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National trends of endoscopic retrograde cholangiopancreatography utilization and outcomes in decompensated cirrhosis

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Abstract

Background Endoscopic retrograde cholangiopancreatography (ERCP) can be challenging in patients with decompensated cirrhosis (DC) due to increased risk of adverse events related to liver dysfunction. Limited data exist regarding its national utilization in patients with DC. We aim to determine the trends in utilization and outcomes of ERCP among patients with DC in US hospitalizations.

Methods We identified hospitalizations undergoing ERCP (diagnostic and therapeutic) between 2000 and 2013 from the National Inpatient Sample (NIS) database and used validated ICD9-CM codes to identify DC hospitalizations. We utilized Cochrane–Armitage test to identify changes in trends and multivariable survey regression modeling for adjusted odds ratios (aOR) for adverse outcomes and mortality predictors.

Results There were 43782 cases of ERCPs performed in DC patients during the study period. Absolute number of ERCPs performed in this population from 2000 to 2013 showed an upward trend; however, the proportion of DC patients undergoing ERCP remained stable. We noted significant decrease in utilization of diagnostic ERCP and an increase of therapeutic ERCPs ($P<0.01$). There was a significant decrease in the mean length of stay for DC patients undergoing ERCP from 8.2 days in 2000 to 7.2 days in 2013 ($P<0.01$) with an increase in the mean cost of hospitalization from $17053 to $19825 ($P<0.001$). Mortality rates showed a downward trend from 2000 to 2013 from 13.6 to 9.6% ($P<0.01$). Increasing age, Hispanic race, diagnosis of hypertension and diabetes mellitus, and private insurance were related to adverse discharges($P<0.01$). Increasing age, presence of hepatic encephalopathy, and sepsis were associated with higher mortality ($P<0.01$).

Conclusions There is an increasing trend in therapeutic ERCP utilization in DC hospitalizations nationally. There is an overall decrease in mortality in DC hospitalizations undergoing ERCP. This improvement in mortality suggests improvement in both procedural technique and peri-procedural care as well as overall decreasing mortality in cirrhosis.

Keywords ERCP · Cirrhosis · Epidemiology · Trends · Healthcare utilization

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Liver cirrhosis affects nearly 5.5 million patients and is the 8th leading cause of mortality in the United States [1, 2]. Cirrhosis can be further classified into compensated and decompensated types. Decompensated cirrhosis is defined as the development of complications of cirrhosis such as ascites, varices, jaundice, and encephalopathy with synthetic dysfunction leading to coagulopathy and increased risk of bleeding [3, 4]. These patients have poor health status and are much more likely to utilize healthcare hospitalization compared to general population [5]. These patients require hospitalizations for multitude of conditions including but not limited to pancreaticobiliary diseases.

It is well known that incidence of cholelithiasis and choledocholithiasis is much higher in cirrhotics than in general population [6–10]. Other hepatobiliary conditions like biliary strictures, gallstone pancreatitis, and cholangitis are also frequently encountered. Surgery carries increased risk of adverse events related to procedures and anesthesia and has poor outcomes when compared to patients without any underlying liver disease [11–13]. Moreover, surgery may be contraindicated in some patients with decompensated disease due to increased risk of bleeding and infectious complications. These problems are best served by an ERCP which is minimally invasive and now has become the mainstay in the management of certain bile duct disorders.

Recent studies published using National database have documented an increased risk of adverse events in decompensated cirrhotics [14, 15]. However, there is paucity of data in the literature about utilization of ERCP, trends of mortality, and adverse events as well as the socio-demographic factors affecting it, in decompensated cirrhosis patients. Using a large inpatient national database, we aimed to analyze trends of utilization of ERCP in patients with decompensated cirrhosis over a period of 13 years. We also aimed to determine the trends of inpatient mortality and adverse outcomes in this population.

Methods and material

The study population was derived from the Nationwide Inpatient Sample (NIS) database from 2000 till 2013. NIS is a component of the Healthcare Cost and Utilization Project (HCUP) sponsored by the Agency for Healthcare Research and Quality (AHRQ). It is available in public domain and contains all-payer information on hospital inpatient admissions from participating states. It consists of approximately 8 million hospital stays from about 1000 hospitals in 45 states. It is designed to approximate a 20% stratified sample of patients from all hospitals in United States. National estimates may be calculated using the weighted discharge files.

NIS data include information for each hospital stay with information on patient's demographic variables, primary and up to 25 secondary discharge diagnosis, primary and secondary procedures, discharge disposition, hospital characteristics, and patient- and hospital-related variables. It is a representative sample of inpatient hospitalization in the United States [16, 17].

