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ORIGINAL ARTICLE

Clinical Characteristics and Outcome of Infective Endocarditis among Intravenous Drug Abusers after 6 Months

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ABSTRACT

Background: Infective endocarditis (IE) is one of the more dangerous complications of intravenous drug use (IVDU). This infection is significantly correlated with morbidity and mortality. The present work aimed to evaluate the acute and short-term clinical characteristics and outcomes of IVDU IE and comparing with non-IVDU IE.

Methods: This retrospective study involved 80 patients with infective endocarditis (IE) who were referred for management by the IE working team at Zagazig University Hospital. The study population was allocated into two groups: 80 individuals who were intravenous (IV) drug users and had IE and another 80 individuals who were not IV drug users but also had IE, as determined by the modified Dukes criteria.

Results: In our study, clinical and diagnostic aspects did not significantly differ between IV-IE and Non-IV-IE patients ($p>0.05$), except for a higher prevalence of needle puncture marks in IV drug users ($p<0.0001$). There was a non-remarkable variance between the groups regarding echocardiographic characteristics and the number and size of vegetation. The administration of gentamicin, vancomycin, and various other antimicrobial therapies did not differ significantly between IV drug users and non-IV drug users with IE.

Conclusion: We found that IVDU-IE is very common among infective endocarditis disease. This type of patient is not predictable and is associated with serious complications, significant morbidity, and mortality. As for therapy, medical treatment is sufficient in some cases, but others may require cardiac surgical intervention. Finally, this observational study allows a better understanding of the most common complications observed in those patients and the relevant causes of mortality.

Keywords: Infective Endocarditis, Intravenous Drug Abusers, Clinical Characteristics, Outcome.

INTRODUCTION

Infective endocarditis (IE) is a bacterial infection of the heart's endothelial lining that mainly affects natural or prosthetic valves but can also impact the valve's surrounding tissue, mural thrombus, or cardio-vascular implants [1].

IE is becoming more common around the world, with intravenous drug use (IVDU), vascular equipment, valve prosthetic valves, and acquired valve disease being the primary etiologies. IVDU is a risk factor for IE, with a frequency of 50–100 times higher in drug users [2].

S. aureus is the pathogen most commonly associated with IVDU IE, just as in non-IVDU IE. This epidemiologic finding is not surprising, given that IV drug users have a greater prevalence of S. aureus skin colonies than peers who only take oral medications or non-drug users. IVDU patients may have compromised nasal mucosa and epidermis, making S. aureus colonization easier. Skin organisms appear to have easy access to the blood vessels after breaking the skin barrier with a needle [3].

The right-sided dominance of diseased valves, with the most impacted tricuspid valve, is well known

among IVDU-IE reports. Direct mechanical damage caused by contaminants in the injected material is a postulated mechanism for right-sided IE in IVDU. High levels of bacteria delivered into the right-sided and venous side flow by needles and skin, IV drug-induced vasospasm resulting in intimal damage and thrombus development, giving a nidus for bacterial aggregation [4].

Endocarditis is a multimodal diagnosis that requires the expertise of multiple doctors. Fever must have a low threshold for considering and evaluating IE in the IVDU group [5]. To reach this diagnosis, clinical suspicion, various symptoms, and imaging [4].

The present work aimed to evaluate the acute and short-term clinical characteristics and outcomes of IVDU IE and comparing with non-IVDU IE.

METHODS

Patients:

It is a retrospective observational study of cases that were admitted to the Department of Cardiovascular Diseases, Zagazig University hospitals. This study included 80 patients with intravenous drug abuse infective endocarditis during the period from the first of February 2016 till the end of January 2022 and compared to 80 patients with non-IVDU-IE of the same period, then follow-up of IVDU patients after six months from hospital discharge to document possible complications that may occur. All patients were diagnosed as definite infective endocarditis according to modified Duke's criteria, two major criteria, one major criteria, and three minor criteria or five minor criteria. Written informed consent was obtained from all participants, the study was approved by the research ethical committee of the Faculty of Medicine, Zagazig University. The study was done according to The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans. This study was carried out after the approval of the Institutional Review Board (IRB#9287/8-3-2022).

