Research Article

Infective endocarditis in an Indian setup: Are we entering the 'modern' era?

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Abstract

Background: The clinical profile of infective endocarditis (IE) has been continuously evolving over last 3-4 decades as highlighted by many studies from developed world. **Objectives:** To evaluate the recent changes in the spectrum and clinical profile, and outcome of IE in an Indian setup. **Materials and Methods:** This was a descriptive, cross-sectional study. Demographic, clinical, characteristics, treatment, and outcome were examined in 'definite' cases of IE admitted at our institute between July 2005 and December 2010. **Results:** 61 'definite' cases were identified. Mean patient age was 49.3 ± 13.7 years. Male to female ratio was 3.3:1. Rheumatic heart disease was the underlying heart disease in 23 (37.7%) patients. 33 (54.1%) patients had already received antibiotic therapy before presentation to us. Blood cultures were positive in 41 (67.2%) patients. *Streptococci* and *staphylococci* were the commonest microbial isolates, 9 (21.4%) patients each. Transesophageal echocardiography (TEE) was done for all the patients. Vegetations were detected in 54 (88%) patients. Surgery was done in 30 (49.2%) patients. In-hospital mortality happened in 4 (6.5%) patients. **Conclusions:** We recorded several new trends, like: 1) an increasing age, 2) an increasing proportion of patients with no previously known heart disease, 3) improving culture positivity rates, 4) rise in staphylococcal infections, 5) increased usage of TEE, 6) high elective surgical rate, and 7) apparent improved survival rates. These changes point to the fact that 'modern era' changes in the profile of IE have started to appear in a selected population in India.

Keywords: Demographics, echocardiography, infective endocarditis, microbiologic characteristics, rheumatic heart disease

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Introduction

Infective endocarditis (IE) is a continuously evolving disease with a persistently high morbidity and mortality despite several advances in diagnostic techniques, anti-microbial chemotherapy, and surgical facilities. The continuous change in the clinical profile of the disease mandates regular appraisal of the management strategies. Thus, despite several guidelines available to treat the disease, IE has always been a challenge for the physicians.[1-4] And, in developing world where 'traditional' profile of IE is more prevalent, it can be even more difficult to manage it with the help of western guidelines. In a country like India, changes are happening in the form of host factors, substrate population, introduction of advanced diagnostic techniques, availability of antibiotics, and aggressive surgical approach. Therefore, the situation here is probably more complex because of double burden of 'traditional' as well as 'modern' IE. Many studies from the West have already uncovered changes in the clinical profile and revealed the 'modern era' of IE.[5-12] Some studies have been published from Indian subcontinent also, but there has been a paucity of reports from cardiac centers involved in active and aggressive cardiac interventions and surgery.[13-16] In this study, we reviewed the clinical profile, with outcome, of IE in a tertiary care exclusively cardiac center in India, which included patient demographics, predisposing conditions, clinical features, microbiologic

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characteristics, echocardiographic findings, treatment, and outcome. With a data collection of last 5 ½ years, we tend to highlight the important differences from Western and already available Indian subcontinental data and to know if we are really entering the 'modern era' of IE.

Materials and Methods

Ours is a tertiary care exclusively cardiac institute, one of its kind in north India, serving patients for more than 20 years. The patient population includes mainly referrals from all over the country. In a systematic retrospective review of clinical records, all adult patients (>18 years of age) admitted at our institute between 1st July 2005 and 31st December 2010 were reviewed from our computer database, and patients with IE were identified. A case was defined as any adult patient admitted with a diagnosis of 'definite' IE based on modified Duke's criteria.[17] Of all the identified patients of IE, patients who were classified as 'possible' cases according to modified Duke's criteria were excluded. Only 'definite' cases were included in the study. For these cases, the following information was collected: Age, sex, transfer from another facility, history of heart disease, procedures and situations at risk for IE, non-cardiac co-morbidities, antibiotic history before admission, presenting symptoms and signs, complications, microbiological data, echocardiographic findings, medical/surgical treatment received, and outcome. Data were collected and entered into a database using Microsoft excel. Statistical analysis was conducted using SPSS for windows version 13.0. Fisher exact test or Chi-square test was applied for comparison of categorical variables. *t*-test was applied for comparison of mean values. $P < 0.05$ were considered statistically significant.

