Published in final edited form as:

J Clin Gastroenterol. 2016 ; 50(5): 417–422. doi:10.1097/MCG.0000000000000493.

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

Clancy J. Clark, MD,

Division of Surgical Oncology, Department of General Surgery, Wake Forest Baptist Health

Nora F. Fino, MS,

Division of Public Health Sciences, Wake Forest Baptist Health, nfitzger@wakehealth.edu

Norman Clark, MD,

Division of Gastroenterology, Department of Internal Medicine, Wake Forest Baptist Health, nrclark@wakehealth.edu

Armando Rosales, MD,

Department of Surgery, Cleveland Clinic of Florida, rosalesarmando@gmail.com

Girsh Mishra, MD, and

Division of Gastroenterology, Department of Internal Medicine, Wake Forest Baptist Health, gimishra@wakehealth.edu

Rishi Pawa, MD

Division of Gastroenterology, Department of Internal Medicine, Wake Forest Baptist Health, rpawa@wakehealth.edu

Abstract

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 (MRI) and endoscopic ultrasound (EUS), indications for ERCP are being redefined.

Study—We performed a retrospective cohort study using the Nationwide Inpatient Sample from 1998-2010. 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.

For correspondence and reprints: Clancy J. Clark MD, Division of Surgical Oncology, Department of General Surgery, Medical Center Blvd., Winston-Salem, North Carolina 27157, Phone: 336-716-7207, Fax: 336-716-9758, cjclark@wakehealth.edu.

Disclosures: Nothing to disclose

Presented as a poster at Digestive Disease Week, May 2014 in Chicago, Illinois

Results—During the study period, 29,318 patients with chronic pancreatitis (mean age 52, 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%), academic (69.0%) hospitals. Mean hospital charges were \$32,929 (S.E. \$1,605). Mean length of stay was six days (S.E. 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.

Keywords

Chronic Pancreatitis; ERCP; In-Hospital Mortality

Introduction

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 exam 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}

While there remains a role for ERCP in the treatment of chronic pancreatitis, such as stent placement, stricture dilation, and stone removal⁹, 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 (1998-2010).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 non-federal, short-term, general, and specialty hospitals in the United States. The sampling frame is a sample of community hospitals that comprises approximately 95% of all hospital discharges in the U.S. 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. Since 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 dataset 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 to 2010, underwent ERCP and discharged with a primary diagnosis of chronic pancreatitis. **(Figure 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 I)**.

Study Variables

The primary outcome measure was the estimated number of diagnostic and therapeutic endoscopic retrograde cholangiopancreatography (ERCP) procedures performed per year in the United States. NIS discharge data was analyzed to identify patients with International Classification of Diseases, ninth revision, Clinical 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), 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 were adjusted to 2010 dollars using the United States

Consumer Price Index for medical care.¹² Hospital charges do not include professional fees or non-covered charges. Emergency room charges prior to admission are included in charges for Medicare patients.

Patient and hospital characteristics were extracted from the dataset, including: age, sex, race, primary payer, hospital region (Northeast, Midwest, South, 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, large) is dependent on region of the United States, teaching status, and urban status, e.g. large urban teaching hospital in the Northeast has more than 425 beds.¹⁰ Year of admission was categorized as 1998-2002, 2003-2006, and 2007-2010. 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 two-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 standard error 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, while changes in mortality over time were assessed using a chi-squared test. To determine variables significantly associated with mortality, univariate and multiple variable analyses were performed using logistic regression. Covariates with overall p-values less than 0.10 and had less than 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 (S.E. 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 (S.E.. 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 = 9,940). Nearly half of the admissions were considered emergency admissions (47.9%, n = 11,949). Patient and hospital characteristics are shown in **Table I**.

From 1998 to 2010, the total number of ERCP procedures performed for hospitalized patients with chronic pancreatitis decreased significantly from 15,076 (1998-2002) to 5,780 (2007-2010), ($p < 0.001$). Type of ERCP performed for patients with chronic pancreatitis are listed in **Table II**. The two most common procedures were diagnostic ERCP (42.6%, n = 10,640) and ERCP with sphincterotomy (35.2%, n = 8,609). 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 (**Figure 2**).

