

# A study of echocardiographic indices in patients of sepsis and severe sepsis

Prashant Gajbhiye<sup>1\*</sup>, Chandrashekhar S Dhurve<sup>2</sup>

<sup>1,2</sup>Assistant Professor, Department of Medicine, Shri V. N. Government Medical College, Yavatmal, Maharashtra, INDIA.

Email: [prash23feb@gmail.com](mailto:prash23feb@gmail.com)

## Abstract

**Introduction:** Patients with sepsis have a markedly depressed LV ejection fraction, a low cardiac output as measured by the Doppler technique, and systemic vascular resistance higher than usual in sepsis. **Aims and Objectives:** To evaluate the various echocardiographic indices in patients of sepsis, severe sepsis and septic shock. To correlate these various clinical parameters and echocardiographic indices with the outcome. **Material and Methods:** This hospital based prospective analytic observational study was performed in the parent institute from June 2009 to November 2010. A total of 70 cases of sepsis who were admitted in Medical ward or in the medical ICU were studied. **INCLUSION CRITERIA:** All patients satisfying the criteria for sepsis admitted to ICU and Medicine Wards. **Observation and Results:** This was a hospital based observational study which was done with 70 patients of sepsis who were admitted in Medicine wards or in the Medical ICU of the parent Institute. Out of 70 cases studied 50 were males as compared to 31 females. Majority of cases were between age group of 41- 50 years. Mean age of the cases was  $43.2 \pm 15.3$  years. The most common symptom was fever which was present in 85% of the patients. Of the 70 subjects included in the study, 26(37.1%) had presented with sepsis, 32(45.7%) had severe sepsis and 12 (17.2%) patients were in septic shock. 46 (66%) survived and 24 (34%) succumbed to the illness. The most common etiology in severe sepsis was consolidation and was present in 47% of the patients. In septic shock, the most common etiology and clinical presentation was consolidation (58%). In the non survivors, admission EF  $\geq 40$  were found in 21 patients (87%) and, EF  $\leq 40$  were found in 3 patients (13%). In the survivors, EF  $\geq 40$  were found in 29 patients (63%) and, EF  $\leq 40$  were found in 17 patients (37%). Thus in our study 17 patients died with Distributive Shock (71%) and 7 patients (29%) died with Cardiogenic Shock had myocardial depression. **Conclusion:** The mortality was more in the septic shock patients (83%) as compared to those with severe sepsis (43.7%). Ejection Fraction and Cardiac Output was higher in Non survivors than Survivors at time of admission. However in non survivors, there were progressive decline in ejection fraction over a period of stay but still their cardiac output was in normal range.

**Keywords:** echocardiographic, sepsis.

## \*Address for Correspondence:

Dr. Prashant Gajbhiye, Assistant Professor, Department of Medicine, Shri. Vasantrao Naik Govt Medical College, Yavatmal, Maharashtra, INDIA.

Email: [prash23feb@gmail.com](mailto:prash23feb@gmail.com)

Received Date: 04/08/2016 Revised Date: 11/09/2016 Accepted Date: 03/10/2016

## Access this article online

Quick Response Code:



Website:

[www.statperson.com](http://www.statperson.com)

DOI: 09 October  
2016

## INTRODUCTION

Severe sepsis is characterised by concomitant organ dysfunction and septic shock results when blood pressures fall despite adequate fluid resuscitation.<sup>1</sup> Severe sepsis or septic shock accounts for as many deaths as

acute myocardial infarction in hospitals.<sup>2</sup> The typical hemodynamic profile in early sepsis is the peripheral vasodilatation, systolic alterations of left ventricular and right ventricular which along with increased vessel permeability leads to hypovolemia and hypotension. Patients with sepsis have a markedly depressed LV ejection fraction, a low cardiac output as measured by the Doppler technique, and systemic vascular resistance higher than usual in sepsis. nowadays it is advised that all patients hospitalized with septic shock should be monitored using echocardiography as a noninvasive bedside procedure. As no Indian studies of echocardiography in sepsis were found, this study was undertaken to evaluate the cardiac functions in patients of sepsis in our setup.

