# Pancreatic surgery

Timothy R. Donahue and Howard A. Reber

Department of Surgery, Division of General Surgery, David Geffen School of Medicine at University of California, UCLA, Los Angeles, California, USA

Correspondence to Howard A. Reber, MD, Division of General Surgery, 72-215 CHS, UCLA Medical Center, Los Angeles, CA 90095-6904, USA
Tel: +1 310 825 4976; fax: +1 310 206 2472;
e-mail: hreber@mednet.ucla.edu

**Current Opinion in Gastroenterology** 2010, 26:499–505

**Purpose of review**

To summarize published research on pancreatic surgery over the past year.

**Recent findings**

Improvements in the treatment of patients with acute gallstone pancreatitis with regards to the timing of ERCP and cholecystectomy as well as management of pancreatic pseudocysts have been reported. It is often difficult to detect malignancy in neoplastic pancreatic cysts; however, a detailed cyst fluid analysis for protein and genetic markers may improve this accuracy. In order to continue to improve pancreatic cancer care in the United States, a standardized reporting system must be developed, and this was a focus of the American Hepato-Pancreatico-Biliary Association Consensus Conference on Resectable and Borderline Resectable Disease. The conference examined pretreatment assessment, surgical treatment, and combined modality treatment for pancreatic cancer. A multi-institutional randomized clinical trial revealed that routine preoperative decompression of malignant biliary obstruction is associated with a higher frequency of complications. Pancreatic fistulas are the most common source of perioperative morbidity following pancreatic surgery. Fortunately, most of these can be managed nonoperatively via interventional radiology techniques.

**Summary**

There is a broad spectrum of pancreatic diseases, which often require surgical treatment. Fortunately, the morbidity and mortality from each of them continues to decrease with more accurate diagnosis, improved management techniques, and standardized reporting systems.

**Keywords**

acute pancreatitis, chronic pancreatitis, delayed gastric emptying, distal pancreatectomy, neoplastic pancreatic cysts, pancreatic cancer, pancreatic fistula, pancreaticoduodenectomy, pancreatic pseudocysts

Curr Opin Gastroenterol 26:499–505

0267-1379

## Introduction

The field of pancreatic surgery is rapidly evolving. A MedLine search for the articles that contain the keyword 'pancreatic surgery' in the last year yielded 2586 publications. Over the past 5–10 years, with the rapid improvement in endoscopic and interventional radiology techniques, the indications for surgery for both benign and malignant pancreatic conditions have changed. For example, pancreatic pseudocysts are now often successfully managed with endoscopic stent drainage [1•], and some complications after pancreaticoduodenectomy can be managed definitively with percutaneous drainage [2]. In addition, some pancreatic surgical techniques have also been closely examined and modified. Total laparoscopic pancreaticoduodenectomy is now feasible, and a series of 62 cases at Mayo Clinic was reported in 2009 [3•]. The improvements in pancreatic surgery have been facilitated by the movement to standardize reporting of pancreatic operations, complications, as well as histopathologic resection margins for patients with pancreatic cancer [4••]. Pancreatic cancer care as well as pancreatic surgery in particular, have been a focus of the National Surgical Quality Improvement Program (NSQIP). Using large databases, it has been shown that pancreatic surgery is best performed at high volume centers and by high volume surgeons [5••]. In all, both the indications and techniques for pancreatic surgery continue to be refined, and this last calendar year was no exception.

## Pancreatitis

Patients with severe acute gallstone pancreatitis often undergo endoscopic retrograde cholangiopancreatography within 48 h of presentation. Van Santvoort *et al.* [6] evaluated this strategy in a prospective randomized trial. One hundred fifty-three patients were enrolled and 81 underwent early ERCP (<48 h) while 72 were observed. All patients who presented with signs and symptoms of acute cholangitis also underwent early bile duct

 DOI:10.1097/MOG.0b013e32833d1174

decompression and were excluded from this analysis. The authors found that the patients with evidence of cholestasis (bilirubin >2.3 mg/dl and/or a dilated common bile duct) developed fewer complications if early ERCP was performed.

In contrast, patients with mild gallstone pancreatitis have their gallbladder removed during the initial hospitalization in order to decrease the frequency of recurrent attacks. The precise timing of the operation remains controversial – that is, some clinicians wait for complete resolution of symptoms before surgery. Aboulian *et al.* [7] intended to randomize 100 patients with mild acute gallstone pancreatitis (Ranson Criteria <3) to early (within 48 h of admission) versus delayed cholecystectomy (after resolution of abdominal pain and normalizing trend of laboratory enzymes). This study was terminated after an interim analysis of 50 patients because the hospital length of stay for the early group was significantly shorter than the delayed group (median 3 vs. 4 days, $P = 0.0016$). Furthermore, there was no statistically significant difference in the need for ERCP or conversion to an open procedure, as well as complication rates between the two groups ($P < 0.05$).

