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ORIGINAL ARTICLE

Charges for Alcoholic Cirrhosis Exceed All Other Etiologies of Cirrhosis Combined: A National and State Inpatient Survey Analysis

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Abstract

Background Inpatient charges for patients with cirrhosis are substantial. We aimed to examine trends in inpatient charges among patients with cirrhosis to determine the drivers of healthcare expenditures. We hypothesized that alcoholic cirrhosis (AC) was a significant contributor to overall expense.

Methods We performed a retrospective analysis of the Health Care Utilization Project Nationwide Inpatient Sample Database 2002–2014 (annual cross-sectional data) and New York and Florida State Inpatient Databases 2010–2012 (longitudinal data). Adult patients with cirrhosis of the liver were categorized as AC versus all other etiologies of cirrhosis combined. Patient characteristics were analyzed using ordinary least squares regression modeling. A random effects model was used to evaluate 30-day readmissions.

Results In total, 1,240,152 patients with cirrhosis were admitted between 2002 and 2014. Of these, 567,510 (45.8%) had a diagnosis of AC. Total charges for AC increased by 95.7% over the time period, accounting for 59.9% of all inpatient cirrhosis-related charges in 2014. Total aggregate charges for AC admissions were $28 billion and increased from $1.4B in 2002 to $2.8B by 2014. In the NIS and SID, patients with AC were younger, white and male. Readmission rates at 30, 60, and 90 days were all higher among AC patients.

Conclusions Inpatient charges for cirrhosis care are high and increasing. Alcohol-related liver disease accounts for more than half of these charges and is driven by sheer volume of admissions and readmissions of the same patients. Effective alcohol addictions therapy may be the most cost-effective way to substantially reduce inpatient cirrhosis care expenditures.

Keywords Alcohol · Charges · Costs · Cirrhosis · Burden

Abbreviations

AC	Alcoholic cirrhosis
HCV	Hepatitis C
NAFLD	Nonalcoholic fatty liver disease
NIS	Nationwide Inpatient Sample
HCUP	Healthcare Cost and Utilization Project
AHRQ	Agency for Healthcare Research and Quality
SID	State Inpatient Database
ICD-9-CM	International Classification of Diseases, 9th Revision, Clinical Modification
NC	Nonalcohol-related cirrhosis

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Introduction

Healthcare expenditures have steadily increased in the USA [1] and inpatient charges for cirrhosis of the liver are likely no exception. Many advances have been made in the treatment and management of cirrhosis that have resulted in improved inpatient cirrhosis mortality [2]. However, the overall economic burden of liver disease remains high [3, 4] and is expected to increase with the aging of the hepatitis C (HCV)-infected population and the increase in incidence of nonalcoholic fatty liver disease (NAFLD).

Because of this, there has been an increased focus on the treatment of HCV and NAFLD. It is not clear, however, if the focus on HCV and NAFLD is commensurate with the economic burden of liver disease [5]. Alcohol is a major contributor to the social and economic burden of liver disease worldwide [6, 7], and no amount of alcohol has been found to be safe [8], yet few advances have been made that impact patient mortality or healthcare costs. To date, there have been no large nationally representative studies to clarify the drivers of the inpatient charges for liver disease.

Quantification of inpatient charges and risks factors for readmission is important for patients, payers and policy makers alike. Discovering populations and characteristics of patients that are at higher risk of admission or readmission can help prioritize resources toward cost-effectively preventing need for hospitalization. Determining the economic burden of disease and targets for prevention will influence research agendas in both the public and private sectors.

We aimed to examine cross-sectional and longitudinal trends in inpatient charges for patients with cirrhosis to determine the main drivers of cirrhosis-related healthcare expenditures. Specifically, we investigated different etiologies of liver disease and the associated volume of inpatient admissions, charges per admission, aggregate costs, length of stay, and readmission rate. We modeled predictors for increased charges in an effort to identify specific areas for intervention that might curb cirrhosis-associated inpatient charges.

Methods

Data Source

Data were obtained from the Nationwide Inpatient Sample (NIS), Healthcare Cost and Utilization Project (HCUP), Agency for Healthcare Research and Quality (AHRQ) from 2002 to 2014 [9]. The NIS is a nationally representative healthcare database and is the largest all-payer resource in the USA, totaling approximately 8 million discharges annually [9]. The NIS data were used to analyze trends in hospital admissions across all etiologies of cirrhosis. However, the NIS is based on per admission information, rather than patient level data. To examine longitudinal data for individual patients and achieve a detailed description of charges, readmission rates, and predictors of 30-day readmission, we used the HCUP State Inpatient Database (SID) files for New York and Florida from 2010 to 2012. The SID provides longitudinal data linked at the patient level and allows patients to be followed across multiple hospital admissions, while the NIS provides annual cross-sectional admissions data.

