Original Article

Indian Journal of Anaesthesia and Analgesia
2017, 4 (3, Part-II), 784-788
DOI: http://dx.doi.org/10.21088/ijaa.2349.8471.4317.38

Incidence and Risk Factors for Infections in Post-Operative Cases of Cardiac Surgery

Shashi Kanth Talamarla[1], Ayya Syama Sundar[2], Srikanth Yelliboina[3], Gopinath[4]

[1]Senior Resident [2]Assistant Professor [3]Associate Professor [4]Professor, Dept of Anesthesiology and Intensive Care, Nizam's Institute of Medical Sciences, Hyderabad, Telangana 500082, India.

Abstract

Cardiac surgery creates a high risk for the development of post operative infections. *Aims:* The objective of this study was to evaluate the incidence, characteristics and risk factors for nosocomial infections after cardiac surgery. *Methods and Material:* All patients who underwent cardiac surgeries under cardiopulmonary bypass (CPB) were enrolled in this study. Preoperative, intraoperative and postoperative variables were collected and examined as possible risk factors for development of infections. *Results:* Infection occurred in 18 of 171 patients (10.5%). Five members with infection died. Infections occurred at different sites like sternal wound infection 11.5%, pneumonia 30.7%, bacteremia 23%, mediastinitis 15.3%, surgical site other than sternotomy 11.3% and central venous catheter infections contributing to 7.6% of infections. **Conclusions:** Use of IABP, reintubation and reexploration are independent risk factors for the development of postoperative infection in cardiac surgery patients.

Keywords: Cardiac Surgeries; Cardiopulmonary Bypass; Nosocomial Infections.

Introduction

Infection in the setting of cardiac surgery increases morbidity [1,2], mortality [3], and cost [4]. Despite the progress made in surgery and anaesthesia, the risk of developing nosocomial infections remains a real threat as most patients are at extremities of age and associated with comorbid illness [3]. These infections may require longterm treatment with antibiotics, additional surgical intervention or both and increases duration of stay in hospital [2]. Thus, there is a critical need to identify patients undergoing cardiac surgery who are at risk for major infections and to develop effective interventions to prevent these infections.

The objectives of this study were to identify the frequency of infection after cardiac surgery with cardio pulmonary bypass (CPB), detect the type of organism and to identify determinants of infection among patients undergoing cardiac surgery.

Methods

This prospective study was performed on 171 patients who had undergone cardiac surgery under CPB, at cardiothoracic intensive care hospital, between July-2012 to Nov-2012. Exclusion criteria were preoperative signs of clinical infection, preoperative hospital stay for more than 3 days, history of recent infection, fever of unknown origin, patients who have already been intubated before surgery, preoperatively clinical administration of corticosteroids and intraoperative accidental abolition of sterile condition of surgical site.

Following ethical committee approval, all patients included consented to the terms of this study during the preoperative evaluation. The patients data that was recorded included age, sex, weight, diagnosis, type of surgery, comorbid illness like diabetes mellitus (DM), hypertension(HTN), lung

Corresponding Author: Ayya Syama Sundar, Assistant Professor, Department of Anaesthesiology and Intensive Care, Nizam's Institute of Medical Sciences, Punjagutta, Hyderabad, Telangana 500082, India.
E-mail: sasyasyama@gmail.com

Received on 18.06.2017, **Accepted on** 22.06.2017

pathologies, peripheral vascular disease (PVD), chronic renal failure (CRF), smoking, alcohol, redo surgeries, emergency surgery and biochemical reports.

Intraoperative data included duration of anaesthesia, duration of CPB, number of blood products transfused, intra aortic balloon pump (IABP) placement. Postoperative data included duration of ventilation, reintubation, reexploration, length of ICU stay, number of blood products transfused and infection data.

Antibiotic prophylaxis was with Cefoperazone (10mg/kg) + Sulbactum (10 mg/kg) intravenously (i.v,) every eight hourly for adults and for paediatric age group Cefoperazone 10mg/kg + Sulbactum-10mg/kg i.v. every eight hourly and Amikacin 15 mg/kg/day i.v. was administered routinely to all patients as a single dose before the induction of anaesthesia and post operatively every eight hourly till the patient was shifted to ward and in case of suspected infection empirical antibiotic therapy was initiated and treatment was modified according to culture.