Cases with the following criteria were included: all patients with infective endocarditis from the first of February 2016 till the end of January 2022, with ages ranging from 22 to 38 years.

Cases with the following characteristics were excluded: Cases that did not meet modified Duke's criteria, cases with significant arrhythmias because we wanted to assess the incidence of arrhythmia as a complication of Infective endocarditis, so if the patient already had arrhythmia, it would mislead the results, patients known to have a cardiac muscle disease and advanced hepatic and renal impairment.

Methods:

All study populations had the following diagnostic workup: Toxicology screening, full medical history, full clinical examination, Electrocardiography (ECG), Chest X-ray (CXR) / Chest CT, Transthoracic echocardiography (TTE), transesophageal echocardiography (TOE), abdominal ultrasonography, CT brain, MRI brain or CT cerebral angiography, and Hepatitis C virus AB, Hepatitis B virus surface antigen, and HIV.

Blood sample and chemistry: Routine workup for infective endocarditis: CBC with differential count on admission and once per week, CRP with titer and ESR on admission and once per week, Blood culture and sensitivity, serology for Aspergillus, Brucella, Coxiella, Listeria, Bartonella, Creatinine, urea (or blood urea nitrogen) on admission and twice weekly during the whole hospital stay, Na, K, Ca, phosphorus, ALT, AST, albumin, and Urine analysis (+/- urine C&S if indicated).

Study design and patient population

The present study includes all IVDU-IE cases that were documented between February 2016 and January 2022. Case information included demographics, clinical characteristics, history, comorbidity, underlying cardiac conditions, and recent operations. IVDU-correlated IE occurred when the case reported injection drug usage within three months before the beginning of IE symptoms. Blood cultures, serologic antibody tests (for Aspergillus, Brucella, Bartonella, and Coxiella burnetii), and surgical specimen cultures. A transthoracic echocardiogram (TTE) was conducted between 24 and 48 hours of hospital stay, followed by transesophageal echocardiography (TEE) within 72 hours if clinically indicated. Hospital consequences included heart failure (HF), sepsis, embolization, cerebral hemorrhage, renal failure, pulmonary infarctions, acute mitral regurgitation, splenic infarctions, mycotic aneurysms, abscesses, and death. All cases had proper diagnostic procedures and a full course of antimicrobial therapy and surgical treatments. Follow-up after discharge by six months was done for IVDU patients. We compared two groups of IVDU patients with the non-IVDU-IE group during a hospital stay.

STATISTICAL ANALYSIS

Data were analyzed using the Social Sciences (SPSS) version 26 statistical package. Quantitative data was summarized using mean and standard deviation, while categorical data was described using count and percentage. The Chi-square (x2) test was used to compare categorical data. The exact test was

performed when the anticipated frequency was less than 5. P-values < 0.05 are considered significant.

RESULTS

The mean age was 31.01±7.04 years, with the majority being male (95.0%) and female 5%. In our study comparing IV-IE to Non-IV-IE, statistically significant differences were found regarding education and socioeconomic status. IV-IE patients had a higher proportion of illiterate individuals (p=0.008) and a lower percentage of those with post-university education (p=0.003) compared to Non-IV-IE cases. Additionally, IV-IE cases were more likely to have a low socioeconomic status (p<0.0001) **(Table 1)**.

In our study, clinical and diagnostic aspects did not significantly vary between IV-IE and Non-IV-IE cases (p>0.05), except for a higher prevalence of needle puncture marks in IV drug users (p<0.0001) **(Table 2)**.

There was a non-significant difference between the groups concerning echocardiographic characteristics and the number and size of vegetation **(Table 3)**.

