Table 1. Quality Assessment

Study Author, Year	Patient Enrollment	Diagnostic performance of ERCP determined without knowledge of other test results	Diagnostic Performance of other test(s) determined without knowledge of ERCP results	Summary Evaluation
MRCP				
Demartines, Eisner, Schnabel et al., 2000	Prospective (n=70) Uncertain enrollment of consecutive patients	Yes	Yes	Good
Guibaud, Bret, Reinhold, et al., 1995	Prospective (n=126) Some exclusions because of no ERCP confirmation	Uncertain	Yes	Fair
Holzknecht, Gauger, Sackmann et al., 1998	Prospective (n=61) 61 of 66 eligible patients enrolled, all exclusions accounted for	Yes	Yes	Good
Lomas, Bearcroft, and Gimson 1999	Prospective (n=69) Consecutive patients enrolled, all exclusions accounted for	Yes	Yes	Good
Soto, Barish, Alvarez et al., 2000	Prospective (n=49) Consecutive patients enrolled, all exclusions accounted for	Yes	Yes	Good
Stiris, Tennoe, Aadland et al., 2000	Prospective (n=50) Consecutive patients enrolled	Yes	Yes	Good
Varghese, Farrell, Courtney et al., 1999	Prospective (n=100) Consecutive patients enrolled, all exclusions accounted for	Yes	Yes	Good
Sugiyama, Atomi, and Hachiya 1998	Prospective (n=97) Nonconsecutive enrollment, but stated to be arbitrary without known selection bias	Uncertain	Yes	Fair
Varghese, Liddell, Farrell et al., 2000	Prospective (n=191) 191 of out 256 consecutive patients enrolled, all exclusions accounted for	Yes	Yes	Good

Table 1. Quality Assessment (cont'd)

Study Author, Year	Patient Enrollment	Diagnostic performance of ERCP determined without knowledge of other test results	Diagnostic Performance of other test(s) determined without knowledge of ERCP results	Summary Evaluation
MRCP (cont'd)				
Burtin, Palazzo, Canard et al., 1997	Prospective (n=68) Consecutive patients enrolled	Yes	Yes	Fair—unorthodox reporting of data, uncertain of data
Endoscopic Ultrasound				
Canto, Chak, Stellato et al., 1998	Prospective (n=64) 64 out of 70 consecutive patients enrolled, 6 refusals	Yes	Yes	Good
Dancygier and Nattermann 1994	Prospective (n=41) Unstated whether consecutive	Uncertain	Yes	Fair
Norton and Alderson 1997	Prospective (n=46) Unstated whether consecutive	Yes	Yes	Fair
Prat, Amouyal, Amouyal et al., 1996	Prospective (n=119) Consecutive patients recruited, exclusions and refusals accounted for	Yes	Yes	Good
Sugiyama and Atomi 1997	Prospective (n=142) Consecutive patients enrolled	Uncertain	Yes	Fair
Sugiyama and Atomi 1998	Prospective (n=35) Consecutive patients enrolled	Uncertain	Uncertain	Fair
Chak, Hawes, Cooper et al., 1999	Prospective (n=36) Consecutive patients enrolled	Yes	Yes	Good

Table 1. Quality Assessment (cont'd)

Study Author, Year	**Patient Enrollment**	**Diagnostic performance of ERCP determined without knowledge of other test results**	**Diagnostic Performance of other test(s) determined without knowledge of ERCP results**	**Summary Evaluation**
CTC				
Ishikawa, Tagami, Toyota et al., 2000	Prospective (n=45) Unstated whether enrollment truly consecutive, not full accounting of exclusions	Uncertain	Uncertain	Fair
Polkowski, Palucki, Regula et al., 1999	Prospective (n=52) Full accounting of enrolled and excluded consecutive patients	Uncertain	Yes	Fair
Soto, Velez, and Guzman 1999	Prospective (n=29) Uncertain consecutive enrollment	Yes	Uncertain	Fair
Jimenez Cuenca, del Olmo Martinez, Perez Homs et al., 2001	Prospective (n=40) 40 of 60 consecutive patients enrolled, 20 excluded due to scheduling	Yes	Yes	Good
Neitlich, Topazian, Smith et al., 1997	Prospective (n=51) 51 of 96 consecutive patients enrolled, all exclusions accounted for	Yes	Yes	Good
Soto, Alvarez, Munera et al., 2000	Prospective (n=51) 51 of 56 eligible consecutive patients enrolled, all exclusions accounted for	Yes	Yes	Good