Results

From July 2005 to December 2010 (5 years and 6 months), 83 patients were admitted at our center with a diagnosis of IE. According to modified Duke's criteria, 22 patients were 'possible' cases, and 61 were labeled as 'definite' cases. 42 (68.8%) cases had native valve endocarditis (NVE), and 19 (31.1%) had prosthetic valve endocarditis (PVE). During the study period, the incidence of IE at our center was 79.6 per 100000 hospital admissions or 14.5 cases per 100000 patient-years.

Demographics [Table 1] showed that there were 47 (77%) males and 14 (23%) females. Male to female ratio was 3.3:1. Mean age was 49.3 ± 13.7 years (age range 19-84 years; median age 51 years). When patients of PVE and NVE were compared, males had a predominance in NVE ($P = 0.017$).

When we studied the predisposing conditions [Table 2], rheumatic heart disease (RHD) was found to be the commonest underlying heart disease (37.7%), followed by congenital heart disease (CHD) (22.9%). Only 1 patient had a history of intravenous drug abuse (IVDA). No patient had a history of undergoing any dental procedure in recent past.

Amongst the clinical symptoms [Table 3], most frequent symptom on presentation was fever, in 56 (91.8%) cases, followed by dyspnea in 38 (62.2%). 16 (26.2%) patients presented with features suggestive of embolism. Most common site for embolism was brain (11.5%).

Regarding microbiological characteristics [Tables 4 and 5], causative microorganisms were identified through blood cultures in 41 patients (67.2%), blood cultures were negative in remaining 20 patients (32.8%). Culture-negative IE cases were diagnosed/labeled as infective endocarditis if blood cultures were not fulfilling the requirements as per 'Modified Dukes criteria,' but patients were otherwise

Table 1: Demographics/general characteristics of patients with definite IE

Characteristic	Result	In NVE	In PVE	*P* value
No. of patients	61	42 (68.8%)	19 (31.2%)	
Age range (years)	19-84	19-84	31-74	
Mean age±S.D.	49.3±13.7	48.9±14.7	50.4±11.4	0.698
Median age	51	48	52	
Male: Female ratio	3.3:1	6:1	1.4:1	0.017
Past history of IE	5	3	2	0.642

IE: Infective endocarditis; NVE: Native valve endocarditis; PVE: Prosthetic valve endocarditis

Table 2: Predisposing conditions and underlying cardiac/non-cardiac diseases in 61 cases

Underlying cardiac diseases	No. of patients (%)
Rheumatic heart disease	23 (37.7)
Mitral valve disease	14 (22.9)
Aortic valve disease	4 (6.5)
Mixed valvular heart disease	5 (8.19)
Congenital heart disease	14 (22.9)
Bicuspid aortic valve	10 (16.4)
Atrial septal defect	1 (1.6)
Ventricular septal defect	1 (1.6)
Tetralogy of fallot	1 (1.6)
Previous cardiac surgery	20 (32.78)
Prosthetic valves	19 (31.2)
Mitral valve prolapse	2 (3.3)
Degenerative aortic valve disease	2 (3.3)
Past history of infective endocarditis	5 (8.2)
No previously known heart disease	9 (14.8)
Non-cardiac diseases	
Diabetes mellitus	8 (13.1)
Inflammatory bowel disease	6 (9.8)
Chronic kidney disease	3 (4.9)
Intravenous drug abuse	1 (1.6)
Dental procedure	0 (0)

