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Original Article

Regional Differences in Hospitalizations and Cholecystectomies for Biliary Dyskinesia

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Background/Aims
Published studies suggest that socioeconomic factors contribute to increasing cholecystectomy rates for biliary dyskinesia (BD). The aim of this study was to identify factors driving admissions and operations for BD by examining regional variability in hospitalizations and cholecystectomies for this disorder.

Methods
Annual hospitalizations and cholecystectomy rates for biliary diseases were assessed using the State Inpatient Databases of the Agency for Healthcare Research and Quality based on diagnosis codes for biliary dyskinesia, cholecystolithiasis and cholecystitis.

Results
Annual admissions for BD varied nearly sevenfold among different states within the United States. Hospitalizations for gallstone disease and its complication showed less variability, differing 2-fold between states. Nearly 70% of admissions for BD and about 85% of admissions for gallstone disease resulted in cholecystectomies. Higher admission rates for BD were best predicted by high overall hospitalization rates, admission rate for gallstone disease and the physician workforce within a state. Cholecystectomy rates for BD were higher in states with low population density and high rates of cholecystectomy for gallstone disease.

Conclusions
These data suggest that established medical practice patterns significantly contribute to the variability in admissions and operations for biliary dyskinesia. The findings also indicate that lower thresholds for operative interventions are an important determinant in the approach to this disorder. Considering the benign course of functional illnesses, the bar for surgical interventions should be raised rather than lowered; in addition active conservative treatment options should be developed for these patients.
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Key Words
Cholecystectomy; Delivery of health care; Gastrointestinal disease

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Introduction

Biliary dyskinesia is defined by chronic problems with intermittent discomfort of presumed biliary origin associated with impaired gallbladder function, which is typically assessed with scintigraphic methods and stimulation, using a cholecystokinin analog.[1,2] We have recently described an increase in admissions for biliary dyskinesia, which disproportionally affected young individuals.[3] Interestingly, health insurance coverage was correlated with higher rates of admission for biliary dyskinesia, suggesting that socioeconomic factors contribute to decisions about managing patients with presumed functional biliary problems.

Considering the potential importance of non-medical factors in decisions about testing and/or treatment of gallbladder diseases, there is a significant regional variability in the approach to pain thought to be of biliary origin, but not associated with structural changes, such as cholecystolithiasis. Functional gallbladder testing has been widely adopted as a routine test in the United States in such scenarios,[1,2] whereas European experts dispute the clinical utility of demonstrating a low gallbladder ejection fraction.[4] In view of these findings, we hypothesized that regional disparities may also be seen within the United States. In order to address this question, we examined the State Inpatient Databases (SID) of the Agency for Healthcare Research and Quality and correlated findings with potentially important socioeconomic variables, such as poverty rates or physician supply. The aim of the study was to identify some of the potential non-medical factors that influence approaches to patients with presumed biliary disease.

Materials and Methods

The SID is a data repository on inpatient treatments for states from all different areas of the United States. We had previously validated the International Diagnosis Code (ICD)-9 575.8 (other specified diseases of the gallbladder) as predominantly used for biliary dyskinesia.[3] Databanks were queried for admissions with the ICD-9 code 575.8 as primary diagnosis during the years 2007-2010. Aggregate data were obtained to determine the total number of admissions per state, the type of hospital (teaching hospitals, metropolitan vs. rural hospitals), hospital ownership (government, private not-for-profit and private for-profit), hospital size, the age distribution defined in distinct cohorts (pediatric patients, patients 18-44, 45-64, 65-84 and those 85 years and above), gender distribution, insurance coverage (Medicare, Medicaid, private insurance and uninsured), and ethnic background, which was collapsed into two subgroups (minorities and Caucasians). For hospitalizations, the percentage of admissions with cholecystectomies was examined. Admissions were normalized to state population numbers as determined by the 2010 census (http://www.census.gov/2010census/data/). In addition, census data for population density, percentages of individuals living below poverty line, percentages residing in urban areas, the fractions of children and individuals over the age of 65 years, women and minorities were extracted. To account for differences in physician workforce, information about clinically active physicians (https://www.aamc.org/download/263512/data/statedata2011.pdf), gastroenterologists (http://www.hipaaspace.com/Medical.Statistics/Healthcare.Professionals.Availability/Gastroenterology/201102) and surgeons (http://www.acshpri.org/.../ACSHPRI_Surgical_Workforce_in_US_apr2010) were obtained from publicly available sources. As obesity is associated with biliary disease, most notably cholecystolithiasis, we obtained published obesity rates for the different states (http://www.cdc.gov/obesity/data/adult.html). Data were compared with admissions and cholecystectomy rates for gallstone disease and its complications, as identified by the diagnosis codes for cholelithiasis with cholecystitis (ICD-9 code 574.0-574.1) and acute cholecystitis (ICD-9 code 575.0-575.2).

