

Supplementary Data

SUPPLEMENTARY TABLE S1. *INTERNATIONAL CLASSIFICATION OF DISEASES*, NINTH EDITION, CLINICAL MODIFICATION
CODES USED IN THE STUDY

<i>Clinical condition</i>	<i>ICD-9-CM codes, Elixhauser Comorbidity variables and Clinical Classification System codes</i>
Palliative care consultation	V667
Do not resuscitate	V4986
Primary liver cell carcinoma	155.0
Liver transplantation	V427, 50.5
ESLD, as defined by Goldberg	Presence of (1 code in chronic liver disease) + (1 code in liver cirrhosis) + (>1 code in decompensation) ^{S1}
Chronic liver disease: hepatitis B virus infection; hepatitis C virus infection; viral hepatitis not otherwise specified; hepatitis D with hepatitis B; alpha-1-antitrypsin deficiency; hemochromatosis; Wilson's disease; Budd-Chiari syndrome; alcohol liver disease; hepatitis, not otherwise specified; autoimmune hepatitis; cholangitis	070.2, 070.3, 070.6, 070.7, 070.9 070.40, 070.41, 070.42, 070.44, 070.49 070.50, 070.51, 070.52, 070.54, 070.59 273.4, 275.0, 275.1 453.0 571.0, 571.1, 571.3, 571.4, 571.8, 571.9 573.0, 573.1, 573.3, 573.8, 573.9 576.1
Cirrhosis: alcoholic; primary biliary disease; no mention of alcohol	571.2, 571.5, 571.6
Decompensation: ascites; spontaneous bacteria peritonitis; jaundice; hepatic encephalopathy; hepatorenal syndrome; variceal bleeding; portal hypertension	456.0, 456.20, 456.1, 456.21 789.51, 789.59 572.2, 567.0, 567.21, 567.22, 567.23, 567.29, 567.89, 567.9 572.4
Protein–energy/calorie malnutrition	260.x, 261.x, 262.x, 263.x, 269.8, 799.4, 783.3, 783.21, 783.22, 783.7
Charlson–Deyo comorbidities	S2

ESLD, end-stage liver disease; ICD-9-CM, *International Classification of Diseases*, Ninth Edition, Clinical Modification.

SUPPLEMENTARY TABLE S2. CHARACTERISTICS OF PATIENTS HOSPITALIZED WITH END-STAGE LIVER DISEASE CATEGORIZED BY 30- AND 90-DAY READMISSION STATUS, NATIONAL READMISSIONS DATABASE 2010–2014

Variables	All-cause 30 days readmission			All-cause 90 days readmission		
	No	Yes	p	No	Yes	p
Number (%)	43,608 (65.1)	23,872 (34.9)	<0.0001	31,931 (47.7)	35,549 (52.3)	<0.0001
Age, years, mean (SD)	56.4 (10.5)	55.7 (10.3)	<0.0001	56.6 (10.6)	55.8 (10.3)	<0.0001
Sex (%)			0.5059			0.04
Female	34.5	34.8		34.1	35.0	
Male	65.5	65.2		65.9	65.0	
DNR (%)	7.3	3.6	<0.0001	8.9	3.4	<0.0001
Hepatocellular carcinoma (%)	9.1	8.6	0.0380	9.8	8.1	<0.0001
Liver transplant (%)	0.4	0.4	0.6117	0.4	0.4	0.3620
Insurance (%)			<0.0001			<0.0001
Medicare	34.7	35.7		33.9	36.1	
Medicaid	26.9	31.8		25.8	31.1	
Private	25.1	22.9		26.0	22.9	
Self-pay and others	13.3	9.6		14.3	10.0	
Median household income (%)			0.0280			0.0619
First quartile (lowest)	32.2	31.5		31.8	32.1	
Second quartile	27.1	26.8		27.3	26.7	
Third quartile	23.3	23.1		23.6	22.9	
Fourth quartile (highest)	17.4	18.6		17.3	18.2	
Hospital bed size (%)			0.2986			0.4449
Small	9.5	9.1		9.5	9.3	
Medium	22.5	22.0		22.5	22.1	
Large	68.0	68.9		67.9	68.6	
Hospital location (%)			<0.0001			<0.0001
Large metropolitan	61.3	65.8		59.8	65.7	
Small metropolitan	32.6	29.3		33.8	29.3	
Micropolitan	5.1	4.0		5.3	4.2	
Nonmicro/metropolitan	1.0	0.9		1.1	0.9	
Hospital teaching status (%)			<0.0001			<0.0001
Metropolitan nonteaching	29.7	28.8		30.3	28.5	
Metropolitan teaching	64.2	66.4		63.3	66.4	
Nonmetropolitan	6.1	4.9		6.4	5.1	
Hospital ownership (%)			0.3091			0.3221
Government	15.7	14.9		15.7	15.2	
Private, nonprofit	71.1	72.0		71.0	71.8	
Private, profit	13.2	13.1		13.3	13.0	
Weekend admission (%)	22.6	22.8	0.7181	22.6	22.8	0.5929
Discharge disposition (%)			<0.0001			<0.0001
Home, home with hospice	79.0	81.1		77.0	82.2	
Left against medical advice	1.7	2.9		1.5	2.7	
Skilled nursing facility	19.4	16.0		21.6	15.1	
Charlson–Deyo comorbidity index (%)			0.3158			<0.0001
Index: 0	40.0	36.7		40.7	37.2	
Index: 1–3	42.5	44.7		41.2	45.2	
Index: >3	17.5	18.6		18.1	17.7	

Self-pay and others, individuals without a health insurance or paying health fees out of pocket.