Cohort Identification

We identified discharges ≥ 18 years of age, with any diagnostic code containing "cirrhosis" in the HCUP NIS data from 2002 to 2014. To identify discharges with cirrhosis, we used a previously validated and previously published administrative coding strategies [2, 10–12]. One or more of the following International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes were required: alcoholic cirrhosis of the liver (571.2), biliary cirrhosis (571.6), or cirrhosis without mention of alcohol (571.5). Secondary diagnoses such as hepatitis B (070.20-3, 070.30-3, 070.42) and C (070.41, 070.44, 070.54), and complications of cirrhosis such as ascites (789.5, 789.51, 789.59), variceal bleeding (4560, 53082, 53140, 53240, 5789, 5780), and encephalopathy (572.2) were identified using standard ICD 9 coding strategies. Patients with multiple etiologies of liver cirrhosis (e.g., alcohol and viral hepatitis) were categorized as alcoholic cirrhosis if alcohol was part of their disease etiology. A full list of administrative codes used is in "Appendix 1."

Primary Outcome and Variables

The primary outcome for the cross-sectional analyses was logged aggregate charges per stay for all cirrhosis hospitalizations from 2002 to 2014. Patients with alcoholic cirrhosis were compared to all other etiologies of cirrhosis combined. The primary outcome for the longitudinal analyses was any readmission within 30-days of discharge. Unique admissions and readmissions within the SID are tracked via a verified person number linking hospital visits across hospitals and time. When a patient is admitted, admissions are categorized as emergent, urgent, elective, trauma, and other. Unplanned readmissions were any category other than "elective." Timing of certain procedures (e.g., > or < 24 h from admission) was calculated by taking the difference between the procedure date and the admission date. For same day procedures, we assessed if the relevant procedure (paracentesis, EGD, etc.) was performed before day 2 of the admission. Variables included in the analyses are shown in Tables 1 and 2.

Statistical Analyses

Data were analyzed using Stata version 15 (Stata Corp, College Station, TX). Descriptive data are reported. Bivariate comparisons using Chi-squared analyses and student's T tests were performed where appropriate.

For cross-sectional multivariable analyses examining predictors of mean charge per cirrhosis discharge in the NIS, an ordinary least squares model was used. A random

Table 1 Characteristics of alcoholic vs. nonalcoholic cirrhosis discharges (NIS 2002–2014)

	Nonalcohol-related cirrhosis ($n = 672{,}624$)	Alcohol-related cirrhosis ($n = 567{,}510$)	p
Age category (%)			
≤40	4.6	8.1	< 0.001
41–50	14.2	25.7	
51–60	29.8	38.7	
61–70	24.0	18.4	
71–80	17.6	7.5	
>80	9.8	1.7	
Race (%)			
White	64.7	66.2	< 0.001
Black	11.1	10.5	
Hispanic	17.5	17.9	
Other	6.8	5.3	
Male (%)	50.9	73.0	< 0.001
Primary expected payer (%)			
Medicare[a]	52.4	32.9	< 0.001
Medicaid[a]	17.6	27.1	
Private Insurance	21.8	22.4	
Self-pay	4.3	11.2	
No charge	0.5	1.3	
Other	3.4	5.2	
Emergency room admission (%)	66.7	74.6	< 0.001
Diagnosis (%)			
Variceal hemorrhage	6.2	10.0	< 0.001
Encephalopathy	13.7	22.4	< 0.001
Ascites	10.4	14.1	< 0.001
Portal hypertension	18.4	23.4	< 0.001
Sepsis	7.3	7.8	< 0.001
Hepatorenal syndrome	2.4	4.0	< 0.001
Hepatocellular carcinoma	5.2	3.1	< 0.001
HCV	1.1	0.6	< 0.001
HBV	1.2	0.6	< 0.001
Alcoholic hepatitis	0.3	9.3	< 0.001
Acute pancreatitis	2.3	4.5	< 0.001
Chronic pancreatitis	1.2	3.0	< 0.001
Interventions (%)			
Transfusion of any blood product	20.0	24.8	< 0.001
EGD	14.3	22.0	< 0.001
Paracentesis	15.9	21.7	< 0.001
Thoracentesis	2.7	2.3	< 0.001
Hemodialysis	5.8	3.0	< 0.001

[a]Medicare is government health insurance for Americans aged 65 or greater or those with disabilities. Medicaid is a joint federal and state program that provides health insurance for people with limited resources

effects logistic model was used to evaluate predictors of 30-day readmissions [13, 14] in the longitudinal SID. Because data were longitudinal by discharge and multiple observations were included on the same discharge (patient), a random effects logistic model was chosen using data pooled across all years for New York and Florida [15]. Odds ratios are reported for the predictors of 30-day readmission. Weighted national estimates of charges, discharges, and length of stay were graphed from the HCUP NIS based on data collected by individual States and provided to AHRQ by the States.