As defined by the 1992 Atlanta Classification System [8], pseudocysts can develop 4–6 weeks after the onset of an episode of acute pancreatitis. Pseudocysts that are larger than 6 cm or cause symptoms should be drained via percutaneous, surgical, or endoscopic approaches. Johnson *et al.* [1•] performed a single-institution review of 61 patients treated surgically ($n = 30$), endoscopically ($n = 24$), or with percutaneous drainage ($n = 7$). They found that surgical and endoscopic drainage appeared to work equally well in terms of pseudocyst resolution (93.5% vs. 87.5%, $P > 0.05$). There was no apparent difference in the rate of complications. Percutaneous drainage was performed less frequently and was reserved for patients in the postoperative setting or with evidence of infection. In our experience, we have found that endoscopic drainage is often successful but can fail in patients with a large amount of debris within the cyst cavity.

## Neoplastic cysts

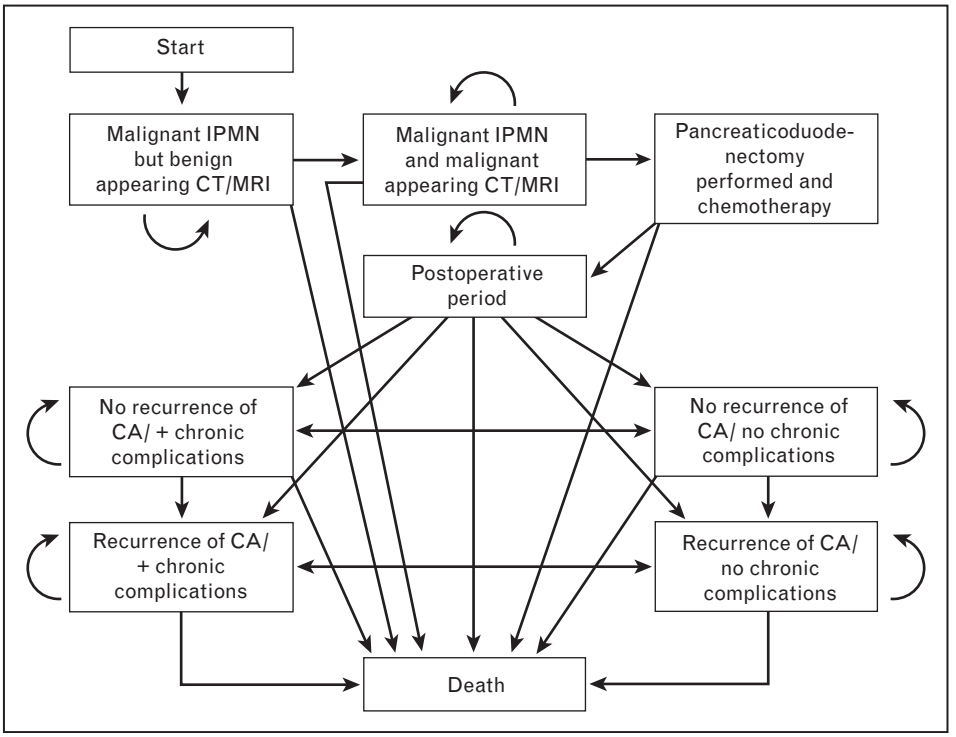
Despite increasing clinical experience with neoplastic pancreatic cysts, the preoperative diagnostic accuracy has improved only slightly. Cyst management is still largely dependent on the 2006 Sendai criteria which recommend resection for mucinous cysts that are associated with main pancreatic duct dilation, are larger than 3 cm, cause symptoms, and/or contain suspicious features of malignancy – for example, a mural nodule [9]. The Massachusetts General Hospital Group reviewed their experience with 401 patients with pancreatic cystic neoplasms from 2004–2007 [10]. They identified invasive malignancy in only 11% of the resected specimens, but found it in 38% of the main-duct intraductal papillary mucinous neoplasms (IPMN). This study illustrates that our current management guidelines still yield a low incidence of malignancy in resected cysts, and suggests that we need more accurate diagnostic markers.

The UCLA group developed a novel cyst management decision approach that used a Markov-based clinical nomogram [11]. An example of a Markov state diagram is illustrated in Fig. 1. Using this technique, they found that resection of pancreatic cysts should depend not only on the Sendai criteria previously mentioned, but also on age, comorbidities, and the quality of life preferences of the individual patient. The quality of life indicators that were considered included potential postsurgical complications, side-effects of chemotherapy, etc. The overall nomogram analysis examined the individual patient's value of their overall survival as compared with their quality-adjusted survival. The authors conclude that a size cutoff for resection of 2 cm should be used for patients who primarily value overall survival but should be increased to 3 cm for those patients who are more focused on quality-adjusted survival.

