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Original Research Article

Estimation of Serial Serum Albumin Levels as Prognostic Marker in Critically Ill Patients Admitted in Medical ICU - A Cross-Sectional Study

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ABSTRACT

Introduction: To evaluate the role of serial serum albumin concentration as a prognostic marker in critically ill patients who are on mechanical ventilator for 5 days or more.
Methods: This study was carried out at a tertiary health centre over a period of 1 year amongst the 50 patients admitted in MICU who needed ventilatory support for at least 5 days or more. Serum albumin estimation was done on day when they were put on mechanical ventilator and on day 3, day 5 and day 10 of their hospital stay. Analysis was done using student's unpaired 't' test and Mann-Whitney's 'u' test .
Results: 31 (62%) patients were discharged from the hospital (survivors) and 19 (38%) died in the hospital (non-survivors). The total decline in serum albumin in the survivors from admission to day 10 was 0.86 g/dl. In non-survivors, it was 1.09 g/dl over a period of 10 days fall in albumin levels in non-survivors was steeper than survivors. Our study indicates that the strongest predictor of outcome of the patient is serum albumin on day three.
Conclusions: Patients who have normal serum albumin level at admission are more likely to survive than those with low serum albumin level at admission, including lesser days on ventilator. A steep decline in serum albumin indicates a poor prognosis. From the above study, serum albumin level on day 3 appears to be one of the major factors determining the outcome of critically ill patients requiring mechanical ventilation.

Keywords: Serum Albumin, Critically Ill, Mechanical Ventilator, Prognosis of Critically Ill

Key message: By monitoring the serum albumin levels in above stated manner, we can predict the outcome of the patient & we can identify patients who are at high risk and manage them more aggressively to improve their outcome.

INTRODUCTION

Albumin is the most abundant plasma proteins in humans. It helps to maintain the colloid osmotic pressure, acts as a carrier protein, and is involved in metabolic, antioxidant and various other functions. Patients who are admitted in Intensive Care Unit (I.C.U.) are at an increased risk of mortality due to the severity of their illness. It is thus, important to identify the patients at the time of admission who are likely to have a poor outcome, so that such patients can be managed aggressively.

Serum Albumin appears to be one such prognostic indicator. Its utility as a prognostic indicator has been studied in various contexts including critically ill patients. A low serum albumin (SA) concentration correlates with increase in

length of stay in ICU increases the risk of death and even readmission to hospital sooner and more frequently. The daily trend of serum albumin can be useful tool in predicting the weaning capability of patients needing mechanical ventilation. It has been used by many investigators as an index of the nutritional and metabolic status of the patients. Hypoalbuminemia is also shown to be a potent independent predictor of poor outcome. Each 10gm/litre decrease in serum albumin concentration significantly increased the mortality by 137%, morbidity by 89%, prolonged ICU stay by 28%, hospital stay by 71% and increased resource utilization by 66%. [1]

In view of the above facts, this study intends to determine the acute changes in the serum albumin concentrations that occur following admission to the ICU and evaluate the role of serial serum albumin measurement as an independent prognostic indicator.

MATERIALS AND METHODS

The present study was carried out at tertiary health centre over a period of one year amongst the patients admitted in medical ICU who needed ventilatory support for at least 5 days or more. A total of 50 patients were included in the study.

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.

The selected patient's informed consent was taken from the relative of the patient explaining the nature of the study. The study included patients with all etiologies who were intubated and were put on mechanical ventilation. The decision for mechanical ventilation was taken by the treating physician.

Clinical and demographic profile at the time of admission to medical ICU including age, sex, smoking status, history of previous hospital admissions, associated chronic illnesses like hypertension, diabetes mellitus, chronic obstructive pulmonary disease were recorded. A careful and detailed history was recorded and thorough clinical examination was conducted. All the points mentioned in the proforma were recorded. Additional information, if any, was recorded. Total blood counts, renal functions, liver functions and serum albumin (SA) done at the time of admission were also recorded. Chest X-ray and arterial blood gas analysis were obtained. Days on ventilator, days of ICU stay and days of hospital stay were recorded for all the patients.