The administration of gentamicin, vancomycin, and various other antimicrobial therapies did not differ significantly between IV drug users and non-IV drug users with IE **(Table 4)**.

In our study, major complications during hospitalization were observed as follows: sepsis occurred in 18 cases, representing 22.5% of patients; pulmonary embolism emerged as the most prevalent complication, affecting 38 cases or 47.5% of patients; renal impairment was identified in 29 cases, accounting for 36.25% of patients; splenic infarct was present in 4 cases, making up 5.0% of patients; cerebral stroke was diagnosed in 8 cases, comprising 10.0% of patients, while intracranial hemorrhage was identified in 1 case, representing 1.25% of patients **(Table 5)**.

In this study, the leading causes of death during hospitalization were pulmonary embolism, which accounted for 16.25% of deaths (13 cases) and severe sepsis, responsible for 15.0% of deaths (12 cases); surgical mortality constituted 8.75% of deaths (7 cases), while CHF-cardiogenic shock and surgery-related causes led to 7.5% (6 cases) and 6.25% (5 cases) of deaths, respectively. Renal failure contributed to 5.0% of deaths (4 cases), and cerebrovascular accidents (cerebral stroke) caused 2.5% of deaths (2 cases). In our study, follow-up data revealed various outcomes among patients after hospital discharge. HF was observed in 18.8% of patients, while 11.3% had ongoing renal impairment, and 11.3% experienced arrhythmias. Sepsis was rare, occurring in only 1.88% of cases. Pulmonary embolism affected 18.86% of patients, and 13% of patients unfortunately passed away during the follow-up period. Additionally, 20.3% of cases experienced a relapse of intravenous drug use after leaving the hospital **(Table 6)**.

There was a highly significant correlation between CHF and Surgical indication (p=0.0003), and there was a highly remarkable correlation between CHF and cardiogenic shock (p<0.0001). There was a highly notable correlation between mortality and CHF (p=0.0009). There was a highly significant correlation between mortality and Sepsis (p=0.005). A remarkable correlation was between mortality and pulmonary embolization (p=0.042) **(Table 7)**.

Table 1: Level of education and socio-economic level and demographic data among cases:

		IV drug users with IE (N = 80)	Non-IV drug users with IE (N = 80)	P. Value
Level of education	Illiterate	13 (16.25%)	3 (3.75%)	0.00841*[X]
	Primary school	10 (12.5%)	10 (12.5%)	>0.99[X]
	Middle school	28 (35%)	23 (28.75%)	0.39629[X]
	Secondary school	11 (13.75%)	11 (13.75%)	>0.99[X]
	University	18 (22.5%)	25 (31.25%)	0.21191[X]
	Post-University	0 (0%)	8 (10%)	0.00371*[f]
Socioeconomic state	Low	61 (76.25%)	28 (35%)	<0.00001*[X]
	Moderate	8 (10%)	40 (50%)	<0.00001*[X]
	High	11 (13.75%)	12 (15%)	0.8217[X]

		IV drug users with IE (N = 80)	Non-IV drug users with IE (N = 80)	P. Value
Demographic data				
Gender	Male	76 (95%)		
	Female	4 (5%)		
AGE	Mean± SD	31.01±7.04		

X: Chi-square test | f: Fisher Exact Test Data represented as a number (Percentage), *P<0.05 significant