Grobmyer *et al.* [12] reviewed their series of 78 patients with cystic lesions who underwent resection. They confirmed previous reports that the risk of malignancy increases with size and concluded that small lesions ($\leq$3 cm) may be managed conservatively in selected patients. In contrast, Ceppa *et al.* [13] from Duke University reviewed their experience with 101 patients with cysts who underwent resection from 2000 to 2008. They found that biliary ductal (BDD) and/or pancreatic ductal (PDD) dilation were the strongest predictors of malignancy in a multivariate model that controlled for other documented risk factors, including size. Thus, they concluded that size should not be used as a selection criterion for patients who have cysts with solid components, BDD, or PDD. We have generally followed the 2006 Sendai criteria, which recommends that patients with cysts that are associated with either PDD or more than 3 cm in size should be resected.

Although cyst fluid CEA level can differentiate mucinous cysts from serous ones with an accuracy of 80% [14], it cannot predict malignancy. Thus, cyst fluid genetic analysis has been proposed as a novel strategy to improve the accuracy of malignant cyst diagnosis. This strategy has been limited by the paucity of high amplitude genomic mutations that are associated with pancreatic cancer, with the exception of KRAS. The PANcreatic cyst fluid DNA Analysis (PANDA) trial [15••] was a multi-institution study that enrolled 113 patients with malignant ($n = 40$), premalignant ($n = 48$), or benign cysts

**Figure 1 Example of a Markov state diagram**




Patients in the model cycled between health states according to annual probability estimates. The model included a wide variety of possible movements across the competing strategies. As an example, the diagram shows the possible state paths for patients undergoing noninvasive surveillance in a patient with an underlying, unrecognized, malignant IPMN. CA, cancer. Adapted from [11].

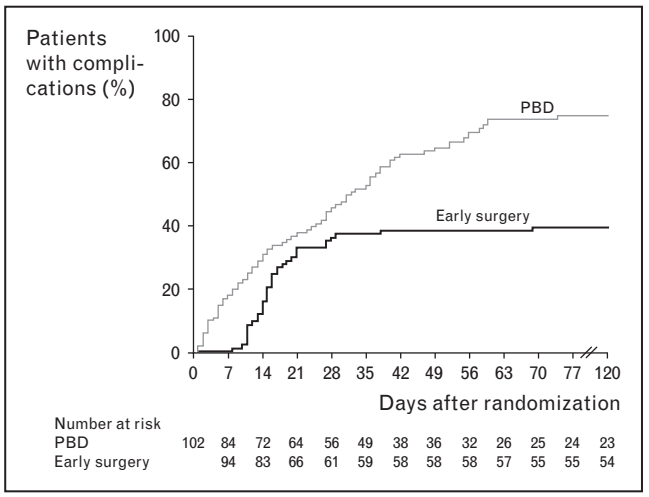
($n = 25$). This trial showed that the presence of KRAS mutations was associated with mucinous cysts with an odds ratio (OR) of 20.9 and specificity of 96%. Furthermore, increased cyst fluid DNA quantity, high amplitude KRAS mutations, and specific mutation sequences showed high specificity (96%) for malignancy. Most importantly, all malignant cysts with negative cytology (10/40) could be diagnosed as being malignant using DNA analysis. Thus, the authors suggest that cyst fluid DNA analysis should be considered for cases in which the cytology is not diagnostic and the risk of a mucinous or malignant cyst is unclear.

## Pancreatic adenocarcinoma

Most of the literature on pancreatic surgery over the last year has focused on pancreatic adenocarcinoma. In January 2008, the American Hepato-Pancreatico-Biliary Association convened a Consensus Conference on Resectable and Borderline Resectable Pancreatic Cancer [4••,16–20]. The conference was divided into pretreatment assessment, surgical treatment, and combined-modality treatment. The consensus statements provide definitions of resectable and borderline resectable disease. The report on pretreatment assessment focuses on the acceptable methods of radiologic and endoscopic evaluation, clinical settings in which preoperative biopsy may be needed, and the selective role of laparoscopic staging. The report on surgical treatment focuses on recommendations against extended lymphadenectomy, the clinical settings in which vascular resection and reconstruction may be justified, the limited role for palliative pancreaticoduodenectomy, as well as an improvement in margin reporting. The Committee also commented on the possible routine use of preoperative chemotherapy (still of no proven efficacy) and also highlighted the conflicting evidence regarding postoperative chemotherapy and chemoradiotherapy.

