Declining Inpatient Mortality Despite Increasing Thirty-Day Readmissions of Alcoholic Hepatitis in the United States From 2010 to 2018

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Abstract

Background: Alcoholic hepatitis (AH) readmissions are commonly secondary to relapse to alcohol use after discharge from the hospital.

Methods: This retrospective interrupted trend study analyzed the National Readmissions Database (NRD) from 2010 to 2018 to identify 30-day readmissions of AH using the International Classification of Diseases (ICD)-9 and ICD-10 codes (571.1 and K70.1). Individuals < 18 years, elective and traumatic readmissions were excluded. The biodemographic characteristics and hospitalization trends were highlighted over an 8-year time frame. A multivariate regression analysis was used to calculate the risk-adjusted odds of trends for all-cause 30-day readmissions, AH-specific readmissions, inpatient mortality, mean length of stay (LOS), and mean total hospital charge (THC) after adjusting for age, gender, grouped Charlson Comorbidity Index (CCI), type of insurance, mean household income, and hospital characteristics. P-values ≤ 0.05 were considered statistically significant.

Results: We noted an increasing trend for total 30-day readmissions of AH from 1,839 in 2010 to 3,784 in 2018 (P-trend < 0.001). Males made up a majority of the population; however, gender distribution was not statistically significant. Additionally, 30-day AH readmissions had an increasing comorbidity burden with time. The 30-day all-cause readmission rate increased from 18.8% in 2010 to 24.4% in 2018 and AH-specific readmission rate from 2.9% in 2010 to 3.9% in 2018 without a statistically significant trend. However, we noted a declining risk-adjusted trend of inpatient mortality for 30-day readmissions of AH from 8.7% in 2010 to 7.4% in 2018 (P-trend = 0.022). Furthermore, the total LOS attributable to 30-day readmissions of AH increased by 132.5% from 11,275 days in 2010 to 26,220 days in 2018 and the attributable

THC increased by 160.9% to over $67 million in 2018.

Conclusions: For 30-day AH readmissions, inpatient mortality declined to 7.4% in 2018, while the total number of hospitalizations, LOS and THC increased from 2010 to 2018.

Keywords: Alcoholic hepatitis; Hepatitis; Mortality; Outcomes; Trends

Introduction

Excess consumption of alcohol places an enormous socioeconomic burden on both individuals and healthcare systems across the globe [1]. From a clinical perspective, alcohol abuse is known to lead to multi-systemic cellular injury; however, the liver sustains the highest degree of cellular damage as it is the primary site of ethanol metabolism [2]. Alcohol liver disease (ALD) encompasses a wide spectrum of clinical conditions ranging from reversable fatty changes of the liver to irreversible cirrhosis and in some cases progression to hepatocellular carcinoma (HCC) [3]. Of the ALDs, alcoholic hepatitis (AH) is a distinct, acute, inflammatory liver disease secondary to chronic alcohol abuse associated with a poor prognosis [4]. In literature, AH has been associated with mortality rates as high as 40% within a 180-day period along with a nine times higher risk of progression to liver cirrhosis as compared to patients with only hepatic steatosis [5]. Patients with AH are at increased risk of subsequent hospitalizations and mortality due to sudden hepatic decompensation or relapse to alcohol use post hospital discharge [6]. However, there is significant paucity of data on early (within 30 days of hospital discharge) readmissions of AH with only a few studies available in literature. Therefore, this study was designed to identify hospitalizations characteristics, trends of readmissions and outcomes for 30-day readmissions of AH.

Materials and Methods

Design and data source

The data analyzed for this retrospective interrupted trend study was extracted from the Nationwide Readmissions Database (NRD) which is the largest, publicly available readmission database in the

US drawn from the Agency for Healthcare Research and Quality (AHRQ) Healthcare Cost and Utilization Project (HCUP) State Inpatient Databases [7]. For each calendar year, NRD contains discharge information from geographically dispersed and diverse states. It stores both patient-level and hospital-level information, and the hospitals are stratified according to ownership control, number of beds, teaching status, and metropolitan/non-metropolitan location. The NRD allows for weighted analysis to obtain 100% of the US readmissions within a given year.