Table 2: Clinical and diagnostic data on admission

	IV drug users with IE (N = 80)	Non-IV drug users with IE (N = 80)	P. Value
Clinical data on admission			
Temperature (oC)	38.66±0.92	38.47±0.91	0.19289
Heart rate (Beat/min.)	109.93±16.29	108.17±16.05	0.49324
SBP (mmHg)	116.91±15.62	115.16±15.84	0.48375
DBP (mmHg)	73.19±12.85	74.07±13.02	0.66817
RR. (Breath/min.)	22.78±6.63	23.05±6.71	0.79861
Constitutional Manifestations	76 (95%)	78 (97.5%)	0.40527
New Murmur (not hemic, not innocent)	76 (95%)	78 (97.5%)	0.40527
Right-side heart failure	25 (31.25%)	25 (31.25%)	>0.99
Left-side heart failure	11 (13.75%)	13 (16.25%)	0.65791
Splenomegaly	22 (27.5%)	25 (31.25%)	0.60257
Cutaneous manifestations	2 (2.5%)	1 (1.25%)	0.56
Needle puncture marks	32 (40%)	2 (2.5%)	<0.0001*
Roth's spots	2 (2.5%)	1 (1.25%)	0.56
Neurological manifestations	5 (6.25%)	3 (3.75%)	0.46816
Clubbing	2 (2.5%)	2 (2.5%)	>0.99

Table 3: Echocardiographic characteristics and Number and size of vegetation of studied patients

		IV drug users with IE (N = 80)	Non-IV drug users with IE (N = 80)	P. Value
Echocardiographic characteristics				
Valve affected	TV	8 (10%)	9 (11.25%)	0.79753
	MV	3 (3.75%)	2 (2.5%)	0.64956
	AV	2 (2.5%)	2 (2.5%)	>0.99
	PV	1 (1.25%)	1 (1.25%)	>0.99
	RV Free Wall	2 (2.5%)	3 (3.75%)	0.64956
	MV and AV	2 (2.5%)	2 (2.5%)	>0.99
	TV and AV	2 (2.5%)	2 (2.5%)	>0.99
	TV and MV	1 (1.25%)	2 (2.5%)	0.56
	TV, AV, PV	1 (1.25%)	1 (1.25%)	>0.99
Non_ valvular lesion	Left Atrial Masses	25 (31.25%)	28 (35%)	0.61433
Normal _mild valvular lesions	TR	2 (2.5%)	2 (2.5%)	>0.99
	MR	3 (3.75%)	3 (3.75%)	>0.99
	AR	1 (1.25%)	2 (2.5%)	0.56
	TR, MR	1 (1.25%)	2 (2.5%)	0.56
	AR	4 (5%)	4 (5%)	>0.99
	MR	2 (2.5%)	3 (3.75%)	0.64956

		IV drug users with IE (N = 80)	Non-IV drug users with IE (N = 80)	P. Value
Moderate severe valvular lesions	MR AR	2 (2.5%)	2 (2.5%)	>0.99
	PR	3 (3.75%)	2 (2.5%)	0.64956
	RT	28 (35%)	25 (31.25%)	0.61433
	TR	3 (3.75%)	3 (3.75%)	>0.99
	TR AR	2 (2.5%)	3 (3.75%)	0.64956
	FLAIL TR	1 (1.25%)	2 (2.5%)	0.56
	MS	2 (2.5%)	2 (2.5%)	>0.99
	TR, MR	1 (1.25%)	1 (1.25%)	>0.99
	TR, PR, AR	1 (1.25%)	1 (1.25%)	>0.99
Number of vegetation				
Number on TV	1	15 (18.75%)	14 (17.5%)	0.8374
	2	10 (12.5%)	11 (13.75%)	0.81489
	3	6 (7.5%)	6 (7.5%)	>0.99
Total Number on TV		53	54	
Number on PV	1	4 (5%)	5 (6.25%)	0.73151
	2	3 (3.75%)	2 (2.5%)	0.64956
Total Number of PV		10	9	
Number on MV	1	5 (6.25%)	6 (7.5%)	0.7547
	2	3 (3.75%)	2 (2.5%)	0.64956
Total Number on MV		11	10	
Number on AV	1	6 (7.5%)	7 (7.75%)	0.7547
Total Number on MV		6	7	
Size of vegetation				
Size on TV	>2 cm	27 (33.75%)	22 (27.5%)	0.39113
	1_2 cm	26 (32.5%)	32 (40%)	0.32378
Size on PV	1_2 cm	10 (12.5%)	9 (11.25%)	0.80693
Size on MV	>1.5 cm	3 (3.75%)	5 (6.25%)	0.46816
	>2 cm	8 (10%)	5 (6.25%)	0.38536
Size on AV	<1 cm	2 (2.5%)	4 (5%)	0.40527
	1_1.5 cm	3 (3.75%)	1 (1.25%)	0.56
	1.5-2 cm	1 (1.25%)	2 (2.5%)	0.56
Size on others	1-2 cm in RV	1 (1.25%)	1 (1.25%)	>0.99