CA19-9 is the most accurate serum tumor marker for pancreatic cancer that has been identified to date. Its value is limited by a low specificity, as it can also be elevated in cases of biliary obstruction. It is best used to monitor response to treatment in patients who have a pretreatment elevation. To this end, two independent studies by Barton *et al.* [21] and Turrini *et al.* [22] each found that very high preoperative CA19-9 by itself should not preclude surgery in patients with no evidence of locally advanced or metastatic disease on imaging. The former study also found that a low preoperative CA19-9 level ($\leq$120 U/ml) is associated with increased overall and recurrence-free survival.

**Figure 2 Proportion of patients with complications**

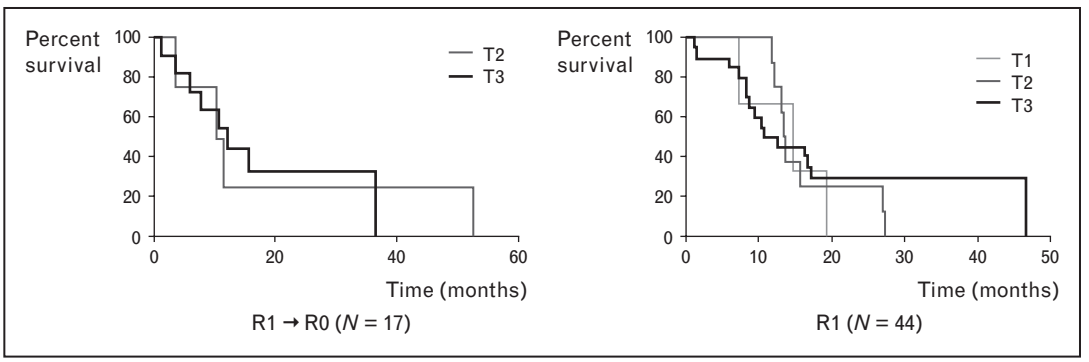



The primary outcome – the rate of serious complications within 120 days after randomization – occurred in 37 patients (39%) who underwent early surgery alone and 75 patients (74%) who underwent preoperative biliary drainage (PBD) followed by surgery [relative risk in the early-surgery group, 0.54; 95% confidence interval (CI), 0.41 to 0.71; $P < 0.001$]. Adapted from [23••].

Oftentimes, patients with pancreatic cancers located in the head of the gland present with biliary obstruction. A decision regarding preoperative biliary decompression must then be made, and a number of different bilirubin threshold levels and approaches have been described. Van der Gaag *et al.* [23••] reported results from a multicenter, randomized trial of 202 patients with elevated bilirubin levels (2.3 to 14.6 mg/dl) who were assigned to undergo immediate surgery or preoperative endoscopic biliary drainage. The authors found that the biliary drainage group had significantly higher endoscopic and stent-related complications ($P < 0.001$) without an improvement in the rate of perioperative complications ($P = 0.14$, Fig. 2). Similarly, Mezhir *et al.* [24] from Memorial Hospital in New York also found that the preoperative endoscopic placement of biliary stents resulted in a two-fold increase in postpancreatectomy infectious complications. These two studies suggest that preoperative biliary stenting should be used selectively in patients with biliary obstruction prior to pancreaticoduodenectomy. We have taken a similar approach and have arranged for patients with bilirubin levels of greater than 25 mg/dl or those with evidence of synthetic liver dysfunction, as assessed by an elevated serum INR level, to undergo preoperative stenting. Surgery is delayed until the bilirubin level is less than 20 mg/dl and the INR is within a normal range.

A number of studies addressed the relation of surgical margin status to survival. The largest series of 202 patients was reported in the *Annals of Surgery* [25]. The authors found that patients who underwent R0 resections ($n = 158$) had significantly improved survival as compared with those patients who had an R1 ($n = 44$) resection ($P < 0.01$). However, the subgroup of 17 patients who required additional resections to achieve complete tumor clearance after an initially positive frozen section (R1→R0) had similar survival to patients who had an R1 resection (11 vs. 13 months, Fig. 3). These results were supported by a smaller study from the Ohio State University [26]. In contrast, the group from the Mayo Clinic [27] compared the survival of patients who underwent an R0 en block resection ($n = 411$) with those who underwent an R1→R0 resection ($n = 57$). They found that there was no difference in survival time between these two groups ($P = 0.28$) and stressed the importance of a negative margin on survival. These conflicting results illustrate that tumor biology may be the most important factor that determines survival in patients with pancreatic cancer. However, until larger studies evaluating the role of margin status are completed, our approach has been to perform an additional pancreatic resection if there is evidence of cancer or high-grade dysplasia at the margin on frozen section analysis.