Clinical outcomes for patients with chronic pancreatitis who underwent inpatient ERCP are summarized in **Table III**. After adjusting to 2010 dollars, mean hospital charges were \$32,929 (S.E. \$1,605), and increased significantly from 1998 to 2010 ($p < 0.0001$). During the study period, mean length of stay (6.4 days, S.E 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 IV**). Independent predictors of increased in-hospital mortality were older age (OR 1.86, 95% CI 1.48-2.35, $p < 0.001$) and two or more comorbidities (OR 3.63, 95% CI 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 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 1980s^{18–21} 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 healthcare 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 Due to 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 (CT, MRI) or less invasive (EUS) imaging studies.⁸ The predominance of diagnostic ERCP may represent the diagnostics 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 in-patient mortality did not change. With no significant changes in 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 healthcare 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 is 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, since ICD-9 billing codes for EUS do not exist, we were unable to evaluate trends in the utilization of EUS during the study period. Lastly, 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.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Grant or Funding Support: None

Abbreviations

ANOVA analysis of variance

CI	confidence interval
ERCP	endoscopic retrograde cholangiopancreatography
EUS	endoscopic ultrasound
H-CUP	Healthcare Cost and Utilization Project
ICD-9	International Classification of Disease, 9 th edition
OR	odds ratio
MRI	magnetic resonance imaging
NIS	Nationwide Inpatient Sample
SE	standard error
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology

Bibliography

1. Steer ML, Waxman I, Freedman S. Chronic pancreatitis. N Engl J Med [Internet]. Jun 1; 1995 332(22):1482–90. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/7739686>.
2. Coté GA, Smith J, Sherman S, Kelly K. Technologies for imaging the normal and diseased pancreas. Gastroenterology [Internet]. Jun; 2013 144(6):1262–71. e1. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/23622136>.
3. Wallace MB, Hawes RH, Durkalski V, et al. The reliability of EUS for the diagnosis of chronic pancreatitis: interobserver agreement among experienced endosonographers. Gastrointest Endosc [Internet]. Mar; 2001 53(3):294–9. Available from: <http://linkinghub.elsevier.com/retrieve/pii/S0016510701704014>.
4. Sahai AV, Zimmerman M, Aabakken L, et al. Prospective assessment of the ability of endoscopic ultrasound to diagnose, exclude, or establish the severity of chronic pancreatitis found by endoscopic retrograde cholangiopancreatography. Gastrointest Endosc [Internet]. Jul; 1998 48(1): 18–25. Available from: <http://linkinghub.elsevier.com/retrieve/pii/S0016510798701233>.
5. Sahai A. EUS and chronic pancreatitis. Gastrointest Endosc. 2002
6. Schöfl R. Diagnostic endoscopic retrograde cholangiopancreatography. Endoscopy [Internet]. Georg Thieme Verlag Stuttgart· New York. Feb; 2001 33(2):147–57. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/11272217>.
7. Adler DG, Baron TH, Davila RE, et al. ASGE guideline: the role of ERCP in diseases of the biliary tract and the pancreas. Gastrointest Endosc [Internet]. Jul; 2005 62(1):1–8. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/15990812>.
8. Adler DG, Lichtenstein D, Baron TH, et al. The role of endoscopy in patients with chronic pancreatitis. Gastrointest Endosc. 2006; 63:933–7. [PubMed: 16733106]
9. Cohen S, Bacon BR, Berlin JA, et al. National Institutes of Health State-of-the-Science Conference Statement: ERCP for diagnosis and therapy, January 14–16, 2002. Gastrointestinal Endoscopy. 2002;803–9. [PubMed: 12447289]
10. Agency for Healthcare Research and Quality. [2014 Mar 9] Healthcare Cost and Utilization Project.. Overview of the Nationwide Inpatient Sample (NIS). [Internet]. 2014. Available from: <http://www.hcup-us.ahrq.gov/nisoverview.jsp>
11. von Elm E, Altman DG, Egger M, et al. Annals of Internal Medicine Academia and Clinic The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: Guidelines for Reporting. Ann Intern Med [Internet]. Oct 16; 2007 147(8):573–8. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/17938396>.
12. Bureau of Labor Statistics. [2014 Mar 9] Consumer Price Index [Internet]. 2014. Available from: <http://www.bls.gov/cpi/>