## MATERIAL AND METHODS

This hospital based prospective analytic observational study was performed in the parent institute from June 2009 to November 2010. A total of 70 cases of sepsis who were admitted in Medical ward or in the medical ICU were studied.

### METHODOLOGY

1. Study Design: Hospital Based Prospective Analytic Observational Study.
2. Number of study subjects: 70
3. Inclusion Criteria: All patients satisfying the criteria for sepsis admitted to ICU and Medicine Wards.
4. Exclusion Criteria: Following patients were excluded from the study.
  - a. Patients with known cardiac disease like rheumatic heart disease, ischemic heart disease, cardiomyopathy.
  - b. Patients who were having ECG changes of ischemic heart disease.
  - c. Patients who were on ventilatory support were also excluded from the study.

### Statistical Analysis

Statistical analysis was performed with the help of SPSS 13.0 software. Statistical analysis included the usual

descriptive and univariate analysis. Student 't' test was used to compare continuous variables. For categorical variables, Chi-square, T test was used and unadjusted odds ratio with 95% confidence interval (CI) were calculated and 'p' values were calculated. In addition to the usual descriptive and univariate analysis, multivariate analysis was also performed. Multiple logistic regression analysis was done to find out association of various clinical parameters with outcome of sepsis.

## OBSERVATIONS AND RESULTS

**Table 1:** Age and sex distribution of the Sepsis patients

Sr. no.	Age in yrs	Male	Female	Total
1	<20	3	1	4
2	21-30	12	3	15
3	31-40	6	6	12
4	41-50	8	8	16
5	51-60	13	1	14
6	>60	8	1	9
<b>Total</b>		<b>50</b>	<b>20</b>	<b>70</b>

Maximum number of patients were in the age group of 41-50 years. The mean age of the study subjects was 43.2±15.3 years. There were 50M and 20F in the study.

**Table 2:** Serial echocardiographic measurements of in terms of survival and non-survival

	SURVIVERS 46			NON SURVIVERS 24		
	DAY 1	DAY3	DAY 5	DAY 1 24	DAY 3 19	DAY 5 7
Lvidd	46.5± 7.1	44.3±3.8	44.8±3.4	47.1±6.5	48.1±4.3	49.8±4.4
Lvids	33.2±7.7	32±4.9	32.9±3.9	31.6±5.5	34.3±3.9	38.8±6.2
Ejection fraction (%)	50±14	50±13	49±9	57±12	48±11	42±17
Stroke volume	60.2±19.9	52.5±13.51	55±10.4	74.2±27.9	68.4±22.01	58.6 ±14.7
Stroke index	38.6±12.21	33.3±8.42	35.2±6.63	46.9±18.02	43.2±13.87	35.8±6.84
Cardiac M-mode	5.76±1.76	5.0±1.27	5.09±0.74	7.92±2.42	7.18±2.16	6.12±1.38
Output Lvt method	5.68±1.59	5.02 ±1.27	5.05±0.87	7.97±2.35	7.11±2.28	6.30±1.64
Cardiac index Lvt method	3.60 ±1.10	3.21±0.75	3.24 ±0.57	5.0 ±1.43	4.55±1.37	3.7±0.93
Distensibility index of lvc	0.63±0.13	0.73±0.14	0.75±0.11	0.46±0.15	0.43±0.13	0.63±0.17
Heart rate	98 ±12	95 ±10	93±8	112± 16	101±24	104± 6

The above table shows serial echocardiographic measurements of study subjects in terms of survival and non survival. LVIDD was overall in the normal range in survivor and they were generally lower than the non survivors. While in non survivors, LVIDD initially in the normal range which gradually started increasing. Similarly LVIDS was overall in the normal range in the patients of sepsis who survived. While in non survivors, LVIDS initially in the normal range which gradually started dilating. Ejection Fraction was around 50% in the survivors which was maintained throughout their monitoring. However in non survivors, ejection fraction

was initially higher than survivors which was gradually decreased. Stroke volume, stroke index, Cardiac output and cardiac index were initially higher in survivor group at the time of admission which was gradually decreased and again started increasing maintaining normal range. While in non survivor, Stroke volume, stroke index, Cardiac output and cardiac index were initially higher on admission and more than survivor which were gradually decreased but remains in higher range throughout their monitoring. Heart rate was in the higher range in the non survivors than survivors throughout their monitoring.