**Figure 3 Survival after pancreaticoduodenectomy is not improved by extending resections to achieve margins after initially positive intraoperative frozen sections**



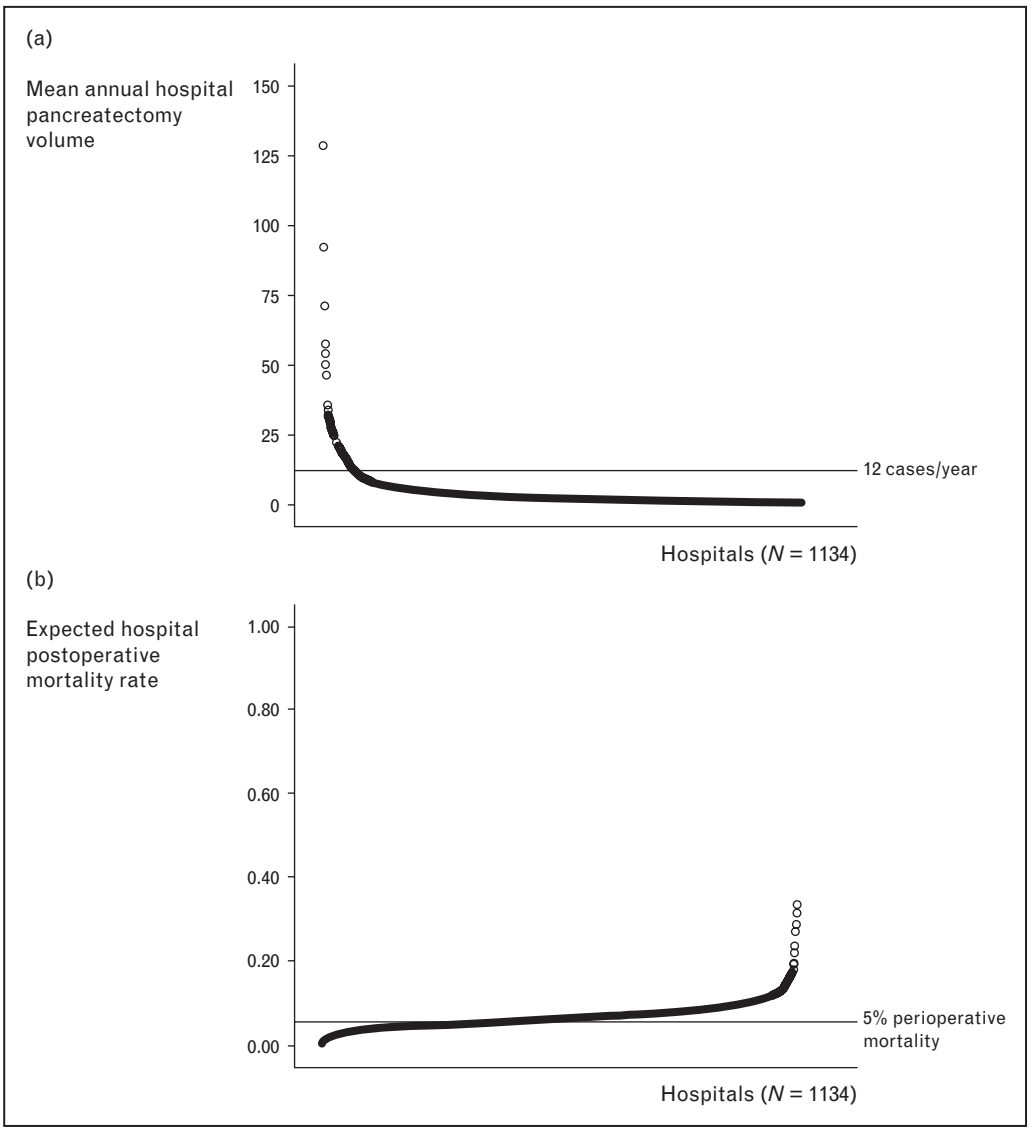

R1 → R0: Initially positive resection margins. R1: Positive resection margins on final pathology. Adapted from [25].

