Original Article

Serum Albumin and Its Influence on Immediate Outcomes in Children with Congenital Heart Disease Undergoing Cardiac Surgery

K M Enayet[1], Mohd. Zahid Hussain[2], Md. Tariqul Islam[3] , Tahmina Karim[4], Tasmin Akhtar Jahan[5], Porimal Kumar Das[6], Faizul Haque Ponir[7], Mostafizur Rahman Bhuiyan[8]

Abstract:

Background:Hypoalbuminemia is associated with morbidity and mortality in critically ill children and is a well-recognized predictor of general surgical risk. It frequently occurs in patients with congenital heart disease (CHD). Moreover, cardiopulmonary bypass (CPB)-induces an inflammatory response, and the overall surgical stress can affect albumin concentration greatly

Objective: To estimate pre-operative, per-operative and post-operative serum albumin level and to see its influence on immediate outcomes in children with congenital heart disease undergoing cardiac surgery with cardiopulmonary bypass

Methods: This cross-sectional observational study was conducted in Paediatric cardiology department, BSMMU in a view to find out the influence of pre-operative, per-operative and post-operative serum albumin level on immediate outcomes in children with congenital heart disease undergoing cardiac surgery with cardiopulmonary bypass(CPB).The study included total 48 patients of CHD who underwent CPB. Patients were selected according to inclusion and exclusion criteria.

Result: Mean pre-operative serum albumin was 3.5±0.9 mg/dl whereas per-operative and post-operative serum albumin was 3.3±0.7mg/dl and 3.1±0.7 mg/dl respectively.CPB time was a bit higher in study population (98.4± 29.1min) where as other outcome parameters were within normal range. Duration of hospital stay was 12.2±3.1days. 22 patient (45.8%) developed valvular regurgitation and 6 patient (12.5%) developed pericardial effusion in post-operative echocardiography. Infection was evident by positive blood culture in 7 patients (14.8%). Pre, per and post-operative hypoalbuminaemia was associated with poor outcome after CPB.

Conclusion: Pre, per and post-operative hypo-albuminaemia is a prudent indicator for speculating poor immediate outcome following CPB in children with CHD.

Keywords : *Serum albumin , congenital heart disease, cardiac surgery*

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1. Medical Officer, Khulna Medical College Hospital, Khulna.
2. Professor of Paediatic Cardiology (Former), BSMMU, Dhaka.
3. Chairman , Department of Paediatric Cardiology, BSMMU, Dhaka.
4. Associate professor, Paediatric Cardiology, BSMMU, Dhaka.
5. Medical Officer (Deputed In BSMMU), Dhaka.
6. Junior Consultant (Paediatrics), Upzila Health Complex, Kotalipara, Gopaljanj, Dhaka.
7. Junior Consultant (Paediatrics), Mugda Medical College Hospital, Dhaka.
8. Medical Officer, BSMMU, Dhaka.

Address of Correspondence: Dr. K M Enayet, Medical Officer, Khulna Medical College Hospital, Mobile: 01717-044776, E-mail: enayetsoton@gmail.com

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Introduction:

Albumin is the most abundant protein in plasma, constituting approximately two-thirds of total plasma protein which is the greatest contributor to plasma colloid oncotic pressure and is responsible for the transport and binding of many plasma molecules. Serum albumin has been extensively used as a biomarker for predicting morbidity and mortality in patients undergoing high-risk surgery.[1] It is not the result of a reduction in albumin synthesis alone, but a multi-faceted phenomenon involving several processes, such as chronic inflammation, recurrent infections, hepatic failure, renal dysfunction, altered gastrointestinal function, increased right-sided heart pressures, dilution from fluid overload, and medications can influence serum albumin concentration.[2] Such states are frequently encountered in patients with long-standing congenital heart disease(CHD).[3]

A recent study found that perioperative hypoalbuminemia is common in the pediatric cardiac patients.[4] In other studies, hypoalbuminemia is associated with acute kidney injury and death in children undergoing repair of cyanotic heart disease and with poor outcome after pediatric heart transplantation.[5, 6] The study is thus aimed to quantify serum albumin concentration in children with different congenital heart defects and evaluate its behavior in response to metabolic stress associated with cardiac surgery and also to assess the correlation between hypoalbuminemia and post-operative outcome.

Materials and Methods:

This across-sectional study was conducted in the Department of Paediatric Cardiology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka. Purposive sampling technique was adopted. Total 48 Patient below 18 years of age with CHD diagnosed in Paediatric cardiology department, BSMMU and undergoing Cardiac surgery with CPB in Cardiac surgery department, BSMMU were included in this study. Patients with preexisting renal failure, cardiac failure, liver dysfunction, immune or central nervous system dysfunction, local or systemic infection or inflammation or on immune-suppressive/anti-inflammatory therapy/ albumin replacement, history of infective endocarditis were excluded from the study.