Unless mentioned otherwise, data are given as percentages of admissions with standard errors. Univariate analyses were performed by determining Spearman correlation coefficients; to determine independent predictors of admissions, variables with P-values < 0.1 were entered into a stepwise forward regression (Sigmastat 2.0; SPSS Inc., Chicago, IL, USA).

Results

Biliary Dyskinesia

As shown in Table 1, admissions for biliary dyskinesia varied more than 6-fold, ranging from $1.1 \pm 0.1/100,000$ in Oregon and Hawaii to $7.4 \pm 0.4/100,000$ in West Virginia. There was some regional pattern with western states generally having lower, southern states higher admission rates (Fig. 1). Most of the admissions were associated cholecystectomies, which were performed in $69.3 \pm 0.5\%$. As was true for the admissions, there was some variability among the states with the lowest cholecystectomy

Table 1. Regional Variability in Annual Admission (Normalized by Population and Expressed as Admission per 100,000) and Surgery Rates (in Percent) for Biliary Dyskinesia and Cholelithiasis and Cholecystitis; the Right Column Lists All Annual Hospitalizations as Reference

State	Biliary dyskinesia		Cholelithiasis/cholecystitis		Annual hospitalizations per 100,000
	Admission per 100,00	Surgery rate	Admission per 100,000	Surgery rate	
West					
California	1.2 ± 0.1	69.1 ± 0.9	90.0 ± 1.5	87.5 ± 0.2	10,375 ± 39
Colorado	2.5 ± 0.2	73.9 ± 1.2	73.1 ± 1.5	92.0 ± 0.1	9,547 ± 50
Nevada	3.7 ± 0.4	74.9 ± 2.3	106.2 ± 2.2	85.7 ± 0.8	10,805 ± 53
Oregon	1.1 ± 0.1	80.7 ± 2.6	87.3 ± 1.6	88.9 ± 0.8	9,849 ± 60
Utah	1.8 ± 0.1	82.5 ± 1.9	60.7 ± 2.0	91.4 ± 0.3	9,642 ± 41
Washington	1.2 ± 0.1	70.9 ± 3.2	78.1 ± 1.5	85.5 ± 0.5	9,561 ± 34
Wyoming	3.2 ± 0.3	64.7 ± 3.8	80.3 ± 1.4	74.9 ± 1.8	9,753 ± 197
Midwest					
Illinois	3.5 ± 0.1	70.0 ± 1.9	93.0 ± 1.8	83.6 ± 0.3	12,617 ± 94
Iowa	2.2 ± 0.2	68.9 ± 2.1	79.6 ± 3.8	80.1 ± 0.7	11,688 ± 202
Kansas	4.6 ± 0.1	71.7 ± 0.6	82.7 ± 3.5	81.2 ± 2.1	11,703 ± 176