For patients who were included in the study, serum albumin estimation was done on the day of admission when they were put on mechanical ventilator and subsequently on day three, day five and day ten of their hospital stay.

Serum albumin was assayed using an automated bromocresol purple (BCP) specific dye binding method. Analysis was done using student's unpaired 't' test and Mann-Whitney's 'u' test .

RESULTS

The present study was conducted on 50 patients who were critically ill and required mechanical ventilation for 5 days or more.

The mean age of study population was 53.3 years (± 20.0 years). The mean age in survivors was 47.8 years (± 21.7 years) with range of 18 - 80 years. The mean age in non-survivors was 62.3 years (± 13.0 years) with range of 21 - 81 years. There was a significant difference ($p = 0.011$) between the two groups indicating a higher age at admission for non survivors. Study population had 74% males and 26% females. Amongst survivors (31), 22

(71.0%) were males and 9 (29.0 %) were females. In non-survivors (19), 15 (78.9 %) were males and 4 (21.1 %) were females. Of the admitted 50 patients included in study, 31 (62%) patients were discharged from the hospital (survivors) and 19 (38%) died in the hospital (non survivors).

The mean level of serum albumin on day one was 3.3 g/dl (±0.4 g/dl) (Table 1). In survivors, it was 3.43 g/dl (±0.41 g/dl) and in non-survivors, it was 3.12 g/dl (±0.19 g/dl) which was significantly lower (p=0.003) in non-survivors suggesting hypoalbuminemia at admission indicates a poorer prognosis in terms of increased mortality. The mean level of serum albumin on day three was 2.9 g/dl (±0.4 g/dl) (Table 1). In survivors, it was 3.04 g/dl (±0.51 g/dl) and in non-survivors, it was 2.75 g/dl (±0.22 g/dl) which was significantly lower (p=0.027) in non-survivors. Also, all non-survivors have hypoalbuminemia on day three as compared to 74.2% of survivors. This suggests hypoalbuminemia at admission indicates a poor prognosis. However, there are other factors affecting patient's outcome as patients with hypoalbuminemia at admission also survived.

Table 1: Serum albumin levels in two groups

DAY 1			
S.albumin in g/dl	**Survivors(n=31)**	**Non-survivors (n=19)**	**Total (n=50)**
< 3.5	17 (54.8 %)	17 (89.5 %)	34 (68 %)
≥ 3.5	14 (45.2%)	2 (10.5 %)	16 (32 %)
DAY 2			
S.albumin in g/dl	**Survivors(n=31)**	**Non-survivors (n=19)**	**Total (n=50)**
< 3.5	23 (74.2%)	19 (100%)	42 (84 %)
≥ 3.5	8 (25.8%)	0 (0 %)	8 (16 %)
DAY 5			
S.albumin in g/dl	**Survivors(n=31)**	**Non-survivors (n=19)**	**Total (n=50)**
< 3.5	26 (83.9%)	19 (100%)	45 (90 %)
≥ 3.5	5 (16.1%)	0 (0 %)	5 (10 %)
DAY 10			
S.albumin in g/dl	**Survivors(n=31)**	**Non-survivors (n=19)**	**Total (n=50)**
< 3.5	29 (93.6%)	19 (100%)	48 (96 %)
≥ 3.5	2 (6.4%)	0 (0 %)	2 (4 %)

The total decline in serum albumin in the survivors from admission to day 10 in survivors is 0.86 g/dl. In non-survivors it is 1.09 g/dl over a period of 10 days (Chart 1).