Table 2. Studies of MRCP, choledocholithiasis outcome, ERCP used as reference standard for all studies except Sugiyama, Atomi and Hachiya (1998)

Study	N	Population	Diagnostic test	Prev (%)	Sens (%)	Spec (%)	PPV (%)	NPV (%)	Comments
Demartines, Eisner, Schnabel et al., 2000	40	Patients with suspected CBD stones referred for ERCP	MRCP	48	100	90	90	100	
Guibaud, Bret, Reinhold, et al., 1995	126	Patients with suspected CBD obstruction referred for ERCP	MRCP	25	81	98	93	94	10 patients with other methods for gold standard
Holzknecht, Gauger, Sackmann et al., 1998	61	Patients referred for ERCP	MRCP (on-site reading) MRCP (off-site independent reading)	21	92 85	96 93	86 79	98 96	
Lomas, Bearcroft, and Gimson 1999	69	Patients with suspected CBD stones or stricture referred for ERCP	MRCP	13	100	97	100	97	
Soto, Alvarez, Munera et al. 2000	51	Patients with suspected CBD stones referred for ERCP	MRCP	51	96	100	100	96	1 false-negative ERCP considered positive after stone found at sphincterotomy
Soto, Barish, Alvarez et al., 2000	49	Patients with suspected CBD stones referred for ERCP	MRCP fast Spin Echo Reviewer 1 Reviewer 2 Single Section half-Fourier RARE Reviewer 1 Reviewer 2 Multisection half-Fourier RARE Reviewer 1 Reviewer 2	49	 96 92 100 92 92 96	 96 100 96 96 92 92	 96 100 96 96 92 92	 96 93 100 92 92 96	
Stiris, Tennoe, Aadland et al., 2000	50	Patients with suspected CBD stones referred for ERCP	MRCP	68	88	94	97	81	

Table 2. Studies of MRCP, choledocholithiasis outcome, ERCP used as reference standard for all studies except Sugiyama, Atomi and Hachiya (1998) (cont'd)

Study	N	Population	Diagnostic test	Prev (%)	Sens (%)	Spec (%)	PPV (%)	NPV (%)	Comments
Varghese, Farrell, Courtney et al. 1999	100	Patients with CBD obstruction referred for ERCP	MRCP	30	93	99	97	97	12 patients with gold standard of IOC or PTC included in analyses
Varghese, Liddell, Farrell et al., 2000	191	Patients with CBD obstruction referred for ERCP	MRCP	18	91	98	91	98	5 patients with gold standard of IOC or PTC included in analyses
ERCP findings confirmed									
Sugiyama, Atomi, and Hachiya 1998	97	Patients with suspected CBD stones referred for ERCP	MRCP ERCP (ERCP findings confirmed)	35	91 100	100 100	100 100	95 100	Positive ERCP confirmed by sphincterotomy, negative ERCP not confirmed

Table 3. Studies of MRCP, mixed outcome including CBD stones, stratified by reference standard

Study	N	Population	Diagnostic test	outcome	Prev (%)	Sens (%)	Spec (%)	PPV (%)	NPV (%)	Comments
ERCP findings confirmed										
Adamek, Albert, Weitz et al., 1998	60	Referrals for ERCP with suspected CBD obstruction	MRCP ERCP	Any abnormality	78	89 91	92 92	98 98	71 75	Uncertain method of ascertaining reference standard
ERCP used as reference standard										
Holzknecht, Gauger, Sackmann et al., 1998	61	Patients referred for ERCP	MRCP (on-site reading) MRCP (off-site reading)	Any abnormality	75	91 94	80 80	93 94	75 80	

Table 4. Studies comparing ERCP to endoscopic ultrasonography, ERCP findings confirmed except for one study (Sugiyama and Atomi, 1998)