All patients included in the study were examined daily, during the morning and evening rounds, by the cardiothoracic intensive care unit attending anaesthesiologists for possible signs of infection. Haematological and biochemical trends and chest X-rays were performed everyday and vital data were recorded routinely.

Body temperature was recorded every 1 hr in the ICU for first 3 days, every 3 h for the next two days and at least twice daily thereafter. Sternal site and indwelling catheter site were examined cleaned and properly dressed. Bronchial secretions, blood, urine, catheter tip, endotracheal tube tip and wound swab were sent for microbiological examination in case of suspected infection. Statistical analysis was performed using SPSS, 17. Tests on categorical variables were based on Pearson chi-square statistics in the case of 2 × 2 tables. Continuous variables were subjected to student *t*-tests and results are presented as mean values±S.D. The variables found to be predictors of nosocomial infection based on univariate analysis were then entered into a forward stepwise multivariate logistic regression model.

A two-sided p-value < 0.05 was considered significant in the multivariate logistic regression model. Adjusted odds ratios, 95% confidence intervals, and two-tailed p-values were calculated for all variables retained in the multivariate logistic regression model.

Results

171 patents were included in statistical analysis, which includes 116 (68.2%) males and 55 (32.8%) females, with age group ranging from 1 year to 76 years. A total of 18 patients have been presented as microbiologically documented nosocomial infection which accounts to 10.5% of the study population out of which 5 patients had multiple infections.

The association of the patient characteristics, examined co-morbidities, preoperative, intraoperative and postoperative factors and risk factors are shown in Table 1. Out of 171 patients 82 patients underwent CABG (coronary artery bypass grafting) for coronary artery disease, 39 patients underwent operation for valvular heart disease, 43 patients got operated for congenital heart disease and 7 for aortic aneurysmal surgery and combined CABG & valvular surgeries.

In this study a total of 5 members with infection died, of which, in 3 members, infection was considered the main cause of death and in two patient's infection was a contributing factor.

The causative organism which lead to infections include gram positive organism such as Staphylococcus species (15.3%), Enterococci faecium (11.5%) and gram negative organisms such as Escherichia coli (11.5%), klebsiella pneumoniae (11.5%), Psuedomona-s aeruginosa (11.5%) and Acinetobacter baumannii (26.9%) of which the main organism causing infection was Acinetobacter baumannii and the rate of mortality among patients infected with Acinetobacter baumannii was very high. Four out of 5 deaths among the infected were due to infections with Acinetobacter baumannii. Fungus such as Candida albicans lead to 11.5 % of infections.

Infections occurred at different sites like sternal wound infection 11.5%, pneumonia 30.7%, bacteremia 23.%, mediastinitis 15.3%, surgical site other than sternotomy 11.3% and central venous catheter infections contributed to 7.6% of infections (Table 2).

Multivariate analysis demonstrated that IABP placement, reintubation and reexploration are statistically significant factors for development of post operative infection in cardiac-surgical patients. Based on the multivariate analysis the risk of acquiring an infection was 14.6 times greater in patients with IABP and 12.7 times higher in reintubated patients and was 18 times more in reexplored patient than in other patient (Table 3).

Table 1: Univariate analysis of the association of various factors with development of infection

