

Trends in the Use of Endoscopic Retrograde Cholangiopancreatography for the Management of Chronic Pancreatitis in the United States

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Goals: The aim of this study was to characterize current trends in the use of endoscopic retrograde cholangiopancreatography (ERCP) in the United States for patients hospitalized with chronic pancreatitis.

Background: Historically, ERCP was the primary tool for diagnostic and therapeutic management of chronic pancreatitis. With increased availability of magnetic resonance imaging and endoscopic ultrasound, indications for ERCP are being redefined.

Study: We performed a retrospective cohort study using the Nationwide Inpatient Sample from 1998 to 2010. We identified patients with a primary discharge diagnosis of chronic pancreatitis who underwent ERCP. We excluded patients diagnosed with biliary, gallbladder, or pancreatic neoplasm and patients who underwent gallbladder or pancreatic operation during the same admission. We analyzed patient and hospital characteristics, length of stay, and in-hospital mortality, and adjusted for weighted sample schema.

Results: During the study period, 29,318 patients with chronic pancreatitis (mean age 52y, 57.2% female) underwent ERCP during their hospitalization. The majority of patients were white (56.1%). The majority of procedures were performed at large (72.4%), urban (95.2%), and academic (69.0%) hospitals. Mean hospital charges were \$32,929 (SE = \$1605). Mean length of stay was 6 days (SE = 0.3), with in-hospital mortality of 0.76%. Over the study period, the number of procedures has decreased significantly ($P < 0.001$).

Conclusions: In the United States, ERCP has been an important diagnostic and therapeutic tool for chronic pancreatitis. Over the last decade, ERCP has become an uncommon inpatient procedure for chronic pancreatitis.

Key Words: chronic pancreatitis, ERCP, in-hospital mortality

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The authors declare that they have nothing to disclose.

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Chronic pancreatitis is defined as irreversible pancreatic structural injury attributable to progressive inflammation. Although current understanding of the pathogenesis of chronic pancreatitis is incomplete, alcohol is the main etiology in western countries and is associated with significant morbidity.¹ Endoscopic retrograde cholangiopancreatography (ERCP) has historically provided a means for both diagnosis and treatment of chronic pancreatitis, and it was the first imaging examination to provide a detailed view of the pancreatic duct.² ERCP is an invasive procedure, conferring low but significant risk to the patient. Newer imaging modalities, such as magnetic resonance cholangiopancreatography (MRCP) and endoscopic ultrasound (EUS), offer less invasive paths to diagnosis,^{3–5} limiting the use of ERCP as a diagnostic tool. Current expert opinion recommends ERCP as primarily a therapeutic procedure for the management of pancreaticobiliary disorders.^{6–8}

Although there remains a role for ERCP in the treatment of chronic pancreatitis, such as stent placement, stricture dilation, and stone removal,⁹ intervention is required in only a minority of patients. The majority of patients with chronic pancreatitis require no intervention at the time of diagnosis. Moreover, endoscopic and surgical interventions can usually be performed on an elective basis.

We hypothesized that overall utilization of ERCP as an inpatient procedure for chronic pancreatitis has decreased over the last decade. The primary aim of the current study was to characterize national trends in the inpatient use of ERCP for the diagnosis and management of chronic pancreatitis over the last decade. Secondary aims of the study were to investigate changes in length of stay, charges, and in-hospital mortality associated with ERCP over this same period.

MATERIALS AND METHODS

Data Source

This is a Wake Forest Baptist Health Institutional Review Board–approved cohort study using the Healthcare Cost and Utilization Project (H-CUP) Nationwide Inpatient Sample (NIS) database (1998 to 2010).¹⁰ This report is in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.¹¹ In the United States, NIS is the largest all-payer inpatient database, containing information from nearly 8 million hospital admissions each year.¹⁰ Data from the NIS are based on both clinical discharge diagnoses and resource use for about 20% of all patient discharges per year from nonfederal, short-term, general, and specialty hospitals in the United States. The sampling frame is a sample of