Study population

We extracted data from 2000 to 2013 based on data availability, adequate sample size, and to observe trends of utilization over a decade. Cases were obtained in accordance with the International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM). The validity of codes for decompensated cirrhosis was confirmed during the study period. We queried the database using ICD-9 diagnosis codes: 56.0, 456.1, 456.2, 571.2, 571.5, 572.2, 572.3, and 572.4. This combination of codes has been validated and has positive and negative predictive values of 78 and 91%, respectively, for identifying decompensated cirrhosis in Veterans and Non-Veterans databases [18–20].

We then queried the database for primary procedural code for an ERCP. The specific ICD-9-CM codes utilized are as follows: ERCP (51.10, 51.11, 52.13, 52.92), ERCP with placement of a nasobiliary or nasopancreatic tube (51.86, 52.97), ERCP with stone extraction (51.88, 52.94), ERCP with dilation of the ampulla, biliary, or pancreatic duct (51.84, 52.98), ERCP with stent placement in either the biliary or pancreatic duct (51.87, 52.93), ERCP with sphincterotomy and papillotomy (51.85), ERCP with brushings and/or biopsies (51.14, 52.14), ERCP with excision of a lesion within the biliary or pancreatic duct (51.64, 52.21, 51.69), and ERCP with manometry (51.15). Diagnostic ERCPs were defined as ERCP (51.10, 51.11, 52.13, 52.92), ERCP with brushings and/or biopsies (51.14, 52.14), and ERCP with manometry (51.15).

We calculated temporal trends of ERCP performed in patients with decompensated cirrhosis. We extracted information on demographics, concurrent diagnosis and hospital-level characteristics, and estimated comorbidity burden and mortality risk using the validated ALL Patient Refined Diagnosis Related Group (APRDRG) mortality score [21]. We defined adverse outcomes as mortality and adverse discharges which were defined as discharge to nursing home or hospice care. The NIS maintains a record of all discharges whether to home or to a facility.

Statistical analysis

Age-Adjusted ERCP rates were calculated for each year from 2000 to 2013 in patients with decompensated cirrhosis. We evaluated temporal trends of Diagnostic and Therapeutic ERCP in decompensated cirrhosis patients by utilizing Joinpoint regression analysis which identifies statistically significant changes over time of a linear slope of the trend. In Joinpoint analysis, the best fitting points where the rates change significantly were chosen and added to the model; the best fitting model was computed by permutation test and annual percentage changes (APC) were calculated for these trends by means of generalized linear models assuming a Poisson distribution. We utilized multivariable logistic regression models to estimate impact of ERCP in decompensated cirrhosis on mortality and adverse discharge rates. We utilized SAS 9.4 (SAS Institute Inc. Cary, NC, USA) and Joinpoint Regression Program, Version 4.5.0.1—June 2017; Statistical Methodology and Applications Branch, Surveillance Research Program, National Cancer Institute, and considered a two-tailed P value < 0.05 as statistically significant.