## Technical considerations

The development of a pancreatic fistula is the most common complication following a distal pancreatectomy. Nathan *et al.* [28] reviewed the cohort of 704 patients who underwent distal pancreatectomy at Johns Hopkins Hospital to identify risk factors for leak following surgery. Multivariate logistic regression analysis revealed that neither the method of closure of the pancreatic remnant ($P = 0.41$) nor ligation of the pancreatic duct ($P > 0.05$) affected the risk of clinically significant pancreatic leak. In contrast, Yamamoto *et al.* [29] from University of California at Irvine examined the routine use of Seamguard to prevent pancreatic leak after distal pancreatectomy. A leak occurred in 10 of 38 patients (26%) undergoing conventional resection vs. only two of 47 (4%) undergoing staple resection using Seamguard reinforcement. The authors suggest that Seamguard be used routinely in distal pancreas resections. However, there are also reports that the Seamguard may actually increase the leak rate [30]. A number of techniques to decrease fistula formation after distal pancreatectomy have been examined. Unfortunately, none of them has worked consistently.

Total laparoscopic pancreaticoduodenectomy is being performed with increasing frequency for many indications, even including cancer. Kendrick and Cusati from the Mayo Clinic [3•] published their experience with 62 cases, which is the largest reported series to date. The pancreaticojejunostomy, hepaticojejunostomy, and

**Figure 4 Examples of hospital performance with respect to hospital-level quality measures [5••]**




(a) Pancreatectomy volume. (b) Perioperative mortality rate. Each circle represents one of the 1134 Commission on Cancer-approved hospitals included in this study. The horizontal line represents the threshold for adherence set by the expert panel.

gastrojejunostomy were all performed using laparoscopic techniques. They found that the perioperative morbidity and mortality rates were comparable to those of the conventional open approach, which is impressive. The authors felt that longer follow-up was needed before a cancer specific survival analysis could be completed, however. Nevertheless, among most experienced pancreatic cancer surgeons, there continues to be great concern about laparoscopic resections for malignant pancreatic diseases of any kind. Before this approach is likely to be more widely accepted, a prospective study similar to that done for laparoscopic colon cancer resection would have to be completed. Presently, open resection for cancer occurring anywhere in the pancreas still remains the standard of care.

## Perioperative morbidity and mortality

Much of the current literature on pancreatic surgery has been hindered by the lack of standardized definitions of operative techniques as well as postoperative complications, for example, pancreatic fistula, delayed gastric emptying (DGE) and so on. The consensus definitions for postpancreatic surgery pancreatic fistula and DGE by the International Study Group of Pancreatic Surgery (ISGPS) has reduced some of the imprecision. In this regard, Shukla *et al.* [31] have published a new classification system to report the technique used for the pancreatic anastomosis. The authors expect that widespread use of this new standardized system will lead to more accurate comparisons of outcomes after pancreatic surgery, although we have some skepticism about its value. Furthermore, Hashimoto and Traverso [32] developed a web-based calculator to promote homogeneity in grading the clinical significance of pancreatic fistula and DGE after PD. In their cohort of patients, they found that the clinical impact, defined as a deviation from the routine clinical course, due to a pancreatic fistula was 10% and DGE was 12%. Factors that were significantly associated with pancreatic fistula were male gender, BMI more than 30 kg/m [2], soft gland texture, and pancreatic duct less than 3 mm in diameter. One of the strongest predictive factors for DGE was a concurrent pancreatic fistula. Thus, we routinely obtain a CT scan for patients who develop DGE in the postoperative setting to look for a fluid collection around the pancreatic anastomosis. If it is found, it usually can be drained percutaneously, and the DGE often resolves quickly.

A number of factors have been shown to be associated with improved outcomes in pancreatic cancer care in the United States, including regionalization of pancreatic operations to high-volume centers [33] and surgeons [34] as well as administration of adjuvant chemotherapy. Bilimoria *et al.* [5••] developed a set of 43 valid quality indicators for pancreatic cancer care that were approved by an expert panel of 20 physicians from various specialties. Of the 43 valid indicators, 11 assessed structural factors of the hospital facility, 19 assessed clinical processes of care, four assessed treatment appropriateness, four assessed efficiency, and five assessed outcomes. Using the National Cancer Database (2004–2005), adherence to each of these measures on both the patient and hospital levels was tested. The results confirmed that there is wide variation in the quality of pancreatic cancer care in the United States; the patient level adherence with the indicators ranged from 49.6 to 97.2% and the hospital-level adherence ranged from 6.8 to 99.9%. Examples of the distribution of hospitals' pancreatectomy volume as well as mortality rates are illustrated in Fig. 4. The authors recommended that hospitals should use these indicators to evaluate and improve the pancreatic cancer care they provide.

## Conclusion

The best management of patients with pancreatic cancer as well as benign pancreatic conditions requires a multidisciplinary approach in which pancreatic surgery plays an essential role. These patients should be treated in specialized medical centers that are able to provide such resources. The pancreatic medical community (surgeons, gastroenterologists, pathologists, medical oncologists) is committed to continuing to improve the care that these patients receive. With this type of effort, we will be able to sustain the momentum and effect fundamental change in the care of many patients with pancreatic diseases in the years to come.