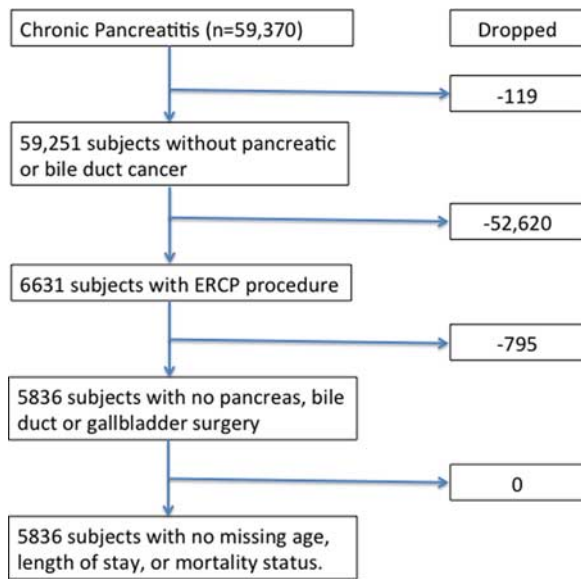


FIGURE 1. Sample selection of chronic pancreatitis patients represented as raw counts, not population estimate. ERCP indicates endoscopic retrograde cholangiopancreatography.

community hospitals that comprises approximately 95% of all hospital discharges in the United States. Researchers and policymakers use the data set to identify, track, and analyze national trends in health care utilization, inpatient charges, quality of care, and clinical outcomes. Data elements within the NIS are drawn from hospital discharge abstracts that allow determination of all procedures performed during a given hospitalization. As NIS is a 20% stratified sample, national level estimates are obtained using a weighting coefficient provided by the database. National estimates and discharge information provided by the NIS correlate with the numbers provided by the hospital discharge survey.¹⁰ The data set is linked to the American Hospital Association’s annual survey of hospitals, and is stratified by various hospital-specific characteristics, such as geographic region, urban or rural location, teaching status, number of beds, and facility ownership. NIS is a publicly available database and does not contain personal identifiers.¹⁰

Subject Identification

This study included patients over 18 years old who were admitted between the years of 1998 and 2010, underwent ERCP and discharged with a primary diagnosis of chronic pancreatitis. (Fig. 1) Only admissions with complete age, length of stay, and in-hospital mortality data were included. We excluded patients with a diagnosis of acute pancreatitis, pancreaticobiliary neoplasms, as well as patients who underwent gallbladder or pancreatic surgery during the same admission (Supplementary Table 1, Supplemental Digital Content 1, <http://links.lww.com/JCG/A224>).

Study Variables

The primary outcome measure was the estimated number of diagnostic and therapeutic ERCP procedures performed per year in the United States. NIS discharge data were analyzed to identify patients with International Classification of Diseases, ninth revision, Clinical

TABLE 1. Patient and Hospital Characteristics for Patients With Chronic Pancreatitis Who Underwent ERCP From 1998 to 2010 (n = 29,318)

Variables	Estimated	
	n or Mean	% or SE
Sex (female)	16,726	57.2
Age (y)	52	0.36
Race*		
White	16,448	56.1
African American	3475	11.9
Other	2621	8.9
> 2 comorbidities†	11,066	37.7
Study period		
1998-2002	15,076	51.4
2003-2006	8462	28.9
2007-2010	5780	19.7
Hospital region		
Northeast	6145	21.0
Midwest	8838	30.2
South	8573	29.2
West	5761	19.7
Urban hospital	27,874	95.2
Hospital teaching	20,198	69.0
Primary payer‡		
Medicare	9940	33.9
Medicaid	4382	15.0
Private insurance	12,381	42.2
Self-pay	1411	4.8
Admission source		
Routine	12,425	49.0
Emergency department	10,753	42.4
Other facility§	2200	8.7
Admission type		
Emergency	11,949	47.9
Urgent	5694	22.8
Elective	7294	29.2
Trauma center	19	0.1
Hospital bedsize		
Small	2081	7.1
Medium	5994	20.5
Large	21,218	72.4
Total charges (\$)	32,929	160,511

*Unknown race: n = 6774, 23.1%.

†Defined by Elixhauser comorbidity algorithm.^{13,14}

‡Unknown primary payer: n = 1203, 4.1%.

§Another hospital, long-term care facility, or skilled nursing facility.

||Adjusted to 2010 dollars.

Modification (ICD-9-CM) procedure codes for ERCP. Diagnostic ERCP was defined as ERCP (51.10), ERC (51.11), ERP (52.13), ERCP with biopsy (51.14, 52.14), ERCP with manometry (51.15), or ERCP with excision or destruction of lesion (51.64, 52.21). Therapeutic ERCP included ERCP with sphincterotomy (51.85), endoscopic dilation (51.84, 52.98), endoscopic stone removal (51.88, 52.94), biliary stent placement (51.87), pancreatic stent placement (52.93), and nasobiliary tube placement (51.86, 52.97). Total number of ERCP represents all procedure codes outlined above.

