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Racial differences in hospitalizations for acute cholangitis: a nationwide time trend analysis, 2008-2018

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Abstract

Background The data on racial epidemiologic trends for acute cholangitis (AC) are scarce. Therefore, we conducted a longitudinal assessment of the racial breakdown of AC-related hospitalizations in the United States (US) over 11 years (2008-2018).

Methods Using the National Inpatient Sample, we retrieved adult (>18 years) patients with AC. The adjusted yearly hospitalization rate per 100,000 for each race category was calculated based on the US population estimate for July 1 of the corresponding year obtained from the US Census Bureau. We followed Healthcare Cost and Utilization Project recommendations to: (1) derive a time-interrupted trend (before and after 2015), after determining that the International Classification of Diseases coding change affected AC hospitalizations because of more specific coding in the tenth revision; and (2) generate proportionate estimates using revised trend weights.

Results A total of 321,849 patients with AC were included in the analysis. Before 2015, the overall hospitalizations (per 100,000 persons) increased from 16.03 in 2008 to 20.76 in 2014 (P<0.001). Following 2015, the overall hospitalizations increased from 14.34 in 2016 to 14.70 in 2018 (P=0.04). After Whites, Asians represented the ethnic group with the highest race-specific AC hospitalizations per 100,000 persons.

Conclusions This cohort study demonstrated an overall rising and disproportionate rate among different races for AC-related hospitalizations. Even though Asians constitute only 6.5% of the US population, they represent the ethnic minority with most hospitalizations for AC.

Keywords Cholangitis, hospitalization, ethnicity, healthcare disparities

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Introduction

Acute cholangitis (AC) is characterized by an infection in the bile duct and carries high morbidity and mortality if diagnosis and treatment are delayed. Cholelithiasis is the most common precipitant factor, and its prevalence is greater in Hispanics than in other race categories in the United States (US) [1,2]. Race plays a multifactorial role in the prevalence of AC, as a result of disparities in risk factors, access to healthcare, and socioeconomic status [3]. In addition, the rapid aging of the population and the prevalence of multimorbidity have changed the epidemiology of the disease, making the updated knowledge of changing trends an essential tool for addressing healthcare discrepancies [4]. However, since the data on racial epidemiologic trends for AC are scarce, we wished to examine the race-related distribution of AC hospitalizations. Consequently, we sought to conduct a longitudinal assessment of the racial breakdown of hospitalizations for AC in the US over 11 years (2008-2018).

Materials and methods

Study design and patients

We conducted a retrospective longitudinal trend survey using the National Inpatient Sample (NIS). This database was designed

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Conflict of Interest: None

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as a stratified sample of 20% of all hospital stays in the USA. Each hospital discharge is then weighted (weight=total number of discharges from all acute care hospitals in the USA divided by the number of discharges included in the 20% sample), making it nationally representative. Using the codes of the International Classification of Diseases (ICD), Ninth Revision, and ICD, Tenth Revision for the corresponding years, we sampled every other year during the study period and included adult patients (≥18 years old) with AC (ICD-9: 576.1, ICD-10: K80.3, K83.0; detailed explanation of codes, with subterms, are provided in the Supplementary Table 1). The race variable is available within the NIS and contains a uniform coding for race and ethnicity. If the data source supplied information on race and ethnicity as separate data elements, ethnicity took precedence over race in setting the uniform values for the variable. The control population consisted of all adult hospitalizations. We followed Healthcare Cost and Utilization Project recommendations to: 1) derive a time-interrupted trend (before and after 2015), after determining that the ICD coding change affected AC hospitalizations because of more specific coding in the tenth revision; and 2) generate proportionate estimates using revised trend weights [5].

Statistical analysis

We used univariate logistic regression to compute unadjusted odds ratios (ORs) for patient and hospital-level variables in the database. Multivariate regression models were constructed by including all variables that were significantly associated with the outcome on univariate analysis with a cutoff P-value of 0.2. Variables deemed clinically important to the outcome based on the literature review were included in the model, irrespective of whether they were significantly associated on univariate analysis [5]. The variables adjusted for in the regression models were: sex, age, race, Charlson Comorbidity Index score, insurance status, median household income for patients' zip codes, hospital location/region/size (beds), and teaching status. The Hosmer-Lemeshow test was used to assess the model's goodness of fit (P>0.99) [6]. The yearly hospitalization rate per 100,000 for each race category was calculated based on the US population estimate for July 1 of the corresponding year obtained from the US Census Bureau. The linear trend for AC hospitalization across years was tested using the Mantel-Haenszel test of linear trend. Adjustment for multiple testing was achieved using the Hochberg method. We used Stata software, version 14.2, to perform analyses, with a 2-sided P<0.05 considered as statistically significant. The Institutional Review Board of Loyola University Medical Center authorized this study and deemed the research project exempt from approval because it was a retrospective review of already collected and de-identified data.

