e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(6); 578-583

Original Research Article

Serial Serum Albumin Levels as A Prognostic Marker in Critically Ill Patients

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Received: 27-03-2023 / Revised: 25-04-2023 / Accepted: 30-05-2023
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Conflict of interest: Nil

Abstract

Introduction: Albumin's the most plentiful protein in human plasma. As an index of patients' nutritional and metabolic status, it has been employed by a number of investigators. **Aim:** To estimate serum albumin concentrations in critically ill patients after they have been admitted to Intensive Care Unit and assess the role of continuous SA measurement as an independent diagnostic indicator.

Methods: A cross-sectional observational study on 100 critically ill Patients admitted to ICU for at least 5 days or more at tertiary care hospital, Ajmer from September 2021 to September 2022. Patient with chronic liver or kidney disease, nephritic syndrome, protein-losing enteropathy and chronic malnutrition were excluded from study.

Results: Out of 100 patients 62% were discharged (survivors) and 38% died (non-survivors). Using the logistic regression equation derived from our study, it was found that it correctly identified 83.87 % (Sensitivity) patients to survive and 78.95 % (Specificity) patients to die. Overall, it was 82% accurate (accuracy) in the prediction of the outcome of the patient.

Conclusion: One major factor influencing the outcome of severely ill patients dependent on mechanical ventilation is likely to be a serial estimation of serum albumine levels.

Keywords: Serum Albumin, Prognostic Marker, Critically Ill.

Introduction

Albumin's the most plentiful protein in human plasma. Extensive studies have been conducted on this subject. The amino acid sequences of albumins, the entire gene sequence for humans and the locations of mutations are currently known. This helps maintain the colloid oncologic pressure, acts as a carrier protein and participates in other functions such as metabolism, antioxidant function.[1]

Patients who are admitted to Intensive Care Unit MICU are at an increased risk of mortality due to the severity of their illness. Therefore, identifying patients at time of admission who are unlikely to achieve a good outcome so that they can be effectively managed is essential.[2]

As an index of patients' nutritional and metabolic status, it has been employed by

a number of investigators. The reduction of serum albumin concentrations in critically ill patients with Septic shock and after severe surgery or other diseases has been shown to be rapid.[3]

An analysis of a range of studies reviewed showed that the risk of death for each 2.5 g L per litre reduction in SA concentration was increased from 24% to 56%. Higher mean concentrations of SA were found in patients who spent five days or more in the Intensive Care Unit and survived compared to nonsurvivors.[4]

In addition, it was observed that patients who were not survivors had a decrease in the concentration of SA on admission into an intensive care unit during the first 24 to 48 hours and their concentrations decreased more rapidly thereafter.[5]

Aim: To estimate serum albumin concentrations in critically ill patients after they have been admitted to Intensive Care Unit and assess the role of continuous SA measurement as an independent diagnostic indicator.

Materials and Methods

A cross-sectional observational study on 100 critically ill Patients admitted to ICU for at least 5 days or more at tertiary care hospital, Ajmer from September 2021 to September 2022. Patient with chronic liver or kidney disease, nephritic syndrome, protein-losing enteropathy and chronic malnutrition were excluded from study.

After taking informed consent patient or a relative in case of an unconscious patient, clinical and demographic profiles were recorded. Careful and detailed records have been kept and a thorough clinical examination has been carried out. All the points mentioned in the explanatory note have been recorded. A total of blood counts, renal functions, liver function and serum albumin9) SA were also recorded at the time of admission. Chest X-ray and arterial blood gas analysis were obtained. For all patients, days on ventilators, days in the Intensive Care Unit, and days in the hospital were recorded.

Patients have been followed until they are admitted to the hospital. If the patients were not receiving ventilatory support for 5 days or more, they should have been eligible to take part in this study. Serum albumin estimate has been carried out on day 1, 3, and 5 of their hospital stay in patients who participated in the study. Data collection and analysis did not include patients who had been released or discharged without medical advice after a maximum of five days in the hospital.

The estimation of serum albumin was was done by automated bromocresol green (BCG) specific dye-binding method. Outcome was noted as survivor (discharge) or non-survivor (death).

Statistical analysis

Data thus collected was entered in Microsoft excel 2007 and analysis was done by Epi info software of CDC using t test and chi square test, considering p value <0.05 as statistically significant.

Results

The mean age of survivors was 47.8 ± 21.7 years (19 – 85 years) and of non-survivors was 62.3 ± 13.0 years (28– 86 years)(p = 0.011).