Large metropolitan (population ≥1,000,000), small metropolitan (population between 50,000 and 1,000,000), micropolitan (population between 10,000 and 50,000), non micro-/metropolitan (population <10,000).

Charlson–Deyo index was calculated excluding ESLD and hepatocellular carcinoma for this study.

DNR, do not resuscitate.

SUPPLEMENTARY TABLE S3. FACTORS ASSOCIATED WITH RECEIVING PALLIATIVE CARE CONSULTATION BEFORE AND AFTER PROPENSITY MATCHING, NATIONAL READMISSIONS DATABASE 2010–2014

Variables	Before propensity matching				After propensity matching			
	aOR	LCL	UCL	p	aOR	LCL	UCL	p
Age								
Per 10-year increase	1.08	1.02	1.15	0.0091	0.98	0.93	1.04	0.588
Sex								
Female vs. male	1.03	0.93	1.14	0.5588	1.02	0.91	1.13	0.7595
DNR	10.01	8.67	11.55	<0.0001	1.11	0.98	1.26	0.1145
Hepatocellular carcinoma	3.00	2.41	3.73	<0.0001	1.11	0.93	1.33	0.2361
Liver transplant	0.08	0.04	0.16	<0.0001	1.62	0.53	4.93	0.3991
Complications of ESKD								
Ascites	1.41	1.18	1.69	0.0002	0.98	0.82	1.17	0.8025
Variceal bleed	0.89	0.79	0.99	0.0364	0.97	0.86	1.09	0.5676
Hepatorenal syndrome	2.41	2.15	2.70	<0.0001	1.00	0.89	1.12	0.9317
Hepatic encephalopathy	1.49	1.31	1.69	<0.0001	0.98	0.87	1.10	0.7436
Portal hypertension	0.89	0.81	0.99	0.0251	1.02	0.92	1.13	0.7117
Jaundice	1.30	1.10	1.54	0.0027	1.00	0.84	1.20	0.9652
Spontaneous bacterial peritonitis	1.29	1.13	1.47	0.0002	0.96	0.84	1.09	0.5169
Protein–energy malnutrition	2.04	1.63	2.55	<0.0001	1.06	0.87	1.29	0.5648
Insurance				0.0003				0.2872
Medicaid vs. Medicare	1.09	0.95	1.25		1.08	0.94	1.24	
Private vs. Medicare	0.96	0.83	1.11		1.14	0.99	1.31	
Self-pay and others vs. Medicare	1.40	1.17	1.66		1.13	0.96	1.35	
Income				0.0262				0.7376
Second quartile vs. lowest quartile	0.84	0.74	0.96		1.00	0.87	1.14	
Third quartile vs. lowest quartile	0.95	0.82	1.09		0.95	0.83	1.09	
Highest quartile vs. lowest quartile	0.86	0.74	0.99		1.03	0.89	1.19	
Hospital bed size				0.4401				0.2281
Medium vs. small	1.23	0.88	1.72		1.04	0.85	1.27	
Large vs. small	1.14	0.84	1.55		1.13	0.94	1.35	
Hospital urban–rural designation				0.024				0.5577
Small metropolitan vs. large metropolitan	1.18	1.03	1.34		1.03	0.92	1.15	
Micropolitan vs. large metropolitan	0.59	0.43	0.82		1.08	0.80	1.45	
Nonmicro/metropolitan vs. large metropolitan	0.36	0.16	0.79		1.94	0.61	6.21	
Hospital teaching status								
Nonteaching vs. teaching	0.81	0.70	0.93	0.0028	0.97	0.87	1.08	0.5906
Hospital control				0.0683				0.7439
Private, nonprofit vs. government	1.03	0.88	1.20		1.05	0.92	1.19	
Private, profit vs. government	0.73	0.54	0.99		1.00	0.81	1.23	
Weekend admission	1.03	0.92	1.14	0.6184	0.98	0.87	1.09	0.6678
Discharge disposition				<0.0001				0.809
Home/routine vs. nonroutine	0.40	0.35	0.44		1.04	0.93	1.15	
LAMA vs. nonroutine	0.15	0.09	0.25		1.00	0.52	1.93	
Charlson–Deyo comorbidity index				<0.0001				0.149
Deyo: 1–3 vs. 0	1.10	0.97	1.25		0.94	0.81	1.08	
Deyo: >3 vs. 0	1.86	1.51	2.29		0.82	0.66	1.01	
Acquired immune deficiency syndrome	1.23	0.69	2.19	0.4922	0.71	0.44	1.14	0.1536
Alcohol abuse	1.22	1.10	1.35	0.0001	0.89	0.80	1.00	0.0399
Chronic deficiency anemia	0.96	0.87	1.05	0.3538	0.96	0.87	1.06	0.4179
Rheumatoid arthritis/collagen vascular diseases	0.84	0.56	1.27	0.4174	1.04	0.68	1.60	0.8535
Chronic blood loss anemia	0.88	0.70	1.11	0.2831	1.09	0.85	1.40	0.5155
Congestive heart failure	1.02	0.84	1.25	0.8443	0.88	0.73	1.06	0.1846
Chronic pulmonary disease	0.97	0.85	1.12	0.6999	0.97	0.84	1.12	0.6479
Coagulation disorders	1.14	1.03	1.26	0.011	1.05	0.95	1.15	0.3793
Depression	1.09	0.96	1.24	0.1894	0.97	0.84	1.13	0.7126
Uncomplicated diabetes mellitus	0.90	0.79	1.02	0.1063	1.00	0.88	1.15	0.9685
Complicated diabetes mellitus	0.69	0.54	0.88	0.0026	1.11	0.87	1.42	0.412
Drug abuse	1.19	1.02	1.39	0.0286	0.98	0.84	1.14	0.7517
Hypertension	0.93	0.84	1.04	0.1921	0.99	0.90	1.10	0.9073

