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## Assessment of sequential serum albumin levels as a prognostic indicator in critically ill patients admitted to the medical ICU: A cross-sectional study at a tertiary care hospital

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### Abstract

**Background:** Albumin is the most prevalent plasma protein in humans. It plays a crucial role in maintaining colloid osmotic pressure, functions as a carrier protein, and is involved in metabolic and antioxidant processes.

**Aim:** To assess the significance of serial serum albumin levels as a prognostic indicator in critically ill patients who have been on mechanical ventilation for five days or longer.

**Materials and Methods:** This study was conducted at Mandya Institute of Medical Sciences, Mandya, over a period of one year, involving 100 patients admitted to the Medical ICU who required ventilatory support for a minimum of five days. Serum albumin levels were measured at the initiation of mechanical ventilation and subsequently on days 3, 5, and 10 of their stay.

**Results:** Of the 100 patients, 64% survived, while 36% died during their hospital stay. Among the survivors, serum albumin levels decreased by 0.72 g/dl from admission to day 10. In contrast, the non-survivors experienced a sharper decline in albumin, with a reduction of 1.25 g/dl over the same period. The fall in albumin levels was more pronounced in non-survivors compared to survivors.

**Conclusion:** Patients with normal serum albumin levels at the time of admission are more likely to survive and typically spend fewer days on mechanical ventilation compared to those with low albumin levels. A rapid decline in serum albumin is associated with a poor prognosis.

**Keywords:** Serum albumin, critically ill, mechanical ventilator, prognosis of critically ill

### Introduction

The most prevalent plasma protein in humans is albumin. In addition to serving as a carrier protein and aiding in the maintenance of colloid osmotic pressure, it also has metabolic, antioxidant, and other roles. The severity of the patient's disease increases the chance of death when the patient is admitted to the Intensive Care Unit (ICU). In order to treat these patients aggressively, it is crucial to identify those at the time of admission who are likely to have a poor result. It seems that serum albumin is one such predictive marker. Its usefulness as a prognostic marker has been investigated in a number of settings, including individuals who are very sick. A low serum albumin (SA) concentration is associated with longer ICU stays, which in turn raises the risk of death and even earlier and more frequent readmissions to the hospital. Patients who require mechanical breathing may be able to be weaned with the use of a daily trend in serum albumin. Numerous researchers have utilized it as a gauge for the patients' nutritional and metabolic health. It has been demonstrated that hypoalbuminemia is a strong independent predictor of unfavorable outcome. Serum albumin concentration drops of 10 g/litre led to a significant increase in death (by 37%), morbidity (89%), extended ICU stays (28%), hospital stays (71%), and resource consumption (66%)<sup>[1]</sup>. Given the aforementioned information, the goal of this study is to ascertain the initial changes in blood albumin concentrations that accompany ICU admission and assess the value of serial serum albumin measurement as a stand-alone prognostic predictor.

### Materials and Methods

The current study involved patients admitted to the medical ICU who required ventilatory support for five days or more, and it was conducted at a tertiary health center over a one-year

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period. The study comprised one hundred patients in all. The chosen patient's relative was consulted to obtain their informed consent, during which the purpose of the study was explained. Patients with intubations and mechanical ventilation of all etiologies were included in the study. The treating physician decided if mechanical ventilation was necessary.

**Inclusion Criteria**

All patients admitted in MICU who needed ventilatory support for at least 5 days or more.

**Exclusion Criteria**

1. Any patient on ventilatory support who dies within 5 days of admission to medical ICU.
2. Any patient who is weaned from ventilatory support within 5 days of being put on ventilatory support.

Clinical and demographic data, such as age, sex, smoking status, history of prior hospitalizations, and co-occurring chronic conditions such diabetes mellitus, hypertension, and chronic obstructive pulmonary disease, were documented at the time of admission to the medical intensive care unit. A comprehensive clinical examination was performed along with a meticulous and comprehensive history recording. Every point listed on the proforma was noted and documented. Serum albumin (SA), liver, kidney, and total blood counts that were performed at the time of admission were also noted. An arterial blood gas analysis and a chest X-ray were acquired. Every patient had their days on a ventilator, days in the intensive care unit, and days in the hospital noted. Serum albumin estimation was performed on the day of admission for research participants who were placed on a mechanical ventilator, as well as on days three, five, and ten of their hospital stay. An automated dye binding technique specific to bromocresol purple (BCP) was used to measure serum albumin. Mann-Whitney's "u" test and the unpaired "t" test for students were used for analysis.