**Table 3:** Comparative echocardiographic data between sepsis, severe sepsis and septic shock

	SEPSIS		SEVERE SEPSIS		SEPTIC SHOCK	
	S(n=26)	NS	S(n=18)	NS(n=14)	S(n=2)	NS(n=10)
LVIDD	45.2±5.7		49.3±7.7	45.3±7.5	38±8.5	49.4±3.7
	43.8±4.0		45.4±3.3	47.7 ±5.6*	42±5.6	47.4±2.4•
	44.9 ±3.6		44.3±3.1	49.8±5.5®	47.5±0.7	50±3.46®
LVIDS	31.3±6.1		36.6±9.0	30.4±6.2	31±7.1	33.3±4.2
	32.4±5.0		31.8±4.9	34.7±4.3	29.5±7.8	33.7±3.6
	33.7±3.4		31.7±4.7	38.8±3.3	33.5±0.7	37.3±9.8
EF	52± 15		48±14	56±13	37±5	57±11
	49±13		52±14	46±7	54±16	50±15
	47±8		51±11	35±8	50±1	51±25
SV	58.3±18.5		66.3±19.1	69.9±30.6	28±15.5	80.3±23.9
	49.6±12.5		57.4±14.4	70±24.7	47.5±10.6	66.6±19.8
	53.8±10.9		55±9.36	52.3±14.3	69.5±2.1	67±12.5
SI	37.5± 10.67		42.6±12.28	44.4±19.96	17.5±7.21	50.5±15.2
	32.2±7.13		35.3±10.3	44.7±16.6	30.5±1.97	41.6±10.8
	34.6±6.10		35.1±7.29	34.4±7.61	41.8±3.25	37.9±6.5
CO-M-MODE	5.86±2.01		5.84±1.35	7.89±2.66	3.8±1.13	7.98±2.18
	4.85±1.25		5.18±1.38	7.53±2.47	5.4±0.28	6.8±1.81
	4.95±0.80		5.15±0	5.55±1.51	6.25±0.07	6.9±0.87
CO LVOT	5.72± 1.76		5.86±1.28	7.80±2.45	3.65±0.21	8.22±2.30
	4.80±1.37		5.32±1.12	7.25±2.51	5.15±0.92	7.02±2.12
	4.98±0.91		4.99±0.66	5.50±1.29	6.45±1.48	7.27±1.72
CILVOT METHOD	3.62±1.18		3.72±0.85	4.94±1.52	2.4±0.14	5.16±1.35
	3.11±0.75		3.38±0.78	4.59±1.59	3.25±0.07	4.39±1.14
	3.23±0.59		3.17±0.50	3.23±0.66	4.05±0.35	4.40±0.87
DI	0.67±0.11		0.59±0.13	0.45±0.16	0.4±0.14	0.46±0.14
	0.74±0.13		0.71±0.15	0.39±0.07	0.61±0.02	0.48±0.18
	0.77±0.11		0.72±0.11	0.73±0.07	0.75±0.07	0.50±0.17
HR	100±10		95±14	118±18	109±16	103±8
	96±8		92±11	98±33	113±10	104±5
	92±4		93±10	99±2	99±16	110±2

\*n=10, ®n=4, •n=9, ®n=3.

The above table shows comparative data between sepsis, severe sepsis and septic shock patients and their survival. In the patient of sepsis, there were no significant difference during monitoring, only cardiac output and cardiac index were initially increased which came to normal. In patient of severe sepsis who survived, there were initial increase in cardiac output and LVIDD and cardiac index which gradually returns to normal range. While in non survival of severe sepsis, there were initial increase in ejection fraction, cardiac output and cardiac index which gradually decreased but were significantly more than survival. LVIDD and LVIDS were initially in normal range which gradually increased their dimensions. In patient of septic shock who survived, there were initial decrease in ejection fraction, cardiac output and LVIDD and cardiac index which gradually returns to normal range. While in non survival of septic shock, there were initial increase in ejection fraction, cardiac output and cardiac index which were remain in the higher range throughout monitoring and were significantly more than survival.

