Timely Infusion of Albumin in Cirrhotic Patients with Spontaneous Bacterial Peritonitis Is Associated with Reductions in Total Hospitalization Cost: A Cross-Sectional Study

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BACKGROUND

- The societal burden of cirrhosis, particularly decompensated cirrhosis, is likely to increase over the next 10–20 years
- SBP, the most common and life-threatening complication of cirrhosis, is an infection of the ascites without an obvious intra-abdominal source, and is is one of the most common and life-threatening complications of cirrhosis [1,2]
- In the US, complications related to SBP are associated with an 18% increase in the cost of treating decompensated cirrhosis[1]

Albumin use in cirrhosis with SBP

- Albumin is the most abundant protein in plasma and plays a crucial role in oncotic pressure, substance transport and disposal, inflammation, oxidative stress, and endothelial stabilization
  - Albumin adjunctive to antibiotics is more clinically effective in patients with SBP than antibiotics alone[3]
  - Use of adjunctive albumin for SBP secondary to decompensated cirrhosis is more cost-effective than antibiotics alone[3]
  - American Association for the Study of Liver Diseases (AASLD) guidelines recommend timely administration of albumin in addition to antibiotics for SBP[4]

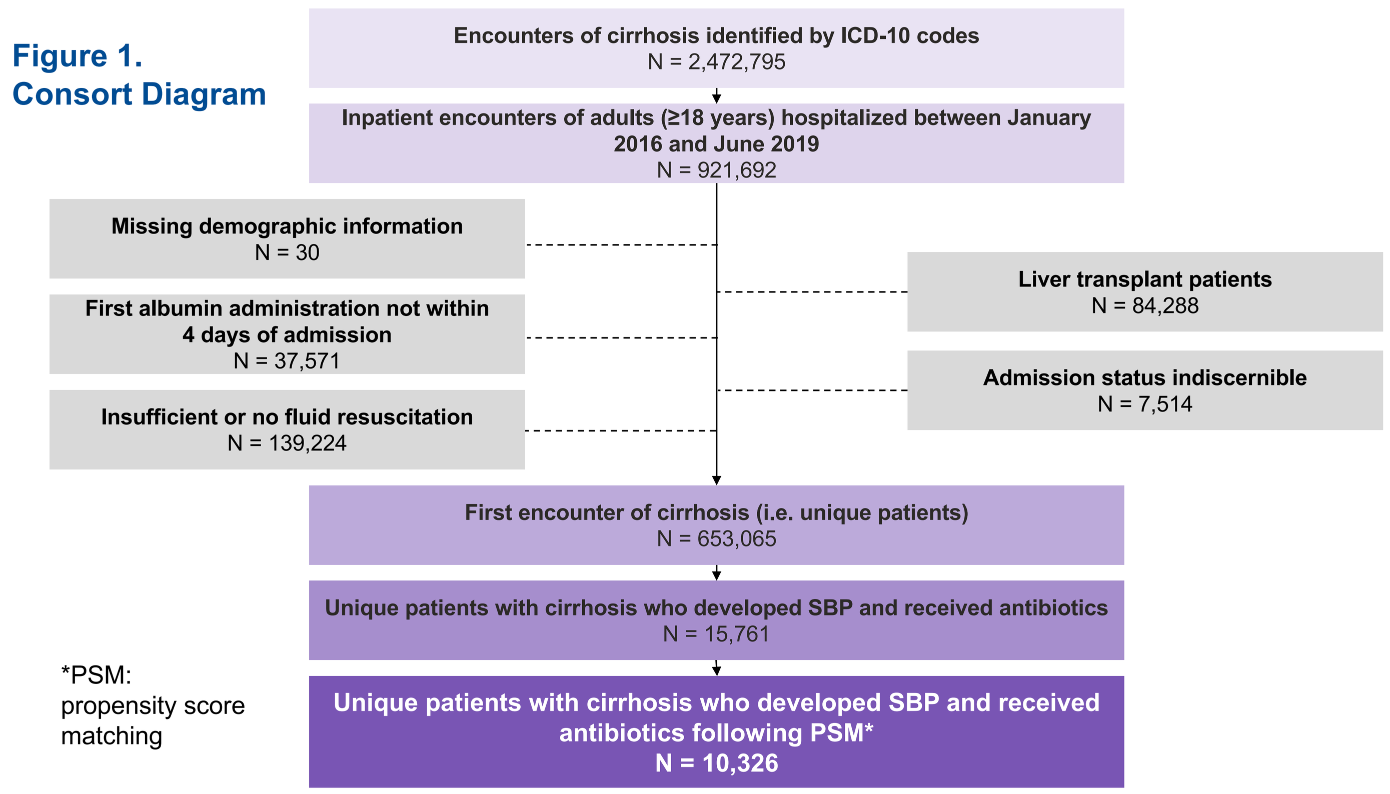
OBJECTIVE

- Using real-world evidence from a multi-hospital U.S. health database (Premier Healthcare Database), we sought to examine the relationship between albumin infusion timing and total hospitalization cost among cirrhotic inpatients who developed SBP during hospitalization