Michigan	3.1 ± 0.2	67.6 ± 1.7	75.9 ± 0.5	87.2 ± 0.2	12,999 ± 59
Minnesota	3.0 ± 0.1	78.4 ± 1.7	73.9 ± 3.7	87.7 ± 0.4	10,847 ± 239
Missouri	6.9 ± 0.2	75.7 ± 1.6	122.7 ± 0.6	80.8 ± 0.3	14,771 ± 47
Nebraska	3.0 ± 0.3	77.4 ± 4.8	88.5 ± 0.9	82.9 ± 0.8	11,748 ± 75
Wisconsin	2.4 ± 0.1	76.5 ± 1.4	82.3 ± 1.6	84.5 ± 0.1	11,117 ± 179
New England					
Maine	1.8 ± 0.2	61.8 ± 4.4	84.0 ± 1.3	82.5 ± 1.1	11,651 ± 146
Massachusetts	1.8 ± 0.2	59.6 ± 4.0	84.8 ± 1.8	82.3 ± 0.5	12,853 ± 22
New Hampshire	1.3 ± 0.1	68.4 ± 0.0	70.7 ± 0.4	78.2 ± 1.2	9,718 ± 37
Rhode Island	1.9 ± 0.4	61.7 ± 9.7	99.3 ± 3.5	84.0 ± 0.5	13,004 ± 141
Vermont			63.2 ± 2.9	70.0 ± 2.1	8,613 ± 63
Atlantic					
Maryland	2.7 ± 0.1	55.0 ± 2.4	87.6 ± 1.1	85.5 ± 0.2	13,205 ± 78
New Jersey	2.0 ± 0.2	60.9 ± 1.5	126.9 ± 1.3	82.8 ± 0.4	12,521 ± 75
New York	2.1 ± 0.1	60.6 ± 1.3	110.1 ± 0.7	74.7 ± 1.2	13,348 ± 29
South					
Arkansas	5.4 ± 0.2	69.6 ± 1.3	101.4 ± 2.1	83.5 ± 0.6	13,718 ± 132
Florida	4.1 ± 0.2	71.4 ± 1.5	114.4 ± 1.5	91.9 ± 0.9	13,541 ± 64
Kentucky	5.6 ± 0.1	67.6 ± 1.0	115.7 ± 2.2	85.9 ± 1.5	14,240 ± 71
North Carolina	3.7 ± 0.2	73.3 ± 1.0	93.0 ± 0.9	86.7 ± 1.4	11,709 ± 29
South Carolina	4.2 ± 0.3	75.0 ± 0.5	94.7 ± 2.5	85.9 ± 0.2	12,023 ± 139
Tennessee	3.7 ± 0.1	72.2 ± 1.6	97.0 ± 2.4	85.3 ± 1.1	13,070 ± 140
West Virginia	7.4 ± 0.4	61.3 ± 3.3	138.5 ± 4.9	78.1 ± 0.3	15,313 ± 43
Southwest					
Arizona	5.6 ± 0.3	79.3 ± 1.2	133.4 ± 2.3	93.4 ± 0.7	12,062 ± 101
New Mexico	3.1 ± 0.5	75.6 ± 3.9	115.2 ± 6.8	85.6 ± 0.8	9,803 ± 93
Oklahoma	3.8 ± 0.3	69.1 ± 4.9	108.2 ± 1.4	80.7 ± 0.4	13,472 ± 125
Texas	3.3 ± 0.1	73.2 ± 0.8	104.7 ± 0.5	86.5 ± 0.1	11,065 ± 40
Hawaii	1.1 ± 0.2		82.5 ± 4.3	86.6 ± 0.6	8,856 ± 25

rates in Maryland (55.0 ± 2.4%) and the highest in Utah (82.5 ± 1.9%). Considering the disproportionate increase in cholecystectomies for biliary dyskinesia in the pediatric population, we next examined variability of admissions in this age group, which demonstrated a similar variability (Fig. 2A).

