	0.56
Rivaroxaban	1 (6.3)	15 (93.7)	0.495

*Single chamber implantable cardiac defibrillator (single chamber ICD) ,Dual chamber implantable cardiac defibrillator (single chamber ICD), Temporary pacemaker (TPM). Cardiac resynchronisation therapy defibrillator (CRT-D) ,Cardiac resynchronisation therapy pacemaker (CRT-P).*

infection identified in our study after CIED replacements such as generator change, lead revision or extraction, and procedures have been described in previous studies.<sup>15,16</sup>

The risk of infection after re-procedures argues that vendors should improve CIED batteries to last longer, and attending physicians should programme the device parameters to increase CIED longevity for implanters. They should appropriately implant leads and devices to minimise the chance of repeated procedures. Despite steady growth in CIED

implantation, a similar study in Thailand found that the annual incidence of CIED infection was around 0.9 per cent. Two other studies from Asia showed the incidence of the infection was (1.1%),11(1.9%).<sup>10,11</sup>

Among our population, several patients had established infection risk factors like diabetes (26.2%), chronic kidney disease (1.5%), and left ventricular dysfunction (17.2%). Numerous predisposing risk factors for CIED infection have been found, yet significant risk factors in one study were not significant in another, and vice versa.<sup>17</sup> The more complicated the

technology, the more likely it is to be infected. In addition, complex devices with multiple leads take a longer time for implantation, which also increases the infection risk.<sup>18</sup>

To prevent CIED infections, patients undergoing CIED operations and using appropriate equipment should be properly screened, and skilled operators should perform interventions. Antibiotic prophylaxis should be administered, as well as skin antisepsis using Chlorhexidine-alcohol. Oral anti-coagulation should be sustained during CIED surgeries in high-risk patients for thrombosis rather than bridging with heparin. Early re-intervention should be avoided in cases of haematoma or lead dislodgement. When infection prevention programmes are adopted, infection rates are reduced. More randomized controlled trials, particularly on skin preparation and Glycopeptide-based antibiotic prophylaxis, are needed to evaluate prophylactic strategies.

### CONCLUSION

Cardiac implantable device (CIED) infection was 2.1%. Hypertension and diabetes were common risk factors, and left ventricular dysfunction was common in high-energy devices, with multiple leads and repeated procedures.

**Conflict of Interest:**None.

### Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

GK & GI: Data acquisition, data analysis, drafting the manuscript, critical review, approval of the final version to be published.

SGA & KFA: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

MWB & AM: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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## Cardiac Implantable Electronic Device

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