**Results**

One hundred severely sick patients who needed mechanical breathing for at least five days participated in the current study. The study population's mean age was 45.3 years ( $\pm$  22.0 years). The age range of the survivors was 18 to 80 years old, with a mean of 39.2 years ( $\pm$  22.7 years). The age range of non-survivors was 21 to 81 years, with a mean of 58.3 years ( $\pm$  14.0 years). The two groups' differences were statistically significant ( $p = 0.00139$ ), suggesting that non-survivors were admitted at a older age. There were 31% women and 69% men in the study population.

**Table 1:** Distribution according to demographic profile among patients

Demographic profile	Survivors (n=64)	Non-survivors (n=36)
Age (Mean $\pm$ SD) years	39.2 $\pm$ 22.7 years	58.3 $\pm$ 14.0 years
Male	44	25
Female	20	11

Of the sixty-four survivors, forty four (68.75%) were men and twenty (31.25%) were women. Of the 36 non-survivors, 11 (30.56%) were female and 25 (69.44%) were male. Of the 100 admitted patients that were part of the study, 64 (64%) were released from the hospital after being classified as survivors, and 36 (36%) passed away there (non

survivors). On the first day, the average serum albumin level was 3.6 g/dl ( $\pm$ 0.5 g/dl). It was 3.26 g/dl ( $\pm$ 0.29 g/dl) in non-survivors and 3.8 g/dl ( $\pm$ 0.46 g/dl) in survivors. The difference was significant ( $p=0.006$ ) in non-survivors, indicating hypoalbuminemia at admission is associated with a worse prognosis in terms of higher mortality. On day three, the average serum albumin level was 2.7 g/dl ( $\pm$ 0.5 g/dl). It was 2.55 g/dl ( $\pm$ 0.42 g/dl) in non-survivors and 3.16 g/dl ( $\pm$ 0.71 g/dl) in survivors, with the latter group having a substantially lower value ( $p=0.037$ ). In addition, on day three, all non-survivors show hypoalbuminemia, but 64.2% of survivors do not. According to this, hypoalbuminemia is indicative of a bad prognosis. Nonetheless, other variables also impact the patient's prognosis, since people who had hypoalbuminemia at arrival managed to live.

**Table 2:** Serum albumin levels in two groups

DAY 1			
S.albumin in g/d	Survivors(n=64)	Non-survivors (n=36)	Total (n=100)
<3.5	34	34	68
>3.5	30	2	32
DAY 3			
S.albumin in g/d	Survivors(n=64)	Non-survivors (n=36)	Total (n=100)
<3.5	46	36	82
>3.5	18	0	18
DAY 5			
S.albumin in g/d	Survivors(n=64)	Non-survivors (n=36)	Total (n=100)
<3.5	52	36	88
>3.5	12	0	12
DAY 10			
S.albumin in g/d	Survivors(n=64)	Non-survivors (n=36)	Total (n=100)
<3.5	58	36	94
>3.5	6	0	6

From the time of admission to day 10, the survivors' serum albumin levels decreased by 0.72 g/dl overall. Over the course of ten days, it is 1.25 g/dl in non-survivors. The findings demonstrate that serum albumin levels in both groups are steadily declining. The decline in non-survivors, however, is steeper than in survivors. It implies that the patient's mortality outlook is influenced by the rate at which the blood albumin level drops. Serum albumin levels that drop sharply are indicative of a bad prognosis. Our research shows that the patient's serum albumin level on day three is the best indicator of their prognosis. The study group experienced mechanical ventilation for an average of 7.5 days ( $\pm$  3.8 days). In survivors, the average length of mechanical ventilation was 7.1 days ( $\pm$  2.2 days), whereas in non-survivors, it was 8.8 days ( $\pm$  2.4 days). In non-survivors, the length of mechanical breathing was substantially longer ( $p=0.037$ ).

**Table 3:** Table showing the need of mechanical ventilator support (in days) in two groups

No. of days	Survivors (n=64)	Non-survivors (n=36)	Total (n=100)
5 – 7	28	12	40
8 – 10	24	8	32
11 – 13	10	12	22
> 13	2	4	6

For the study group, the average length of stay in the intensive care unit was 11.7 days ( $\pm$  4.6 days). In non-survivors, the average length of stay in the intensive care unit was considerably higher ( $p=0.0317$ ). For the study group, the average number of days spent in the hospital was 13.2 days ( $\pm$  6.2 days). Survivors' hospital stays were

noticeably longer ( $p=0.0337$ ).