Majority 60% were males, amongst survivors 61.3% were males and in non-survivors 57.9 %.

Out of the 100 cases in a study group, the largest number of patients were with neurological disorders 32%, included stroke 20%, Guillain Barre syndrome 4%, Tubercular meningitis 4%, Normal pressure hydrocephalus 2%, and myasthenia gravis 2%. Respiratory disorders were 18% with 12% of COPD and 6 cases 6% of community-acquired pneumonia. 14% were Organophosphorous compound poisoning. Infective causes were 12% including cerebral malaria 6% and septic shock 6%.

8% cases were diabetic nephropathy. Metabolic causes 4% cases including hyponatremic metabolic encephalopathy 2% and hypoglycemic seizures 2% cases. Left ventricular failure 4 cases (4%), snake bite 2 cases (2%), esophageal carcinoma 2 cases (2%), and other poisons 4(4%) comprised the rest of the cases.

In our study, 62% of patients had to be put on mechanical ventilation secondary to acute respiratory failure with acute respiratory distress syndrome. In this group, the largest number comprised of patients with aspiration pneumonia 22 cases (22%) and sepsis 20 cases (20%) along with four cases (8%) of pulmonary edema, three cases (6%) of community-acquired pneumonia, two cases(4%) of congestive cardiac failure and one case (2%) of trauma. 20% of patients had to be put on mechanical ventilation secondary to Acute Respiratory Failure with coma, 12% secondary to Acute Respiratory Failure with Chronic pulmonary disease and 6% secondary to Acute Respiratory Failure with neuromuscular disease.

Table 1: Outcome

Outcome	Number	Percentage
Survivors	62	62%
Non Survivors	38	38%

Out of 100 patient 62% patients were discharged (survivors) and 38% died (non-survivors).

Table 2: etiological diagnosis of nonsurvivors and serum albumin levels

Etiological diagnosis	Sr. Albuminon Day one	Sr. albumin onDay 5	The difference in serum albumin
Stroke	3.2	1.9	1.3
Stroke	3.1	1.3	1.8
Stroke	3.5	1.9	1.6
Stroke	3.1	2.3	0.8
Stroke	3	2.2	0.8
COPD	3.2	2.1	1.1
COPD	3.3	2.4	0.9
COPD	3.2	2.1	1.1
COPD	3.3	2.3	1
Septicemic shock	3	1.7	1.3
Septicemic shock	3	1.3	1.7
Diabetic Nephropathy	3.1	2.1	1
Carcinoma esophagus	3.2	1.6	1.6
Left ventricularfailure	3	2.6	0.4
Traumatic chestinjury	2.7	2.1	0.6
Diabetic nephropathy	3.1	2	1.1
Community-acquired pneumonia	2.9	2	0.9
Organophosphorus compound poisoning	3.5	2.7	0.8
Tubercular meningitis	3	2.1	0.9

The results show that the non-survivor group comprised 10 cases(26.3%) of stroke, 8 cases (21.1%) of COPD, 4 cases (10.5%) each of septicemic shock and diabetic nephropathy, and 2 cases (5.2%)

each of tubercular meningitis, organophosphorus poisoning, community-acquired pneumonia, traumatic chest injury, left ventricular failure, and carcinoma esophagus. The mean difference between serum albumin at the time of admission and 5 days later is 1.09 g/dl. In this group the decline in serum albumin is very steep, giving a bad prognosis.

Table 3: Comparison of serum albumin levels

Day One		
S. Albumin InG/Dl	**Survivors (N=62)**	**Non-Survivors(N=38)**
< 3.5	34	34
≥ 3.5	28	4
Day Three		
< 3.5	46	38
≥ 3.5	16	0
Day Five		
< 3.5	52	38
≥ 3.5	10	0

At admission, mean S. albumin was 3.43 ±0.41 g/dl in Survivor whereas 3.12 ±0.19 g/dl in non-survivors (p=0.003). On subsequent follow up 3.04 ±0.51 and 2.75 ±0.22 respectively (p=0.027) on third and 2.76 ±0.50 and 2.31 ±0.32 respectively (p=0.001) on fifth day were observed.

Table 4: Comparative levels of mean serum albumin

Day	**Mean S albumin (g/dl)**	
	Survivors	**Non-survivors**
Day 1	3.3	3.18
Day 3	3.09	2.66
Day 5	3.1	2.45

The total decline in serum albumin in the survivors from admission to day 5 is 0.86 g/dl. For a five day period, it is 1.09 gdl in nonsurvivors.

it was found that 52 patients were correctly identified as survivors but 10 patients who were predicted to die, actually survived. The results indicate that in almost 84% of patients, this equation is capable of accurately predicting survival. Similarly, 30 patients were correctly identified as non-survivors but 8 patients who were predicted to survive, actually died. It suggests that in almost 80% of cases, this equation accurately predicts the patient's death.