Table 3: Clinical profile of 61 cases

Presenting symptoms	No. of patients (%)
Fever	56 (91.8)
Dyspnea	38 (62.2)
Weight Loss	26 (42.6)
Arthralgia	16 (26.2)
Palpitations	14 (23)
Generalized weakness	10 (16.4)
Cough	8 (13.1)
Anorexia	5 (8.1)
Complications	
Congestive heart failure	29 (47.54)
Intra-cardiac abscess	6 (9.8)
Chordal rupture	2 (3)
Renal dysfunction	20 (32.78)
Sepsis	13 (21.3)
Stroke	7 (11.5)
Peripheral embolisation	9 (15)
Spleen	3 (4.9)
Lung	2 (3.3)
Lower limb	1 (1.6)
Retinal	1 (1.6)
Kidney	1 (1.6)
Multiple (spleen and kidney)	1 (1.6)
Treatment before admission	
Received antibiotic therapy before presentation at study center	33 (54.1)

Table 4: Distribution of 42 microbial isolates in 41 cases of culture-positive IE

Organisms	Total *n* (%)
Gram-positive organisms	23 (54.76)
Streptococcus	9 (21.4)
Streptococcus bovis	1
Streptococcus oralis	1
Streptococcus species	7
Staphylococcus	9 (21.4)
Staphylococcus aureus	5
Staphylococcus hominis	3
Staphylococcus epidermidis	1
Enterococcus faecium	2
Corynebacterium	1
Gram-positive bacillus	2
Gram-negative organisms	12 (28.6)
E. coli	2
Pseudomonas aeruginosa	5
Klebsiella pneumoniae	2
Salmonella species	1
Burkholderia species	1
Gram negative bacilli	1
Fungi	6 (14.3)
Candida tropicalis	3
Candida glabrata	1
Candida species	2
Others	1 (2.4)
Mycobacterium species	1 (2.4)

IE: Infective endocarditis

fitting into the definition of 'Definite' IE (i.e., presence of 1 major and 3 minor criteria; or presence of 5 minor criteria) based on echocardiography, laboratory, or clinical findings.[17] Amongst the 41 culture-positive cases, 1 patient had polymicrobial infection (*Streptococcus* and *Pseudomonas*). Commonest microbial isolates were *Streptococci* and *Staphylococci*, with an equal incidence of 21.4% (9/42 each). While comparing culture-positive and culture-negative cases, age of the patients was the only statistically significant factor ($P = 0.048$). 54% had already received some antibiotic therapy before presenting at our center. Amongst 20 culture-negative cases, 12 (60%) had received antibiotic treatment before admission, while among 41 culture-positive cases, 21 (51.2%) had received prior antibiotic treatment ($P = 0.596$). Mortality was seen in culture-positive cases only, but it was statistically not significant ($P = 0.293$).

When we collected echocardiographic data [Table 6], it was observed that transthoracic echocardiography (TTE) as well as TEE was performed in all the cases. Common echocardiographic findings were vegetations (88%), new/worsening regurgitation (11%), and cardiac abscess (10%). Left side of the heart was affected much more frequently. Right-sided endocarditis was seen in just 1 patient.

Now considering the treatment and outcome part [Table 7], it was observed that all 61 patients were treated with appropriate antibiotics (based on American Heart Association guidelines). An empirical treatment regimen involved injection ceftriaxone, vancomycin, and gentamycin. Oral rifampicin was added if it was a case of early PVE (<12 months post-surgery). Later on, the antibiotics were reviewed according to the blood culture and susceptibility report. 31 patients received only medical therapy. Out of these 31 patients, 3 were discharged on request before completion of therapy. Along with medical therapy, early surgery was performed in 30 patients. In total, there were 4 in-hospital deaths. Follow up records after discharge were not available to analyze mortality on long-term basis.

Discussion

Reports from the West have shown a change in the spectrum of IE. However, reports from our country are very few, and those too are probably not a true reflection of the spectrum of IE due to a lack of the diagnostic and management modalities in the country. We analyzed our results one by one including demographics, predisposing conditions, clinical features, microbiological characteristics, echocardiographic findings, treatment, and outcome; and tried to find any important differences from western and already available Indian subcontinental data.