Missing data

Most of the variables had a very low percentage of missing data (<0.05%), except for hospital size (0.52%), insurance (0.19%), and median income in the patient's zip code (2.32%) (Supplementary Table 2). To test whether missing data could introduce bias into the study, we assumed that data were not missing at random and applied a multivariate imputation by chained equations (MICE) method estimated from sequential multivariate models with fully conditional specifications [7]. Overall, 10 imputed datasets were constructed, using information from all covariates used in the regression models and other covariates in the database without missing information. Results with and without imputation were not meaningfully different. Thus, results without imputation were reported.

Results

A total of 321,849 patients with AC were included in the analysis (Fig. 1). Men had more hospitalizations than women over the entire cohort (50.85-54.93% vs. 45.07-49.15%; Table 1). Mean hospital length of stay decreased from 7.89 days in 2008 to 7.28 days in 2014 (P<0.001), but the trend stabilized after 2015 (P=0.57). The Hosmer-Lemeshow test resulted in a non-significant statistic with P-value of >0.99. The hospitalization rates for different races in 2008 were (in descending order): Asian 18.46 (95% confidence interval [CI] 13.07-23.86), White 14.34 (95%CI 12.61-16.07), Hispanic 8.54 (95%CI 6.66-10.42), and Black 7.45 (95%CI 6.08-8.82) (P<0.001) (Fig. 2). In 2014, the rates were: White 21.56 (95%CI 20.32-22.81), Asian 17.53 (95%CI 14.99-20.06), Black 13.55 (95%CI 12.29-14.81), Hispanic 12.71 (95%CI 11.54-13.88) (P<0.001). Rates in 2018 were: White 15.72 (95%CI 14.69-16.76), Asian 11.38 (95%CI 9.65-13.11), Black 11.11 (95%CI 9.99-12.22), and Hispanic 9.63 (95%CI 8.71-10.55) (P<0.001).

Time trend analysis

Before 2015, the overall hospitalizations (per 100,000 persons) increased from 16.03 (95%CI 14.49-17.65) in 2008 to 20.76 (95%CI 19.77-21.75) in 2014 (P<0.001). Trends for each racial category from 2008 to 2014 were found to