AV: aortic valve, MV: mitral valve, PV: pulmonary valve, TV: tricuspid valve, MS: mitral stenosis, RV: right ventricle, AR: aortic regurge, PR: pulmonary regurge MR: mitral regurge.

Table 4: Antimicrobial therapy of the studied patient

	IV drug users with IE (N = 80)	Non-IV drug users with IE (N = 80)	P. Value
Gentamycin	67 (83.75%)	66 (82.5%)	0.83282
Vancomycin	68 (85%)	68 (85%)	>0.99
Ampicillin sulbactam	12 (15%)	12 (15%)	>0.99
Rifampicin	8 (10%)	10 (12.5%)	0.6168
Claforan	2 (2.5%)	1 (1.25%)	0.56
Ciprofloxacin	14 (17.5%)	15 (18.75%)	0.8374
Teicoplanin	3 (3.75%)	6 (7.5%)	0.30331
Teinam	3 (3.75%)	4 (5%)	0.69912
Tavanic	2 (2.5%)	2 (2.5%)	>0.99
Ceftriaxone	2 (2.5%)	3 (3.75%)	0.64956

		IV drug users with IE (N = 80)	Non-IV drug users with IE (N = 80)	P. Value
Diflucan		2 (2.5%)	2 (2.5%)	>0.99
Meropenem		2 (2.5%)	3 (3.75%)	0.64956
Amikin		2 (2.5%)	2 (2.5%)	>0.99
Linezolid		2 (2.5%)	2 (2.5%)	>0.99
Cefazoline		1 (1.25%)	1 (1.25%)	>0.99
Ceftriaxone		1 (1.25%)	1 (1.25%)	>0.99
Cotrimoxazole, Vibramycin		1 (1.25%)	1 (1.25%)	>0.99
Amphotericin B, Ceftazidim		1 (1.25%)	2 (2.5%)	0.56
Response	Yes	34 (42.5%)	46 (57.5%)	0.0578
	No	46 (57.5%)	34 (42.5%)	

Table 5: Major complications during hospitalization

	Count	%
CHF	16	20.0%
Sepsis	18	22.5%
Cerebral strokes	8	10.0%
Mycotic aneurysms	1	1.25%
Splenic infarcts	4	5.0%
Renal impairment	29	36.25%
Pulmonary embolization	38	47.5%
Cerebral haemorrhage	1	1.25%
Mortality	27	33.75%

Table 6: Causes of death and follow-up of the patients after hospital discharge

	Count	%
Causes of death		
Surgical mortality	7	8.75%
Severe sepsis	12	15.0%
CHF-cardiogenic shock	6	7.5%
Pulmonary embolism	13	16.25%
Surgery related	5	6.25%
Renal failure	4	5.0%
Cerebrovascular accident	2	2.5%
Follow up with the patients after hospital discharge		
CHF	16	20.0%
Sepsis	18	22.5%
Cerebral strokes	8	10.0%
Mycotic aneurysms	1	1.25%
Splenic infarcts	4	5.0%
Renal impairment	29	36.25%
Pulmonary embolization	38	47.5%
Cerebral haemorrhage	1	1.25%
Mortality	27	33.75%

Table 7: Relation between CHF and other complications, and complication and mortality