Table 2 Characteristics of alcoholic vs. nonalcoholic admissions for FL/NY SID combined (2010–2012)

	Nonalcohol-related cirrhosis ($n = 103{,}391$)	Alcohol-related cirrhosis ($n = 112{,}495$)	p
Mean age, years (SD)	63.9 (12.8)	57.0 (10.8)	< 0.001
Race (%)			
White	59.5	67.7	< 0.001
Black	11.6	10.2	
Hispanic	19.9	15.5	
Other	8.9	6.6	
Male (%)	51.5	71.5	< 0.001
Complications of cirrhosis (%)			
Sepsis	10.1	9.5	< 0.001
Variceal hemorrhage	6.0	9.3	< 0.001
Acute kidney injury	19.8	18.5	< 0.001
Hepatorenal syndrome	2.9	4.3	< 0.001
Hepatocellular carcinoma	7.3	4.0	< 0.001
Ascites	20.8	25.8	< 0.001
Encephalopathy	15.9	23.0	< 0.001
Interventions (%)			
Liver transplant	2.1	1.0	< 0.001
EGD within 24 h of admission	10.0	15.3	< 0.001
Paracentesis within 24 h of admission	9.7	12.6	< 0.001
Readmission rates (%)			
Thirty-day readmission	11.7	13.9	< 0.001
Sixty-day readmission	17.1	19.7	< 0.001
Ninety-day readmission	19.9	22.9	< 0.001
Primary expected payer (%)			
Medicare	57.3	37.0	< 0.001
Medicaid	18.8	30.0	
Private insurance	17.5	17.9	
Self-pay/no charge	3.1	10.7	
Other	3.2	4.4	
Patient is homeless (%)	2.3	3.6	< 0.001
Had major operating room procedure (%)	15.8	10.4	< 0.001
Died in hospital (%)	6.3	6.6	0.010
Mean total charges, dollars (SD)	56,326 (85,982)	53,838 (79,809)	< 0.001

Results

National Cross-Sectional Data

In total, 1,240,152 patients with cirrhosis were admitted to US hospitals participating in the NIS between 2002 and 2014. Of these, 567,510 (45.8%) had a diagnosis of alcoholic cirrhosis (AC). Characteristics of the patient population are shown in Table 1. Though total discharges remained relatively constant from 2002 to 2014, mean charges per discharge increased approximately twofold. Total charges for AC increased by 95.7% over the time period, accounting for 59.9% of all inpatient cirrhosis-related charges in 2014. AC patients were younger and more likely to be white, uninsured, and male compared to nonalcohol-related cirrhosis (NC). Over a third were 51–60-year-olds and over a quarter were 41–50-year-olds. Patients with AC were admitted through the emergency room 74.6% of the time compared to 66.7% among NC patients ($p > 0.001$). Over time, emergency room admissions became more common for both groups. Patients admitted with AC were sicker as measured by the Elixhauser comorbidity index and had more variceal hemorrhage (10.0% vs. 6.2%; $p < 0.001$), and encephalopathy (22.4% vs. 13.7%; $p < 0.001$). Patients with AC were more likely to have portal hypertension (e.g., evidence of portal hypertension on imaging or physical exam, ICD-9 572.3) even without a discrete decompensation event, like ascites or a variceal bleed (23.4% vs. 18.4%; $p < 0.001$). More interventions such as having an EGD, paracentesis and blood transfusion were performed in the AC population, while this population received less hemodialysis than NC patients (Table 1).

Over the study period, aggregate annual charges for hospitalizations of AC admissions exceeded those of all other etiologies of cirrhosis. Total aggregate charges for AC admissions over the 13-year period were $28 billion and rose steadily from $1.4 billion in 2002 to over $2.8 billion by 2014 (Fig. 1). Standardized to year 2000 dollars to adjust for inflation, the total aggregate alcohol-related charges are $23 billion, ranging from $1.4B in 2002 to $2.0B in 2014, a 43% increase. Relationships among patient demographics, inpatient interventions and how they impact inpatient charges among patient with AC are shown in Table 3. Adjusting for all other covariates considered, advancing age increased the total charges. Patients 61–70 years of age had a $1473 greater mean total charges for an admission versus those < 40 years of age. Charges were on average $1155 lower for women with AC compared to men with AC. Medicare, Medicaid, Self-pay, and other forms of insurers were charged from $2062 to $7287 less than AC patients with private insurance. Increasing Elixhauser comorbidity index among AC patients led to an increase of $1784 per point and interventions such as hemodialysis and mechanical ventilation led to marked increases in charges. Alcohol detoxification led to $3488 less in charges per admission for AC patients (Table 3). Drivers of hospital charges among NC patients were similar in theme. Older male patients with more comorbid conditions had higher charges. Interventions like mechanical ventilation and hemodialysis led to higher charges (data not shown).