Study population

This study analyzed hospitalizations from the NRD for the years 2010, 2012, 2014, 2016 and 2018 with AH as the cause for index admission using the International Classification of Diseases (ICD)-9 and ICD-10 codes (571.1 and K70.1). Using unique hospitalization identifiers, index hospitalizations were identified and one subsequent hospitalization within 30 days for AH was tagged as a readmission. Individuals < 18 years, traumatic and elective hospitalizations were excluded from the study.

Statistical analysis and outcome measures

The data were analyzed using Stata® Version 16 software (StataCorp, Texas, US). All analyses were performed using weighted samples for national estimates in adjunct with HCUP regulations for the utilization of the NRD. The comorbidity burden was assessed using Sundararajan's adaptation of the modified Deyo's Charlson Comorbidity Index (CCI) [8]. A multivariate regression analysis was used to calculate the risk-adjusted odds of trend for all-cause 30-day readmissions, AH-specific readmissions, inpatient mortality, length of stay (LOS), and total hospital charge (THC) after adjusting for age, gender, grouped CCI, type of insurance, mean household income, and hospital characteristics. The THC was obtained using the HCUP Cost-to-Charge Ratio files and adjusted for inflation using the Medical Expenditure Panel Survey index for hospital care, with 2018 as the reference point [9, 10]. All P-values were 2 sided, with 0.05 set as the threshold for statistical significance.

Ethical considerations

The NRD lacks specific patient and hospital identifiers. Therefore, this study was exempt from Institutional Review Board (IRB) approval as per guidelines put forth by our institutional IRB for NRD database studies.

Results

Hospitalization characteristics for 30-day AH readmissions

There was a rising trend for the total number of 30-day readmissions of AH from 1,839 in 2010 to 3,784 in 2018 (P-trend < 0.001). The mean age was noted to be around 46 years (Table 1). Although a higher proportion of the readmissions were observed for males, there was no statistically significant trend for gender. Additionally, 30-day readmissions for AH were observed to have an increasing comorbidity burden over time (Table 1). From a hospital perspective, large bed-sized and metropolitan hospitals had the highest proportion of 30-day AH readmissions. However, an increasing trend for 30-day readmissions of AH was noted only for metropolitan teaching hospitals with an increase from 50.3% in 2010 to 75.1% in 2018 (P-trend < 0.001).

Readmission trends for 30-day AH readmissions

The 30-day all-cause readmission rate of AH increased from 18.8% in 2010 to 24.4% in 2018 (P-trend = 0.107) and the 30-day AH-specific readmission rate increased from 2.9% in 2010 to 3.9% in 2018 (P-trend = 0.546) without a statistical trend after adjusting for patient-specific and hospital-specific factors (Table 2). Additionally, the 30-day AH readmission proportion increased from 18.6% in 2010 to 20% in 2018 without a statistical trend (P-trend = 0.402). However, inpatient mortality had a declining risk-adjusted trend from 8.7% in 2010 to 7.4% in 2018 (P-trend = 0.022) (Table 2).

Impact of 30-day AH readmissions on the United States healthcare system

From 2010 to 2018, the total LOS attributable to 30-day AH readmissions increased by 132.5% from 11,275 days in 2010 to 26,220 days in 2018. The mean LOS per readmission increased from 6.1 days in 2010 to 6.7 days in 2018 (P-trend = 0.822) without a statistical trend (Table 2). Furthermore, the THC attributable to 30-day AH readmissions increased by 160.9% to over $67 million in 2018 while the mean THC per admission increased from $14,285 in 2010 to $17,227 in 2018 (P-trend = 0.306) without a statistically significant trend. Medicaid was the largest insurer for the study period, followed by private insurance and Medicare.

Discussion

This study evaluates the trends of readmissions and outcomes for 30-day readmissions of AH from 2010 to 2018. We noted an increasing trend for the total number of 30-day readmissions of AH from 1,839 in 2010 to 3,784 in 2018 (P-trend < 0.001) with metropolitan teaching hospitals accommodating the highest readmissions. The 30-day all-cause readmission rates, 30-day AH-specific readmission rate and 30-day AH readmission proportion increased from 2010 to 2018 without a statistical trend. However, inpatient mortality had a declining risk-adjusted trend from 8.7% in 2010 to 7.4% in 2018 (P-trend = 0.022) (Fig. 1). Furthermore, the total LOS and THC attributable to 30-day AH readmissions increased by 132.5% and 160.9%, respectively.