Echocardiography was done by G&E Echo machine ModelVividS70N. Patients were checked in supine and lateral positions. Pediatric probe 5MHz and 6MHz was used. Serum albumin and serum creatinine concentration was measured before surgery in the ward. Serum albumin measurement was Done by Atellica CH analyzer of SIEMENS Healthineers. Serum creatinine measurement was Done by Atellica CH analyzer of SIEMENS Healthineers.

The blood samples were obtained from a peripheral vein at rest with other routine tests and the measurements was obtained from the research lab of the Biochemistry department, BSMMU. During cardiac surgery Cardiopulmonary bypass time and aortic cross clamp time was recorded. Again blood sample was sent for per-operative serum albumin. In post-operative ICU clinical signs were noted. Post-operative echo-cardiography was done within 24 hours of surgery to evaluate pericardial effusion, left ventricular function (ejection fraction and fractional shortening), right ventricular function (TAPSE), and any form of valvular regurgitation.48 hours after cardiac surgery post-operative serum albumin and serum creatinine level was measured. Duration of mechanical ventilation, Post-operative mortality and post-operative length of ICU stay was also evaluated. The pre, per and postoperative serum albumin concentration was compared with normal values in references.Then pre-operative, per-operative and post-operative serum albumin level was compared with immediate outcomes

Statistical Methods:

Computer based statistical analysis were carried out with appropriate techniques and systems. All data were recorded systematically in preformed data collection form (questionnaire). Continuous data were expressed as mean and standard deviation and qualitative data were expressed as frequency distribution and percentage. Statistical analysis was performed by using window based computer software devised with Statistical Packages for Social Sciences (SPSS-22) (SPSS Inc, Chicago, IL, USA). Comparison between two means of quantitative data were analyzed byunpaired two sample t test or student's t test and comparison between qualitative data was done by Chi-square test. For all statistical tests, p value <0.05 was considered as statistically significant.

Results:

Table-I

Socio-demographic and anthropometric data of Study Subject (n=48)

Variable	Mean±SD*
Age (month)	82.12±41.45
Weight(kg)	16.8±5.5
Height (cm)	108.3±16.3
BSA(m2)	0.69±0.16
Social Status (According to monthly income in taka)	
Lower (<20000)	58.33% (28)
Middle (20000-40000)	31.25% (15)
Upper (>40000)	10.41% (5)
Urban area (%)	52.3% (25)

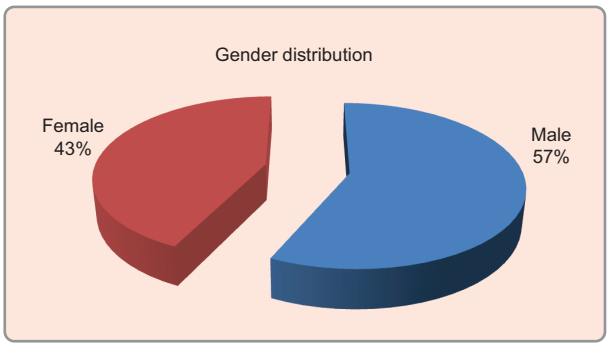

Figure-1: *Pie chart showed gender distribution among the study subjects. 57% of them were male and 43% were female*

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Table-II

Clinical presentation on admission in study subject (n=48)

Clinical presentation	Percentage(n)*
H/O Recurrent RTI	60.4%(29)
Feeding difficulty	41.6%(20)
Dyspnoea	38.4%(19)
Cyanosis	38.4%(19)

*Data was expressed as Frequency and percentage

Table-III

Clinical examination findings on admission in study subject (n=48)

Variable	Mean±SD*
Heart rate (Beat/min)	97.1±9.4
SPO2 (%)	90.3±9.7

*Data was expressed as mean±SD

Table-IV

Serum albumin in study subject (n=48)

Serum Albumin (gm/dl)	Mean±SD
Pre-operative	3.5±0.9
Per-operative	3.3±0.7
Post-operative	3.1±0.7

*Data was expressed as mean±SD,

Table-IV

Per-operative and post-operative outcome in study subject (n=48)

Variable	Mean±SD*
S. Creatinine (mg/dl)	0.84±0.38
CPB time (min)	98.4± 29.1
ACC time (min)	82.5±45
Duration of MV (hr)	44.6±17.1
ICU stay length(hr)	53.04±32.2
Hospital stay (hr)	12.2±3.1
Echocardiographic findings	
TAPSE (mm)	17.2±3.1
EF	55.8±7.84
FS	29.1±3.2
Pericardial effusion (%)	12.5%(n=6)
Valvular regurgitation (%)	45.8%(22)
Infection (%)	14.8%(n=7)
Death (%)	6.25%(n=3)