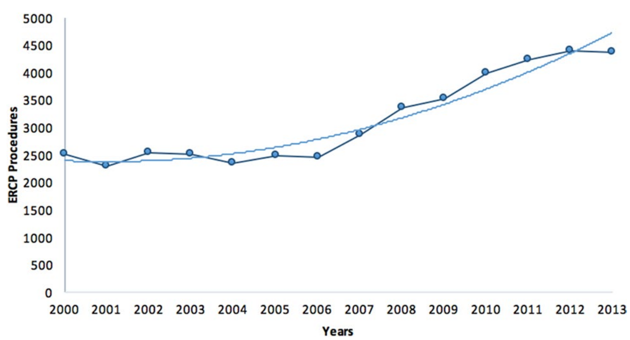


Fig. 1 Trends of ERCP in patients with decompensated cirrhosis

Results

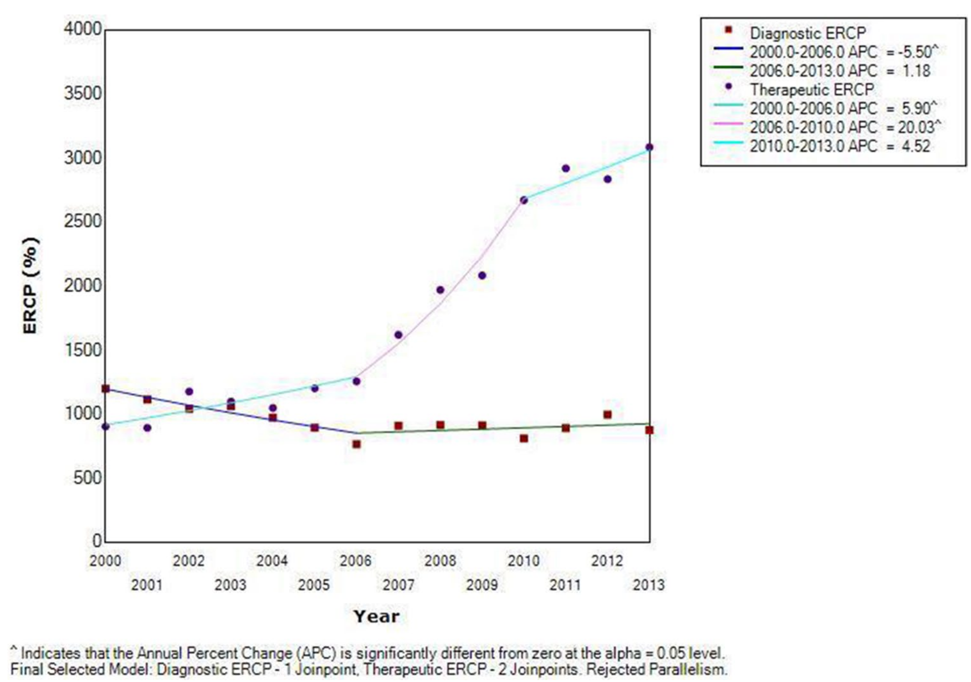
General trends of ERCP utilization

There were a total of 4,445,677 adult hospitalizations with decompensated cirrhosis from 2000 to 2013. Among these hospitalizations, ERCP was performed in 43,782 cases. There was an increase in the absolute number of ERCP performed in patients with decompensated cirrhosis from 2489 in the year 2000 to 4360 in 2013 (Fig. 1). However, the proportion of decompensated cirrhotic patients undergoing ERCP remained stable during the study.

Diagnostic versus therapeutic ERCPs

From the NIS between 2000 and 2013, 13,352 decompensated cirrhosis patients who underwent diagnostic ERCP were identified. Analyses of trends using join point regression indicated that there was a significant decrease in trend during the years 2000–2006 with an APC of 5.50 and no significant change in trend during the years 2007–2013. Between 2000 and 2013, 24,760 decompensated cirrhosis patients who underwent therapeutic ERCP were identified. Analyses of trends demonstrated a significant increase during the time period of 2000–2006 with an APC of 5.9 and also during 2007–2010 with an APC of 20.03 (Fig. 2).

Fig. 2 Trends of diagnostic and therapeutic ERCP in patients with decompensated cirrhosis



Study population

Our study population was significantly older than DC patients without ERCP (mean age of 59.5 years). There was no difference in terms of gender. Black, Hispanic, and other races were less in number in the population of interest. Overall, the study population was sicker with higher CCI. Comorbidities such as sepsis, DM, alcohol abuse, and hepatic encephalopathy were noted to be higher in patients undergoing ERCP. Most ERCPs were performed in large hospitals (Appendix). The overall mortality was higher in the study group, and more cases were discharged to specialized institutional care in the study group. Statistically significantly higher number of patients with Medicare and private insurance underwent ERCP. Demographics of study population are depicted in Table 1.

Primary indications for ERCP in DC patients

The most common indication to perform ERCP in patients with DC was choledocholithiasis. Around 25.6% patients had primary indication as choledocholithiasis. Biliary stricture diseases accounted for approximately 22.6% of patients undergoing ERCP followed by cholangitis (19.3%), acute biliary pancreatitis (16.9%), Jaundice (10.1%), malignant neoplasm of pancreas (3.2%), and cholangiocarcinoma (1.7%) (Table 2).

Length of stay and cost of hospitalization

We observed a statistically significant decrease in the mean length of stay for DC patients undergoing ERCP from 8.2 days in 2000 compared to 7.2 days in 2013 ($P<0.01$). Similarly, LOS also decreased for DC patients not undergoing ERCP from 4.1 days to 3.8. DC patients undergoing ERCP had twice as much as LOS compared to no ERCP group for both years ($P<0.001$) (Figs. 3, 4).