Table 1. Demographic and Hospitalization Characteristics for 30-Day Readmissions of Alcoholic Hepatitis

Variables	Year				
	2010	2012	2014	2016	2018
Number of readmissions within 30 days	1,839	2,227	2,716	3,503	3,784
Mean age (years)	46.8 ± 0.9	46.4 ± 0.8	46.4 ± 0.7	45.9 ± 0.6	46.1 ± 0.5
Males (%)	58.1	53.4	57.2	56.7	54.4
Charlson Comorbidity Index score (%)					
0	23.3	23.6	21.5	5.4	5.6
1	24.6	23.5	18.0	26.8	27.0
2	6.3	5.8	6.7	10.0	10.1
≥ 3	45.8	47.1	53.8	57.8	57.3
Insurance type (%)					
Medicare	14.9	13.6	15.5	15.2	15.5
Medicaid	37.7	35.4	41.8	43.7	41.2
Private	29.2	33.3	29.3	29.8	30.6
Uninsured	18.2	17.7	13.4	11.3	12.7
Household income quartile (%)					
1	28.8	29.6	26.4	25.9	26.9
2	23.7	24.5	27.6	26.7	27.5
3	25.6	23.5	23.8	26.3	26.7
4	21.9	22.4	22.2	21.1	19.0
Hospital characteristics					
Hospital bed size (%)					
Small	13.2	12.1	17.2	14.2	15.8
Medium	21.0	25.6	28.3	27.3	27.8
Large	65.8	62.3	54.5	58.5	56.4
Teaching status (%)					
Metropolitan non-teaching	42.3	34.4	23.0	24.5	19.4
Metropolitan teaching	50.3	57.1	72.0	70.1	75.1
Non-metropolitan	7.4	8.5	5.0	5.4	5.5
Hospital volume quintiles (%)					
Q1	5.2	3.1	4.7	3.1	3.5
Q2	6.2	6.9	5.6	7.3	7.6
Q3	10.8	12.7	11.5	11.3	10.9
Q4	20.3	19.8	19.9	21.0	20.4
Q5	57.5	57.5	58.3	57.3	57.6

AH negatively impacts the patient's quality of life and places significant burden on the healthcare system. Furthermore, in patients who survive the first inpatient admission for AH, it is paramount to prevent relapse to alcohol use as the long-term survival depends on abstinence from alcohol rather than the severity of the disease [11]. In current literature, the relapse rates have been reported to be as high as 25% at 1 year and 60% at 5 years [11, 12]. Therefore, it is essential to estimate the magnitude of 30-day readmissions of AH and its impact on individuals and the healthcare system. In the US

from 2006 to 2014, alcohol-related emergency department (ED) visits increased by 47% accounting for an annual average increase of 210,000 [13]. A retrospective study from 2010 to 2014 noted that 30-day and 90-day readmissions for AH-related hospitalizations were 22.8% and 36.6%, respectively in the US with rates that were statistically unchanged for the study period [14]. Furthermore, from a mortality perspective, a systematic review by Hughes et al reported that the overall mortality of AH from 1971 to 2016 was 26% at 28 days, 29% at 90 days and 44% at 180 days after hospitalization and has

Table 2. Trends of Readmission Rates, Adverse Outcomes, and Healthcare Utilization for 30-Day Readmissions of Alcoholic Hepatitis

Outcome	Year					P-trend
	2010	2012	2014	2016	2018	
All-cause readmission rate (%)	18.8	19.9	21.3	25.9	24.4	0.107
Alcoholic hepatitis-specific readmission rate (%)	2.9	3.0	2.9	3.7	3.9	0.546
Alcoholic hepatitis readmission proportion (%)	18.6	18.0	16.6	18.1	20.0	0.402
Inpatient mortality (%)	8.7	8.5	8.5	9.1	7.4	0.022
Mean length of stay (days)	6.1	6.0	6.1	6.7	6.7	0.822
Mean total hospital cost ($)	14,285	12,952	13,331	16,456	17,227	0.306

not improved with time [15].