State Longitudinal Data

The SID from New York and Florida showed 215,886 discharges of 96,295 unique patients between 2010 to 2012. Patient demographics are described in Table 2. State data and national data were not meaningfully clinically different for etiology of disease, age, gender, and race.

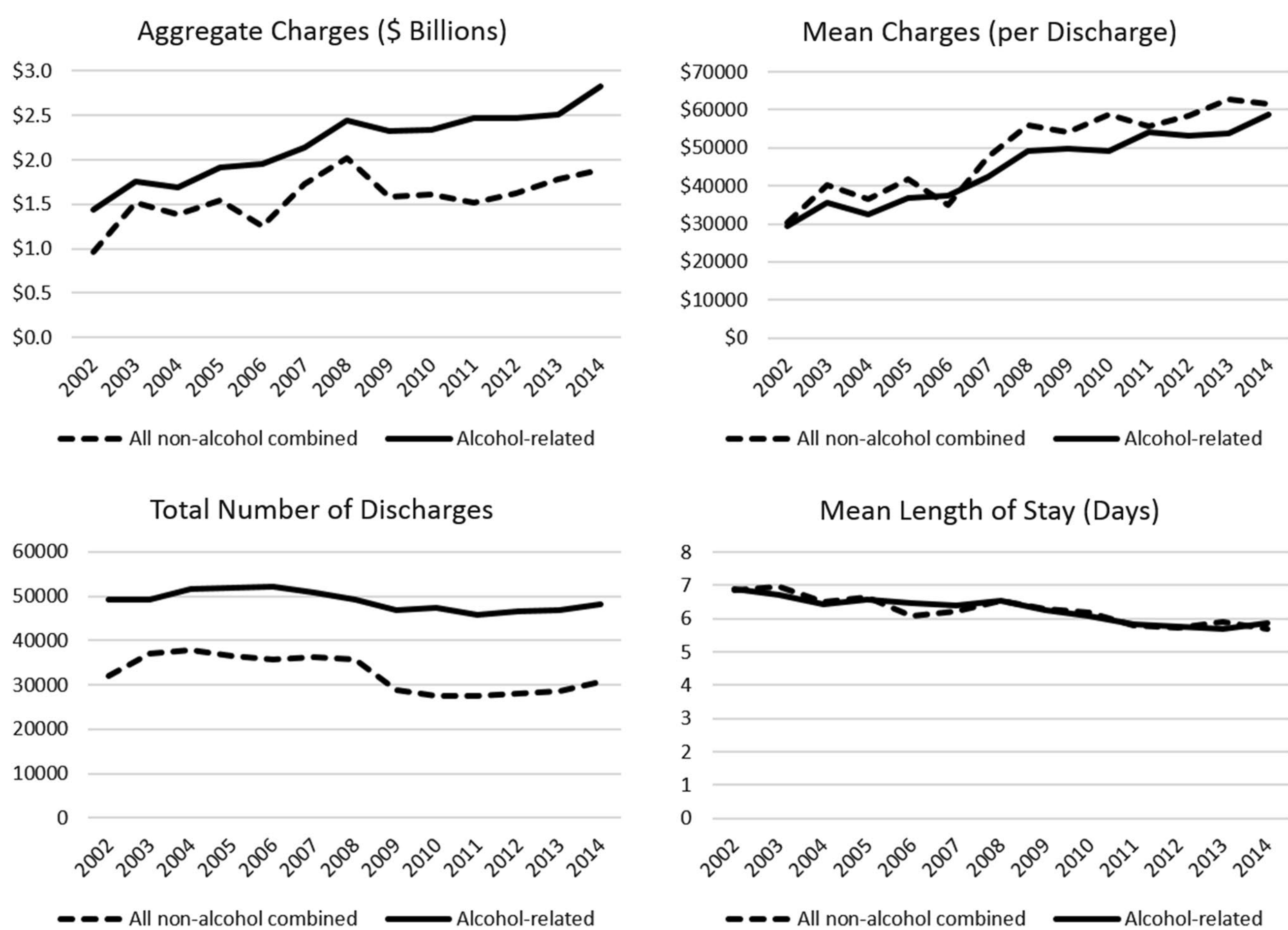

Fig. 1 Charts above are weighted national estimates from HCUP National (Nationwide) Inpatient Sample (NIS), Agency for Healthcare Research and Quality (AHRQ), based on data collected by individual States and provided to AHRQ by the States. Overall, the aggregate charges for alcohol-related cirrhosis exceeded all other etiologies of cirrhosis combined, while charges per admission and length of stay remained relatively similar