13. Agency for Healthcare Research and Quality. [2014 Mar 9] HCUP Comorbidity Software [Internet]. 2014. Available from: <http://www.hcup.us.ahrq.gov/toolssoftware/comorbidity/comorbidity.jsp>
14. Elixhauser A, Steiner C, Harris DR, Coffey RM. Comorbidity measures for use with administrative data. Med Care [Internet]. Jan; 1998 36(1):8–27. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/21509773>.
15. Grendar J, Shaheen A a, Myers RP, et al. Predicting in-hospital mortality in patients undergoing complex gastrointestinal surgery: determining the optimal risk adjustment method. Arch Surg [Internet]. Feb; 2012 147(2):126–35. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/22006854>.
16. Peery AF, Dellon ES, Lund J, et al. Burden of gastrointestinal disease in the United States: 2012 update. Gastroenterology [Internet]. Nov; 2012 143(5):1179–87. e1–3. Available from: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3480553&tool=pmcentrez&rendertype=abstract>.
17. Mazen Jamal M, Yoon EJ, Saadi A, Sy TY, Hashemzadeh M. Trends in the utilization of endoscopic retrograde cholangiopancreatography (ERCP) in the United States. Am J Gastroenterol [Internet]. May; 2007 102(5):966–75. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/17319932>.
18. Sivak MV, Kaufman A. Endoscopic ultrasonography in the differential diagnosis of pancreatic disease. A preliminary report. Scand J Gastroenterol Suppl [Internet]. Jan.1986 123:130–4. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/3535029>.
19. Lees WR. Endoscopic ultrasonography of chronic pancreatitis and pancreatic pseudocysts. Scand J Gastroenterol Suppl. Jan.1986 123:123–9. [PubMed: 3535028]
20. Kaufman AR, Sivak M V. Endoscopic ultrasonography in the differential diagnosis of pancreatic disease. Gastrointest Endosc. 35(3):214–9. [PubMed: 2668100]
21. Dancygier H, Classen M. Endosonographic diagnosis of benign pancreatic and biliary lesions. Scand J Gastroenterol Suppl. Jan.1986 123:119–22. [PubMed: 3535027]
22. Catalano MF, Lahoti S, Alcocer E, Geenen JE, Hogan WJ. Dynamic imaging of the pancreas using real-time endoscopic ultrasonography with secretin stimulation. Gastrointest Endosc. Dec; 1998 48(6):580–7. [PubMed: 9852447]
23. Catalano MF, Lahoti S, Geenen JE, Hogan WJ. Prospective evaluation of endoscopic ultrasonography, endoscopic retrograde pancreatography, and secretin test in the diagnosis of chronic pancreatitis. Gastrointest Endosc [Internet]. Jul; 1998 48(1):11–7. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/9684658>.
24. Nattermann C, Goldschmidt AJ, Dancygier H. Endosonography in chronic pancreatitis--a comparison between endoscopic retrograde pancreatography and endoscopic ultrasonography. Endoscopy [Internet]. Nov; 1993 25(9):565–70. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/8119205>.
25. Buscail L, Escourrou J, Moreau J, et al. Endoscopic ultrasonography in chronic pancreatitis: a comparative prospective study with conventional ultrasonography, computed tomography, and ERCP. Pancreas [Internet]. Apr; 1995 10(3):251–7. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/7624302>.
26. Barish MA, Yucel EK, Ferrucci JT. Magnetic resonance cholangiopancreatography. N Engl J Med [Internet]. Jul 22; 1999 341(4):258–64. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/10413739>.
27. Matos C, Metens T, Devière J, et al. Pancreatic duct: morphologic and functional evaluation with dynamic MR pancreatography after secretin stimulation. Radiology [Internet]. May; 1997 203(2):435–41. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/9114101>.
28. Soto JA, Barish MA, Yucel EK, Clarke P, Siegenberg D, Chuttani R, et al. Pancreatic duct: MR cholangiopancreatography with a three-dimensional fast spin-echo technique. Radiology [Internet]. Aug; 1995 196(2):459–64. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/7617861>.