Relation between CHF and other complications		CHF				X2	P value
		Yes		no			
		Count	%	Count	%		
Surgical indication	yes	12	75.0%	17	26.5%	12.92	0.0003**
	no	4	25.0%	47	73.5%		
Surgical mortality	Yes	2	12.5%	5	7.80%	0.35	0.55
	No	14	87.5%	59	72.2%		
Severe sepsis	Yes	4	25.0%	8	12.5%	1.56	0.21
	No	12	75.0%	56	87.5%		
CHF-cardiogenic shock	Yes	5	31.3%	1	1.5%	16.22	0.00**
	No	11	68.7%	63	98.5%		
Pulmonary embolism	Yes	5	31.3%	8	12.5%	3.03	0.06
	No	11	68.7%	56	87.5%		
Surgery related	Yes	2	12.5%	3	4.9%	1.33	0.24
	No	14	87.5%	61	95.1%		
Renal failure	Yes	2	12.5%	2	3.1%	2.36	0.12
	No	14	87.5%	62	96.9%		
Cerebrovascular accident	Yes	1	6.2%	1	1.5%	1.09	0.29
	No	15	93.8%	63	98.5%		
complication and mortality		Mortality					
		Yes		No			
		Count	Row N %	Count	Row N %		P value
CHF	Yes	11	40.7%	5	9.4%	10.9	0.0009**
	No	16	59.3%	48	90.6%		
Sepsis	Yes	11	40.7%	7	13.2%	7.77	0.005*
	No	16	59.3%	46	86.8%		
Cerebral strokes	Yes	5	18.5%	3	5.6%	3.28	0.061
	No	22	81.5%	50	94.4%		
Mycotic aneurysms	Yes	0	0.0%	1	1.8%	0.51	0.47
	No	27	100.0%	52	98.2%		
Splenic infarcts	Yes	0	0.0%	4	7.50%	2.14	0.14
	No	27	100.0%	49	92.5%		
Renal impairment	Yes	11	40.7%	18	33.9%	0.35	0.55
	No	16	59.3%	35	66.1%		
Pulmonary embolization	Yes	17	40.8%	21	39.6%	3.91	0.042*
	No	10	22.6%	32	60.4%		
Cerebral haemorrhage	Yes	1	100.0%	0	0.0%	1.98	0.15
	No	26	30.7%	53	100.0%		

DISCUSSION

Infective endocarditis is a serious condition that is associated with life-threatening complications in case of inadequate management. IE complications depend on factors such as the severity of the pathogen, duration of illness before initiating treatment, and the significant cardiac comorbidities. Complications can occur before, during, and after completion of therapy that can be almost managed with appropriate antibiotics, and up to 50% of patients can undergo surgery [6].

This retrospective study included 80 patients with infective endocarditis (IE) who were referred for management by the IE working team at Zagazig University Hospital. The study population was allocated into two groups: 80 individuals who were intravenous (IV) drug users and had IE and another

80 individuals who were not IV drug users but also had IE, as determined by the modified Dukes criteria. As for the basic demographic information of patients, the study showed that the mean age was 31.01±7.04 years, with the majority being male (95.0%) and female 5%.

The findings of this study match with previous investigations of IVDU-IE in other regions as most of the cases were males, and the mean age was 31.01±7.04 years. Considering the demographic data relevant to injection drug use, this condition is more common in young males in their 20s and 30s [7].

In the present study, the tricuspid valve was the most commonly affected in 70.6%, mitral in 9.8%, aorta in 3.9%, and pulmonary in 2%. This finding was consistent with similar studies in which, in the case of IV drug addict-related IE, the tricuspid valve was the most affected in 46.78% of the cases, the mitral valve in 24.32% and the aortic valve in 8.19%. About (16%) of cases have multiple valve involvement [8].

In the present study comparing IV-IE to non-IV-IE, significant differences were found in education and socioeconomic status. In contrast, a study by Wilson et al. [9] among HIV-seropositive individuals with infective endocarditis found no significant differences in education levels or homelessness compared to control subjects.