METHODS

- Using ICD-10 and billing codes, we performed a cross-sectional study of inpatient data from the Premier Healthcare Database corresponding to adult cirrhotic patients who developed SBP and received antibiotics, between Jan-2016 and Jun-2019
- The 'timely albumin' group included patients who received albumin within 1- day of hospitalization, whereas the 'non-timely' group received albumin after day 1 of hospitalization or not at all
- Propensity score matching (PSM) (1:1) was used to balance both cohorts by sociodemographic characteristics, baseline Elixhauser Comorbidity Index, and presence of hepatorenal syndrome, end-stage renal disease, and ascites. Generalized linear models were employed to examine the association between albumin infusion timing and total hospitalization cost, controlling for common comorbidities (e.g., gastrointestinal bleeding)
- Total hospitalization cost consisted of fixed costs plus variable costs (volume-linked expenses such as supplies and patient care)

Figure 1. Consort Diagram



*PSM: propensity score matching

RESULTS

- PSM yielded a total of 10,326 patients, of whom 8,482 survived to discharge
- A risk-adjusted cost ratio (CR) model showed that, compared to the non-timely group, timely albumin was associated with an 11% total cost reduction among all patients (CR: 0.89, 95% CI: 0.86-0.91, p<0.001) and among survivors (CR: 0.89, 95% CI: 0.87-0.92, p<0.001)