Secondary outcomes included length of stay, in-hospital mortality, and hospital charges. Length of stay was measured as number of days from date of admission to date of discharge. Discharge on same day of admission was recorded as 0 days. In-hospital mortality was defined as death during hospitalization and does not include death after discharge. To account for inflation, hospital charges

TABLE 2. Type of ERCP Procedure

Primary Procedure	Estimated [n (%)]
Diagnostic ERCP	10,640 (42.6)
ERCP with sphincterotomy or dilation	8609 (35.2)
Pancreatic stent insertion	2683 (11.0)
Biliary stent insertion	1916 (7.8)
Endoscopic stone removal	795 (3.3)
Nasobiliary tube placement	43 (0.2)

ERCP indicates endoscopic retrograde cholangiopancreatography.

were adjusted to 2010 dollars using the United States Consumer Price Index for medical care.¹² Hospital charges do not include professional fees or noncovered charges. Emergency room charges before admission are included in charges for Medicare patients.

Patient and hospital characteristics were extracted from the data set, including: age, sex, race, primary payer, hospital region (Northeast, Midwest, South, and West), hospital teaching status, urban or rural hospital, hospital size, type of admission, source of admission, year of admission, and number of comorbidities. As defined by NIS, hospital size (small, medium, and large) is dependent on region of the United States, teaching status, and urban status; for example, large urban teaching hospital in the Northeast has >425 beds.¹⁰ Year of admission was categorized as 1998 to 2002, 2003 to 2006, and 2007 to 2010. A comorbidity score was assigned to each patient using validated H-CUP comorbidity software, which is based on the Elixhauser comorbidity algorithm.^{13–15}

Statistical Analysis

Statistical analyses were performed using SAS 9.2 (SAS Institute Inc., Cary, NC). Hypothesis testing was 2-sided at the 0.05 significance level. Given the stratified, weighted, sampling strategy used by NIS, all data are reported as national estimates.¹⁰ Descriptive statistics are reported for all variables, using estimated mean and SE or count with percent, as appropriate using SAS survey procedures. For analyses, hospital charges and length of stay were transformed logarithmically given right skew. Changes in length of stay and total hospital charges over time were assessed using ANOVA, whereas changes in mortality over time were assessed using the χ^2 test. To determine variables significantly associated with mortality, univariate and multiple variable analyses were performed using logistic regression. Covariates with overall *P*-values < 0.10 and had < 10% of data missing were retained in the final multiple variable model.

RESULTS

Overall 29,318 patients were hospitalized with the principle diagnosis of chronic pancreatitis and had ERCP performed during the same admission. Mean age of patients was 52 years (SE = 0.36), with the majority being female (57.2%, n = 16,726) and white (56.1%, n = 16,448). The majority of procedures were performed at large (72.4%, n = 21,218), urban (95.2%, n = 27,874), and teaching (69.0%, n = 20,198) hospitals. The mean comorbidity score was 1.33 (SE = 0.1), with most patients having a comorbidity score of 0 or 1 (62.3%, n = 18,252). Primary payer was largely private insurance (42.2%, n = 12,381) or Medicare (33.9%, n = 9940). Nearly half of the admissions were

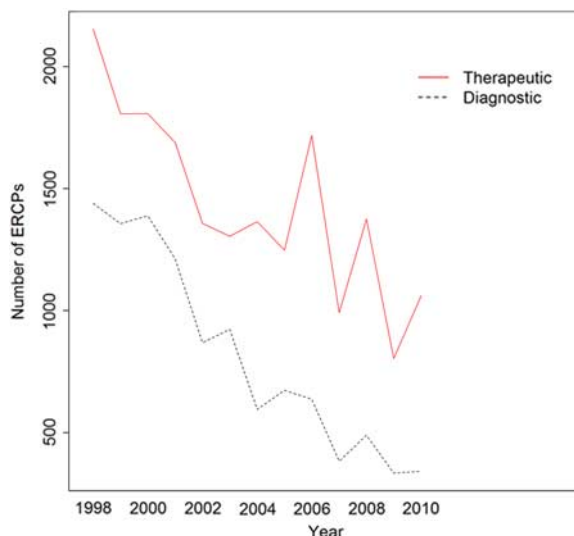


FIGURE 2. Estimated number of diagnostic and therapeutic endoscopic retrograde cholangiopancreatographies (ERCPs) for inpatients with chronic pancreatitis from 1998 to 2010 (n = 29,318).

considered emergency admissions (47.9%, n = 11,949). Patient and hospital characteristics are shown in Table 1.