Cholelithiasis and Cholecystitis

Admissions due to gallstone disease and its complications varied by a factor of 2, with Utah having the lowest number (60.7 ± 2.0/100,000) and West Virginia having the highest number of hospitalizations (138.5 ± 4.9/100,000). Cholecystectomy rates for gallstone disease were higher than those for biliary dyskinesia (84.1 ± 0.8% vs. 70.3 ± 1.2%, respectively; $P < 0.01$). As was true for biliary dyskinesia, there were regional differences with the lowest rates in Vermont (70.0 ± 2.1%) and the highest in Arizona (93.4 ± 0.7%). Pediatric patients accounted for a smaller fraction of admissions than in biliary dyskinesia (1.5 ± 0.1% vs. 9.0 ± 1.4%, respectively; $P < 0.01$) with an about twofold difference between states (Fig. 2B).

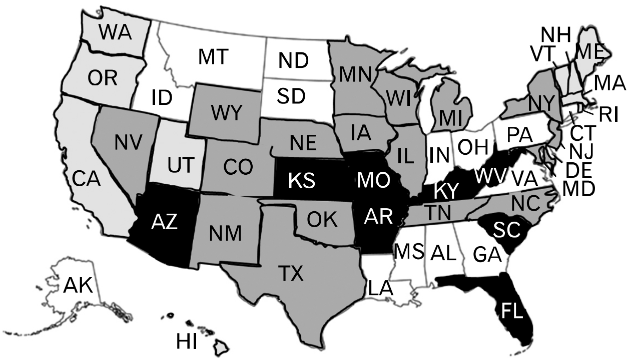

Figure 1. Regional variation in annual admission rates for biliary dyskinesia within the United States. White, no data; light grey, 1-2/100,000; dark grey, 2-4/100,000; black, > 4/100,000.

Predictors for Admission and Cholecystectomy for Biliary Disease

To identify potential predictors of admissions for biliary dyskinesia, univariate analyses were performed. Focusing on demographic characteristics of the different states, poverty and adult obesity rates strongly correlated with a higher number of admissions for biliary dyskinesia and cholelithiasis/cholecystitis. In addition, the percentage of minority individuals living within a state correlated with admissions for complications of gallstone disease (Table 2). Looking at patient demographics, the fraction of younger patients and women correlated with admission rates for the biliary diseases examined. Interestingly, the pattern differed between biliary dyskinesia and complications of gallstone disease, with the latter correlating with higher, ther former with lower admission rates. There was an inverse relationship between the fraction of privately insured patients and the number of admissions for biliary problems (Table 2). Lastly, variables related to differences in the healthcare system and practice patterns were assessed. Higher number of annual hospitalizations for all reasons and those for different biliary problems strongly correlated significantly with each other (Fig. 3). There was an inverse relationship between physician workforce within a state and admissions for biliary dyskinesia. Hospital ownership and size correlated with admissions for biliary diseases (Table 2). The best independent predictors for admissions due to biliary dyskinesia were overall hospitalization rates, admissions for cholelithiasis/cholecystitis and the physician workforce within a state. Annual