Table 1. Patient Demographics and Hospital Characteristics

	ALL PATIENTS N = 10,326 visits		SURVIVORS ONLY N = 8,482 visits	
	Timely Albumin	Non-Timely Albumin	Timely Albumin	Non-Timely Albumin
	N = 5,163 visits (50%)	N = 5,163 visits (50%)	N = 4,241 visits (50%)	N = 4,241 visits (50%)
Characteristic				
Sex				
Male	3269 (63.3%)	3317 (64.2%)	2695 (63.5%)	2727 (64.3%)
Female	1894 (36.7)	1846 (35.8%)	1546 (36.5%)	1514 (35.7%)
Age (years)				
18-29	69 (1.3%)	63 (1.2%)	62 (1.5%)	60 (1.4%)
30-49	1027 (19.9%)	1047 (20.3%)	842 (19.9%)	866 (20.4%)
50-64	2521 (48.8%)	2514 (48.7%)	2058 (48.5%)	2045 (48.2%)
65+	1546 (29.9%)	1539 (29.8%)	1279 (30.2%)	1270 (29.9%)
Ethnicity				
White	3896 (75.5%)	3965 (76.8%)	3226 (76.1%)	3276 (77.2%)
Black	349 (6.8%)	325 (6.3%)	270 (6.4%)	267 (6.3%)
Other	825 (16.0%)	781 (15.1%)	668 (15.8%)	620 (14.6%)
Not Specified	93 (1.8%)	92 (1.8%)	77 (1.8%)	78 (1.8%)
Admission Type				
Elective	189 (3.7%)	183 (3.5%)	158 (3.7%)	163 (3.8%)
Emergency	4441 (86.0%)	4448 (86.2%)	3630 (85.6%)	3625 (85.5%)
Trauma	18 (0.3%)	22 (0.4%)	16 (0.4%)	14 (0.3%)
Urgent	515 (10.0%)	510 (9.9%)	437 (10.3%)	439 (10.4%)
Payor Group				
Medicare	2152 (41.7%)	2126 (41.2%)	1801 (42.5%)	1766 (41.6%)
Managed Care, Commercial	1132 (21.9%)	1114 (21.6%)	926 (21.8%)	948 (22.4%)
Medicaid	1401 (27.2%)	1465 (28.4%)	1136 (26.8%)	1153 (27.2%)
Self Pay	239 (4.6%)	232 (4.5%)	185 (4.4%)	172 (4.1%)
Other	239 (4.6%)	226 (4.4%)	193 (4.6%)	202 (4.8%)
Hospital Characteristics at Index Visit				
Hospital Type				
Urban	4690 (90.8%)	4694 (90.9%)	3854 (90.9%)	3851 (90.8%)
Rural	473 (9.2%)	469 (9.1%)	387 (9.1%)	390 (9.2%)
Teaching Facility				
Yes	2934 (56.8%)	2892 (56.0%)	2378 (56.1%)	2413 (56.9%)
No	2229 (43.2%)	2271 (44.0%)	1863 (43.9%)	1828 (43.1%)
Clinical Characteristics and Conditions At/Before Index Visit				
Baseline Elixhauser Comorbidity Index (ECI), Mean ± SD	19.1 ± 9.3	19.0 ± 9.5	18.4 ± 9.2	18.6 ± 9.5
ECI, Median [25th, 75th]	19.0 [13.0, 25.0]	19.0 [13.0, 25.0]	19.0 [12.0, 24.0]	18.0 [12.0, 25.0]
Baseline Hepatorenal Syndrome	1398 (27.1%)	1356 (26.3%)	993 (23.4%)	959 (22.6%)
Baseline ESRD	587 (11.4%)	561 (10.9%)	462 (10.9%)	459 (10.8%)
Baseline Ascites	3382 (65.5%)	3345 (64.8%)	2844 (67.1%)	2797 (66.0%)
Acute Kidney Injury (AKI)	3342 (64.7%)	2907 (56.3%)	2503 (59.0%)	2115 (49.9%)
Hepatic Encephalopathy (HE)	1773 (34.3%)	1518 (29.4%)	1403 (33.1%)	1188 (28.0%)
Glucose Level				
Both Hyper- and Hypoglycemia	577 (11.2%)	529 (10.2%)	364 (8.6%)	368 (8.7%)
Hyperglycemia only	1165 (22.6%)	1168 (22.6%)	979 (23.1%)	924 (21.8%)
Hypoglycemia only	837 (16.2%)	832 (16.1%)	584 (13.8%)	646 (15.2%)
Neither Hyper- nor hypoglycemia	2584 (50.0%)	2634 (51.0%)	2314 (54.6%)	2303 (54.3%)
Exposures/Clinical Interventions During Index Visit				
Large Volume Paracentesis (LVP)	3424 (66.3%)	2925 (56.7%)	2859 (67.4%)	2395 (56.5%)
GI Bleeding (GIB) and Transfusions				
Both	330 (6.4%)	382 (7.4%)	213 (5.0%)	268 (6.3%)
GIB only	238 (4.6%)	270 (5.2%)	180 (4.2%)	208 (4.9%)
Transfusions only	1390 (26.9%)	1250 (26.9%)	1056 (24.9%)	961 (22.7%)
Neither	3205 (62.1%)	3261 (63.2%)	2792 (65.8%)	2804 (66.1%)
Use of Mechanical Ventilation	752 (14.6%)	654 (12.7%)	276 (6.5%)	277 (6.5%)
Vasopressor Use	1520 (29.4%)	1048 (20.3%)	826 (19.5%)	489 (11.5%)
Use of Diuretics	3476 (67.3%)	3630 (70.3%)	2964 (69.9%)	2993 (70.6%)
Use of Steroids	692 (13.4%)	795 (15.4%)	530 (12.5%)	637 (15.0%)
Use of Beta Blockers	920 (17.8%)	1150 (22.3%)	847 (20.0%)	1008 (23.8%)

SUMMARY/CONCLUSION

Early albumin infusion was associated with a significant reduction in total hospitalization –

suggesting that albumin as an adjuvant to antibiotics may alleviate the growing cost burden of SBP as a complication of cirrhosis.