About the demographics, the incidence of IE in our study was 14.5 cases per 100000 patient years, which is very

Table 5: Comparison of culture-positive and culture-negative cases

Characteristic	Culture positive *n* (%)	Culture negative *n* (%)	*P* value
No of patients	41 (67.2%)	20 (32.8%)	
Mean age (years)	51.8±14.3	44.4±11.2	0.048
Male:Female ratio	29: 12	18: 2	0.084
Prior antibiotic therapy	21 (51.2%)	12 (60%)	0.596
Underlying heart disease	34	18	0.729
Rheumatic heart disease	19	4	0.087
Congenital heart disease	6	8	0.049
Prosthetic valve	16	3	0.108
Degenerative heart disease	0	2	0.104
Mitral valve prolapse	2	0	0.811
Treatment received			
Only medical	25	6	0.046
Both medical and surgery	16	14	0.046
Mortality	4	0	0.293

Table 6: Echocardiography findings in 61 cases

Echocardiography findings (*n*)	Total *n* (%)	NVE *n* (%)	PVE *n* (%)
Vegetations	54 (88)	36 (59)	18 (29)
Mitral valve	38 (70.4)	23 (37.7)	15 (24.5)
Aortic valve	28 (51.8)	20 (32.8)	8 (13)
Tricuspid valve	1 (1.85)	1 (1.6)	0
Interventricular septum	2 (3.7)	2 (3.3)	0
Large vegetation (≥10 mm)	18 (29.5)	14 (23)	4 (6.5)
Other Findings			
New/Worsening regurgitation	7 (11.4)	6 (9.8)	1 (1.6)
Chordal rupture	2 (3.3)	2 (3.3)	0
Cardiac abscess	6 (9.8)	4 (6.5)	2 (3.3)
New dehiscence of prosthetic valve	2 (3.3)	0	2 (3.3)

NVE: Native valve endocarditis; PVE: Prosthetic valve endocarditis

Table 7: Treatment received and outcome findings in 61 patients with definite IE

Characteristic	*n* (%)	*P* value
Only medical treatment	31/61 (50.8)	
Medical and surgical treatment	30/61 (49.2)	
Mean LOS in hospital (days)	35.9	
In-hospital mortality	4 (6.5)	
Mortality in NVE	3/4 (75)	0.776
Mortality in PVE	1/4 (25)	(not significant)

IE: Infective endocarditis; NVE: Native valve endocarditis; PVE: Prosthetic valve endocarditis

high compared to the western incidence of 1.7-6.2 cases per 100000 patient years.[18] The high incidence can be explained by the fact that ours is a cardiac tertiary care center with a prominent cardiac patient population. Majority of our patients (mean age 49.3 ± 13.7 years) presented in the fifth decade of life, which is in contrast to the earlier Indian studies (mean age ~27 years),[13-14] but closer to the western data.[6-9] The reasons for lower age reported in earlier Indian studies are likely multifactorial and include a higher incidence of RHD and uncorrected CHD in developing countries like India while a more aged population and lower incidence of RHD in the West. An upward shift in the mean age in our patients in comparison to the last century data from this part of the world (49.3 years vs. 27 years) is suggestive of a gradual fall in the incidence of RHD here also. Most of our patients were males with a male to female ratio of 3.3:1. Even previous studies from Indian subcontinent have persistently shown this trend of male predominance, but the M: F ratio in our data is higher than that reported by any of them, 2.5:1,[13] 2.7:1,[14] 1.8:1,[15] and 2.7:1.[16] This change in ratio towards males may again be due to the decreasing incidence of RHD in our society, as RHD is well known to be more common in females.