29. Takehara Y, Ichijo K, Tooyama N, et al. Breath-hold MR cholangiopancreatography with a long-echo-train fast spin-echo sequence and a surface coil in chronic pancreatitis. *Radiology* [Internet]. Jul; 1994 192(1):73–8. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/8208969>.
30. Fox CJ, Harry RA, Cairns SR. A prospective series of out-patient endoscopic retrograde cholangiopancreatography. *Eur J Gastroenterol Hepatol*. 2000; 12:523–7. [PubMed: 10833095]
31. Jeurnink SM, Poley JW, Steyerberg EW, Kuipers EJ, Siersema PD. ERCP as an outpatient treatment: a review. *Gastrointestinal Endoscopy*. 2008;118–23. [PubMed: 18308308]
32. Duncan HD, Hodgkinson L, Deakin M, Green JR. The safety of diagnostic and therapeutic ERCP as a daycase procedure with a selective admission policy. *Eur J Gastroenterol Hepatol*. 1997; 9:905–8. [PubMed: 9355791]
33. Tham TCK, Vandervoort J, Wong RCK, et al. Therapeutic ERCP in outpatients. *Gastrointest Endosc*. 1997; 45:225–30. [PubMed: 9087827]
34. Katsinelos P, Kountouras J, Chatzimavroudis G, et al. Outpatient therapeutic endoscopic retrograde cholangiopancreatography is safe in patients aged 80 years and older. *Endoscopy*. 2011; 43:128–33. [PubMed: 21108173]
35. Jupp, J.; Fine, D.; Johnson, CD. *Best Pract Res Clin Gastroenterol* [Internet]. Vol. 24. Elsevier Ltd; Jun. 2010 The epidemiology and socioeconomic impact of chronic pancreatitis.; p. 219-31. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/20510824> [2014 Feb 6]
36. Rösch T, Daniel S, Scholz M, et al. Endoscopic treatment of chronic pancreatitis: a multicenter study of 1000 patients with long-term follow-up. *Endoscopy* [Internet]. Oct; 2002 34(10):765–71. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/12244496>.
37. Cahen DL, Gouma DJ, Nio Y, et al. Endoscopic versus surgical drainage of the pancreatic duct in chronic pancreatitis. *N Engl J Med* [Internet]. Feb 15; 2007 356(7):676–84. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/17301298>.
38. Díte P, Ruzicka M, Zboril V, Novotný I. A prospective, randomized trial comparing endoscopic and surgical therapy for chronic pancreatitis. *Endoscopy* [Internet]. Jul; 2003 35(7):553–8. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/12822088>.
39. Ahmed Ali U, Issa Y, Bruno MJ, et al. Early surgery versus optimal current step-up practice for chronic pancreatitis (ESCAPE): design and rationale of a randomized trial. *BMC Gastroenterol* [Internet]. Jan.Feb.2013 13:49. Available from: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3610165&tool=pmcentrez&rendertype=abstract>.
40. van der Gaag, N a; van Gulik, TM.; Busch, ORC., et al. Functional and medical outcomes after tailored surgery for pain due to chronic pancreatitis. *Ann Surg* [Internet]. Apr; 2012 255(4):763–70. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/22418009>.
41. Berwick DM. Reshaping US health care: from competition and confiscation to cooperation and mobilization. *JAMA*. 2014; 312(20):2099–100. [PubMed: 25423217]
42. Bodger, K.; Bowering, K.; Sarkar, S.; Thompson, E.; Pearson, MG. *Gastrointest Endosc* [Internet]. Vol. 74. Elsevier Inc.; 2011. All-cause mortality after first ERCP in England: Clinically guided analysis of hospital episode statistics with linkage to registry of death.; p. 825-33. Available from: <http://dx.doi.org/10.1016/j.gie.2011.06.007>
43. Strömberg C, Arnelo U, Enochsson L, Löhr M, Nilsson M. Possible mortality reduction by endoscopic sphincterotomy during endoscopic retrograde cholangiopancreatography: a population-based case–control study. *Surg Endosc*. 2012; 26:1369–76. [PubMed: 22083337]
44. Lorence DP, Ibrahim IA. Benchmarking variation in coding accuracy across the United States. *J Health Care Finance* [Internet]. Jan; 2003 29(4):29–42. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/12908652>.