Figure 3: Significant Cost Saving Among Patients Treated with Albumin in a Timely Manner

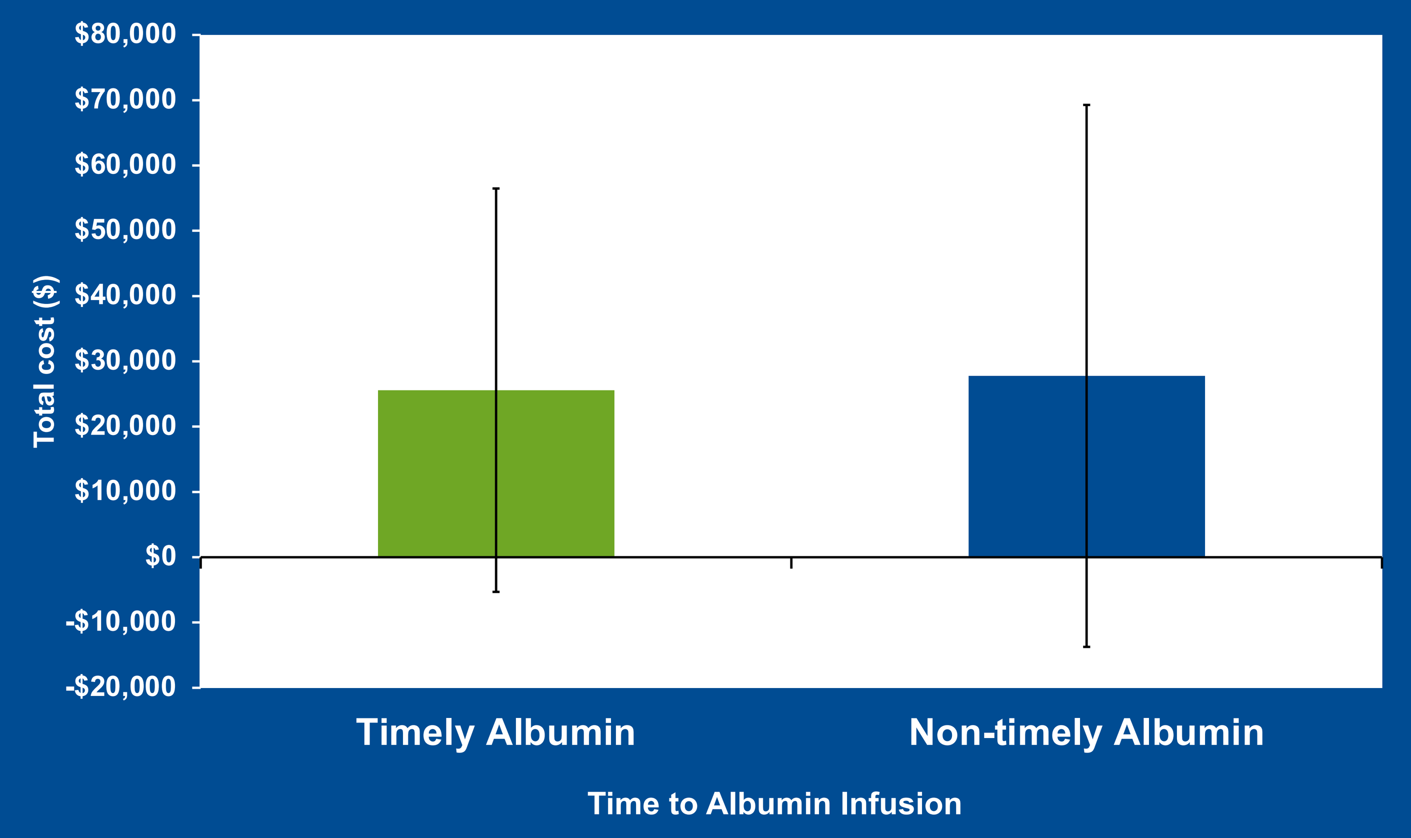


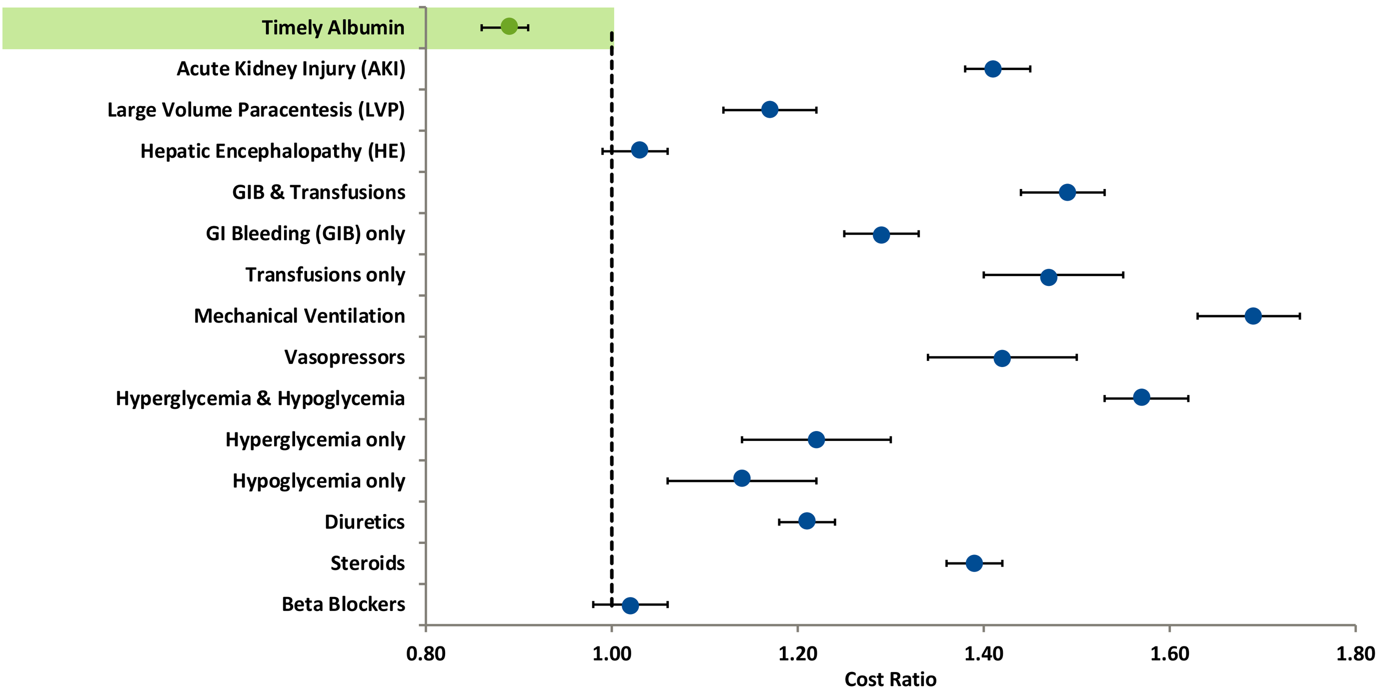
Table 2: Association Between Timely Albumin and Total Care Costs after 1:1 Propensity Score Matching (PSM)

All Patients (N = 10,326)
Surviving Patients (N = 8,482)

	Odds Ratio (OR)		95% Confidence Interval (CI) Lower Limit		95% Confidence Interval (CI) Upper Limit	
Characteristic	All Patients	Surviving Patients	All Patients	Surviving Patients	All Patients	Surviving Patients
Timely (≤1 day of Hospital Admission) vs. Non-Timely (None or Late) Albumin Administration	**0.89***	**0.89***	**0.86**	**0.87**	**0.91**	**0.92**
Acute Kidney Injury (AKI)	1.41*	1.40*	1.37	1.36	1.45	1.44
Large Volume Paracentesis (LVP)	1.17*	1.14*	1.14	1.11	1.20	1.17
Hepatic Encephalopathy (HE)	1.03*	1.02	1.00	0.99	1.06	1.06
Gastrointestinal Bleeding (GIB) and Transfusions						
Both	1.49*	1.49*	1.41	1.40	1.57	1.59