From 1998 to 2010, the total number of ERCP procedures performed for hospitalized patients with chronic pancreatitis decreased significantly from 15,076 (1998 to 2002) to 5780 (2007 to 2010) (*P* < 0.001). Type of ERCP performed for patients with chronic pancreatitis are listed in Table 2. The 2 most common procedures were diagnostic ERCP (42.6%, n = 10,640) and ERCP with sphincterotomy (35.2%, n = 8609). Nasobiliary tube placement was rarely performed (0.2%, n = 43). The number of ERCP procedures per year decreased significantly for both diagnostic (*P* < 0.001) and therapeutic (*P* = 0.001) ERCP (Fig. 2).

Clinical outcomes for patients with chronic pancreatitis who underwent inpatient ERCP are summarized in Table 3. After adjusting to 2010 dollars, mean hospital charges were \$32,929 (SE = \$1605), and increased significantly from 1998 to 2010 (*P* < 0.0001). During the study period, mean length of stay (6.4 d, SE = 0.3) and in-hospital mortality (0.76%) did not change significantly.

Univariate and multiple variable analyses were performed to identify predictors of increased mortality among chronic pancreatitis patients undergoing ERCP (Table 4). Independent predictors of increased in-hospital mortality were older age (odds ratio = 1.86; 95% confidence interval, 1.48–2.35; *P* < 0.001) and 2 or more comorbidities (odds ratio = 3.63; 95% confidence interval, 1.81–7.30; *P* < 0.001).

DISCUSSION

In the current study, we observed a dramatic (76%) decline in the utilization of ERCP for inpatients with primary admitting diagnosis of chronic pancreatitis in the United States. Although prior studies have demonstrated a similar decline in ERCP procedures,^{16,17} this is the first study to demonstrate national trends in ERCP utilization for chronic pancreatitis over the last decade. The decline of

TABLE 3. Clinical Outcomes for Patients With Chronic Pancreatitis Managed With ERCP From 1998 to 2010

Outcome	All Cases	1998-2002	2003-2006	2007-2010	P
Length of stay [mean (SE)] (d)	6.4 (0.3)	6.5 (0.6)	6.5 (0.2)	6.3 (0.25)	0.735
Today hospital charges [mean (SE)] (\$)*	32,929 (1605)	26,969 (2200)	35,584 (1404)	44,391 (2317)	< 0.001
In-hospital mortality (%)	0.76	0.69	0.93	0.70	0.644

*Adjusted to 2010 dollars.

ERCP indicates endoscopic retrograde cholangiopancreatography.

ERCP procedures in patients admitted with chronic pancreatitis is likely secondary to the expanding role of MRCP and EUS in the diagnosis of pancreaticobiliary disease. EUS was first used to describe the pancreatic anatomy in the late 1980s¹⁸⁻²¹ and was validated against current diagnostic standards in the late 1990s.²²⁻²⁵ Similarly, the 1990s marked the advent of MRCP.²⁶⁻²⁹

Over the last decade, we have also witnessed a shift in the use of ERCP from the inpatient to outpatient setting. Outpatient ERCP has proven to be safe and decreases health care costs.³⁰⁻³³ Even for the very elderly, outpatient ERCP can be performed safely.³⁴ The transition to the ambulatory setting was likely a significant contributor to the decline in inpatient ERCP for chronic pancreatitis. With the availability of MRCP and EUS, diagnostic ERCP has few, if any, indications.

Chronic pancreatitis is challenging to manage with its protracted and variable course.³⁵ Optimal timing of endoscopic and surgical intervention is not clear.³⁶⁻³⁹ Even with surgical intervention tailored to the patient's specific anatomy, current therapeutic interventions are unable to resolve

pain in over 30% of patients.⁴⁰ Because of these therapeutic challenges, patients with chronic pancreatitis are frequently referred to large, tertiary hospitals. Therefore, it is of no surprise that majority of ERCPs were performed in large, urban teaching hospitals.