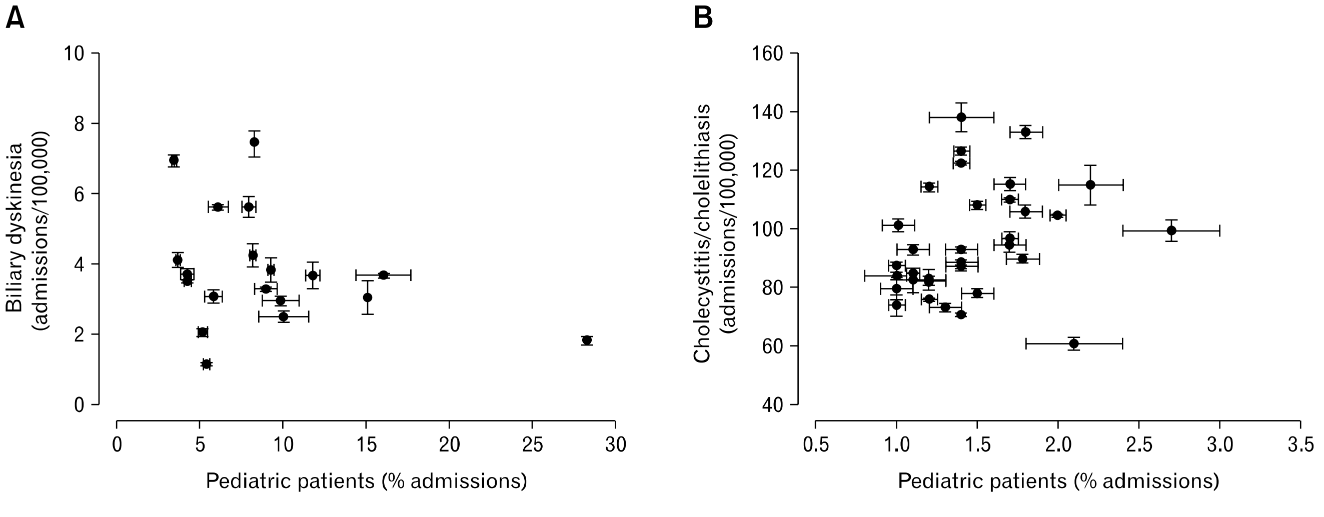

Figure 2. Scatterplots depicting the relationship between the fraction of pediatric admission for biliary dyskinesia (A) or complications of gallstone disease (B) the overall admission rates for these disorders normalized by population size.

Table 2. Correlation Coefficient Showing Relationship Between Rates of Admissions and Surgery for Biliary Dyskinesia or Cholecystitis/Cholelithiasis and Socioeconomic Variables

Variable	Biliary dyskinesia		Cholelithiasis/cholecystitis	
	Admission per 100,00	Surgery rate	Admission per 100,000	Surgery rate
Population				
Size	0.15	-0.02	0.27	0.38[b]
Density	-0.15	-0.52[c]	0.20	0.04
Poverty rate	0.59[c]	0.23	0.62[c]	0.33[a]
Urbanization	-0.25	0.05	0.13	0.46[c]
Minority	0.07	0.07	0.38[b]	0.47[c]
< 18 yr	0.18	0.55[c]	-0.1	0.16
≥ 65 yr	0.02	-0.2	0.19	-0.32[a]
Obesity rate	0.61[c]	-0.07	0.34[b]	-0.15
Physician workforce				
Physicians/100,000	-0.61[c]	-0.41[b]	-0.19	-0.08
GI-MD/100,000	-0.20	-0.31[a]	0.14	0.12
Surgeon/100,000	-0.37	-0.59[c]	-0.15	-0.44[b]
Demographics				
Patient < 18 yr	-0.32[b]	0.35	0.41[b]	0.19
Patient ≥ 65 yr	0.08	-0.44[b]	-0.32[a]	-0.55[c]
Women	-0.33[a]	-0.20	0.62[c]	0.36[b]
Minority patients	0.07	0.22	0.30	0.55[c]
Urban residence	-0.14	-0.17	0.24	0.18
Rural residence	0.28	-0.03	-0.21	-0.41[a]
Insurance coverage				
Medicare	0.14	-0.23	-0.11	-0.05
Medicaid	-0.30	0.09	0.16	0.17
Private insurance	-0.48[b]	0.12	-0.33[a]	0.32[a]
Uninsured	0.23	-0.20	0.38	-0.20
Hospital characteristics				
Government hospital	-0.02	0.16	0.03	0.16
Non-profit hospital	-0.47[c]	-0.28	-0.21	-0.44[b]
For profit hospital	0.11	0.27	0.41[b]	0.26
Teaching hospital	-0.28	-0.17	0.01	-0.11
Metropolitan hospital	-0.31[a]	0.38[b]	0.3[a]	-0.07
Large hospital	0.57[c]	0.42[c]	0.47[c]	-0.02
Practice pattern				
Overall admissions	0.65[c]	-0.40[b]	0.68[c]	-0.20
Biliary dyskinesia admissions	n/a	0.15	0.61[c]	0.03
Biliary dyskinesia operations	0.15	n/a	-0.11	0.56[c]
Cholelithiasis/cholecystitis admission	0.61[c]	-0.11	n/a	-0.03
Cholelithiasis/cholecystitis operations	0.03	0.56[c]	-0.03	n/a

GI-MD, gastroenterologists; n/a, not applicable.
[a]$P < 0.1$, [b]$P < 0.05$, [c]$P < 0.01$.

hospitalizations, poverty rate and the fraction of women admitted independently predicted admissions due to complications of gallstone disease (Table 3).