Table 3 Factors influencing total charges for alcohol-related cirrhosis discharges (NIS 2002–2014). Data in U.S. Dollars

Predictor	Est.	SE	95% CI L	95% CI U	*p* value
(Intercept)	14,798.2	490.3	13,837.3	15,759.1	< 0.001
Number of years since 2002	1896.0	40.8	1816.1	1975.9	< 0.001
Age Category (ref. < 40 years)					
41–50	172.9	401.4	− 613.8	959.5	0.667
51–60	224.4	392.1	− 544.2	993.0	0.567
61–70	1473.4	448.4	594.5	2352.3	0.001
71–80	− 297.9	546.4	− 1368.8	773.0	0.586
>80	− 427.9	861.3	− 2116.1	1260.3	0.619
Race (ref. White)					
Black	− 3273.6	337.7	− 3935.4	− 2611.7	< 0.001
Hispanic	5240.5	275.4	4700.7	5780.3	< 0.001
Other	2039.9	471.4	1116.0	2963.8	< 0.001
Female	− 1155.5	233.3	− 1612.9	− 698.2	< 0.001
Payer (ref. private)					
Medicare	− 4552.5	304.5	− 5149.3	− 3955.7	< 0.001
Medicaid	− 2675.8	299.0	− 3261.7	− 2089.8	< 0.001
Self-pay	− 4874.5	374.5	− 5608.6	− 4140.5	< 0.001
No Charge	− 7287.1	834.1	− 8922.0	− 5652.3	< 0.001
Other	− 2062.3	484.4	− 3011.8	− 1112.9	< 0.001
Weekend admission	− 1082.0	243.7	− 1559.6	− 604.4	< 0.001
Short stay	− 18,271.8	346.5	− 18,951.0	− 17,592.6	< 0.001
Adverse drug reaction	8650.1	553.9	7564.5	9735.7	< 0.001
Antibiotic	3361.6	969.3	1461.8	5261.3	0.001
Elixhauser comorbidity index	1784.3	65.1	1656.7	1911.8	< 0.001
Complications					
Sepsis	30,610.8	382.1	29,862.0	31,359.7	< 0.001
Encephalopathy	1515.5	248.6	1028.2	2002.8	< 0.001
Ascites	− 16.4	254.4	− 515.1	482.3	0.949
Portal hypertension	− 1358.4	262.6	− 1873.0	− 843.7	< 0.001
Variceal hemorrhage	− 1673.7	361.4	− 2382.0	− 965.4	< 0.001
Hepatorenal syndrome	18,075.9	550.4	16,997.0	19,154.7	< 0.001
Interventions					
Hemodialysis	41,265.1	604.3	40,080.7	42,449.5	< 0.001
Alcohol detoxification	− 3488.7	498.0	− 4464.7	− 2512.8	< 0.001
Mechanical ventilation > 96 h	122,227.7	594.9	121,061.8	123,393.6	< 0.001
EGD ≤ 24 h from admission	2644.3	343.5	1971.1	3317.5	< 0.001
EGD > 24 h from admission	13,776.1	341.4	13,107.0	14,445.2	< 0.001
Transfusion ≤ 24 h from admission	6220.5	297.9	5636.6	6804.5	< 0.001
Transfusion > 24 h from admission	17,872.4	331.8	17,222.1	18,522.8	< 0.001
Paracentesis ≤ 24 h from admission	− 4973.2	350.2	− 5659.6	− 4286.8	< 0.001
Paracentesis > 24 h from admission	13,569.5	355.8	12,872.1	14,266.8	< 0.001
Thoracentesis ≤ 24 h from admission	137.4	1037.9	− 1896.7	2171.6	0.895
Thoracentesis > 24 h from admission	35,494.1	850.6	33,826.9	37,161.3	< 0.001
TIPS ≤ 24 h from admission	36,288.5	1414.6	33,515.9	39,061.0	< 0.001
TIPS > 24 h from admission	56,724.1	1228.3	54,316.7	59,131.6	< 0.001

Alcoholic cirrhosis accounted for 53% of total admissions and 51% of cirrhosis-related inpatient charges, totaling $6B. Charges per admission were $53,838 for AC and $56,326 for NC ($p < 0.001$). Mean charges were similar for index admission charges and subsequent readmission charges at 30, 60, and 90 days. Importantly, readmission rates at 30, 60, and 90 days were all higher among AC patients (Table 2).