Study	**N**	**Population**	**Diagnostic test**	Prevalence (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	**Comments**
Prat, Amouyal, Amouyal et al., 1996	119	High suspicion of CBD stones, sphincterotomy candidates	EUS ERCP	66	94 90	98 100	99 100	89 84	Sphincterotomy and endoscopic exploration on all patients. Numbers differ from published report due to rounding errors in published report
Burtin, Palazzo, Canard et al., 1997	68	Patients with suspected CBD obstruction referred for ERCP	EUS ERCP	50	97 91	97 97	97 97	97 92	Unorthodox presentation of data in report, test characteristics calculated from text descriptions, technical failures counted as neg tests
Canto, Chak, Stellato et al., 1998	64	Patients with suspected CBD stones referred for ERCP	EUS ERCP	31	84 95	98 98	94 no report	93 no report	Actual numbers not reported, all values quoted from study. Positive ERCP confirmed with stone extraction, negatives with 12 mo clinical follow up
Norton and Alderson 1997	46	Patients with suspected CBD stones referred for ERCP	EUS ERCP	52	88 79	96 92	95 90	89 83	Positive ERCP and EUS confirmed by sphincterotomy, no confirmation of negative ERCP and EUS
Dancygier and Nattermann 1994	41	Patients with obstructive jaundice, referred for ERCP	EUS ERCP	39	94 100	100 100	100 100	96 100	Positive ERCP confirmed by sphincterotomy, no apparent confirmation of negative ERCP
Polkowski, Palucki, Regula et al., 1999	50	Patients referred for ERCP for suspected CBD stones	EUS ERCP	68	91 91	100 100	100 100	84 84	Positive ERCP confirmed by sphincterotomy, selective confirmation of negative ERCP
Sugiyama and Atomi 1997	142	Patients referred for ERCP for suspected CBD stones	EUS ERCP	36	96 100	100 100	100 100	98 100	Positive ERCP confirmed by sphincterotomy, no apparent confirmation of negative ERCP

Table 4. Studies comparing ERCP to endoscopic ultrasonography, ERCP findings confirmed except for one study (Sugiyama and Atomi, 1998) (cont'd)

Study	**N**	**Population**	**Diagnostic test**	Prevalence (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	**Comments**
Chak, Hawes, Cooper et al., 1999	36	Patients with suspected acute biliary pancreatitis	EUS ERCP	33	91 92	100 87	100 79	95 94	Positives for either test confirmed with sphincterotomy, negatives not confirmed
ERCP + sphincterotomy as ref standard									
Sugiyama and Atomi 1998	35	Patients with suspected acute biliary pancreatitis	EUS	43	100	100	100	100	ERCP reference standard, but positive ERCP confirmed with stone removal

Table 6. Quality Assessment

Study Author, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Cuschieri, Lezoche, Morino et al., 1999	RCT (n=300) Good comparability — computerized randomization — comparable characteristics	31 patients not treated according to random allocation, reported separately	Adequate for comparison	Adequate outcome measures used.	Those treated to assigned treatment reported as principal findings. Patients not treated by assigned treatment reported separately.	good
Rhodes, Sussman, Cohen et al., 1998	RCT (n=80) Uncertain comparability — randomization technique unknown — limited data on comparability	All patients retained for analysis	Adequate for comparison	Outcomes were not assessed blindly Uncertain how morbidity rates determined	All retained patients analyzed	Good
Chang, Lo, Stabile et al., 2000	RCT (n=59) Good comparability — sealed envelope randomization — comparable characteristics	All patients retained for analysis	Adequate for comparison	Outcomes were not assessed blindly Definition of morbidity not provided	All retained patients analyzed	Good

Table 6. Quality Assessment (cont'd)

Study Author, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Targarona, Ayuso, Bordas et al., 1996	RCT (n=98) Good comparability — stratified randomization with sealed envelopes — patient characteristics comparable	2 out of 100 patients excluded because of incorrect randomization	Adequate for comparison	Outcomes were not assessed blindly Short-term morbidity rates do not capture difference in invasiveness between treatments	All patients retained for short-term outcomes analysis 89/93 surviving patients retained for long term outcomes analysis	Good
Trias, Targarona, Ros et al., 1997	Prospective study with historical control group (n=110) Good comparability Patient characteristics comparable	All patients prospectively identified as eligible enrolled	Surgical arm may include endoscopic sphincterotomy, more intensive treatment	Outcomes were not assessed blindly Short-term morbidity rates do not capture difference in invasiveness between treatments	All patients retained for short-term outcomes analysis 99/105 surviving patients retained for long term outcomes analysis	Fair
Hammarstom, Holmin, Stridbeck et al., 1995	RCT (n=80) Good comparability — random numbers — patient characteristics comparable	All potential patients accounted for, few refusals	Adequate for comparison	Outcomes not systematically defined or enumerated	Adequate follow up	Poor, most results could not be tabulated