	Variables		With infections (SD/%)	Without infection (SD/%)	p value
Preoperative parameters		Age	47.6±23.8		0.188
	Sex	Male	13(11.2)		0.794
		Female	5(9.1)	50(99.9)	
	Type of surgery	CAD	10(12.8)	68(87.2)	
		VHD	4(10.8)	33(89.2)	
		CAD & valve surgery, aneurysm	1(14.3)	41.6±18.4	0.824
		CHD	3(7.3)	105(88.8)	
	Diabetes mellitus		5(13.2)	33(86.8)	0.554
	Hypertension		8(15.5)	47(84.5)	0.28
	Lung pathology		2(33.3)	4(66.7)	0.122
	Peripheral vascular disease		1(20)	4(80)	0.431
	Chronic renal failure		2(16.4)	11(83.6)	0.631
	Smoking		1(3.4)	28(96.6)	0.310
	Recent MI		1(12.5)	7(87.5)	0.597
	Re –do surgeries		1(33.3)	2(66.6)	0.285
	Emergency		1(83.3)	5(16.7)	0.492
Intraoperative parameters	Duration of anaesthesia		5.73±1.4	5.36±1.4	0.324
	CPB-Time		158.2±46	138±53	0.13
	IABP		5(50)	5(50)	0.001
	DOV		42.9±57.7	20±15.0	0.00
Postoperative parameters	Reintubation		6(66.7)	3(33.3)	0.00
	Re-exploration		3(37.5)	5(62.5)	0.00
	Duration of ICU stay		10±5.1	4.15±1.8	0.00
	Blood products		7.17±12.3	2.8±4.3	0.003

CAD - coronary artery disease, CHD-congenital heart diseases, CPB-cardiopulmonary bypass, DOV-duration of mechanical ventilation, IABP-intraaortic balloon pump, Recent MI-Recent myocardial infaction, VHD-valvular heart diseases.

Table 2: Site of infection and causative organism

	Sternal wound	Pneumonia	Bacteremia	Mediastinitis	CRBSI	SSI other than sternotomy	Total
Staphylococcus species	-	1(12.5%)	1(16.6%)	-	1(50%)	-	3(11.5%)
Enterococcus faecium	2(66.6%)	-	1(16.6%)	-	-	-	3(11.5%)
Acinetobacter baumannii	-	3(37.5%)	1(16.6%)	2(50%)	-	1(33.3%)	7(26.9%)
Pseudomonas aeruginosa	1(33.3%)	-	2(33.3%)	1(25%)	-	-	4(15.3%)
Klebsiella pneumoniae	-	1(12.5%)	1(16.6%)	1(25%)	-	1(33.3%)	4(15.3%)
Escherichia coli	-	1(12.5%)	-	-	-	1(33.3%)	2(7.6%)
Candida albicans	-	2(25%)	-	-	1(50%)	-	3(11.5%)
	3(11.5%)	8(30.7%)	6(23.07%)	4(15.3%)	2(7.6%)	3(11.5%)	26(100%)

CRBSI-Central venous catheter related blood stream infection, SSI-surgical site infection. Staphylococci species include staphylococci aureus, methicillin resistant staphylococci aureus and coagulase negative staphylococci. Values are given in number of infections (%).

Table 3: Statistically significant factors according to multiple logistic regression analysis associated with a higher risk to acquire infection

Risk Factor	Odds ratio	p Value	95% C.I for EXP(B)	
			Lower	Upper
DV	1.010	0.323	0.99	1.030
Blood products tranfusion	1.05	0.151	0.980	1.143
IABP	14.627	0.001*	3.146	68
Reintubation	12.700	0.006*	2.09	77.1
Reexploration	18.017	0.001*	3.063	105.2

CI-Confidence interval, * statistically significant factors after step 3 of multiple logistic regression analysis.

Discussion

In this study the incidence of infection among patients who have undergone cardiac surgery with CPB was 18 out of 171 patients which amounts to 10.5%. In these 18 patients, 5 (27.8%) members died and infection was considered as the main cause or was a major contributing factor for mortality. We have observed a great variation existing in the literature about the incidence of hospital infections among cardiac surgical patients. In a study conducted by Lana Lola et al, the rate of infection in CTICU was 13.95% and the observational mortality among those with infections was 25% [2]. The ESGNI008 (European study group on nosocomial infections 008) study [5] that was conducted in 42 hospitals over 13 countries found that overall prevalence of nosocomial infections in post cardiac patients was 26.8%. Fowler et al [6] in their study which was done using the Society of Thoracic Surgeons (STS) national cardiac data base found that major infections occur in 3.51% of patients and the associated mortality rate was 17.3%.

In our study it was observed that pneumonia was the most common type of infection followed by bacteremia, mediastinitis, sternal wound infection, surgical site infection other than sternal wound and the site for least infection was central venous catheter sites.