Inflation-adjusted cost of hospitalization was also calculated for both groups. We observed increase in the mean cost of hospitalization for the group undergoing ERCP from $17,053 to $19,825, which was statistically significant. Cost of hospitalization in control group also showed an increase from $7607 in 2000 to $9203 in 2013. DC patients undergoing ERCP incurred more than twice the cost when compared to non-ERCP group (Figs. 3, 4).

Mortality

We calculated age-adjusted mortality in patients undergoing ERCP with and without decompensated cirrhosis from 2000 till 2013. The cumulative mortality in patients with decompensated cirrhosis who did not undergo ERCP was 9.8% ($n=420{,}977$ out of 4,401,895) compared to decompensated cirrhotic cases with ERCP where cumulative mortality was significantly higher at 10.9% ($n=4773$ out of 43782 total cases) ($P<0.01$) during the study period. In 2000, out of total DC cases undergoing ERCP, 328 died during the same hospitalization (13.6%); whereas in 2013, of the total number of decompensated cirrhosis patients undergoing ERCP, 420 patients died bringing the mortality down to 9.6%. Age-Adjusted mortality showed a significant downward trend as depicted in Fig. 5 ($P<0.001$). Comparison of mortality trends between decompensated cirrhosis patients with ERCP and without ERCP showed a significant decline in the annual percentage mortality rate in both groups. The decline was steeper in DC patients with ERCP compared to DC patients; however, the mortality trend in patients undergoing ERCP was still significantly higher compared to those who did not ($P<0.01$) (Fig. 6).

Factors affecting adverse outcomes (Table 3)

Over the study period, we found that 34.4% cases ($n=15{,}016$) who underwent ERCP were discharged to specialized care facility when compared to 32.1% cases of DC who did not undergo ERCP ($P<0.01$). Mortality, as stated above, was also significantly higher in ERCP group.

We performed multivariable logic analysis to find patient, demographic, and hospital factor responsible for adverse outcomes as noted below.

Patient factors

Age, sex, and race

Increasing age (> 60 years) had 2 times the odds of mortality in the study cohort when compared to the reference age group of 18–49 years (Age group 60–69: OR 1.99 CL (1.51–2.63); Age group ≥ 70: OR 2.01, CL 1.48–2.73; $P<0.001$). Adverse discharge, therefore, had decreasing odds in older population as they had more odds of mortality. There was no difference in adverse discharges in male vs female. Hispanic race had higher odds of adverse discharges when compared to white, black, or other races (OR 1.56; CL (1.3–1.87) $P<0.001$).

Comorbidities

Concurrent diagnosis of hypertension and diabetes mellitus were associated with adverse discharges.

Hospital location and bed size

There was no difference in outcomes noted in terms of adverse discharges in small, medium, or large hospital as well as urban versus rural hospitals.

Table 1 Characteristics of study population

Characteristics	DC without ERCP *N*=(4,401,895)	DC with ERCP *N*= (43,782)	*P* value
Patient characteristics			
Age in years, (%)	56.2 (49.1–66.4)	59.5 (50.7–70.7)	< 0.001
18–49	1,089,857 (24.8)	9197.4 (21.1)	
50–59	1,465,772 (33.3)	12204.8 (27.8)	
60–69	972,225 (22.1)	10033.9(22.9)	
≥70	874,040 (19.9)	12345.4 (28.2)	
Gender, (%)			0.125
Male	2741084.7 (62.3)	26918.8 (61.5)	
Female	1660810.3 (37.7)	16863.2 (38.5)	
Race, (%)			< 0.001
White	2428961.1 (65.3)	24250.1 (65.3)	
Black	393525.3 (10.6)	3593.8 (9.7)	
Hispanic	665794.1 (17.9)	6195.5 (16.7)	
Others	230957.6 (6.2)	3078.8 (8.3)	
Charlson Comorbidity Index, (%)			< 0.001
0	2248463.6 (51.1)	21092.4 (48.2)	
1	1078217.9 (24.5)	10533.0 (24.1)	
2	1075213.6 (24.4)	12156.0 (27.8)	
Comorbidities, (%)			
Sepsis	460464.0 (10.5)	9337.5 (21.3)	< 0.001
Obesity	259820.5 (5.9)	2360.7 (5.4)	0.041
Alcohol abuse	1491670.0 (33.9)	9415.9 (21.5)	< 0.001
Diabetes mellitus	1180019.1 (26.8)	10855.4 (24.8)	< 0.001
Hypertension	1590987.3 (36.1)	16013.2 (36.6)	0.395
Coronary artery disease	506439.2 (11.5)	4628.7 (10.6)	0.006
Hepatic encephalopathy	1476853.0 (33.6)	12017.3 (27.4)	< 0.001
Hospital characteristics			
Hospital bed size, (%)			< 0.001
Small	457277.2 (10.4)	2995.8 (6.9)	
Medium	1097129.7 (25.0)	9641.4 (22.1)	
Large	2827875.3 (64.5)	30952.4 (71.0)	
Hospital location, (%)			< 0.001
Rural	452196.7 (10.3)	1782.2 (4.1)	
Urban non-teaching	1787594.0 (40.8)	14636.7 (33.6)	
Urban teaching	2142491.6 (48.9)	27170.6 (62.3)	
Cost, median (IQR)	9245.7 (5369.0, 17210.1)	20106.7 (12206.3, 37926.9)	< 0.001
Median household income category for patient's zip code‖, (%)			
0–25th percentile	1239757.7 (29.1)	10271.7 (24.2)	< 0.01
26–50th percentile	1124507.8 (26.4)	10966.6 (25.8)	
51–75th percentile	1008155.1 (23.6)	10789.5 (25.4)	
76–100th percentile	893369.4 (20.9)	10479.6 (24.7)	<0.01
Discharge disposition, (%)			< 0.001
Routine	2,471,387 (56.2)	23532.9 (53.9)	
Discharge to specialized care	1,411,445 (32.1)	15016.5 (34.4)	
Against medical advice	87411.5 (1.9)	284.6 (0.8)	
Died	420,977 (9.8)	4773.6 (10.9)	
Primary payer type, (%)			< 0.001
Medicare	1832840.4 (41.7)	19970.3 (45.7)	
Medicaid	933176.5 (21.3)	6797.5 (15.6)	