In this study, we noted an increase in the total number of readmissions within 30 days following index hospitalization of AH. This rising trend was expected as there is an increased consumption and dependence on alcohol use in the US population. Additionally, relapse to alcohol use, unwillingness to participate in an alcohol rehabilitation program post-discharge and sudden hepatic decompensation in these patients may also have a role to play. Population-based studies conducted in the US have reported the highest prevalence of ALD in the 45 - 64 age group with a mean age of 53 years [16]. A male predominance has also been reported [16]. Our study echoed these findings as the mean age for 30-day AH readmissions was noted to be approximately 46 years and a male predominance without a statistical trend for gender (Table 1). Furthermore, we noted an increase in the 30-day all-cause readmission rate, 30-day AH-specific readmission rate and 30-day AH readmis-

sion proportion without a statistical trend. These findings were in line with current literature in terms of similar proportions for 30-day AH readmission and statistically unchanged readmission rates for the study period [14]. However, we observed a declining risk-adjusted trend of inpatient mortality for 30-day AH readmissions from 8.7% in 2010 to 7.4% in 2018. These findings contradict prior studies which reported higher 30-day mortality with no improvement over time [15]. Although the exact reason for this downtrend in mortality, despite increasing trend of 30-day readmissions, is currently unknown, we hypothesize that it may in part reflect better management strategies and early access of subspeciality care for these patients. Nonetheless, we advocate for the need of additional large, prospective multi-center studies to further investigate these trends of inpatient mortality.

Moreover, with an increase in the overall 30-day readmissions of AH, the financial burden on the US healthcare system
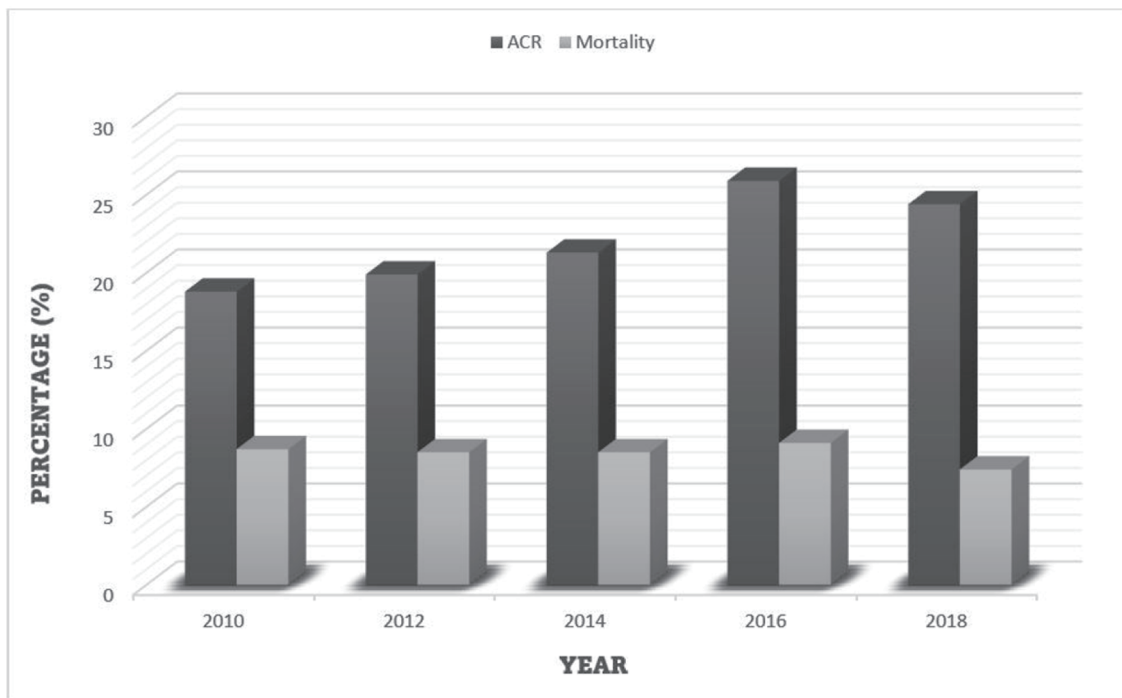

Figure 1. Trend of ACR and inpatient mortality for 30-day readmission of alcoholic hepatitis. ACR: all-cause readmission.