Pneumonia was observed in 30% of all infections. A study by Argyris michalapodos et al [1] showed that the most common site of infection is the lower respiratory tract with the incidence of pneumonia being 45.7% which is much higher than that observed in our study. The cases of bacteremia in our study represented 23% of all infections (6/26). The organisms isolated in patients with bacteremia were coagulase negative Staphylococci, Pseudomonas aeruginosa, Enterococci faecium, Acinetobacter baumannii and 2 cases with klebsiella pneumoniae. The organisms in our study correlate with previous literature [2,7]. A study by Falagas at al [8] showed that bacteremia was the second most common cause of clinical infection (after pneumonia) and the cases with bacteremia represented 26.9% of all infections.

Mediastinitis was seen in 15.3% of all infected patients and the causative organisms were Klebsiella pneumoniae, Pseudomonas aeruginosa and Acinetobacter baumannii. Our study was not in accordance with Lana Lola et al [2] which indicated only 3.3% of mediastinitis. Literature shows greater variation in the incidence of post cardiac surgery mediastinitis, ranging from 3.3% [2] to 45% [9].

The incidence of sternal wound infections was 11.5%, mainly caused by Enterococcus faecium and Pseudomonas aeruginosa. This rate of infection is quite similar to those reported in the literature (infection rate: 9.7%) [10].

Our study was not in accordance with the previous studies which highlighted that surgical site infections are the most common type of infections [2,11]. In a study by Ku et al [11] it was concluded that sternal infections accounted for 37% of all infections in cardiac surgical patients. Central venous catheter-related infections were observed in our study too (incidence of 7.2% of all infections). Michalopoulos et al [1] described a rate of central venous catheter-related infection of 1.1% in the total number of patients (25.2% of those with infection), which was mainly caused by gram-positive cocci.

In this study none of the co-morbidities have proven to be risk factors for development of nosocomial infections (Table 2).

Previous studies have proven that co-morbidities like obesity [3,9], smoking, COPD [9] and arterial hypertension were considered to be independent risk factors for nosocomial infections. Lana Lola et al [2] showed diabetes mellitus was an independent risk factor for nosocomial infections. In our study no intraoperative factors such as duration of anaesthesia, duration of surgery have been proven to have significant effect on post operative infections.

Post operative events had significant impact on the rate of nosocomial infections. IABP placement post operatively or intraoperatively to support the hemodynamics have been registered to be an independent risk factor according to the multivariate analysis, the odds ratio being 14.6 ($p < 001$). According to a study by Borges at al [12] the infection rate for IABP insertion, was 7.0%. He also commented that the rate of pneumonia was high in patients who were on IABP. In a study by Unverzagts at all [13], found that local infection and ischemic skin loss was found in 3% of patients who were placed on IABP support.

Reintubation was proven to be statistically significant in patients who developed nosocomial infections with an odds ratio of 12.7 ($p < 0.006$). A study by Jean Chastre at al [14] showed the pneumonia rate was 47% for reintubated patients compared with 4% for control subjects matched for the duration of prior mechanical ventilation.

Reexploration due to haemorrhage or due to any other cause is considered to be a risk factor for post operative nosocomial infections with an odds ratio of 18.1 ($p < 0.001$). A study by Reser at al [15].

compared the sternal wound infection in normal post operative cases and patients with reexploration and found no difference between rate of infection which is in contradiction to our study. Boeken u at al [16] in their study concluded that reexploration as well as delay in reexploration increases risk of infections.

Univariate analysis have shown that duration of mechanical ventilation and blood transfusion were significant in causing post operative infections but the multivariate analysis didn't not show any significant relationship of duration of ventilation and blood product transfusion with post-operative infections. Length of ICU stay was more in patients with infection than in patients without infections but we have not considered it as a risk factor while calculating multivariate analysis because it may be the consequence of infection.

The main limitation of our study is the small sample size. Weight of patients and other comorbidities could not be related with post operative infections as we have included a wide range of age group which includes paediatric population to adults.

We did not include the post operative myocardial function which could have probably influenced duration of ventilation and length of ICU stay. Another main limitation of our study is that the antibiotics were used until the patient was discharged from ICU as it is our institute protocol, thus negatively influencing blood culture yield.