### Discussion

One hundred critically sick patients who needed mechanical breathing for five days or more were included in the current study. Serum albumin concentrations were monitored on a serial basis as a prognostic indicator to forecast whether the patient would die in the hospital or be released. The length of hospital stays, ICU stays, and mechanical ventilation durations between survivors and non-survivors were also compared in our study.

### Age

The patients in our study had an average age of 45.3 years ( $\pm 22.0$  years). The average age of individuals who did not survive was 58.3 years ( $\pm 14.0$  years), whereas survivors were 39.2 years ( $\pm 22.7$  years). The age of admission for non-survivors was higher, with a significant difference ( $p=0.00139$ ) between them. The average age of patients placed on a mechanical ventilator was found to be 56.2 years ( $\pm 15.3$  years) in one study [2]. According to a different study, the age of non-survivors is 59 years ( $\pm 4.8$  years), which is considerably older ( $P<0.05$ ) than the age of survivors, which is 47 years. (5.1 years,  $\pm$ ). This is comparable to the subjects of our study [3].

### Gender

Our study included 69 males (78%) and 31 females (22%). Of the sixty-four survivors, forty four (68.75%) were men and twenty (31.25%) were women. Of the 36 non-survivors, 11 (30.56%) were female and 25 (69.44%) were male. According to the survey, men are more likely than women to experience a serious disease. This was determined to be 38.7% female and 59.3% male in one study [2]. According to another survey, there are 46% females and 54% males. This is similar to the people in our study [3].

### Division of Patients Based on Outcome at the End of Study

There were one hundred patients in our study. After being declared survivors, 64 (64%) people were discharged from the hospital, while 36 (36%) people died (non survivors). According to a comparable study, 28% were nonsurvivors and 72% were survivors. 55% of survivors and 45% of non-survivors were recorded in another study [4,5]. This is similar to our study.

### Serum Albumin Concentrations as a Prognostic Factor

The average blood albumin level on the first day of our trial was 3.6 g/dl ( $\pm 0.5$  g/dl). In non-survivors, it was 3.26 g/dl ( $\pm 0.29$  g/dl), while in survivors, it was 3.8 g/dl ( $\pm 0.46$  g/dl). When it came to non-survivors, the difference was substantial ( $p=0.006$ ). When compared to the non-survivor group, only 12% of patients had normal serum albumin levels upon admission; this suggests that hypoalbuminemia at admission is associated with a worse prognosis, namely higher mortality. It is possible that a low blood albumin level at admission portends a bad prognosis because more non-survivors than survivors were hypoalbuminemic at admission. According to one study, albumin levels were higher in survivors (2.67 g/dl vs. 2.20 g/dl,  $p<0.05$ ) at admission [3]. Our study's mean blood albumin levels on day one are similar to one study's, which reported 3.1 g/dl ( $\pm 0.7$  g/dl) [6]. The average serum albumin level on day three was