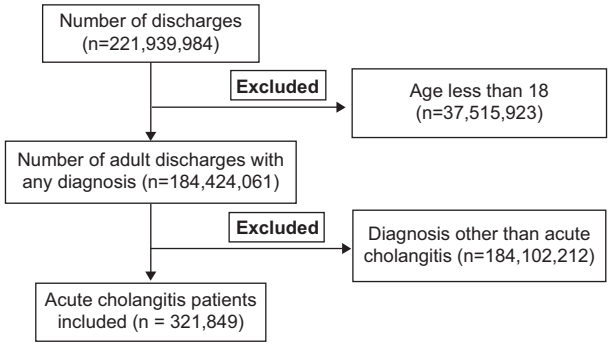
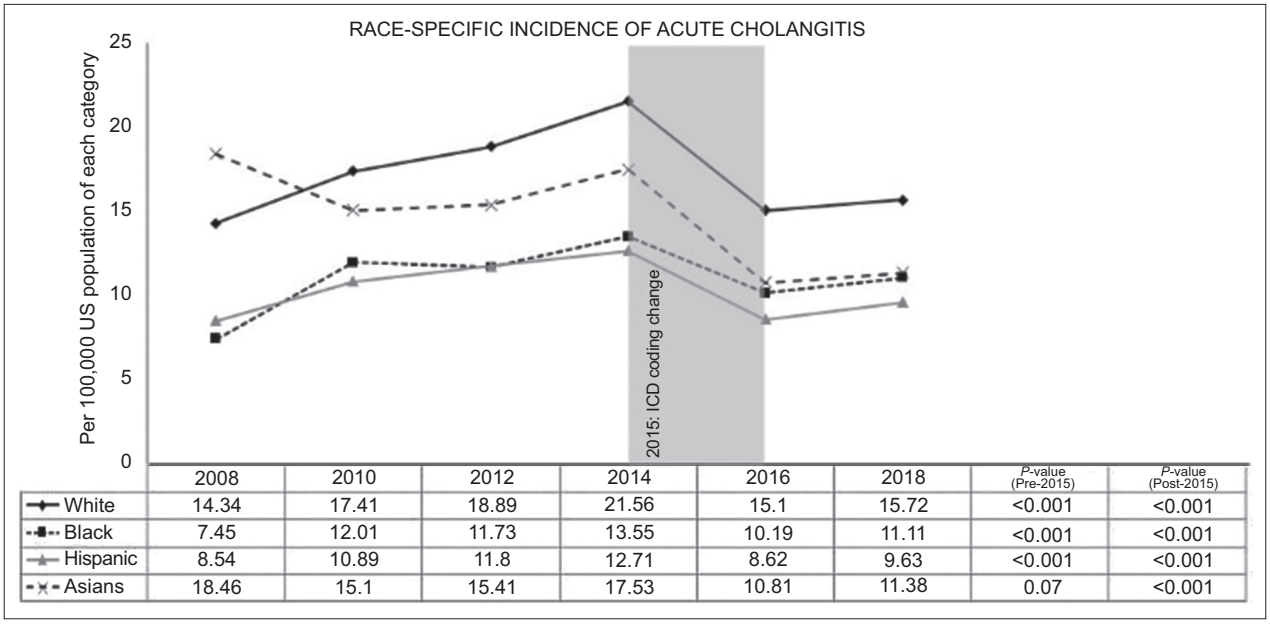


Figure 1 Patient selection process



	2008	2010	2012	2014	2016	2018	*P*-value (Pre-2015)	*P*-value (Post-2015)
White	14.34	17.41	18.89	21.56	15.1	15.72	<0.001	<0.001
Black	7.45	12.01	11.73	13.55	10.19	11.11	<0.001	<0.001
Hispanic	8.54	10.89	11.8	12.71	8.62	9.63	<0.001	<0.001
Asians	18.46	15.1	15.41	17.53	10.81	11.38	0.07	<0.001

Figure 2 Trends in racial and ethnic distribution of hospitalization rate of acute cholangitis 2008-2018
ICD, international classification of diseases

Table 1 Characteristics of patients hospitalized with acute cholangitis 2008-2018

Outcomes	Year							
	2008	2010	2012	2014	P-value[a,b]	2016	2018	P-value[a,b]
Acute cholangitis								
No. of hospitalizations	48,744	54,767	57,910	66,085	N/A	46,319	48,024	N/A
Hospitalizations per 100,000 persons	16.03	17.70	18.45	20.76	<0.001	14.34	14.70	0.04
Sex, %								
Male	50.85	52.04	53.01	52.01	0.05	54.85	54.93	0.62
Female	49.15	47.96	46.99	47.99	0.06	45.15	45.07	0.77
Age, mean, y	65.04	65.09	65.40	65.16	0.67	63.32	63.65	0.37
Length of hospital stay, mean, d	7.89	7.62	7.29	7.28	<0.001	7.32	7.17	0.57
Ethnic distribution of all adult patients hospitalized for any diagnosis, %								
White	54.49	60.36	65.09	64.84	<0.001	64.88	65.25	0.96
Black	10.29	14.06	13.89	14.01	<0.001	14.48	14.72	0.46
Hispanic	7.88	9.31	9.72	10.11	<0.001	10.37	11.22	0.04
Asians	2.04	2.06	2.25	2.42	0.04	2.58	2.72	0.38
Others	26.30	14.21	9.05	8.62	0.64	7.69	6.09	0.33

[a]P-value adjusted for sex, age, Charlson Comorbidity Index score, insurance status, median household income for patients' zip codes, hospital location/region/bedside, and teaching status

[b]Linear P trend values

be 14.34 to 21.56 in Whites, 7.45 to 13.55 in Blacks, 8.54 to 12.71 in Hispanics, and 18.46 to 17.53 in Asians (Fig. 2). Following 2015, the overall hospitalizations increased from 14.34 (95%CI 13.56-15.12) in 2016 to 14.70 (95%CI 13.85-15.55) in 2018 (P=0.04). Significant racial trends from 2016 to 2018 were; 15.10 to 15.72 in Whites, 10.19 to 11.11 in Blacks, 8.62 to 9.63 in Hispanics, and 10.81 to 11.38 in Asians (P values <0.001).