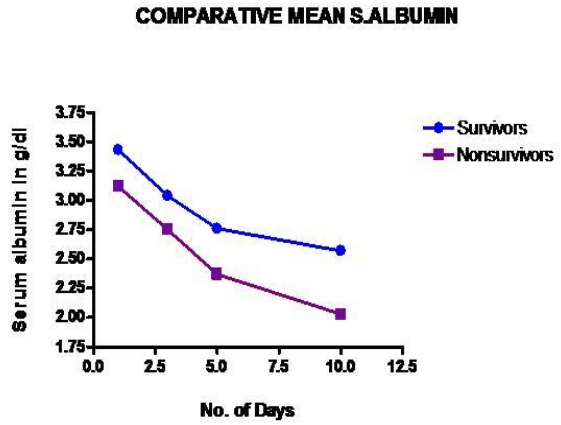

Chart 1: Chart showing the comparative mean serum albumin levels between the survivors and non-survivors

The results show that there is a steady fall in serum albumin in both groups. However the fall in non-survivors is more steep than survivors. It suggests that the rapidity with which serum albumin level falls has an effect on the prognosis of the patient in terms of mortality. A steep decline in serum albumin indicates a poor prognosis. Our study indicates that the strongest predictor of outcome of the patient is serum albumin on day three. Outcome of the patient is poorly correlated with serum albumin level on day one. In the study group, the mean duration of mechanical ventilation was 8.8 days (± 2.8 days) (Table 2).

Table 2: Table showing the need of mechanical ventilator support (in days) in two groups

No. of days	Survivors (n=31)	Non-survivors (n=19)	Total (n=50)
5 – 7	14 (45.1%)	6 (31.5%)	20 (40%)
8 – 10	11 (35.4%)	4 (21.0%)	15 (30%)
11 – 13	5 (16.1%)	7 (36.8%)	12 (24%)
> 13	1 (3.2%)	2 (10.5%)	3 (6%)

The average number of days survivors were on mechanical ventilation was 8.2 days (± 2.6 days) and in non-survivors, this duration was 9.7 days (± 2.9days). The duration of mechanical ventilation was significantly more (p=0.049) in non-survivors.

The average number of days of ICU stay was 12.6 days (± 3.5 days) for the study group (Table 3). The average duration for which patient were in ICU was significantly higher (p=0.0317) in non-survivors.

Table 3: Table showing the number of days of ICU-stay in two groups

No. of days	Survivors (n=31)	Non-survivors (n=19)	Total (n=50)
5 – 7	2 (6.4%)	0 (0%)	2 (4%)
8 – 10	13 (41.9%)	2 (10.5%)	15 (30%)
11 – 13	9 (29.0%)	9 (47.3%)	18 (36%)
> 13	7 (22.5%)	8 (42.1%)	15 (30%)

The average number of days spent in hospital was 15.8 days (± 4.2 days) for the study group (Table 4). The average duration of hospital stay was significantly longer (p=0.0136) in survivors.

Table 4: Table showing the number of days of hospital-stay in two groups

No. of days	Survivors (n=31)	Non-survivors (n=19)	Total (n=50)
5 -10	3 (9.6%)	2 (10.5%)	5 (10%)
11 – 15	15 (48.3%)	15 (78.9%)	30 (60%)
16 – 20	7 (22.5%)	1 (5.2%)	8 (16%)
>20	6 (19.3%)	1 (5.2%)	7 (14%)

DISCUSSION

The present study was conducted on 50 patients who were critically ill and required mechanical ventilation for five days or more. Serial serum albumin concentrations were measured as a prognostic marker to predict their outcome as either death in the hospital or discharge from the hospital. Our study also compared the duration of mechanical ventilation, the length of ICU stay and length of hospital stay between survivors and non survivors.