Univariate analyses showed correlations between surgery rates for biliary dyskinesia and population density (inverse), the percentage of children living in a state, the fraction of older individuals admitted for biliary dyskinesia (inverse), hospital ownership, size and location, physician workforce (inverse) and the rate of cholecystectomies for other biliary diseases (Table 2 and Fig. 3). While hospital ownership, physician workforce and pa-

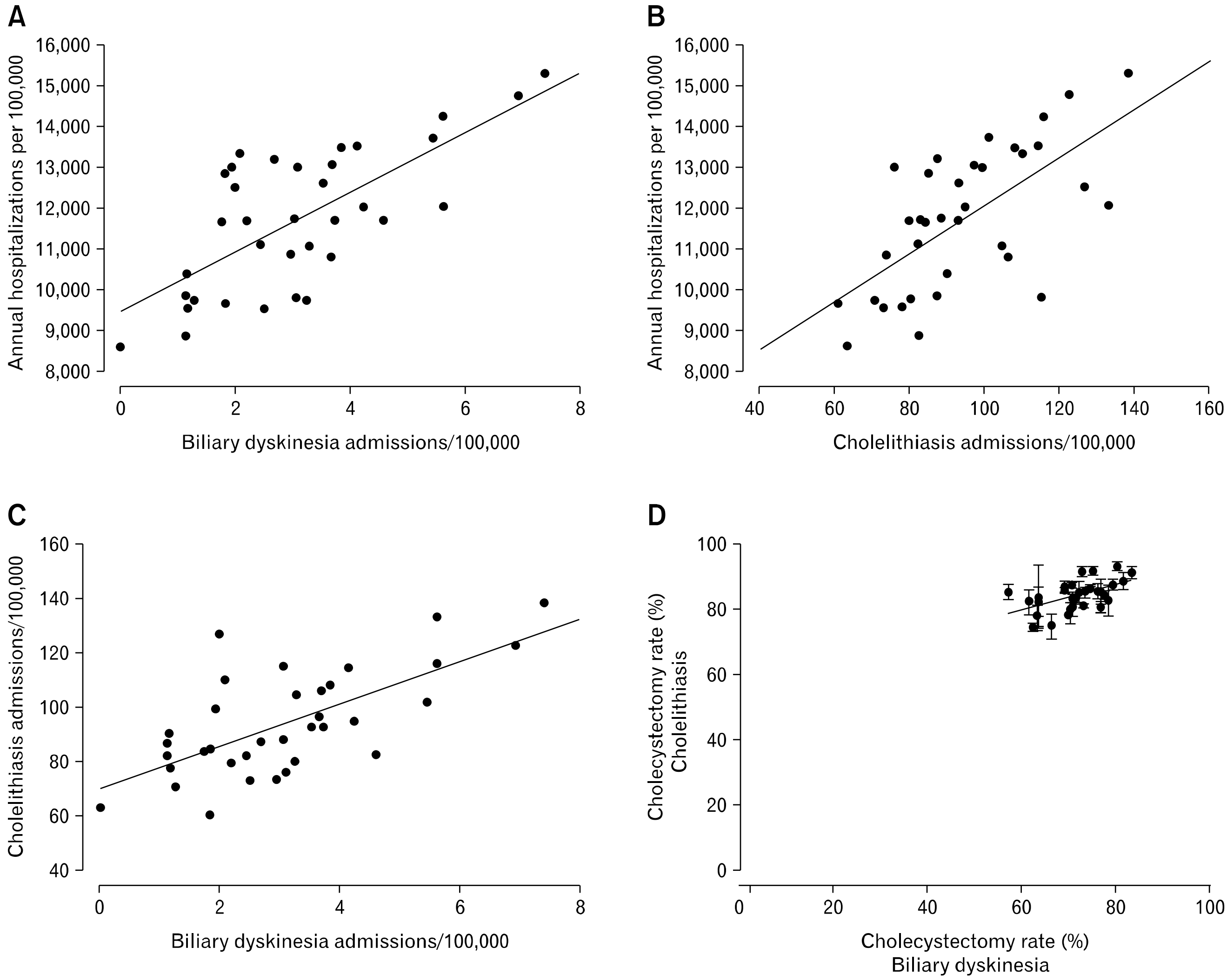

Figure 3. Scatter plots showing the correlation between admissions for biliary dyskinesia (A) and gallstone disease (B) and overall annual hospitalizations, normalized by population size. The relationship for admissions and cholecystectomy rates between these biliary diseases is depicted in C and D.

Table 3. Independent Predictors of Admission and Surgery Rates for Biliary Dyskinesia and Cholelithiasis as Determinant by Stepwise Forward Regression

Dependent variable	Predictor	R^2	Significance
Admissions for biliary dyskinesia	Admissions for cholelithiasis	0.550	$P = 0.036$
	Overall admission rate	0.673	$P = 0.004$
	Physicians work force	0.766	$P = 0.027$
Cholecystectomy for biliary dyskinesia	Population density	0.471	$P < 0.001$
	Cholecystectomy rate for cholelithiasis	0.613	$P = 0.007$
Admissions for cholelithiasis	Overall admission rate	0.428	$P < 0.001$
	Fraction of female patients	0.607	$P = 0.005$
	Poverty rate	0.653	$P = 0.053$
Cholecystectomy for cholelithiasis	Poverty rate	0.395	$P < 0.001$
	Private insurance coverage	0.477	$P < 0.001$

tient age similarly correlated with cholecystectomy rate for cholelithiasis/cholecystitis, there were also significant relationships with population size and density as well as urbanization (Table 2). The best independent predictors for surgery were low population density and high rates of cholecystectomy for complications of gallstone disease in the case of biliary dyskinesia and higher poverty rates and a lower fraction of privately insured patients for surgical therapy of cholelithiasis/cholecystitis (Table 3).