Consistent with the NIS, the SID showed patients with AC were younger, primarily white and male (Table 2). AC patients show a lower incidence of sepsis and acute kidney injury than NC patients (9.5% vs. 10.1%; $p<0.001$ and 18.5% vs. 19.8%; $p<0.001$). However, AC patients have a greater incidence of encephalopathy, variceal hemorrhage, ascites, and hepatorenal syndrome. There was one notable difference between the NIS and the SID dataset: the overall rates of ascites among AC patients (14.1% vs 25.8%). Other small differences were present in some patient characteristics, but not of clinical importance.

Unplanned Readmission Risks for Patients with Alcoholic Cirrhosis

Predictors of readmission were found using a random effects logistic regression model with a binary 30-day unplanned readmission outcome in AC patients (Table 4). There were no significant themes for readmission based on diagnosis, but several patient-specific characteristics stood out. Adjusting for all other covariates considered, odds for readmission increased in 2011 and 2012 compared to the referent year, 2010. Older patients (age > 60) had lower odds of readmission compared to those under 40. Black and Hispanic patients had a lower odds for readmission while women had a higher odds compared to men with AC. AC patients with any insurance other than private insurance were more likely to be readmitted within 30 days as well. For each additional comorbid condition as captured by the Elixhauser comorbidity index, there was a 17% increase in the odds of readmission. AC patients with a diagnosis of encephalopathy had 51% greater odds for a 30-day readmission compared to those without. Ascites, hepatorenal syndrome, spontaneous bacterial peritonitis, and acute kidney injury all increased the odds of readmission. AC patients that had acute alcoholic detoxification in the hospital were 59% less likely to be readmitted within 30 days. A shorter length of stay was also predictive of unplanned readmission [OR 0.987 (95% CI 0.984, 0.990)] Predictors of 30-day unplanned readmissions among the NC group were similar in theme (data not shown).

Discussion

This nationally representative cross-sectional study of inpatient charges for patients with cirrhosis shows a marked increase in cirrhosis-related charges from $1.4 billion in 2002 to $2.8 in 2014, with AC being responsible for more of these aggregate charges than all other etiologies of cirrhosis combined. This increase persisted after adjusting for inflation. Longitudinal data derived from two corresponding state databases (New York and Florida) indicate that the high inpatient charges for alcohol-related cirrhosis care are driven by higher total volume and readmission rates of these patients rather than differences in charges per admission. The difference in charges per admission between AC and NC admissions was small, yet the patients with AC were sicker as measured by the Elixhauser comorbidity index. As AC was the leading etiology of inpatient expenditures and the remainder of NC etiologies made up a heterogeneous group of viral hepatitis, cholestatic liver disease, and others, we restricted our charges and readmission analyses to AC and nonalcoholic cirrhosis.

As expected, complications of cirrhosis such as sepsis, ascites, hepatorenal syndrome, and variceal hemorrhage were all associated with higher charges regardless of cirrhosis etiology. Paracentesis any time during the stay increased the total charges but if paracentesis was performed within 24 h of admission, charges were reduced for both NC and AC patients. Need for paracentesis, overall, implies significant portal hypertension and more advanced liver disease, but early diagnostic paracentesis has been shown to improve inpatient outcomes, which may explain this dichotomous association between any versus early paracentesis and charges [16, 17].

Readmission rates were higher among patients with alcoholic cirrhosis and were associated with Caucasian race for unclear reasons. Having been discharged to another facility or home health care was also associated with readmission possibly due to closer monitoring or access to care. A shorter length of stay was slightly but statistically significantly associated with readmission as well, potentially indicating that a rush to discharge AC patients is self-defeating. The elderly (< 70) were significantly less likely to be readmitted perhaps due to outpatient mortality or increased use of hospice care (Table 4). Alcoholic cirrhosis patients tended to present with higher comorbidity index and more likely to present with ascites, encephalopathy or variceal hemorrhage. However, AC patients were also younger which may account for the slightly (4%) lower charges per admission, despite these more complex presentations. Also, a number of admissions for the alcohol-related cirrhosis patients may have been for detoxification only. Such admissions may carry significantly lower overall charges compared to patients coming in with hepatic decompensation, thus skewing the average charges per admission downward. Indeed, alcoholic cirrhosis patients that underwent alcoholic detoxification while hospitalized showed a reduction in inpatient charges and readmission risk. As alcohol use can impact surgical outcomes [18], it is also possible that patients with AC did not receive some elective procedures or the same level of care as NC patients. Readmission rates increased over time as well (OR 1.5 for 2011, 1.6 for 2012). This is likely due to a minority of patients receiving alcohol-specific therapies like detoxification and to improved survival of patients with

Table 4 Predictors of 30-day unplanned readmission (pooled NY/FL 2010–2012) alcohol-related cirrhosis