is expected to rise. A retrospective study conducted from 2010 to 2014 noted a substantial increase in the annual hospital cost to $164 million and the total hospitalization days to 22,244 for 30-day readmissions of AH in 2014 [14]. In our study, the mean LOS increased from 6.1 days in 2010 to 6.7 days in 2018 which attributed to an overall increase by 132.5% from a total 11,275 days in 2010 to 26,220 days in 2018. The mean THC per admission also increased from $14,285 in 2010 to $17,277 with the total attributable hospital cost increasing by 160.9% to over $67 million by 2018. From a purely hospital perspective, large bed-size hospitals were found to have the most 30-day readmission of AH for the study period, followed by medium bed-size and small-bed size hospitals. This may be attributed to the overall higher admission capacity of these larger hospitals. Furthermore, we noted an increasing trend in the proportion of 30-day readmissions of AH from 50.3% in 2010 to 75.1% in 2018 for metropolitan teaching hospitals. This may be due to the fact that these metropolitan hospitals are usually located in population dense urban areas and serve as tertiary care referral centers accepting patients from large geographical areas. Additionally, these hospitals are well equipped with a multi-disciplinary team of specialists and the resources required to manage not only AH readmissions, but also to treat associated complications, if any.

Strength and limitations

Our study has several strengths and limitations. The key strengths of this study are the study population, the unique study design, and the methodology. The data for this study were gathered from one of the largest, multi-ethnic, publicly available databases in the US developed through a unique Federal-State-Industry partnership. The NRD contains data from hospitals across the US covering about 97% of the population. Therefore, the results derived from the study are applicable to most hospitals across the US. Additionally, through its unique design and methodology, the study offers a comprehensive analysis of the biogeographic and hospitalizations characteristics along with adverse outcomes associated with 30-day readmissions of AH, adding meaningful information to current literature. Furthermore, the 9-year study periods helped to establish meaningful trends. However, we do acknowledge the limitations associated with this study. The NRD does not contain data on the severity of the disease at the time of readmission or the exact duration after discharge to readmission. Additionally, it does not contain information on the treatment aspects of AH. We were also unable to determine the proportion of patients with associated mood disorders, and those treated in alcohol rehabilitation centers. Moreover, due to the retrospective nature of the study, it is amenable to all biases associated with retrospective studies. Finally, the NRD is an administrative database that uses codes to store information on readmissions; therefore, it is susceptible to coding errors. Despite these limitations, we believe that this study helps us better understand the topic in question and fill the gaps in current knowledge. Through this study we aim to encourage intellectual conversation and promote future research on 30-day readmissions of AH.

Conclusion

AH is a significant health concern worldwide and in the US. From 2010 to 2018, there was a rising trend for 30-day readmissions for AH in the US from 1,839 in 2010 to 3,784 in 2018, which may be due to relapse to alcohol use post hospital discharge or sudden hepatic decompensation in patients with underlying ALD. However, the inpatient mortality rate for these readmissions was on a decline from 8.7% in 2010 to 7.4% in 2018 reflecting better access to care and significant improvement in management. There was an increase in the 30-day all-cause readmission rate from 18.8% in 2010 to 24.4% in 2018, 30-day AH-specific readmission rate from 2.9% in 2010 to 3.9% in 2018, and 30-day AH readmission proportion from 18.6% in 2010 to 20% in 2018, but no statistical trend was observed. Additionally, 30-day readmissions of AH places significant burden on the US healthcare system as the total days of hospital stay, and attributable hospital costs increased by 132.5% and 160.7%, respectively.

Data Availability

The NRD is a large, multi-ethnic, all-payer publicly available

inpatient database containing information on more than 18 million hospital stays per year in the US. Its large sample size provides sufficient data for analysis of readmissions for both common and relatively uncommon disorders across all hospital types. The NRD is available at: https://www.hcup-us.ahrq.gov/nrdoverview.jsp.

Abbreviations

AH: alcoholic hepatitis; AHRQ: Agency for Healthcare Research and Quality; ALD: alcoholic liver disease; CCI: Charlson Comorbidity Index; HCC: hepatocellular carcinoma; HCUP: Healthcare Cost and Utilization Project; ICD: International Classification of Diseases; IRB: Institutional Review Board; LOS: length of stay; NRD: National Readmissions Database; THC: total hospital charge; US: United States

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