In the present study, clinical and diagnostic aspects did not significantly differ between IV-IE and Non-IV-IE patients, except for a higher prevalence of needle puncture marks in IV drug users.

The present study findings were in contrast with Goyal et al. [10] study, which revealed differences between intravenous drug abuse (IVDA) and non-IVDA groups, including higher rates of chronic comorbidities and predisposing cardiac conditions in the non-IVDA group, emphasizing the need for tailored approaches to infective endocarditis management based on patient risk factors.

The present study results agreed with previous studies in which staph aureus was the main organism causing IVDU-IE detected in blood culture [5].

The present study involved 80 patients; the hospital mortality rate was 33.75%, with 87% of those who died indicated for surgery and 25% classified as surgical mortality. Another study of 55 patient IVDU-associated infective endocarditis patients hospitalized in Melbourne, Australia, from 2008 to 2015, mentioned that 36% of cases were subjected to surgical therapy. All cases received antibiotics treatment; total mortality was 14.5%, and surgical mortality was 10% [11].

In a previous retrospective cohort study of forty-two patients of IVDU-IE who were admitted to a tertiary care center in southern Canada, it was found that the mortality rate for those with first episode IVDU-IE was significant at 20.7% [12]. The difference in the mortality rates between our study and the other three studies above may be attributed to the late presentation of patients to hospitals or later referral.

In line with the present study findings regarding complications in IVDU-IE during a hospital stay, Sam Straw et al. [13] observed forty-two hospitalized cases of IVDU, they found that 17(40.5%) had pulmonary embolisms, and 16 (38%) had renal impairments. In addition, 6 (14.3%) patients had a cerebral stroke, 4 (9.5%) patients had a cerebral hemorrhage, and (5) 11.9% patients had splenic infarction.

The previous observational cohort study, inconsistent with ours, included 92 IVDU-IE patients. The major complications in the study were stroke in 16 (15%), pulmonary emboli in 20 (19%), splenic emboli in 11(11%), and renal impairment in 8(7%) [12].

In the present study, we observed that HF, specifically congestive heart failure (CHF), was identified in 16 cases, representing 20.0% of the patients either before or during their hospitalization period.

In a relevant previous observational cohort study, 92 IVDU-IE, the most common complication was HF in 49% of patients. HF was the major reason for operation in 33 cases and a secondary cause in four (76%) [12].

A similar investigation at a tertiary care hospital in southern New Brunswick used a retrospective chart review to determine IVDU-IE cases hospitalized between January 2013 and December 2017. Forty-two cases of IVDU-IE met the inclusion criteria. Half of the cases experienced HF as a complication during admission, and 45.2% needed valve repair or replacement [13].

The present study results concerning causes of death during hospital stay were in line with Ortiz-Bautista et al. [14] study, 28 individuals, accounting for approximately 42%, experienced pulmonary embolism as a complication. This finding highlights the significant prevalence of pulmonary embolism among IVDU with IE.

The present study results concerning patients' follow-up after hospital discharge agreed with Rudasill et al. [15] who found that 8.1% of intravenous drug users with infective endocarditis (IDU-IE) experienced heart failure as one of the outcomes.

In the present study, during the follow-up period, we observed that re-abuse, specifically Intravenous Drug User (IVDU) relapse, affected 20.3% of cases. Furthermore, 13.20% of patients experienced a disease recurrence during their follow-up. These findings underscore the ongoing challenges and risks associated with both substance abuse relapse and the recurrence of IE in this patient population after hospital discharge.

In a similar retrospective study of hospitalized individuals, it was found that 103 patients were diagnosed with IVDU infective endocarditis. It recorded high rates of re-admission for endocarditis of 21(20%) patients and 13 readmissions due to recurrence [16]. It is not consistent with our study.

In another retrospective study, 94 IVDU cases met Duke's standards for IE. 7.5% of patients died from their first episode of IE. Among the 87 survivors, 22 had recurrent IE [18]. It is not consistent with our study.