Predictor	OR	SE	95% CI L	95% CI U	*p* value
Year (ref. 2010)					
2011	1.498	0.052	1.400	1.603	< 0.001
2012	1.573	0.055	1.469	1.685	< 0.001
Age category (ref. < 40 years)					
41–50	1.077	0.075	0.939	1.235	0.289
51–60	1.002	0.068	0.877	1.145	0.974
61–70	0.814	0.059	0.706	0.938	0.004
71–80	0.667	0.055	0.567	0.784	< 0.001
>80	0.622	0.066	0.506	0.765	< 0.001
Race (ref. White)					
Black	0.605	0.030	0.550	0.666	< 0.001
Hispanic	0.830	0.032	0.769	0.896	< 0.001
Other	0.249	0.019	0.214	0.289	< 0.001
Female	1.108	0.034	1.044	1.176	0.001
Patient is homeless	0.555	0.047	0.470	0.654	< 0.001
Discharge destination (ref. routine)					
Transfer to short term hospital	1.362	0.086	1.204	1.541	< 0.001
Transfer to skilled nursing facility, intermediate care facility, or other	1.672	0.056	1.566	1.785	< 0.001
Home health care	1.537	0.055	1.433	1.648	< 0.001
Against medical advice	0.864	0.050	0.771	0.969	0.012
Payer (ref. private)					
Medicare	1.447	0.059	1.335	1.568	< 0.001
Medicaid	1.336	0.055	1.232	1.447	< 0.001
Self-pay	1.030	0.055	0.927	1.144	0.582
No charge	1.253	0.103	1.067	1.471	0.006
Other	2.189	0.132	1.945	2.464	< 0.001
Elixhauser comorbidity index	1.171	0.011	1.149	1.194	< 0.001
Weekend admission	1.080	0.028	1.027	1.135	0.003
Total length of stay	0.987	0.002	0.984	0.990	< 0.001
Complications of cirrhosis					
Variceal hemorrhage	0.923	0.038	0.850	1.001	0.053
Acute kidney injury	1.169	0.038	1.097	1.246	< 0.001
Spontaneous bacterial peritonitis	1.105	0.072	0.973	1.254	0.125
Ascites	1.177	0.030	1.119	1.238	< 0.001
Encephalopathy	1.517	0.041	1.439	1.599	< 0.001
Sepsis	0.917	0.038	0.844	0.995	0.037
Hepatocellular carcinoma	1.025	0.064	0.906	1.159	0.695
Hepatorenal syndrome	1.266	0.071	1.134	1.414	< 0.001
Interventions					
Alcohol acute detoxification (in hospital)	0.411	0.031	0.354	0.477	< 0.001
EGD within 24 h of admission	0.563	0.024	0.517	0.613	< 0.001
Paracentesis within 24 h of admission	1.303	0.044	1.221	1.391	< 0.001
Had major OR procedure	0.780	0.031	0.721	0.844	< 0.001
Any ICU stay	1.492	0.134	1.250	1.779	< 0.001
Liver transplant	2.639	0.273	2.155	3.231	< 0.001
Constant	0.031	0.002	0.026	0.036	< 0.001

cirrhosis overall [2], and thus more patients with AC are alive to be readmitted.

There were some small differences among patients with AC and NC that do not have an obvious explanation. AC patients had a slightly lower incidence of sepsis and acute kidney injury than NC patients (18.5% vs 19.8% for kidney injury). As both ascites and HRS were more common in AC than NC, this would seem to be unexpected. It is possible that AC patients admitted for detox might dilute the prevalence of complications for AC patients. Additionally, infectious and renal problems may be increased among the NC patients as this group includes those with cirrhosis from NAFLD with diabetes. Without reliable ICD9 coding for NAFLD, it is difficult to explore this relationship.

The NIS and SID databases are established, quality controlled data for outcomes research [9]. The NIS is organized at the level of hospital discharge (i.e., a patient may be discharged multiple times and account for multiple entries into the NIS per year) and allows for annual cross-sectional analyses of representative hospitals nationwide. The SID databases have patient level data where unique patients may be followed longitudinally over time. Using either database requires defining variables of interest using ICD-9-CM coding schemes that may lack sensitivity and specificity. One such code that has changed since the timeframe of this analysis is primary biliary cirrhosis to primary biliary cholangitis (PBC). While is it possible that noncirrhotic PBC patients were included, we believed this risk to be small based on prior studies. To reduce the risk of misclassification bias, previously validated and/or published coding schemes [2, 10–12] were utilized to extract variables from the data. Although we used only SID data from Florida and New York as a convenience sample for our longitudinal analyses, the demographic characteristics of patients in these two large-state databases were not clinically different, with the exception of ascites, from those in the nationwide NIS and thus thought to be nationally representative.