Discussion

Using the State Inpatient Databank, we identified a significant regional variability in hospitalizations and operations for biliary dyskinesia. While the differences in demographic characteristics, such as rates of poverty or obesity, potentially contribute to these differences, they are not the main factors as shown by our analysis. Independent of the results of statistical testing, a six-fold difference in hospitalizations for biliary dyskinesia between Maine and West Virginia is difficult to reconcile with presumed differences in disease mechanisms, as both states have a relatively low population density with the majority living in smaller, mostly rural communities, with Caucasians making up more than 90% of the population and without strikingly different adult obesity or poverty rates. Consistent with the results of our statistical assessment, the differences between these two states also extends to admissions for gallstone disease and overall hospitalization rates, pointing more at established practice patterns than biological causes as the underlying cause. The importance of established patterns is further supported by the close correlation between cholecystectomies for complications of gallstone disease and the rate of surgical treatment for biliary dyskinesia, and may well go beyond the approach to biliary disease. Beyond factors examined in this study, regional differences in the organization of healthcare delivery or the health insurance market may contribute to this pitcture. Lastly, similarities between neighboring states described above may be a reflection of similarities in medical training, which does not only affect medical decision making, forming a culture of medical reasoning and decision-making, but also practice locations, as the majority of physicians choose practices in relatively close proximity to the location of their residency.[5,6]