## References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

- • of special interest
- •• of outstanding interest

Additional references related to this topic can also be found in the Current World Literature section in this issue (pp. 535–536).


**1** • Johnson MD, Walsh RM, Henderson JM, *et al.* Surgical versus nonsurgical management of pancreatic pseudocysts. J Clin Gastroenterol 2009; 43:586–590.

Endoscopic drainage of pseudocysts is successful in a majority of cases and is being performed with increasing frequency. Surgical drainage is often reserved for cysts that fail endoscopic drainage, contain a large amount of debris, or are not anatomically accessible via endoscopic techniques.

**2** Pedrazzoli S, Liessi G, Pasquali C, *et al.* Postoperative pancreatic fistulas: preventing severe complications and reducing reoperation and mortality rate. Ann Surg 2009; 249:97–104.

**3** • Kendrick ML, Cusati D. Total laparoscopic pancreaticoduodenectomy: feasibility and outcome in an early experience. Arch Surg 2010; 145:19–23.

This is the largest single institution series of total laparoscopic pancreaticoduodenectomy and demonstrates its feasibility in experienced hands. The experience is still early and a prospective study would be needed to evaluate its role in patients with cancer.

**4** •• Vauthey JN, Dixon E. AHPBA/SSO/SSAT Consensus Conference on Resectable and Borderline Resectable Pancreatic Cancer: rationale and overview of the conference. Ann Surg Oncol 2009; 16:1725–1726.

This Conference occurred in 2008; however, the reports were published in 2009. It defined borderline and locally advanced cancers as well as examined multiple aspects of pancreatic cancer treatment including pretreatment assessment, surgical treatment, and combined modality treatments.

**5** Bilimoria KY, Bentrem DJ, Lillemoe KD, *et al.* Pancreatic Cancer Quality •• Indicator Development Expert Panel ACoS. Assessment of pancreatic cancer care in the United States based on formally developed quality indicators. J Natl Cancer Inst 2009; 101:848–859; PMCID: PMC2697207.
Using the National Cancer Database, this paper examined the heterogeneity of pancreatic care that is occurring in the United States and generated a list of quality indictators that were approved by an expert panel.

**6** van Santvoort HC, Besselink MG, de Vries AC, *et al.* Early endoscopic retrograde cholangiopancreatography in predicted severe acute biliary pancreatitis: a prospective multicenter study. Ann Surg 2009; 250:68–75.

**7** Aboulian A, Chan T, Yaghoubian A, *et al.* Early cholecystectomy safely decreases hospital stay in patients with mild gallstone pancreatitis: a randomized prospective study. Ann Surg 2010; 251:615–619.

**8** Bradley EL 3rd. A clinically based classification system for acute pancreatitis. Summary of the International Symposium on Acute Pancreatitis, Atlanta, Ga, September 11 through 13, 1992. Arch Surg 1993; 128:586–590.

**9** Tanaka M, Chari S, Adsay V, *et al.* International consensus guidelines for management of intraductal papillary mucinous neoplasms and mucinous cystic neoplasms of the pancreas. Pancreatology 2006; 6 (1–2):17–32.

**10** Ferrone CR, Correa-Gallego C, Warshaw AL, *et al.* Current trends in pancreatic cystic neoplasms. Arch Surg 2009; 144:448–454.

**11** Weinberg BM, Spiegel BM, Tomlinson JS, Farrell JJ. Asymptomatic pancreatic cystic neoplasms: maximizing survival and quality of life using Markov-based clinical nomograms. Gastroenterology 2010; 138:531–540.

**12** Grobmyer SR, Cance WG, Copeland EM, *et al.* Is there an indication for initial conservative management of pancreatic cystic lesions? J Surg Oncol 2009; 100:372–374.

**13** Ceppa EP, De la Fuente SG, Reddy SK, *et al.* Defining criteria for selective operative management of pancreatic cystic lesions: does size really matter? J Gastrointest Surg 2010; 14:236–244.

**14** Brugge WR, Lewandrowski K, Lee-Lewandrowski E, *et al.* Diagnosis of pancreatic cystic neoplasms: a report of the cooperative pancreatic cyst study. Gastroenterology 2004; 126:1330–1336.

**15** Khalid A, Zahid M, Finkelstein SD, *et al.* Pancreatic cyst fluid DNA analysis in •• evaluating pancreatic cysts: a report of the PANDA study. Gastrointest Endosc 2009; 69:1095–1102.
This study evaluated the utility of genomic analysis of cyst fluid for patients with pancreatic cysts. It showed that such analysis might improve the accuracy of both mucinous and malignant cyst diagnosis, especially for cases in which the cytology is nondiagnostic.