Age

In our study, the mean age of the patients was 53.34 years (± 20.04 years). The mean age of survivors was 47.8 years (± 21.7 years) and that of non-survivors was 62.3 years (± 13.0 years). There was a significant difference (p=0.011) between the 2 groups indicating a higher age at admission for non-survivors. One study reported the mean age of patients to be put on mechanical ventilator to be 59.2 years (± 17.3 years). [2] Another study reports the age of non-survivors as 58 years (± 3.8 years) which is significantly more (P<0.05) than survivors as 49 years. (± 4.1 years). This is similar to our study population. [3]

Sex

Our study included 37 males (74%) and 13 females (26%). Amongst survivors (31), 22 (71%) were males and 9 (29%) were females. In non survivors (19), 15 (78.9 %) were males and 4 (21.1 %) were females. The study shows that males are more likely to suffer from a critical illness than females. In one study, this was found to be 59.3% males and 38.7% females. [2] Another study reported it to be 57% males and 43% females. [3] This is comparable to our study population.

Division of Patients Based On Outcome at the End of Study

Our study included 50 patients. Out of these, 31 patients (62%) were discharged from the hospital (survivors) and 19 patients (38%) expired in the hospital (non survivors). One similar study has reported 70% survivors and 30% non-survivors. [4] Another study reported 54% survivors and 46% non-survivors. [3] This is comparable to our study.

Serum Albumin Levels As Prognostic Marker

In our study, mean serum albumin level on day of admission (Day 1) for the study group was 3.3 g/dl (± 0.4 g/dl). In

survivors, it was 3.4 g/dl (± 0.4 g/dl) and in non-survivors it was 3.1 g/dl (± 0.19 g/dl). It was significantly lower (p = 0.003) in non-survivors. In the survivor group, 45.2% patients have normal serum albumin levels on admission as compared to just 10.5% in the non-survivor group, suggesting hypoalbuminemia at admission indicates a poorer prognosis in terms of increased mortality. More non-survivors were hypoalbuminemic at admission than survivors suggesting that a low serum albumin at admission indicates a poor prognosis. One study reports survivors had higher admission albumin (2.57 g/dl vs 2.10 g/dl, p<0.005) than non-survivors. [5] Another study reports similar findings with survivors having higher mean albumin concentration (18.3 ± 4.6 g.L-1) compared to non survivors (15.7 ± 5.1 g.L-1) (p < 0.05). [3] In one study, the mean serum albumin levels on day one were reported to be 3.2 g/dl (± 0.7 g/dl) which is comparable to our study. [6]

In our study, the mean level of serum albumin on day three in study group was 2.9g/dl (± 0.4g/dl). In survivors it was 3.04 g/dl (± 0.51 g/dl) and in non-survivors it was 2.75g/dl (± 0.22 g/dl). It was significantly lower (p = 0.027) in non-survivors. All non-survivors were hypoalbuminemic at day three indicating that they have a poorer prognosis as compared to survivors where 74.2% patients had hypoalbuminemia. One study reports day three levels as 2.9 g/dl (± 0.6 g/dl) [6] which are similar to our studies.

Similarly, mean serum albumin levels on Day five were significantly lower (p=0.001) in non-survivors (2.31 g/dl ± 0.32 g/dl) as compared to survivors (2.76 g/dl ± 0.50 g/dl). The mean for the study group was 2.6g/dl (± 0.5 g/dl). All the non-survivors were still hypoalbuminemic as compared to survivors where now, 83.9% of patients were hypoalbuminemic.

The mean level of serum albumin on Day ten in study group was 2.4 g/dl (± 0.5 g/dl). In survivors it was 2.57 g/dl (± 0.51 g/dl) and in non survivors it was 2.03 g/dl (± 0.37 g/dl). It was significantly lower (p=0.003) in non-survivors. All the non-survivors and 93.6% of survivors were now hypoalbuminemic, suggesting there is a rapid decline in the serum albumin levels in both the groups. Our study shows that between survivors and non-survivors, there was a statistically significant difference in the serum albumin concentrations on admission and on Day three, Day five and Day 10. In both groups, the serum albumin level fell after admission. This decrease in serum albumin was most marked in between Day one and Day three for survivors and in between Day three and Day five for non survivors. However, a study reports most marked falls in first 24 hours in both groups. [4] This could be possibly explained by the fact that in the study, both survivors and non survivors had had very aggressive fluid resuscitation after ICU admission, therefore both groups had a marked drop in their albumin concentration in first 24 hours.