(continued)

SUPPLEMENTARY TABLE S3. (CONTINUED)

Variables	Before propensity matching				After propensity matching			
	aOR	LCL	UCL	p	aOR	LCL	UCL	p
Hypothyroidism	0.90	0.76	1.07	0.2343	1.06	0.89	1.26	0.5075
Lymphoma	1.20	0.77	1.85	0.4192	0.88	0.54	1.43	0.6067
Fluid and electrolyte disorders	1.33	1.20	1.47	<0.0001	0.94	0.84	1.05	0.2612
Metastatic cancer	1.56	1.10	2.20	0.0119	0.94	0.73	1.22	0.6541
Chronic neurological disorders	1.03	0.81	1.30	0.8324	0.94	0.78	1.14	0.5316
Obesity	0.91	0.76	1.08	0.2574	1.06	0.89	1.27	0.5263
Paralysis	0.95	0.63	1.43	0.8109	1.10	0.68	1.79	0.7031
Peripheral vascular disorders	0.73	0.55	0.97	0.0319	0.93	0.70	1.23	0.6004
Psychoses	1.05	0.87	1.27	0.5861	0.98	0.80	1.21	0.8797
Pulmonary circulatory disorders	1.15	0.86	1.53	0.3456	1.11	0.84	1.48	0.4543
Chronic renal failure	1.08	0.93	1.24	0.316	0.92	0.80	1.05	0.206
Solid tumor (no metastasis)	0.90	0.71	1.14	0.3863	0.84	0.69	1.02	0.0822
Peptic ulcer (no bleeding)	0.79	0.22	2.84	0.7177	1.00	0.18	5.51	0.9993
Valvular diseases	0.91	0.69	1.21	0.5181	1.07	0.81	1.42	0.6384
Weight loss	0.76	0.60	0.97	0.0247	0.91	0.74	1.12	0.3627

Self-pay and others, individuals without a health insurance or paying health fees out of pocket.

Large metropolitan (population ≥1,000,000), small metropolitan (population between 50,000 and 1,000,000), micropolitan (population between 10,000 and 50,000), non micro-/metropolitan (population <10,000).

Charlson–Deyo index was calculated excluding ESLD and hepatocellular carcinoma for this study.

aOR, adjusted odds ratio; LCL, lower confidence limit; UCL, upper confidence limit.

SUPPLEMENTARY TABLE S4. IMPACT OF PALLIATIVE CARE CONSULTATION ON READMISSION RATE AND OUTCOMES DURING READMISSIONS AMONG PATIENTS WITH END-STAGE LIVER DISEASE, NATIONAL READMISSIONS DATABASE 2010–2014

	PCC vs. no-PCC	p
Readmission rate, relative risk (95% CI)		
30-day	0.45 (0.41–0.50)	<0.0001
90-day	0.42 (0.39–0.46)	<0.0001
Readmission mortality rate, relative risk (95% CI)		
30-day	1.41 (1.14–1.74)	<0.0001
90-day	1.53 (1.27–1.85)	<0.0001
Length of stay, mean ratio (95% CI)		
30-day	0.75 (0.66–0.87)	<0.0001
90-day	0.83 (0.73–0.94)	<0.0001
Hospital cost, mean ratio (95% CI)		
30-day	0.64 (0.53–0.78)	<0.0001
90-day	0.70 (0.60–0.83)	<0.0001
Readmission rate, hazard ratio (95% CI)		
30-day	0.42 (0.38–0.47)	<0.0001
90-day	0.38 (0.34–0.42)	<0.0001

CI, confidence interval; PCC, palliative care consultation.

Supplementary References

- S1. Goldberg D, Lewis J, Halpern S, et al. Validation of a coding algorithm to identify patients with end-stage liver disease in an administrative database. *Pharmacoepidemiol Drug Saf* 2012;21:765–769.
- S2. Quan H, Sundararajan V, Halfon P, et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Med Care* 2005;43:1130–1139.