2.7 g/dl ( $\pm 0.5$  g/dl). The values were 2.55 g/dl ( $\pm 0.42$  g/dl) for the non-survivors and 3.16 g/dl ( $\pm 0.71$  g/dl) for the survivors, with a significant difference ( $p=0.037$ ) between the two groups. On day three, all non-survivors exhibited hypoalbuminemia, which suggests that their prognosis is worse than that of survivors, of whom 36% also had hypoalbuminemia. Day three levels are similar to our research, according to one study [6], which finds 2.9 g/dl ( $\pm 0.6$  g/dl). On the fifth day, the average serum albumin levels in non-survivors (2.42 g/dl  $\pm 0.32$  g/dl) were notably lower ( $p=0.001$ ) than in survivors (2.87 g/dl  $\pm 0.50$  g/dl). Within the study group, the mean was 2.7 g/dl ( $\pm 0.7$  g/dl). Compared to survivors, who now had 72% of patients hypoalbuminemic, all nonsurvivors remained hypoalbuminemic. On Day 10, the study group's mean blood albumin level was 2.2 g/dl ( $\pm 0.6$  g/dl). It was 2.09 g/dl ( $\pm 0.47$  g/dl) in non-survivors and 2.67 g/dl ( $\pm 0.71$  g/dl) in survivors. In non-survivors, it was considerably lower ( $p=0.004$ ). Ninety-two percent of the survivors and all of the non-survivors were now hypoalbuminemic, indicating a sharp drop in serum albumin levels in both groups. According to our research, there was a statistically significant difference in the serum albumin concentrations between survivors and non-survivors on Day 3, Day 5, and Day 10. Following hospitalization, the serum albumin levels decreased in both groups. For survivors, the greatest drop in serum albumin occurred between Days One and Three, and for non-survivors, between Days Three and Five. But according to a research, both groups saw their biggest drops in the first 24 hours [4]. This may be explained by the fact that, following ICU admission, both the survivors and the non-survivors in the study underwent extremely vigorous fluid resuscitation; as a result, both groups saw a significant decrease in albumin concentration over the first 24 hours. Additionally, our research demonstrates that non-survivors' serum albumin levels dropped more quickly. Overall, the survivors' serum albumin levels dropped by 0.72 g/dl from the time of admission to day 10. In those who do not survive, it is 1.25 g/dl during a ten-day period. This is comparable to a study that found non-survivors had a more rapid decline in serum albumin levels [4]. According to this, people who experience a sharp drop in their serum albumin level are likely to die sooner rather than later. Our research shows that the patient's serum albumin level on day three is the best indicator of their prognosis. The patient's outcome and serum albumin level on the first day had no correlation. Day five albumin levels are the best indicator of death, according to one study [6]. The method of data processing and the application of several statistical tests to forecast the result are the reasons for this disparity.

### Duration of Mechanical Ventilation

The average duration of mechanical ventilation for the study group was 7.5 days ( $\pm 3.8$  days). The mean duration of mechanical breathing was 7.1 days ( $\pm 2.2$  days) for survivors and 8.8 days ( $\pm 2.4$  days) for non-survivors. The duration of mechanical breathing was significantly longer in non-survivors ( $p=0.037$ ). According to one study, the total time needed to initiate mechanical ventilation was 5.8 days ( $\pm 7.2$  days) [2]. This time is reported to be  $11.5 \pm 1.0$  days by another study [7]. This difference is shown because the patients in this study had mean blood albumin concentrations that were lower in the beginning, which suggests that they were on mechanical ventilation for a

longer period of time. This study also shows that the amount of time a patient spent on mechanical breathing was not predicted by the albumin content at the time of ICU admission. Nonetheless, there is prognostic relevance to the profile of change in serum concentrations. Serum albumin levels in nonsurvivors were shown to be continuously declining in this investigation.

The study group spent an average of 11.7 days ( $\pm$  4.6 days) in the intensive care unit. The average duration of stay in the intensive care unit was significantly longer in non-survivors ( $p=0.0317$ ). According to one study, patients on mechanical ventilation spent 12.2 days ( $\pm$  13.6 days) in the intensive care unit [2]. This discrepancy is probably due to a bigger sample size—there were 5183 participants in the research compared to just 100 patients in our study. Another study shows that for every 10g/L drop in serum albumin, there is a significant 28% increase in the likelihood of a prolonged ICU admission. Since non-survivors in our study cohort always have lower serum albumin levels than survivors, this helps to explain why they spend more time in the intensive care unit.

### Length of Hospital Stay

Patients in our study group stayed in the hospital for an average of 13.2 days ( $\pm$  6.2 days). In the hospital, survivors stayed for 15.3 days ( $\pm$  4.6 days), while non-survivors stayed for 13.9 days ( $\pm$  3.9 days). Among survivors, the average length of hospital stay was substantially longer ( $p=0.0337$ ). According to a cohort research, the likelihood of a prolonged hospital stay increases significantly by 71% when hypoalbuminemia is present [1]. Nonetheless, a bigger sample size of 2,91,453 patients and the study's liberal inclusion criteria have significantly altered the findings. According to one study, patients on mechanical ventilation stay in the hospital for an average of 21.5 days ( $\pm$  23.7 days) [2]. The greater sample size of 5183 patients included in the study accounts for this discrepancy.

### Conclusion

Every patient who is seriously ill has their serum albumin regularly measured. This test is inexpensive, widely accessible, and performed in all laboratories. Its significance as a prognostic indicator has long been recognized. Serum albumin serial estimate gives the treating physician information about the patient's prognosis so that proactive management is possible. This study demonstrates that we may forecast a patient's fate by serially estimating serum albumin levels. In order to enhance their prognosis, we can simultaneously identify patients who are at a high risk of passing away and treat them more aggressively.

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