*Quantitative data was expressed as Mean±SD and qualitative data was expressed as frequency and percentage

Table-V

Comparison of per-operative and post-operative quantitative outcome between pre-operative hpyoalbuminaemia and normal albumin group

Variable	Hypoalbu-minaemia Group (n=6)	*Normal Albumin group (n=42)*	P value**
S.creatinine(mg/dl)	0.94±0.6	0.49±0.3	0.0013
CPB time(min)	136.4± 39.1	86.4± 22.6	<0.0001
ACC time(min)	94.2±18.4	80.9±23.7	0.08
Duration of MV(hr)	77.6±17.1	38.4±21.4	<0.0001
Length of HS(day)	16.2±2.6	9.1.2±3.4	<0.0001
ICU stay length(hr)	98±18.3	42.6±16.8	<0.0001
TAPSE(mm)	14.4±2.9	18.1±3.2	0.01
EF(%)	47.2±8.4	60.4±6.25	<0.0001
FS(%)	24.3±4.5	32.1±3.6	<0.0001

*Data was expressed as Mean±SD

Unpaired t test was done as a test of significance .**P value <0.05 was considered statistically significant

This table shows comparison of per-operative and post-operative quantitative outcome between hyoalbuminaemia group (n=10) and normal albumin group (n=38) based on per-operative serum albumin level. All the comparison was statistically significant.

Table-VI

Comparison of per-operative and post-operative quantitative outcome between post-operative hpyoalbuminaemia and normal albumin group

Variable	Hypoalbu-minaemia Group (n=13)	*Normal Albumin group (n=35)*	P value**
S.creatinine(mg/dl)	1.12±0.7	0.62±0.45	0.005
CPB time(min)	144.6± 30.1	85.9± 25.4	<0.0001
ACC time(min)	104.6±13.2	74.3±21.9	<0.0001
Duration of MV(hr)	86.4±16.6	32.5±11.2	<0.0001
Length of HS(day)	20.2±2.4	8.6±2.8	<0.0001
ICU stay length(hr)	105.6±16.3	38.5±12.7	<0.0001
TAPSE(mm)	13.1±2.9	16.4±3.5	0.004
EF(%)	46.3±5.4	62.2±6.8	<0.0001
FS(%)	24.6±3.2	33.1±3.4	<0.0001

*Data was expressed as Mean±SD
Unpaired t test was done as a test of significance
**P value <0.05 was considered statistically significant

This table shows comparison of per-operative and post-operative quantitative outcome between hyoalbuminaemia group (n=13) and normal albumin group (n=35) based on post-operative serum albumin level. All the comparison was statistically significant.

Table-VII

Comparison of per-operative and post-operative qualitative outcome between pre-operative hpyoalbuminaemia and normal albumin group

Outcome	Hypoalbu-minaemia Group (n=6)	*Normal Albumin group (n=42)*	P value**
Pericardial effusion	3(50%)	3(7.1%)	0.02
Valvular regurgitation	6(100%)	16(38%)	0.12
Infection	4(66.6%)	3(7.1%)	0.004

*Data was expressed as frequency and percentage
Chi-square test was done as a test of significance
**P value <0.05 was considered statistically significant

This table shows comparison of per-operative and post-operative qualitative outcome between hyoalbuminaemia group (n=6) and normal albumin group (n=42) based on pre-operative serum albumin level. All the comparison was statistically significant except valvular regurgitation.

Table-VIII

Comparison of per-operative and post-operative qualitative outcome between per-operative hpyoalbuminaemia and normal albumin group

Outcome	Hypoalbu-minaemia Group (n=10)	*Normal Albumin group (n=38)*	P value**
Pericardial effusion	4(40%)	2(5.2%)	0.01
Valvular regurgitation	9(90%)	13(30.9%)	0.12
Infection	6(60%)	1(2.3%)	0.0004

*Data was expressed as frequency and percentage
Chi-square test was done as a test of significance
**P value <0.05 was considered statistically significant

This table shows comparison of per-operative and post-operative qualitative outcome between hyoalbuminaemia group (n=10) and normal albumin group (n=38) based on per-operative serum albumin level. All the comparison was statistically significant except valvular regurgitation.

Table-IX

Comparison of per-operative and post-operative qualitative outcome between post-operative hpyoalbuminaemia and normal albumin group

Outcome	Hypoalbu-minaemia Group (n=13)	*Normal Albumin group (n=35)*	P value**
Pericardial effusion	5(38.4%)	1(2.85%)	0.005
Valvular regurgitation	10(76.9%)	12(34.2%)	0.12
Infection	6(46.13%)	1(2.85%)	0.002

*Data was expressed as frequency and percentage
Chi-square test was done as a test of significance
**P value <0.05 was considered statistically significant

This table shows comparison of per-operative and post-operative qualitative outcome between hyoalbuminaemia group (n=13) and normal albumin group (n=35) based on post-operative serum albumin level. All the comparison was statistically significant except valvular regurgitation.