Established or changing practice patterns have previously been shown to influence the approach to biliary diseases. The introduction of laparoscopic techniques resulted in a significant increase in cholecystectomies with a shift to more elective operations in younger, low risk patients with chronic symptoms.[7-9] Independent of such innovations, others have reported regional differences in the management of gallbladder disease that cannot be explained by variability of demographic characteristics or availability of medical services. For example, treatment of acute cholecystitis varied significantly within a region or even a single city.[10,11] Consistent with a role of practice location and practice patterns, a prior study demonstrated that biliary dyskinesia is more commonly diagnosed by surgeons in rural settings.[12] We did not identify a correlation between cholecystectomy rates and patients with rural residence or treatment in a rural hospital. However, a low population density and fewer practicing physicians within a state, both variables associated with rural environments, were independent predictors for admission and/or surgery rates for biliary dyskinesia.

While lower than in biliary dyskinesia, we also noted regional variability in the approach to cholelithiais/cholecystitis. As was the case for biliary dyskinesia, regional differences in practice patterns contributed to this variability, as overall annual hospitalizations independently predicted the rate of admissions for complications of gallstone disease, when controlling for obesity, poverty, age and racial composition of the different states. Our findings fit into a larger picture, demonstrating regional variations in healthcare utilization, which influences the choice of diagnostic testing, medical or surgical therapy[10-17] and may be confounded by physician or patient preference, difference in insurance status and demographic or economic factors.[12,15,18]

The study has several important limitations. First, biliary dyskinesia does not have a distinct diagnosis code. Using a validation sample with a detailed analysis of medical records, we have previously shown that biliary dyskinesia accounted for more than 80% of the patients with the ICD-9 code 575.8 as the primary diagnosis code. The validation study was based on a single medical center. Thus, regional variability in coding could affect our results, but is unlikely to explain the seven-fold difference in admission rates. As is true for all studies based on large databanks, correlations do not proof causality. The analyses combined data from different sources, not allowing us to truly relate obesity as a potentially relevant comorbid condition to biliary disease. We used the published rates for adult obesity within states and may thus underestimate its true impact on the manifestations of biliary disease. In addition, some variables may simply be indicators or surrogate markers of other influences that were not included. For example, poverty levels are often also associated with lower educational achievements and different dietary habits. Finally, all data are based on admissions, not patients. Therefore, repeat admissions could skew the results. Considering cholecystectomy rates of about 70%, the contribution of such repeated admissions will not account for a large number of hospitalizations.

Despite these limitations, the results fit into a bigger picture. The significant variability in admissions for biliary dyskinesia as central finding is consistent with prior studies suggesting a significant impact of socioeconomic rather than biological factors in the diagnosis of biliary dyskinesia as an indication for cholecystectomy.[3,12] European experts question the utility of functional gallbladder testing in diagnosing a clinically relevant disorder or predicting treatment outcomes.[4] While it has never been systematically analyzed, the approach to presumed functional disorders of the biliary tree seems to differ even more strikingly on a global level. Published case series of pediatric patients undergoing cholecystectomies did not include biliary dyskinesia in European studies,[19-22] while it accounts for up to more than 50% of the operations in the United States.[23-28] Focusing on adult patients, a meta-analysis of surgical case series describing the outcomes after cholecystectomy for biliary dyskinesia similarly only identified studies conducted in the United States.[29] In contrast, meta-analyses focusing on surgical techniques or antibiotic prophylaxis for cholecystectomy identified studies performed in multiple countries including the United States.[30-33]

In conclusion, admissions and operations for biliary dyskinesia are at least partly driven by practice patterns, with regional variations likely reflecting differences in threshold for operative interventions. No study has ever addressed the natural history of biliary dyskinesia. While cholecystectomy may be associated with symptomatic improvement, long-term results suggest a lessening benefit and show an ongoing impairment of quality of life measures,[34] findings that fit into our understanding of the natural history of other functional gastrointestinal disorders.[35,36] Considering the benign natural history of gallstone disease[37] and the risk of cholecystectomy, it is time to study the natural history of this syndrome and test non-operative interventions that have shown benefit in related disorders, such as functional dyspepsia.

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