In the present study, post-discharge findings showed that 18.8% of patients had heart failure, 11.3% had ongoing renal impairment, 11.3% had arrhythmias, 13.20% had neurological conditions, 13.20% experienced disease recurrence, 1.88% had sepsis, 18.86% had a pulmonary embolism, 13% passed away, and 20.3% had an intravenous drug user (IVDU) relapse.

In consistence with the present study results, Huang et al. [17] study found that complications by follow-up 22 of patients abusing intravenous drugs experienced repeat IE after discharge from the first episode.

In the present study, 13% of patients experienced mortality during their follow-up period after hospital discharge. Furthermore, 76.8% did not share further mortality, while 11.4% had an unknown status regarding mortality.

Macedo and Grawe [18], in a previous retrospective cohort, 38 cases were included; the main result of the prevalence of death two years after diagnosis was 43% in the surgery group and 26% in the no-surgery group. It is higher than our study.

Leahey et al. [16] reported that 103 patients were diagnosed with IVDU-IE. In-hospital mortality was 6(6%) patients, and one-year mortality was 16(16%). It is consistent with our study. The mortality after discharge differs according to years, with mortality after one year, two or three years, etc [19].

In cases of CHF, the significantly elevated rates of surgical indications, surgical mortality, severe sepsis, CHF-cardiogenic shock, pulmonary embolism, surgery-related complications, renal failure, and cerebral stroke underscore the complex interplay between CHF and these adverse events. These findings are in line with the understanding that CHF can lead to compromised cardiac function, increased susceptibility to infections, and a heightened risk of thromboembolic events, contributing to the observed complications. Similarly, sepsis emerges as a pivotal factor associated with increased surgical indications, surgical mortality, and various complications, further emphasizing its role as a major driver of adverse outcomes in hospitalized patients [20,21].

In the present study, we observed significant correlations between various complications and mortality. Furthermore, pulmonary embolization demonstrated a notable association with mortality, with a prevalence rate of 40.8%, emphasizing its significance. These findings were supported by highly significant correlations, with a p-value of 0.0009 for CHF, 0.005 for sepsis, and a significant p-value of 0.042 for pulmonary embolization, further highlighting their impact on patient mortality.

Also, the Ortiz-Bautista et al. [14] study revealed significant correlations between complications and mortality. The overall in-hospital mortality rate in their series (24%) was higher than previously reported rates, which typically ranged from 9% to 18%, according to studies. This difference was attributed to the elevated prevalence of heart failure, renal failure, and pulmonary embolism observed during hospitalization in their series.

Moreover, in their study, Caceres et al. [22] aimed to investigate the long-term outcomes of individuals with infectious endocarditis who were intravenous drug users (IVDU). The research identified several remarkable risk factors linked to long-term mortality in this population. These risk factors included IV drug use, with a hazard ratio (HR) of 1.92, and age exceeding 65 years (HR, 1.78), CHF (HR, 1.87), and enterococcus endocarditis (HR, 1.54). Furthermore, the study observed that the 5-year reoperation rates were comparable between the IVDU and non-IVDU groups, at 2.4% and 2.7%, respectively. These findings underscore the importance of recognizing these risk factors when evaluating the long-term outcomes of individuals with IE, particularly those who are intravenous drug users.

CONCLUSION

We found that IVDU-IE is very common among infective endocarditis disease. This type of patient is not predictable and is associated with serious complications, significant morbidity, and mortality. As for therapy, medical treatment is sufficient in

some cases, but others may require cardiac surgical intervention. Finally, this observational study allows a better understanding of the most common complications observed in those patients and the relevant causes of mortality. As for therapy, medical treatment is sufficient in some cases, but others may require cardiac surgical intervention. Finally, this observational study allows a better understanding of the most common complications observed in those patients and the relevant causes of mortality.

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