Table 1 (continued)

Characteristics	DC without ERCP *N*=(4,401,895)	DC with ERCP *N*= (43,782)	*P* value
Private	1050266.0 (23.9)	12952.6 (29.7)	
Self-pay or no charge or others	574737.6 (13.1)	3946.8 (9.0)	

Table 2 Primary indications for ERCP in Decompensated cirrhosis patients

Indications	Percentage (%)
Choledocholithiasis	25.6
Biliary stricture disease	22.6
Cholangitis	19.3
Acute biliary pancreatitis	16.9
Jaundice	10.1
Malignant neoplasm of pancreas	3.2
Cholangiocarcinoma	1.7

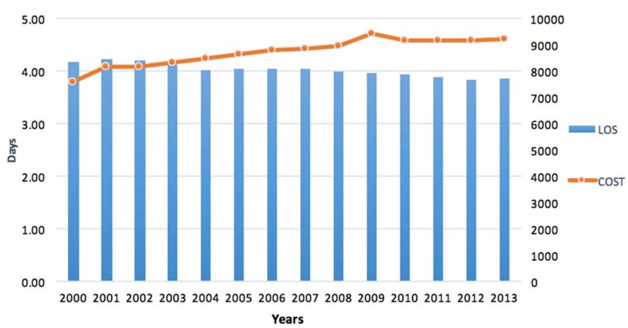


Fig. 3 Length of stay and cost of hospitalization in decompensated cirrhosis patients undergoing ERCP

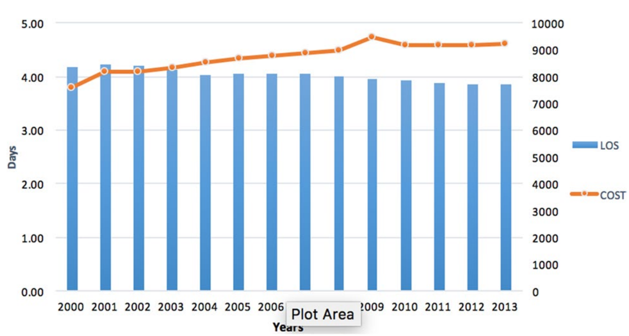


Fig. 4 Length of stay and cost of hospitalization in decompensated cirrhosis patients without ERCP

Median income and insurance

The NIS data contain information about median income for each hospitalization. We divided income into 4 quartiles. There was no statistically significant outcome change

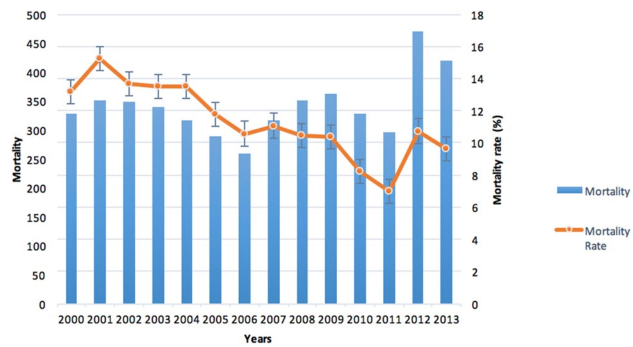


Fig. 5 Mortality trends in decompensated cirrhosis patients undergoing ERCP

between all quartiles in terms of adverse discharges. We found a statistically significant higher odds of adverse discharges in patients with private insurance and self-pay/other group.