Figure 1. Sample selection of chronic pancreatitis patients represented as raw counts, not population estimate.

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

Table I

Patient and Hospital Characteristics for Patients with Chronic Pancreatitis who Underwent ERCP from 1998 to 2010 (n = 29,318).

Variable	Estimated	
	n or mean	% or S.E.
Sex, Female	16,726	57.2
Age, years	52	0.36
Race *		
White	16,448	56.1
African American	3,475	11.9
Other	2,621	8.9
More than Two Comorbidities ^β	11,066	37.7
Study Period		
1998-2002	15,076	51.4
2003-2006	8,462	28.9
2007-2010	5,780	19.7
Hospital Region		
Northeast	6,145	21.0
Midwest	8,838	30.2
South	8,573	29.2
West	5,761	19.7
Urban Hospital	27,874	95.2
Hospital Teaching	20,198	69.0
Primary Payer [†]		
Medicare	9,940	33.9
Medicaid	4,382	15.0
Private Insurance	12,381	42.2
Self-pay	1,411	4.8
Admission Source		
Routine	12,425	49.0
Emergency Department	10753	42.4
Other Facility [‡]	2200	8.7
Admission Type		
Emergency	11,949	47.9
Urgent	5,694	22.8
Elective	7,294	29.2
Trauma Center	19	0.1
Hospital Bedsize		

	Estimated	
Variable	n or mean	% or S.E.
Small	2,081	7.1
Medium	5,994	20.5
Large	21,218	72.4
Total Charges ^{††}	\$32,929	\$160,511

* Unknown Race, n=6,774; 23.1%

β Defined by Elixhauser comorbidity algorithm[13,14]

[†] Unknown Primary Payer, n=1,203; 4.1%

[‡] Another hospital, long-term care facility, or skilled nursing facility.

^{††} Adjusted to 2010 dollars

Table II

Type of Endoscopic Retrograde Cholangiopancreatography Procedure

Primary Procedure	Estimated	
	n	%
Diagnostic ERCP	10,640	42.6
ERCP with Sphincterotomy or Dilation	8,609	35.2
Pancreatic Stent Insertion	2,683	11.0
Biliary Stent Insertion	1,916	7.8
Endoscopic Stone Removal	795	3.3
Nasobiliary Tube Placement	43	0.2

Table III

Clinical Outcomes for Patients with Chronic Pancreatitis managed with ERCP from 1998 to 2010.

	All Cases	1998-2002	2003-2006	2007-2010	p-value
Length of Stay Days (S.E.)	6.4 (0.3)	6.5 (0.6)	6.5 (0.2)	6.3 (0.25)	0.735
Today Hospital Charges * (S.E.)	\$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.

Table IV

Predictors of Mortality for Inpatients with Chronic Pancreatitis Undergoing ERCP.

Variable	Univariate Analysis				Multiple Variable Analysis			
	OR	95% CI Lower	95% CI Upper	p-value	OR	95% CI Lower	95% CI Upper	p-value
Age [*]	2.01	1.62	2.50	<0.001	1.86	1.48	2.35	<0.001
Male Sex	1.56	0.89	2.73	0.122	1.73	0.98	3.05	0.058
Two or More Comorbidities ^β	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				
Non-teaching Hospital	0.90	0.46	1.75	0.753				
Region				0.493				
West	Ref							
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	Ref							
Emergency	1.95	0.74	5.15	0.178				
Urgent	1.00	0.31	3.22	0.998				
Study Period				0.660				
1998-2002	Ref							
2003-2006	1.35	0.68	2.68	0.396				
2007-2010	1.01	0.45	2.25	0.985				

* Every ten years.

^β Defined by Elixhauser comorbidity algorithm[13,14][†] Includes Medicare, Medicaid, Self Pay, and unknown insurance