**Table 4:** Echocardiographic indices in patient who died

Type of Patients	<2 Days	3-5 days	>5 days
High CO and high EF(Distributive Shock)	3	5	1
High CO and low EF (Distributive Shock)	1	3	4
Low CO and low EF ( Cardiogenic Shock)	1	4	2
<b>Total</b>	<b>5</b>	<b>12</b>	<b>7</b>

There were 5 patients who died within 48 hours. Of the 5 patients, 3 patients had high cardiac output and high ejection fraction, 1 patient had High Cardiac Output and Low Ejection Fraction (Distributive Shock). 1 had Low Cardiac Output and Low Ejection Fraction (Cardiogenic Shock). There were 12 patients who died within 3-4 days. Of the 12 patients, 5 patients had high cardiac output and high ejection fraction. 3 patients had High Cardiac Output and Low Ejection Fraction (Distributive Shock). 4 had Low Cardiac Output and Low Ejection Fraction (Cardiogenic Shock). There were 7 patients who died after 5 days. Of the 7 patients, 1 patients had high cardiac output and high ejection fraction. 4 patients had High

Cardiac Output and Low Ejection Fraction (Distributive Shock) 2 had Low Cardiac Output and Low Ejection Fraction (Cardiogenic Shock). Thus 17 patients died with Distributive Shock (71%) and 7 patients (29%) died with Cardiogenic Shock had myocardial depression.

**Table 5:** Multiple logistic regression showing association of various clinical parameters with outcome of sepsis

Clinical Parameters	Odds Ratio	95% C. I.	'z' value	'p' value
Age	0.93	0.85 to 1.03	-1.43	0.152
RR	0.39	0.16 to 0.68	-2.97	0.003
TLC	1.00	1.003 to 1.004	2.27	0.023
PLATELETS	1.00	1.0 to 1.0001	2.49	0.013
GRADES	0.04	0.003 to 0.46	-2.57	0.01
HEART RATE	0.47	0.25 to 0.91	-2.25	0.024
EF	0.88	0.73 to 1.06	-1.29	0.195
SI	0.36	0.15 to 0.86	-2.29	0.022
CO	0.08	0.004 to 1.72	-1.60	0.109
CI	5812	3.62 to 9.31	2.22	0.026

The table shows association of various clinical parameters on admission with outcome of sepsis in multiple logistic regression analysis. In this model, age and grades of sepsis are taken as categorical variables. The analysis shows that after multiple logistic regression, RR ( $p < 0.003$ , OR=0.39, 95% CI =0.16 to 0.68), TLC ( $p < 0.023$ , OR=1.00, 95% CI =1.003 to 1.004), PLATELETS ( $p < 0.013$ , OR=1.00, 95% CI =1.0 to 1.0001), GRADES ( $p < 0.001$ , OR=0.04, 95% CI =0.03 to 0.46), HEART RATE ( $p < 0.024$ , OR=0.47, 95% CI =0.25 to 0.91), SI ( $p < 0.022$ , OR=0.36, 95% CI =0.15 to 0.86), and CI ( $p < 0.026$ , OR=5812, 95% CI =3.62 to 9.31) are found to be independently associated with outcome of sepsis.

## DISCUSSION

**Age And Sex:** The mean age of the study subjects was  $43.2 \pm 15.3$  years with majority of the study subjects being in the age group of 41-50 years. There was a predominant involvement of the male sex (71%), with females comprising 29% of the study group.