Factors affecting mortality (Table 4)

Patient factors

As noted above, increasing age had higher odds (~2 times) of mortality when compared to reference population in Age group 18–49. No significant difference in mortality noted among sex or race.

Concurrent diagnosis

Patient with DC undergoing ERCP with concurrent diagnosis of sepsis had higher odds of mortality [3.95; CL (3.19–4.89) $P<0.0001$]. Also, patient with concurrent diagnosis of hepatic encephalopathy had 2.7 odds of mortality when compared to reference population [OR 2.7; CL (2.22–3.3); $P<0.0001$].

Hospital location and bed size

There was no difference in outcomes noted in terms of mortality in small, medium, or large hospital as well as urban versus rural hospitals.

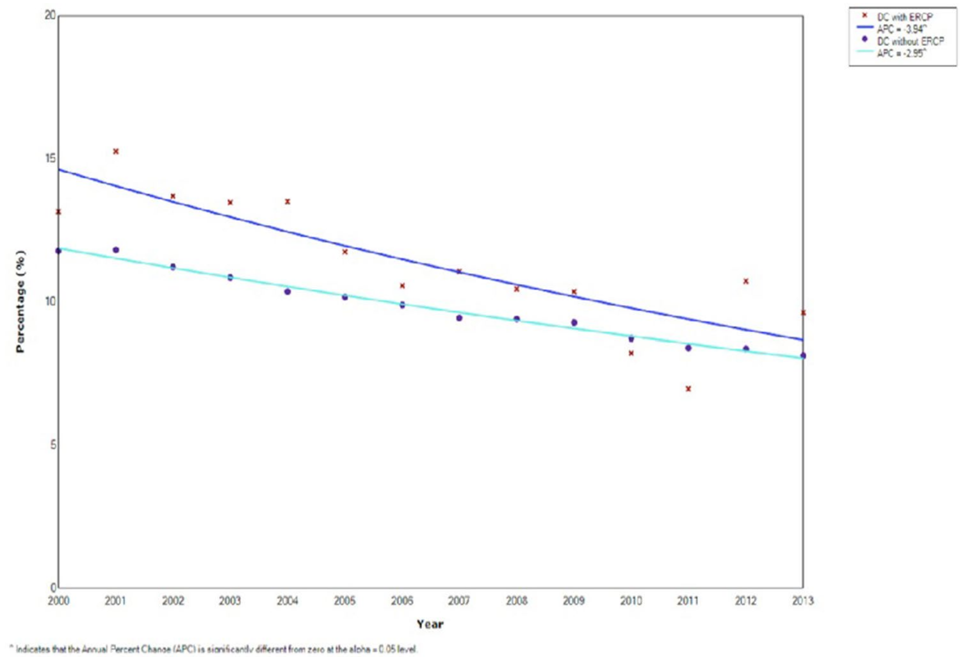


Fig. 6 Comparison of Mortality in decompensated cirrhosis patients with ERCP vs without ERCP

Median income and insurance

Median income of the patient as well as insurance status had no impact on mortality in these patients.

Discussion

In this study, we looked into the nationwide inpatient trends and epidemiology of ERCP, outcomes in terms of adverse discharges and mortality as well as factors affecting it, in patients with decompensated cirrhosis from 2000 to 2013. Data regarding ERCP in this patient population are scant, and this study is an important addition to the growing pool of literature. A total of 43,782 inpatients having decompensated cirrhosis were seen to have undergone ERCP in our study cohort.

Overall, there is an increase in the use of ERCP for therapeutic purposes and a decline in diagnostic ERCPs. This can be explained by the advent of more sophisticated non-invasive diagnostic studies, like MRCP and Endoscopic ultrasound and their increased utilization due to overall safety profile, especially in these patients [22]. It is seen that utilization of ERCP in the general population has declined over the last few years [23]. Our study found that the overall proportion of decompensated cirrhotic patients undergoing inpatient ERCP has remained the same over the past decade. This can be explained by higher incidence and prevalence of gallstones and related complications in cirrhotic patients [9, 10, 24].