When we analyzed the predisposing conditions, it was found that quite similar to previous studies from this part of the world and contrary to western reports, RHD was the commonest underlying heart disease (37.7%) in our patients also.[13-15] This is well explained by decreased incidence of rheumatic fever in the West. However, the percentage of RHD was lower in our study compared to other Indian studies, suggesting that the trends are changing here also. Mitral valve prolapse (MVP) as an underlying heart disease was seen only in 3.3% cases, again matching well with Indian studies[13,14] but not with the Western data where MVP has been relatively more common.[19] Incidence of IE in structurally normal heart (14.8%) is also showing a change in the trend towards western data, which report an incidence of 30% .[20] This change suggests that we are also entering the era of ageing population with an increased incidence of degenerative cardiovascular disease. PVE constituted 31.1% of cases in our study, which is a very high rate, compared to 10-15% reports from west.[20,21] and 1-10% from India.[13,14] This discrepancy could be directly related to the patient selection in a tertiary care cardiac center. Recent social changes have caused a rise in IVDA and right-sided IE in the west.[5,20] But, we encountered right-sided IE in structurally normal tricuspid valve in only 1 patient and that too with no history of IVDA. This suggests that IVDA is yet not that big social problem in Indian subcontinent. This fact was supported by another study by Tariq *et al.*, from Pakistan, where 9% of their patients had right-sided IE, but only 1 subject had a history of IVDA.[15]

The clinical presentation and complications of IE in our patients were not very different from previous reports, either from west,[7,8,10] or from developing world,[13-16] except that incidence of stroke was quite low compared to two of the western reports.[8,10] Amongst the complications, congestive heart failure was the commonest one (47%) matching with many other reports,[10,13-15] but the frequency of sepsis was slightly

higher (21%) in our patients compared to many of the western[8,10] or developing world reports.[13-15] Also, stroke was not encountered that frequently in our study (11%) as reported by the western studies.[8,10] Very interestingly, history of dental procedures was not present in any of our patients. Other recent studies have also shown no significant relationship between dental procedures and IE.[22]

Before discussing the microbiological characteristics, we should understand that because IE can present with a long period of illness prior to hospital admission, many of these patients might have already been prescribed antibiotics without a proper diagnostic work up. This practice has been an issue not only for the developing world but has also been reported from developed world.[9,23] In our study culture, positivity rate was 67.2%. In contrast, western data report culture positivity rates of 69-97%.[6] As per our data, antibiotic therapy was already received by 54% of cases. The more frequent practice of empirical use of antibiotics in the developing world could be the reason for a low yield of blood cultures in our study. Interestingly, when we compared our culture-positive and negative cases, prior antibiotic use was not found to be a statistically significant factor ($P = 0.596$). This is well in contrast to the study by Chaudhary *et al*., Garg *et al.*, and a latest report from Pakistan where significant association was found between previous intake of antibiotic and incidence of culture-negative endocarditis.[13-16] Mortality was seen only in culture-positive cases, though this was statistically insignificant ($P = 0.293$), probably due to a small sample size. In the past, *Streptococcus* species has been documented as the most commonly identified organism in cultures.[5] But recently, *Staphylococcus* has scored over the *Streptococcus* group.[11-13] This change in trend in the West may be attributable to changing patient characteristics (ageing, IVDA, and prosthetic valves), interventions, nosocomial and iatrogenic endocarditis etc., Though this change was not proved in one of the recent Indian studies,[14] our data shows an equal incidence (21.4%) for *Staphylococcus* and *Streptococcus*, supporting the fact that changes reported by western researchers, in the spectrum of organisms causing bacterial endocarditis, have started appearing in the developing world also. Moreover, literature indicates that prosthetic valves are generally at higher risk from *Staphylococcus*, and our study had relatively high incidence of prosthetic valve endocarditis.[24]

Utility of TTE and TEE has been well recognized in the diagnosis of IE.[25] Sensitivity of TTE is reportedly 40-63%, while that for TEE has been reported as 90-100%. But, a service burden of echocardiography has been a hindrance for making this modality a routine for the diagnosis of IE, and early echocardiography to diagnose IE is arguable. But, the situation in the developing world is different, where culture negativity rates are high, and modern serological and molecular diagnostic techniques remain poorly resourced, while the manpower for echocardiography is relatively easily available and cost effective. Ours being a tertiary care cardiac center, virtually all the patients admitted here undergo a TTE, at least as a preliminary evaluation. TEE is performed for all the patients admitted with a suspicion of IE. A study by Heidenreich *et al.*, concluded that TEE was more cost-effective than TTE in people with a high pre-test probability of IE, and it provided evidence supporting use of TEE as the first and only imaging study in the work up of the patients with higher probability of IE.[26] Now, considering the echo positivity rate, vegetations were detected in 88% of our cases, which compares well with many other recent reports from developing and developed world.[9,10,14] Echo positivity rate was much higher than that reported by Chaudhary *et al*., (probably because TEE was not used in their patients, and sensitivity of TTE to diagnose IE is low).[13] In our study, mitral valve was involved more commonly (70%) than aortic valve (51.8%). In other studies, rate of mitral valve involvement compared to aortic valve was either almost the same (36% vs. 35%)[14] or lower (29% vs. 35%)[8] and (36% vs. 38%).[10] We found large vegetations (>10 mm) in 29% of our cases as compared to 43% reported by Garg *et al*. and 13% by Tariq *et al,*[14,15] The clinical or epidemiological importance of these findings is not clear at this point of time [Table 8].