**Echocardiographic indices in study subjects:** Parker *et al*<sup>27</sup> In 1984, performed serial RNCA and simultaneous thermodilution cardiac output studies on 20 patients with septic shock. The 13 survivors and 7 nonsurvivors had the typical hyperdynamic (high cardiac output, low SVR) profile of septic shock. In our study, Comparative echocardiographic study between sepsis, severe sepsis and septic shock patients and their survival shows that in the patient of sepsis, there were no significant difference during monitoring, only cardiac output and cardiac index were initially increased which came to normal. In patient of severe sepsis who survived, there were initial increase in cardiac output and LVIDD and cardiac index which gradually returns to normal range. While in non survival

of severe sepsis, there were initial increase in ejection fraction, cardiac output and cardiac index which gradually decreased but remained higher than the survivors. LVIDD and LVIDS were initially in normal range which gradually increased their dimensions. In patient of septic shock who survived, there were initial decrease in ejection fraction, cardiac output and LVIDD and cardiac index which gradually returns to normal range. While in non survival of septic shock, there were initial increase in ejection fraction, cardiac output and cardiac index which were remain in the higher range throughout monitoring and were significantly more than survival. Thus in our study 17 patients died with distributive shock (71%) and 7 patients (29%) died with cardiogenic shock had myocardial depression.

**Effect of various clinical and echocardiographic indices on outcome of sepsis:** Cornelis PC de Jager *et al*<sup>21</sup> in 2010, studied 92 patients of sepsis to evaluate the ability of conventional infection markers, lymphocyte count and NLCR to predict bacteraemia in adult patients admitted to the Emergency Department with suspected community acquired bacteraemia. They found significant differences between patients with positive and negative blood cultures were detected with respect to the CRP level (mean  $\pm$  standard deviation  $176 \pm 138$  mg/l vs.  $116 \pm 103$  mg/l;  $P = 0.042$ ), lymphocyte count ( $0.8 \pm 0.5 \times 10^9/l$  vs.  $1.2 \pm 0.7 \times 10^9/l$ ;  $P < 0.0001$ ) and NLCR ( $20.9 \pm 13.3$  vs.  $13.2 \pm 14.1$ ;  $P < 0.0001$ ) but not regarding WBC count and neutrophil count. In multivariate analysis adjusted for age and severity of infection, only following admission parameters are associated with negative outcome of sepsis (mortality) viz high respiratory rate, high TLC, low platelets, grades of sepsis, high heart rate, stroke index and cardiac index are found to be independently associated with sepsis.

## CONCLUSIONS

Of the 70 patients included in the study, 46 (66%) survived and 24 (34%) succumbed to the illness. The mortality was more in the septic shock patients (83%) as compared to those with severe sepsis (43.7%). There was no mortality in patients with sepsis without any organ involvement. Clinical parameters respiratory rate, platelets, TLC adjusted for age and severity of infection are found to be independently associated with outcome of sepsis in univariate as well as multivariate analysis. Ejection Fraction and Cardiac Output was higher in Non survivors than Survivors at time of admission. However in non survivors, there were progressive decline in ejection fraction over a period of stay but still their cardiac output was in normal range (Distributive Shock). Few had low cardiac output and low ejection fraction when they succumbed (Cardiogenic Shock).<sup>17</sup> (71%)

patients had distributive shock before their death and 7 (29%) had cardiogenic shock and myocardial depression before their death.