A recent cross-sectional analysis of ERCP, using the same database for the year 2009, found that the indications of ERCP in cirrhotics in descending order were CBD stones/gall stones (57%), biliary stricture (18%), cholangitis (14%), jaundice and abnormal liver tests (6%), and primary sclerosing cholangitis (4%) [14]. In this large database, we found that primary indications were quite similar to the study quoted above, with CBD stones remaining as the most common primary indication.

We found a significant decrease in mortality rate in DC patients undergoing ERCP, from 13.6% (2000) to 9.6% (2013). Although still high when compared to compensated cirrhotics and non-cirrhotic general population, this is consistent with an overall decrease in mortality in cirrhosis, irrespective of procedural intervention [25]. This decrease seen in our study can be partially explained by the improvement in inpatient cirrhosis care, newer guidelines, and reviews published over the past decade regarding management of decompensated cirrhotic patients [26]. This decrease can also be attributed to pre-procedural prevention practices, improved procedure techniques, and management of procedure-related complications, including post-ERCP pancreatitis, perforation, and bleeding [27–31].

Our results suggest that DC patients with advancing age, sepsis, and hepatic encephalopathy have higher rates of inpatient mortality. Irrespective of the ERCP procedure, this population is sicker and has a higher mortality. Interestingly, there were decreased adverse discharges in these patients, which may be explained by increased inpatient mortality and overall lesser discharges. There was no significant difference in mortality or adverse discharges

Table 3 Factors responsible for adverse outcome in DC patients undergoing ERCP

Adverse discharges factors	OR (95% CI)	*P* value
Age in years		< 0.0001
18–49	Reference	
50–59	0.72 (0.62–0.83)	
60–69	0.59 (0.50–0.70)	
≥70	0.43 (0.36–0.51)	
Gender		0.06
Male	Reference	
Female	0.89 (0.79–1.01)	
Race		< 0.0001
White	Reference	
Black	1.07 (0.89–1.3)	
Hispanic	1.56 (1.3–1.87)	
Others	0.96 (0.78–1.19)	
Concurrent diagnosis		
Diabetes mellitus	1.18 (1.03–1.35)	0.0201
Hypertension	1.32 (1.15–1.5)	< 0.0001
Coronary artery disease	1.13 (0.9–1.41)	0.3012
Hepatic encephalopathy	0.39 (0.35–0.45)	< 0.0001
Obesity	0.81 (0.64–1.03)	0.09
Alcohol abuse	0.96 (0.84–1.09)	0.4893
Sepsis	0.28 (0.25–0.33)	< 0.0001
Hospital characteristics		
Hospital bed size		0.94
Small	1.04 (0.83–1.3)	
Medium	1.01 (0.87–1.18)	
Large	Reference	
Hospital location		0.81
Rural	1.02 (0.78–1.32)	
Urban non-teaching	1.01 (0.89–1.12)	
Urban teaching	Reference	
Cirrhosis Comorbidity Index		< 0.0001
0	Reference	
1	0.72 (0.62–0.83)	
≥2	0.48 (0.41–0.55)	
Median household income category for patient's zip code		0.74
0–25 percentile	Reference	
26–50 percentile	1.09 (0.93–1.28)	
51–75 percentile	1.03 (0.88–1.21)	
76–100 percentile	1.03 (0.87–1.22)	
Primary payer		< 0.0001
Medicare	Reference	
Medicaid	1.07 (0.91–1.27)	
Private	1.29 (1.12–1.49)	
Self-pay or no charge or others	1.88 (1.49–2.37)	