GIB only	1.29*	1.24*	1.21	1.17	1.37	1.34
Transfusions only	1.47*	1.42*	1.43	1.37	1.52	1.47
Mechanical Ventilation	1.69*	1.94*	1.61	1.82	1.77	2.07
Vasopressors**	1.42*	1.52*	1.36	1.45	1.47	1.59
Glucose Level						
Both	1.57*	1.55*	1.50	1.46	1.65	1.63
Hyperglycemia	1.22*	1.19*	1.18	1.14	1.26	1.23
Hypoglycemia	1.14*	1.14*	1.09	1.09	1.18	1.19
Diuretics	1.21*	1.21*	1.17	1.17	1.24	1.25
Steroids***	1.39*	1.35*	1.34	1.30	1.44	1.41
Beta Blockers****	1.02	1.03	0.99	1.00	1.06	1.07

*p < 0.05; **Vasopressors identified included: dobutamine, dopamine, epinephrine, norepinephrine, vasopressin; ***Steroids included budesonide, cortisone, dexamethasone, dexamethasone/lidocaine, fludrocortisone, methylprednisolone, prednisolone, prednisone; ****Beta blockers included carvedilol, nadolol, nadolol/Bendroflumethiazide, propranolol, propranolol/ hydrochlorothiazide

Figure 2: Cost Ratio Forest Plot



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