## REFERENCES

1. Annane D, Bellissant E, Cavaillon JM (2005) Septic shock. *Lancet* 365: 63–78
2. Martin GS, Mannino DM, Eaton S, Moss M (2003) ;The epidemiology of sepsis in the United States from 1979 through 2000. *N Engl J Med* 348: 1546–1554.
3. Angus DC, Linde-Zwirble WT, Lidicker J, Clermont G, Carcillo J, Pinsky MR (2001) Epidemiology of severe sepsis in the United States: analysis of incidence, outcome, and associated costs of care. *Crit Care Med* 29: 1303–1310.
4. Rivers E, Nguyen B, Havstad S, Ressler J, Muzzin A, Knoblich B, Peterson E, Tomlanovich M; Early Goal-Directed Therapy Collaborative, Group (2001) Early goal-directed therapy in the treatment of severe sepsis and septic shock. *N Engl J Med* 345: 1368–1377
5. Kern JW, Shoemaker WC (2002) Meta-analysis of hemodynamic optimization in high-risk patients. see comment. *Crit Care Med* 30: 1686–1692
6. Gibot S, Kolopp-Sarda MN, Bene MC, Cravoisy A, Levy B, Faure GC, Bollaert PE (2004) Plasma level of a triggering receptor expressed on myeloid cells-1: its diagnostic accuracy in patients with suspected sepsis. *Annals of Internal Medicine*. 141:9–15
7. Meisner M (2005) Biomarkers of sepsis: clinically useful? *Current Opinion Crit Care* 11: 473–480
8. Farand P, Hamel M, Lauzier F, Plante GE, Lesur O (2006) Review article: organ perfusion/permeability-related effects of norepinephrine and vasopressin in sepsis. *Can J Anaesth* 53: 934–946
9. Pfeiffer; Untersuchungeniiber das choleagift. *Ztschr.f.hyg.* 1891-92, 11; 393-412
10. Centanni; Untersuchungeniiber das in fektionsfieber das fieber gift BakterienDtsch med Wochenschr 1894,20;148
11. Bone RC, Balk RA, Cerra FB, Dellinger RP, Fein AM, Knaus WA, Schein RM, Sibbald WJ (1992) American College of Chest Physicians/Society of Critical Care Medicine Consensus Conference: definitions for sepsis and organ failure and guidelines for the use of innovative therapies in sepsis. *Crit. Care Med* 20: 864–874
12. Levy MM, Fink MP, Marshall JC, Abraham E, Angus D, Cook D, Cohen J, Opal SM, Vincent JL, Ramsay G, International Sepsis Definitions C (2003) 2001 SCCM/ESICM/ACCP/ ATS/SIS International Sepsis Definitions Conference. *Intensive Care Med* 29: 530–538
13. Calandra T, Cohen J, International Sepsis Forum Definition of Infection in the ICU Consensus, Conference (2005) The international sepsis forum consensus conference on definitions of infection in the intensive care unit. *Crit. Care Med* 33: 1538–1548
14. Antonelli M, Levy M, Andrews PJ, Chastre J, Hudson LD, Manthous C, Meduri GU, Moreno RP, Putensen C, Stewart T, Torres A (2007) Hemodynamic monitoring in shock and implications for management : International Consensus Conference, Paris, France, 27–28 April 2006. *Intensive Care Med* 33:575–590.
15. Ailko W. J. Bossink, MD; A. B. Johan Groeneveld, MD, PhD; C. Erik Hack, MD, PhD; and Lambertus G. Thijs, MD, PhD The Clinical Host Response to Microbial Infection in Medical Patients With Fever; *Chest* 1999;116;380-390.
16. Parker SM, Shelhamer JH, Natanson C, Alling DW, Parrillo JE: Serial cardiovascular variables in survivors and non-survivors of human septic shock: heart rate as an early predictor of prognosis. *Crit Care Med* 1987, 15:923-929.
17. Parker MM, Shelhamer JH, Bacharach SL, Green MV, Natanson C, Frederick TM, Damske BA, Parrillo JE: Profound but reversible myocardial depression in patients with septic shock. *Ann Intern Med* 1984, 100:483-490.
18. Amr,omar,masudur. Rehman;left atrial function for outcome prediction in severe sepsis and septic shock-an echocardiographic study *Indian journal of crit..care Med* april-june 2009 vol13
19. Silva E, Pedro M D A, Sogayar A C B, Silva T M D O, Janiszewski M Rodrigues R G *et al*, Brazilian sepsis epidemiological study”. *The critical care forum*2004; 8(4): 251-60
20. Baumgartner J, Vaney C, Perret C: An extreme form of hyperdynamic syndrome in septic shock. *Intensive Care Med* 1984, 10:245-249.
21. Cornelis PC de Jager1, Paul TL van Wijk, Rejiv B Mathoera, Jacqueline de Jongh-Leuvenink, Tom van der Poll, Peter C Wever Lymphocytopenia and neutrophil-lymphocytecount ratio predict bacteremia better thanconventional infection markers in an emergencycare unit *Critical Care* 2010, 14:R192

Source of Support: None Declared  
Conflict of Interest: None Declared