Table 4 Factors affecting mortality in DC patients undergoing ERCP

Mortality factors	OR (95% CI)	*P* value
Age in years		< 0.0001
18–49	Reference	
50–59	1.52 (1.17–1.96)	
60–69	1.98 (1.51–2.63)	
>=70	2.01 (1.48–2.73)	
Gender		0.68
Male	Reference	
Female	0.96 (0.78–1.18)	
Race		0.53
White	Reference	
Black	0.82 (0.59–1.14)	
Hispanic	0.88 (0.67–1.18)	
Others	0.85 (0.58–1.24)	
Concurrent diagnosis		
Sepsis	3.95 (3.19–4.89)	< 0.0001
Hepatic encephalopathy	2.7 (2.22–3.3)	< 0.0001
Obesity	1.07 (0.71–1.63)	0.73
Alcohol abuse	0.76 (0.59–0.98)	0.03
Diabetes mellitus	0.6 (0.46–0.79)	0.0002
Hypertension	0.65 (0.51–0.82)	0.0004
Coronary artery disease	0.67 (0.43–1.07)	0.09
Hospital characteristics		
Hospital bed size		0.62
Small	0.83 (0.54–1.28)	
Medium	0.92 (0.72–1.19)	
Large	Reference	
Hospital location		0.93
Rural	0.93 (0.59–1.46)	
Urban non-teaching	0.97 (0.82–1.16)	
Urban teaching	Reference	
Cirrhosis Comorbidity Index		< 0.0001
0	Reference	
1	1.33 (1.03–1.71)	
≥2	1.97 (1.56–2.49)	
Median household income category for patient's zip code		0.75
0–25 percentile	Reference	
26–50 percentile	0.91 (0.68–1.22)	
51–75 percentile	1.05 (0.79–1.4)	
76–100 percentile	1.03 (0.76–1.39)	
Primary payer		0.12
Medicare	Reference	
Medicaid	1.21 (0.89–1.66)	
Private	0.87 (0.66–1.15)	
Self-pay or no charge or others	1.13 (0.78–1.64)	

in male or female patients. In general, hospital characteristics have shown significant differences in mortality in patients with cirrhosis [32]. Our study has not shown any significant variation in mortality with hospital characteristics in DC patients undergoing ERCP.

We found a racial disparity with higher adverse discharges in Hispanic DC populations undergoing ERCP. There are no known data explaining this finding; however, in general, it may be linked to lower socioeconomic status and less health care seeking behavior in Hispanics. There is an increased prevalence of hepatobiliary and pancreatic disease in this population [33, 34]. We did not find any mortality differences in different races. More studies are needed to explore this social disparity. We found a statistically significant difference in mortality between general populations and decompensated cirrhotic patients undergoing ERCP with similar Charlson comorbidity index. This can be related to increased risk of infection, coagulopathy due to poor synthetic liver function leading to increased risk of bleeding as well as anesthesia-related complications [35, 36].

Limitations

Limitations of the data include its retrospective nature. The data are dependent on ICD codes documentation to capture information correctly. However, dataset is checked for errors and has been validated to ensure that the data are accurate. Also, these data contain only inpatient information and does not include outpatients ERCP. However, patients with decompensated cirrhosis are sicker and it is likely that majority of them undergo ERCP in a hospitalized setting to closely monitor for complications. Although the data provide socio-demographic information about patients as well as hospital characteristics, it is limited as it does not give any relevant clinical information about patient's presentation, administration of medications, or inpatient management as well as success rate of a procedure.

Despite the above-mentioned limitations, we can conclude that the trend of therapeutic ERCP utilization in decompensated cirrhosis has been on a rise. Also, the mortality of DC patients undergoing ERCP is higher than their non-cirrhotic/compensated cirrhotic counterparts. The decreasing trends of mortality over the past decade are promising and partially reflect improved procedural skills and ability to manage peri-procedural complications such as post-ERCP pancreatitis, bleeding, perforation. Interestingly, we also found racial disparity in Hispanic population with DC undergoing the procedure; they are more likely to have an adverse discharge than their counterparts. This social disparity needs to be thoroughly evaluated and confirmed with prospective studies. To our knowledge, this is the first large study shedding light on utilization of ERCP on a nationally representative inpatient sample in this subgroup of patients.

Compliance with ethical standards

Disclosures Drs. Dhruv Mehta, Priti Poojari, Aparna Saha, Supreet Kaur, Shanti Patel, Lavneet Chawla, Arun Kumar, Priya Simoes, Deepthi Busayavalasa, Girish Nadkarni, and Madhusudhan Sanaka have no conflicts of interest or financial ties to disclose.

Appendix

See Table 5.

Table 5 NIS description of hospital bed size

Bed size categories			
Location and teaching status	Hospital bed size		
	Small	Medium	Large
Northeast region			
Rural	1–49	50–99	100+
Urban, non-teaching	1–124	125–199	200+
Urban, teaching	1–249	250–424	425+
Midwest region			
Rural	1–29	30–49	50+
Urban, non-teaching	1–74	75–174	175+
Urban, teaching	1–249	250–374	375+
Southern region			
Rural	1–39	40–74	75+
Urban, non-teaching	1–99	100–199	200+
Urban, teaching	1–249	250–449	450+
Western region			
Rural	1–24	25–44	45+
Urban, non-teaching	1–99	100–174	175+
Urban, teaching	1–199	200–324	325+

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