Diagnostic ERCP was the most common inpatient ERCP procedure during the study period. Therapeutic interventions including stenting and stone removal were uncommon. Current guidelines for the management of chronic pancreatitis indicate that diagnostic ERCP should be limited to patients who have unclear diagnosis after noninvasive pancreatic function testing or other noninvasive (computed tomography, magnetic resonance imaging) or less invasive (EUS) imaging studies.⁸ The predominance of diagnostic ERCP may represent the diagnostic challenges faced in this patient population, along with a period of transition away from diagnostic ERCP.

During this period of decreased ERCP utilization of chronic pancreatitis, length of hospital stay and inpatient mortality did not change. With no significant changes in

TABLE 4. Predictors of Mortality for Inpatients With Chronic Pancreatitis Undergoing ERCP

Variables	Univariate Analysis				Multiple Variable Analysis			
	OR	95% CI Lower	95% CI Upper	P	OR	95% CI Lower	95% CI Upper	P
Age*	2.01	1.62	2.50	< 0.001	1.86	1.48	2.35	< 0.001
Sex (male)	1.56	0.89	2.73	0.122	1.73	0.98	3.05	0.058
≥ 2 comorbidities†	4.73	2.34	9.58	< 0.001	3.63	1.81	7.30	< 0.001
Race, non-white	0.86	0.48	1.54	0.604				
Primary payer, other than private insurance‡	5.93	2.32	15.19	< 0.001	2.43	0.92	6.392	0.073
Large hospital size	1.12	0.54	2.32	0.756				
Nonteaching hospital	0.90	0.46	1.75	0.753				
Region				0.493				
West	Reference							
Northeast	0.48	0.16	1.50	0.209				
Midwest	0.99	0.39	2.49	0.975				
South	1.07	0.46	2.50	0.882				
Rural hospital	1.46	0.46	4.65	0.525				
Admission source, not emergency department	0.53	0.26	1.09	0.064				
Admission type				0.210				
Elective	Reference							
Emergency	1.95	0.74	5.15	0.178				
Urgent	1.00	0.31	3.22	0.998				
Study period				0.660				
1998-2002	Reference							
2003-2006	1.35	0.68	2.68	0.396				
2007-2010	1.01	0.45	2.25	0.985				

*Every 10 years.

†Defined by Elixhauser comorbidity algorithm.^{13,14}

‡Includes Medicare, Medicaid, self-pay, and unknown insurance.

CI indicates confidence interval; ERCP, endoscopic retrograde cholangiopancreatography; OR, odds ratio.

medical management of chronic pancreatitis over the last decade, the lack of improvement in these benchmarks is not unanticipated. Meanwhile, hospital charges increased from \$27,000 to \$44,000. This 61% increase reflects overall national trends in rising cost of health care in the United States.^{16,41}

Given the large study cohort and low mortality associated with ERCP, we sought to identify predictors of in-hospital mortality among patients with chronic pancreatitis who undergo ERCP. In-hospital mortality was not associated with hospital characteristics including size, region, teaching status, or urban location. However, patient characteristics—specifically, advanced age and multiple comorbidities—were associated with in-hospital mortality. Such findings are consistent with those of previous, large studies, which identified age and multiple comorbidities as major predictors of mortality.^{42,43}

A retrospective study utilizing the NIS has several limitations. First, each record in the NIS represents a single hospital discharge and not an individual patient. Therefore, we were unable to evaluate clinical outcomes based on multiple admissions or readmissions. Second, NIS data are dependent on billing and does not provide the granular data available in prospective single institution studies.⁴⁴ For example, the underlying cause of chronic pancreatitis and specific details of the ERCP findings are not available. Third, as ICD-9 billing codes for EUS do not exist, we were unable to evaluate trends in the utilization of EUS during the study period. Finally, because mortality is limited to in-hospital events, we could not investigate mortality after discharge. Despite these limitations, the NIS is the only data source that enables national estimates of inpatient procedures.

CONCLUSIONS

In the United States, ERCP has historically been an important diagnostic and therapeutic tool for chronic pancreatitis. However, findings of this nationwide, population-based study suggest that over the last decade ERCP has become an uncommon inpatient procedure for chronic pancreatitis. This is most likely attributable to ERCP being utilized almost exclusively as a therapeutic procedure, which reflects current practice standards and guidelines since the arrival of less-invasive diagnostic modalities.

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