We conclude that postoperative infections in cardiac surgery patients represent a serious problem and are directly related to postoperative outcomes. Placement of IABP, reintubation and reexploration are considered to be the independent risk factors for the development of post-operative nosocomial infections in the cardiac surgical patients.

References

1. Michalopoulos A, Geroulanos S, Rosmarakis ES, Falagas ME: Frequency, characteristics, and predictors of microbiologically documented nosocomial infections after cardiac surgery, Eur J Cardiothorac Surg 2006;29: 456-460.
2. Lola I, Levidiotou S, Petrou A, Arnaoutoglou H, Apostolakis E, Papadopoulos G: Are there independent predisposing factors for postoperative infections following open heart surgery?, Journal of Cardiothoracic Surgery 2011;6:151.
3. Chen LF, Arduino JM, Sheng S, Muhlbaier LH, Kanafani et al: Epidemiology and outcome of major postoperative infections following cardiac surgery: Risk factors and impact of pathogen type, Am J Infect Control 2012;40:963-968.
4. Brown PP, Kugelmass AD, Cohen DJ, Reynolds MR, Culler SD, Dee AD, Simon AW: The frequency and cost of complications associated with coronary artery bypass grafting surgery: results from the United States Medicare program, Ann Thorac Surg 2008;85:1980-1986.
5. Bouza E, Hortal J, Munoz P, Pascau J, Perez MJ, Hiesmayr M: Postoperative infections after major heart surgery and prevention of ventilator-associated pneumonia: a one-day European prevalence study (ESGNI-008), J Hosp Infect 2006;64:224-230.
6. Fowler VG, Jr., O'Brien SM, Muhlbaier LH, Corey GR, Ferguson TB, Peterson ED: Clinical predictors of major infections after cardiac surgery, Circulation 2005;112: I358-365.
7. Gordon SM, Serkey JM, Keys TF, Ryan T et al: Secular trends in nosocomial bloodstream infections in a 55-bed cardiothoracic intensive care unit, Ann Thorac Surg 1998; 65:95-100.
8. Falagas ME, Rosmarakis ES, Rellos K, Michalopoulos A, Samonis G, Prapas SN: Microbiologically documented nosocomial infections after coronary artery bypass surgery without cardiopulmonary bypass, J Thorac Cardiovasc Surg 2006;132:481-490.
9. Ranucci M, Bozzetti G, Ditta A, Cotza M, Carboni G, Ballotta A: Surgical reexploration after cardiac operations: why a worse outcome?, Ann Thorac Surg 2008;86:1557-1562.
10. Cayci C, Russo M, Cheema FH, Martens Tet al J: Risk analysis of deep sternal wound infections and their impact on long-term survival: a propensity analysis, Ann Plast Surg 2008;61:294-301.
11. Ku C-H, Ku S-L, Yin J-C, Lee A-J: Risk Factors for Sternal and Leg Surgical Site Infections after Cardiac Surgery in Taiwan, American Journal of Epidemiology 2005;161: 661-671.
12. Borges LHB, Camargo LFA, Strabelli TMV, Uip DE, Auler Júnior JOC: Contrapulsação em operação cardíaca: análise retrospectiva da incidência de infecção, Revista Brasileira de Cirurgia Cardiovascular 1994;9:88-94.
13. Unverzagt S, Machemer MT, Solms A, Thiele H, et al: Intra-aortic balloon pump counterpulsation (IABP) for myocardial infarction complicated by cardiogenic shock, Cochrane Database Syst Rev 2011;6.
14. Chastre J, Fagon J-Y: Ventilator-associated Pneumonia, American Journal of Respiratory and Critical Care Medicine 2002;165:867-903.
15. Reser D, Rodriguez Cetina Biefer H, Plass A, Ruef C et al: Incidence of Sternal Wound Infection After Reexploration in the Intensive Care Unit and the Use of Local Gentamycin, Ann Thorac Surg 2012;94:2033-2037.
16. Boeken U, Eisner J, Feindt P, Petzold TH, Schulte HD, Gams E: Does the time of resternotomy for bleeding have any influence on the incidence of sternal infections, septic courses or further complications?, Thorac Cardiovasc Surg 2001;49:45-4.