Table 6: Accuracy of prediction of outcome

	Sensitivity	**Specificity**	**Accuracy**	**NPV**	**PPV**
S albumin	83.87%	78.95%	82%	86.67%	75%

Using the logistic regression equation derived from our study, it was found that it correctly identified 83.87 % (Sensitivity) patients to survive and 78.95 % (Specificity) patients to die. Overall, it was 82% accurate in the prediction of the outcome of the patient. It was also found that the probability that this equation will predict the outcome of survivors correctly is 86.67 % (NPV). Also, the probability that this equation will correctly predict the outcome of non-survivors correctly is slightly lower at 75 % (PPV).

Table 7: ICU and hospital stay.

	Survivors (N=62)	Non-Survivors (N=38)
No. of Days of ICU Stay		
5 – 7	4 (6.4%)	0 (0%)
8 – 10	26 (41.9%)	4 (10.5%)
11 – 13	18 (29.0%)	18 (47.3%)
> 13	14 (22.5%)	16 (42.1%)
No. of Days of Hospital Stay		
5-10	6 (9.6%)	4 (10.5%)
11 – 15	30 (48.3%)	30 (78.9%)
16 – 20	14 (22.5%)	2 (5.2%)
>20	12 (19.3%)	2 (5.2%)

ICU stay was higher in non survivors (15.4 ± 2.9) than survivors (p = 0.0127).

Hospital stay was 16.3 ± 4.5 in survivors whereas 14.9 ±3.6 for non-survivors (p = 0.0275).

Discussion

In our study, the mean age was 47.8 ± 21.7 in survivor group whereas 62.3 ± 13.0.in non-survivors (p = 0.032). similar age groups were seen by many study. Amongst survivors (62), 38 (61.3%) were males whereas in non-survivors (38), 22 (57.9 %) were males. Similar male preponderance was seen by other studies[5,6]

Our study suggests that the largest number of patients requiring mechanical ventilation had the neurological disease as the etiology. In that also, stroke was the most common cause requiring mechanical ventilation. One study reports sepsis (24%), COPD (22%), and severe pneumonia (20%) as the common causes among others. The smaller sample sizes observed in both trials are the reason for this difference.

In our study, 62% of patients had to be put on mechanical ventilation secondary to acute respiratory distress syndrome, 20% secondary to coma, 12% secondary to acute respiratory failure on Chronic pulmonary disease, and 6% secondary to neuromuscular disease. The largest number of patients had to be put on mechanical ventilation secondary to aspiration pneumonia (22%). The next leading cause was sepsis with 20% of patients. Similarly reported by Esteban A et al.[5]

Out of 100 patient 62% patients were discharged (survivors) and 38% died (non-survivors). Also Khilnani GC et al.2 reported 69% survivors.

At admission, mean S. albumin was 3.43 ±0.41 g/dl in Survivor whereas 3.12 ±0.19 g/dl in non-survivors (p=0.003). On subsequent follow up 3.04 ±0.51 and 2.75 ±0.22 respectively (p=0.027) on third and 2.76 ±0.50 and 2.31 ±0.32 respectively (p=0.001) on fifth day were observed.

Similarly Yap FM et al.[8] found similar S. albumin on admission. Also Banga A et al.[7] found higher level in survivors than non-survivors (p < 0.05).[7]

In our study, total decline in serum albumin in the survivors from admission to day 5 is 0.86 g/dl. For a five day period, it is 1.09 gdl in nonsurvivors. The results show that serum albumin levels are decreasing steadily in both groups. However, the decline among survivors is less steep than that of those who are not survivors. This suggests that the prognosis of the patient in terms of mortality is influenced by the rapid decrease in serum albumin levels. A poor prognosis may be seen with a steep decline in serum albumin.

ICU stay was higher in non survivors (15.4 ± 2.9) than survivors (p = 0.0127). Similarly reported by Esteban A et al.[6]

Hospital stay was 16.3 ± 4.5 in survivors whereas 14.9 ±3.6 for non-survivors (p = 0.0275). Also Banga A et al reported similar hospital stay.

Conclusion

One major factor influencing the outcome of severely ill patients dependent on mechanical ventilation is likely to be a serial estimation of serum albumin levels.

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