With regard to the outcome analysis, we would like to point out that several western studies from 1990s and 2000s have shown that mortality of IE is still from 10-24% though the trend has been towards improvement in survival over last 3 decades.[5,7,8,10,20] The trend towards decreased mortality has also been seen in most of the Indian subcontinental reports: 42% in 1970,[27] 20.3% in 1981,[28] 25% in 1992,[13] and 13% in 2001.[29] Though some studies in recent times are still showing high mortality rates,[14,15] in our study, the mortality was relatively very low (6.5%). The probable reasons for such a low mortality will be discussed below. Amongst the patients who died ($n = 4$), 3 patients died with a diagnosis of 'sepsis with congestive heart failure,' while 1 patient died due to 'septicemic shock and multi-organ dysfunction and acute kidney disease.'

At our institute, surgical consultation is requested on a prompt basis if patient has class I, class IIa, or class IIb indications for surgery according to 'ACC/AHA 2006

Guidelines for the management of patients with valvular heart disease.' Our observation revealed that almost half (49%) of the patients were taken for surgery, and this increasing need for surgery in IE has also been advocated by one of the recent reviews.[30] In another review, the data showed that surgery was required in 25-30% of cases during acute infection and in 20-40% cases during convalescence;[11] but the proper selection of patients for surgery (based on requirement and fitness status) can be difficult. Therefore, the impact or benefit of surgery on patient outcome can be varied in different studies. There are no randomized controlled trials of early surgical treatment with long-term antibiotics vs. medical treatment alone. Existing knowledge is based on observational data only. The results of a study incorporating 10 years data from 7 US hospitals showed that surgical treatment was associated with reduced mortality (15% vs. 28%, $P = 0.01$).[31] Similar trend towards improved outcome in patients undergoing surgery has been shown in many other international series.[8,9]

In spite of suggested benefits, the surgery in IE is not risk-free and may have a high operative mortality rate. In one study, overall surgical mortality in active IE has been reported as 8-16%,[32] while in another study, surgical mortality has been reported as 5-10% in patients without heart failure and 15-35% in patients with heart failure.[33] Still, these rates are far less than the mortality rates for IE with heart failure without surgical therapy, which can be as high as 50%.[34] At our center, the rate of surgical intervention was fairly comparable to the reports from the Western world[5,7-9] and much higher than that in any of the Indian subcontinental reports.[13-15] But, very surprisingly, no mortality was seen in our operated cases, though this finding was not statistically significant ($P = 0.293$), probably due to less number of cases. The probable reasons for low mortality in our series (overall as well as surgical mortality) could be early surgical intervention, high rate of surgery, differences in disease characteristics, less number of cases, and bias in case selection.