Our study also shows that in spite of having hypoalbuminemia at admission, 17 patients survived, suggesting that there are other factors associated with the prognosis of the patients in terms of mortality, since patients with hypoalbuminemia at admission survived. Our study also shows that the serum albumin levels decreased more rapidly in non survivors. The total decline in serum albumin in the survivors from admission to day 10 is 0.86 g/dl. In non-survivors it is 1.09 g/dl over a period of 10 days. This is similar to one study which reports that serum albumin levels decreased more steeply in non survivors. [4] This suggests that patients who have a rapid decline in the serum albumin level have a poor prognosis in terms of increased mortality.

Our study indicates that the strongest predictor of outcome of the patient is serum albumin on day three. Outcome of the patient is poorly correlated

with serum albumin level on day one. One study reports day five albumin levels to be the strongest predictor of mortality. [6] This difference is noted because of the method of analysis of data and the use of different kind of statistical test to predict the outcome.

Duration of Mechanical Ventilation

In our study group, the mean duration of mechanical ventilation was 8.8 days (± 2.86 days). In the survivors, this duration was 8.2 days (± 2.6days) as compared to non-survivors in which it was 9.7 day (± 2.9 days). It was significantly more (p=0.049) in non-survivors. One study reports this duration for all reason for the initiation of mechanical ventilation to be 5.9 days (± 7.2 days). [2] Another study reports this duration to be 10.5 ± 1.0 days. [7] This difference is observed because in this study, patients had lower initial mean serum albumin concentrations, thereby indicating a longer duration of mechanical ventilation. This study also reports that albumin concentration on ICU admission was not a predictor of the length of time spent receiving mechanical ventilation. However, the profile of change in serum concentrations has a predictive value. This study noted a continuous decrease in serum albumin levels in non-survivors.

Duration of ICU Stay

In our study, the patients spent an average of 12.64 days (± 3.59 days) in Intensive Care Unit. This duration was 11.4 days (± 3.4 days) in survivors and 14.6 days (± 3.0 days) for non-survivors. The length of ICU stay was significantly longer (p=0.0317) in non-survivors. One study reports length of ICU stay for mechanically ventilated patients to be 11.2 days (± 13.7 days). [2] This difference is noted presumably because of a larger sample size, i.e. 5183 patients in the study versus 50 patients in our study. One another study reports a significant 28% increase in odds for prolonged ICU stay per 10g/L decrement in serum albumin. [1] This explains the longer ICU stay of non survivors in our study population since they have lower serum albumin levels at all times as compared to survivors.

Duration of Hospital Stay

In our study group, patients spent a mean of 15.8 days (± 4.23 days) in hospital. Survivors spent 16.3 days (± 4.5 days) in hospital whereas non-survivors spent 14.9 days (± 3.6 days) in hospital. The average duration of hospital stay was significantly longer (p=0.0136) in survivors. One cohort study reports a significant hypoalbuminemia related increase of 71% in odds of prolonged hospital stay. [1] However, the broad inclusion criteria adopted in the study and a larger sample size of 2,91,443 patients have made a significant difference in the observations. One study reports an average of 22.5 days (± 23.7 days) as length of stay in hospital for mechanically ventilated patients. [2] This difference is observed because of a larger sample size of 5183 patients included in the study.

CONCLUSIONS

Serum albumin is routinely measured in all critically ill patients. It is a cheap and easily available test done in all laboratories. Its value as an important prognostic marker has been well established. The serial estimation of serum albumin provides the treating doctor an insight in the prognosis of the patient so that they can be managed aggressively. As this study shows, using serial estimation of serum albumin, we can predict the outcome of the patient. At the same time, we can identify patients who are at high risk of dying and manage them more aggressively to improve their outcome.

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