**16** Callery MP, Chang KJ, Fishman EK, *et al.* Pretreatment assessment of resectable and borderline resectable pancreatic cancer: expert consensus statement. Ann Surg Oncol 2009; 16:1727–1733.

**17** Choti MA, Dixon E, Tyler D. Pretreatment assessment of resectable and borderline resectable pancreatic cancer: expert consensus statement by Callery *et al.* Ann Surg Oncol 2009; 16:1734–1735.

**18** Evans DB, Farnell MB, Lillemoe KD, *et al.* Surgical treatment of resectable and borderline resectable pancreas cancer: expert consensus statement. Ann Surg Oncol 2009; 16:1736–1744.

**19** Abrams RA, Lowy AM, O'Reilly EM, *et al.* Combined modality treatment of resectable and borderline resectable pancreas cancer: expert consensus statement. Ann Surg Oncol 2009; 16:1751–1756.

**20** Berlin J, Hoffman JP, Regine WF. Editorial: Combined modality treatment of resectable and borderline resectable pancreas cancer: expert consensus conference. Ann Surg Oncol 2009; 16:1757–1759; PMCID: PMC2695869.

**21** Barton JG, Bois JP, Sarr MG, *et al.* Predictive and prognostic value of CA 19-9 in resected pancreatic adenocarcinoma. J Gastrointest Surg 2009; 13:2050–2058.

**22** Turrini O, Schmidt CM, Moreno J, *et al.* Very high serum CA 19-9 levels: a contraindication to pancreaticoduodenectomy? J Gastrointest Surg 2009; 13:1791–1797.

**23** van der Gaag NA, Rauws EA, van Eijck CH, *et al.* Preoperative biliary drainage •• for cancer of the head of the pancreas. N Engl J Med 362:129–137.
This study showed that routine preoperative biliary drainage for malignant bile duct obstruction does not improve perioperative outcomes. In fact, the group of patients who were randomized to undergo drainage had a higher rate of morbidity that was due to endoscopic-related complications.

**24** Mezhir JJ, Brennan MF, Baser RE, *et al.* A matched case-control study of preoperative biliary drainage in patients with pancreatic adenocarcinoma: routine drainage is not justified. J Gastrointest Surg 2009; 13:2163–2169.

**25** Hernandez J, Mullinax J, Clark W, *et al.* Survival after pancreaticoduodenectomy is not improved by extending resections to achieve negative margins. Ann Surg 2009; 250:76–80.

**26** Dillhoff M, Yates R, Wall K, *et al.* Intraoperative assessment of pancreatic neck margin at the time of pancreaticoduodenectomy increases likelihood of margin-negative resection in patients with pancreatic cancer. J Gastrointest Surg 2009; 13:825–830.

**27** Fatima J, Schnelldorfer T, Barton J, *et al.* Pancreatoduodenectomy for ductal adenocarcinoma: implications of positive margin on survival. Arch Surg 145:167–172.

**28** Nathan H, Cameron JL, Goodwin CR, *et al.* Risk factors for pancreatic leak after distal pancreatectomy. Ann Surg 2009; 250:277–281.

**29** Yamamoto M, Hayashi MS, Nguyen NT, *et al.* Use of Seamguard to prevent pancreatic leak following distal pancreatectomy. Arch Surg 2009; 144:894–899.

**30** Hawkins WG. To mesh or not to mesh, that is the question: comment on 'Use of Seamguard to prevent pancreatic leak following distal pancreatectomy'. Arch Surg 2009; 144:899.

**31** Shukla PJ, Barreto SG, Fingerhut A, *et al.* Toward improving uniformity and standardization in the reporting of pancreatic anastomoses: a new classification system by the International Study Group of Pancreatic Surgery (ISGPS). Surgery 2009; 147:144–153.

**32** Hashimoto Y, Traverso LW. Incidence of pancreatic anastomotic failure and delayed gastric emptying after pancreatoduodenectomy in 507 consecutive patients: use of a web-based calculator to improve homogeneity of definition. Surgery 2010; 146:503–515.

**33** Teh SH, Diggs BS, Deveney CW, Sheppard BC. Patient and hospital characteristics on the variance of perioperative outcomes for pancreatic resection in the United States: a plea for outcome-based and not volume-based referral guidelines. Arch Surg 2009; 144:713–721.

**34** Eppsteiner RW, Csikesz NG, McPhee JT, *et al.* Surgeon volume impacts hospital mortality for pancreatic resection. Ann Surg 2009; 249:635–640.