Table 8. A comparison of different studies on Infective Endocarditis

Characteristics	Netzer *et al*[5]	Metanalysis[6]	Castillo *et al*[7]	French Survey[8]	EHS[9]	EIRA-2 Investigators[10]	Choudhury *et al*[13]	Garg *et al*[14]	Tariq *et al*[15]	Khan *et al*[16]	Present Study
Duration	1980-1995	1993-2003	1987-1997	1999(1 year)	April-July 2001	2001-2002	1981-1991	1992-2001	1988-2001	2006(6 months)	2004-2009
Episodes	212	3784	138	390	159	390	190	198	159	75	61
Age	52	36-69	44±20	59.5±17.2	56±17	58.5±17.3	25±12	27.6±12.7	34.6±21.2	23±8.9	49.3±13.7
Male: Female ratio	3:1	2:1	NA	2.4:1	NA	2.3:1	2.5:1	2.7:1	1.8:1	2.7:1	3.3:1
Predisposing events (%)	42	NA	38	NA	41-48	52.8	NA	NA	59	NA	NA
Underlying heart disease											
RHD	5	NA	NA	NA	NA	5.4	42	46.9	21	NA	37.7
CHD	4	NA	NA	1	NA	9	33	28	25	25	23
PVE	17	7-25	31	16	26	16	1	10		8	31
IV drug abuse	10.4	15	NA	6	NA	3.8	0.5	0	1	8	1.6
Complications (%)											
CHF	41	NA	40	34	NA	36	42	41	22	NA	47
Stroke	NA	NA	NA	48	NA	5	16	112	15	NA	11
Sepsis	NA	NA	19	9	NA	13	NA	NA	4	NA	21
AKD	39	NA	12	27	NA	21	27	13	11	NA	33
Blood culture positivity (%)	91	70-97	88	91	86	89	46	67	46	53	67
Percentage of Isolates											
Streptococcus	42	NA	33	48	NA	40	30	34	52	27	21
Staphylococcus	34	NA	34	29	NA	38	36	29	29	52	21
TTE done (%)	90	NA	100	100	NA	100	99	100	NA	NA	100
TEE done (%)	25	NA	68	90	NA	65	NA	46	NA	NA	100
ECHO positivity (%)	NA	NA	86	91	82	100	64	89.9	72	NA	88
ECHO findings (%)											
Mitral valve involvement	35	NA	NA	43	NA	37	28	36	NA	43	70
Aortic valve involvement	53	NA	NA	49	NA	42	25	35	NA	23	52
Large vegetation	NA	NA	NA	NA	NA	NA	NA	43	13	NA	29
Surgery for IE(%)	38	25-40	51	49	52	26	1	23	11	NA	49
In-hospital mortality(%)	15	16 (Median)	21	16	12.6	24	25	21	23	NA	6.5

EHS: European heart survey; RHD: Rheumatic heart disease; CHD: Congenital heart disease; PVE: Prosthetic valve endocarditis; IV: Intravenous; CHF: Congestive heart failure; AKD: Acute kidney disease; TTE: Transthoracic echocardiography; TEE: Transesophageal echocardiography; NA: Not Available

To conclude, our patients showed many of the 'classical' developing world characteristics of IE including male predominance, a high incidence of RHD, and high culture negativity rates. Still, we recorded several new trends such as: 1) Increasing age category, indicating RHD as a lesser common antecedent to IE, 2) an increasing proportion of patients with no previously known heart disease, 3) improving culture positivity rates, 4) changes in the microbiological spectrum i.e., a rise in Staphylococcal infections, 5) increased usage of TEE, 6) high elective surgical rate, 7) Apparent improvement in survival rates. Thus quite similar to the 'modern era' profile of IE reported by western researchers, important changes in the demographic, clinical, and microbiological profile appear to have started appearing in India as well. These changes point to the fact that the disease now requires a new approach, particularly relating to diagnostic and treatment options in the future. And, the need of the times is to include patient data from other developing Nations as well in multicenter studies.

The limitations of this study also deserve a mention here. In particular, this was a retrospective, single-center study. Because we studied a disease of low incidence, we faced the problem of sample-size limitation also. Due to scarce technical resources in the developing world, serological and molecular techniques are not in common use; so, our results might not reflect 'true' microbiological profile of the disease. Another strong limitation of the data presented here is that the center is a tertiary care center, with its inherent selection bias. Therefore, this data may not be generalizable to the community. Finally, regarding outcome of the disease, no follow-up data was available after discharge of the patient from hospital. Strength of the present study was that only 'definite' cases were included for analysis.

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