This table shows correlation of pre-operative, per-operative and post-operative hypoalbuminemia and normal albumin group with per-operative and post-operative outcome. Here CPB time, ACC time, duration of MV, ICU stay and Hospital stay were negatively correlated whereas TAPSE, EF% and FS% were positively correlated and all the correlation parameters were statistically significant.

Table-X

Correlation of pre-operative, per-operative and post-operative hypoalbuminemia and normal albumin group with per-operative and post-operative outcome

	CPB tm min	ACC Tm min	MV hr	Icu St hr.	Hosp. St day	TAPSE mm	EF %	FS %	
Preoperative S.Albumin mg/dl	r-value	-.335*	-.267	-.433**	-.420**	-.213	.279	.478**	.467**
	p-value	.020	.067	.002	.003	.147	.055	.001	.001
PeroperativeS.Albumin mg/dl	r-value	-.552**	-.492**	-.660**	-.657**	-.531**	.533**	.664**	.666**
	p-value	.000	.000	.000	.000	.000	.000	.000	.000
Postoperative S.Albumin mg/dl	r-value	-.677**	-.593**	-.683**	-.575**	-.548**	.676**	.697**	.690**
	p-value	.000	.000	.000	.000	.000	.000	.000	.000

Pearson correlation test is done as test of significance
P value <0.05 was considered statistically significant

Discussion:

Mean pre-operative serum albumin was 3.5±0.9 mg/dl whereas per-operative and post-operative serum albumin was 3.3±0.7 mg/dl and 3.1±0.7 mg/dl respectively.CPB time was a bit higher in study population (98.4± 29.1min) whereas other outcome parameters were within normal range. Duration of hospital stay was 12.2±3.1days. 22 patient (45.8%) developed valvular regurgitation and 6 patient (12.5%) developed pericardial effusion in post-operative echocardiography. Infection was evident by positive blood culture in 7 patients (14.8%). Leite HP et al found similar finding when he studied 30 CHD patients who underwent cardiac surgery[5]. Like this study mean pre-operative serum albumin was 3.4±0.25g/dl which decreased in 2nd post-operative day. Concerning lowpostoperative values, the transcapillary flow of plasma proteins secondary to the endothelial lesion is the main underlying mechanism to explain hypoalbuminemia[7, 2]. The contact of the blood with the surface of cardiopulmonary bypass tubes may produce an endothelial lesion that in turn is a triggering factor of the systemic inflammatory response [8].They also found length of hospital stay 11±3.5 days and 26.6% patient suffered from infection[5] .

In this study comparison of quantitave outcome between hyoalbuminaemiagroup and normal albumin group based on pre-operative, per-operative and post-operative serum albumin level was statistically significant. KittisakmontriK et al stated that lower pre-operative serum albuminlevelswere associated with prolonged post-operative length of hospital stay [9]. Koertzen M et al concluded Pre-operative and admission hypoalbuminemia have been associated with increased duration of mechanical ventilation and ICU stayfor ICU patients undergoing CPB [10]. Probable explanation is lower albumin is likely most often a consequence of secondary protein energy malnutrition, plus heart failure in CHD. These factors influence the worse post-operative outcomes in patients undergoing CPB[1]. On the contrary Shiller O et al didn't find significant association between pre-operative albumin and post-operative outcome[4] .Concomitantly Davari P et al described that post-operative serum albumin was significantly associated with worst prognosis and outcome after cardiacsurgery[11]. A multicenter study of 203 study population conducted by Henry BM et al exerted similar association [12].

In this study comparison of qualitative outcome between hyoalbuminaemia group and normal albumin group based on pre,per and post-operative serum albumin level was also done and that revealed pericardial effusion and infection was higher in hyoalbuminaemiagroup. Rady MY et al and Kirklin JW et al noted higher infection cases in pre-operative hyoalbuminaemia group [13 , 14]. Low post-operative albumin concentrations have been associated with high concentrations of C-reactive protein, a1-antitrypsin, interleukin-6 and procalcitonin, in patients after cardiac surgery [15] .In this study Preoperative, per-operative and post-operative albumin level was chosen as a possible predictive variable since it may be helpful in communicating our assessment of the complexity of the per-operative and postoperative course to the patient's parents. There was a significant correlation between albumin levels with per-operative and post-operative outcome. Here CPB time, ACC time, duration of MV, ICU stay and Hospital stay were negatively correlated whereas TAPSE, EF% and FS% were positively correlated.

Conclusion:

Pre, per and post-operative hypoalbuminaemia are important indicators for identifying poor immediate outcome following cardiac surgery under CPB in children with CHD

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