The increase in admissions, readmissions, and inpatient charges for alcohol-related cirrhosis patients described in our study is consistent with other trends described over the last decade. Case and Deaton recently reported on rising morbidity and mortality among white, non-Hispanic Americans. The increase in death rates of whites was mostly due to drugs, alcohol and chronic liver disease [19]. In our study, the same middle-aged Caucasians were at highest risk of readmission and the most expensive hospitalizations. Both studies speak to the societal burden of alcohol and liver disease, especially in this population. While lately, there has been a push for controlling the overuse and addiction problems related to prescription narcotics in this demographic, alcohol addiction must not be overshadowed, if the charges, morbidity, and mortality of cirrhosis are to be addressed. It is indeed possible with greater attention pain to opiate overuse and narcotic addiction, many of these patients may resort to alcohol misuse instead.

A potential limitation of this study is the use of charges rather than costs. Charges are prices hospitals set for services provided and can be used as a benchmark for negotiating with insurers. Costs are the financial burden to the hospital for providing care. Both of these factors can vary in private versus public settings, insurance carrier and by geography. Both of these terms can be used as metrics to define disease burden in monetary terms. A cost-to-charge ratio file is available for some years within the HCUP dataset, but was not available for all years of this analysis, thus data are presented as charges only.

As stated previously, misclassification bias can occur in administrative databases. One such concern here is the seemingly low prevalence of viral hepatitis in this study. As this is an inpatient study, the prevalence of viral hepatitis, HCV in particular, may not match some estimates of overall or outpatient prevalence. Nevertheless, our prevalence was comparable to prior estimates of about 1% for the National Health and Nutrition Examination dataset from 2003 to 2010 [20], 1.6% from 1999 to 2002 [21] and 1.8% from 1988 to 1994 [22]. Furthermore, much of the expense associated with HCV is incurred on an outpatient basis rather than as an inpatient. Continued vigilance is required, however, as the epidemiology of viral hepatitis changes [23, 24] and the opiate and alcohol epidemics remain intertwined. [19].

This study shows that inpatient costs for alcoholic cirrhosis dwarf other individual etiologies of liver disease such as NAFLD, viral hepatitis and cholestatic diseases and remain even greater than all these etiologies combined. Advances in the treatment of viral hepatitis and greater attention to NAFLD should be celebrated and these advances will keep patients out of the hospital. However, until greater attention is paid to alcoholic liver disease, inpatient cirrhosis-related healthcare expenditures will likely continue to rise. The burden of these charges will continue to fall on hospitals and the public as a whole, particularly since a greater proportion of alcoholic cirrhosis patients are uninsured or covered by Medicaid. Earlier addiction interventions with these patients may reduce index admission charges while understanding the predictors of readmission may allow for appropriate discharge planning to ultimately reduce readmission rates.

Compliance with ethical standards

Conflict of interest The authors have no relevant conflicts to disclose.

Appendix 1: Additional Cirrhosis-Related ICD-9 Codes Used

1. Alcoholic cirrhosis: 5712

2. Nonalcoholic cirrhosis: 5715
3. Biliary cirrhosis: 5716
4. Variceal hemorrhage: 4560, 53082, 53140, 53240, 5789, 5780
5. Encephalopathy: 5722
6. Ascites: 7895, 78951, 78959
7. Portal hypertension: 5723
8. Sepsis: 99591
9. Hepatorenal syndrome: 5724
10. Hepatocellular carcinoma (HCC): 1550
11. Hepatitis B (HBV): 07020-3, 07030-3, 07042
12. Hepatitis C (HCV): 07041, 07044, 07054
13. Acute Kidney Injury (AKI): 5845-9
14. Liver transplant: 505, 5051, 5059, V427 (or procedure codes 5051, 5059, 505, 0091, 0092, 0093)
15. Alcoholic hepatitis: 5711
16. Acute pancreatitis: 5770
17. Chronic pancreatitis: 5771
18. Primary Sclerosing cholangitis (PSC): 5761
19. Primary Biliary Cirrhosis/Cholangitis (PBC): 5716
20. Spontaneous Bacterial Peritonitis (SBP): 56723, 567, 5672, 5678, 5679
21. Transfusion: 9904, 9905, 9907
22. Esophagogastroduodenoscopy (EGD): 4513, 4233, 4516, 4443
23. Paracentesis: 5491
24. Thoracentesis: 3491
25. Trans-jugular intrahepatic portosystemic shunt (TIPS): 391
26. Hemodialysis: 3995
27. Mechanical ventilation > 96 h: 9672
28. Alcohol detoxification: 9462

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