Discussion

This cohort study demonstrated a disproportionate AC hospitalization rate among different races. Asians represent approximately 2-3% of patients hospitalized for any cause but were the ethnic minority with the highest race-specific AC hospitalization per 100,000 persons. These findings are in accordance with a small non-US study demonstrating

that Asians have a higher AC prevalence than other ethnic populations [8]. Social determinants of healthcare, including socioeconomic status, living conditions and inequalities in access to healthcare, can explain the heterogeneity of the AC hospitalization rate [9,10]. Additional research is warranted to establish whether this reflects disparities in the prevalence of risk factors for AC, or whether race-specific genomics and eco-social factors also influence the disease course.

We also demonstrated that the hospitalization trend of AC shows a rise in the US. The prevalence of gallbladder disease is surging globally, as reported in studies by Urbach *et al* and Huang *et al* [11,12]. In addition to greater vigilance and advanced diagnosis strategies, the increasing prevalence of risk factors for cholelithiasis, including obesity, is also instrumental in the ever-changing trends. The specificity of ICD-10 coding resulted in better capturing and an apparent sharp decrease in the hospitalization rate of AC after 2015. Before the ICD coding change, trends were obtained uniformly by the ICD-9 coding system and represent true hospitalization rate variations. Limited available literature described ethnic AC incidence as a percentage among all AC patients, but these represent raw numbers [13,14]. The total population at risk is an essential parameter of incidence estimation, and we calculated the hospitalization rate per 100,000 persons of each race, which delineates the racial disease distribution more precisely.

A limitation of this survey is the likelihood of coding aberrations stemming from the reliance of the NIS on ICD codes. We relied on multivariate regression models to control for confounders, but residual confounding can still exist. We applied the Charlson Comorbidity Index for comorbidity burden and controlled for the various patient and hospital-level characteristics. However, the present results indicate that, even though Asians constitute only 6.5% of the US population, they represent the ethnic minority with most AC-related hospitalizations. Therefore, nationwide strategies are needed to identify the reasons for the variabilities and to halt this continuing disproportionate trend [15].

In conclusion, this cohort study demonstrated an overall rising and disproportionate hospitalization rate among different races for AC-related hospitalizations. Even though Asians constitute only 6.5% of the US population, they represent the ethnic minority with most AC-related hospitalizations.

Summary Box

What is already known:

- Cholelithiasis is the most common precipitant factor for acute cholangitis (AC), and its prevalence is greater in Hispanics than in other race categories in the United States (US)
- Studies describe AC-related ethnic differences in hospitalization as percentages among the hospitalized patients, without taking into account the total number at risk in each racial category
- The longitudinal trends of hospitalization due to AC are not known

What the new findings are:

- This cohort study demonstrated a disproportionate incidence of AC-related hospitalizations among the different races per 100,000 persons
- Even though Asians constitute only 6.5% of the US population, after Whites, they represent the ethnic minority with most AC-related hospitalizations
- The hospitalization rate for AC in the US continues to show a rising trend

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Supplementary material

Supplementary Table 1 International Classification of Diseases (ICD) codes

Disease/Procedure	ICD-9/10-CM codes
Calculus of bile duct with cholangitis, unspecified, without obstruction	K80.30
Calculus of bile duct with cholangitis, unspecified, with obstruction	K80.31
Calculus of bile duct with acute cholangitis without obstruction	K80.32
Calculus of bile duct with acute cholangitis with obstruction	K80.33
Calculus of bile duct with chronic cholangitis without obstruction	K80.34
Calculus of bile duct with chronic cholangitis with obstruction	K80.35
Calculus of bile duct with acute and chronic cholangitis without obstruction	K80.36
Calculus of bile duct with acute and chronic cholangitis with obstruction	K80.37
Other type of cholangitis	K83.09
Cholangitis, not otherwise specified	576.1

Supplementary Table 2 Missing data

Variables	Data missing (%)
Age (y)	0.02
Sex	0.03
Charlson comorbidity index	0.00
Median income in patient's zip code	2.32
Hospital region	0.00
Hospital size (beds)	0.52
Hospital location/teaching status	0.00
Insurance	0.19