Table 6. Quality Assessment (cont'd)

Study Author, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Lai, Mok, Tan et al., 1992	RCT (n=82) Good comparability — randomized by consecutive envelopes — patient characteristics comparable	82 of 96 patients with severe acute cholangitis enrolled	Adequate for comparison	Outcomes were not assessed blindly Complication rates do not capture difference in invasiveness between treatments	All patients retained for analysis	Good
Leese, Neoptolemos, Baker et al., 1986	Retrospective observational study (n=82) Not very comparable Patients undergoing ERCP older, greater numbers of risk factors	Not applicable-retrospective study	Adequate for comparison	Outcomes were not assessed blindly	Analysis does not take into account difference in risk factors	Poor

Table 6. Quality Assessment (cont'd)

Study Author, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Adamek, Maier, Jakobs et al., 1996	Retrospective observational study (n=145) Fair comparability Patients comparable on all measured characteristics	Not applicable-retrospective study	Adequate for comparison	Outcomes were not assessed blindly	Simple unadjusted comparisons	Fair/poor
Neuhaus, Zillinger, Born et al., 1998	RCT (n=60) Good comparability — randomization technique unknown — patients comparable on all measured characteristics	All patients retained for analysis	Adequate for comparison	Outcomes were not assessed blindly	All patients retained for analysis	Good
Bergman, Rauws, Fockens et al., 1997	RCT (n=202) Good comparability — blinded computer-generated randomization — patients comparable on all measured characteristics	16 out of 218 excluded after randomization because of ineligibility	Adequate for comparison	Outcomes were not assessed blindly	All patients retained for analysis	Good

Table 6. Quality Assessment (cont'd)

Study Author, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Ochi, Mukawa, Kiyosawa et al., 1999	RCT (n=110) Good comparability — randomization not described — patients comparable on all measured characteristics	All patients retained for analysis	Adequate for comparison	Outcomes were not assessed blindly	All patients retained for short-term outcome analysis 105/110 patients retained for long-term outcome analysis	Good
Mavrogiannis, Liatsos, Romanos et al., 1999	RCT (n=153) Good comparability – randomization by sealed envelopes – Baseline characteristics similar for age, gender, presence of GB and gallstones	No cross-overs, drop outs reported.	Adequate for comparison.	Adequate outcome measures used. Outcomes were not assessed blindly.	Intention to treat analysis used.	Good
Chopra, Peters, O'Toole et al., 1996	RCT (n=86) Good comparability — Randomization by sealed envelopes — patients comparable on all measured characteristics	All patients retained for analysis	Adequate for comparison	Outcomes not blindly assessed Adequate for comparison	All patients analyzed for short term outcomes, 82/86 followed for long term outcomes	good

Table 7. Preoperative versus Postoperative ERCP in Cholecystectomy: Randomized Trials

Study	N	Population and Interventions	Outcomes	P	Adverse effects, complications	P	Resource utilization	P
Chang, Lo, Stabile et al., 2000	59	59 patients with mild to moderate gallstone pancreatitis, undergoing cholecystectomy after acute pancreatitis Mandatory preoperative ERCP (n=30) vs. selective postoperative ERCP (n=29) based on IOC findings	Stone Removal, successful ERCP/ERCP with stones: Preop ERCP: 12/12, 100% Postop ERCP: 7/7 , 100%		Morbidity rates (not defined) Preop ERCP: 10% Postop ERCP: 10%	n.s.	Hospital stay: mean, median days Preop ERCP: 11.7,9.5 Post op ERCP: 9.0 , 8 ICU days: mean, median Preop ERCP: 1.7, 1 Post op ERCP: 1.9 ,1 Total Costs: Preop ERCP: $10,210 Postop ERCP: $8,586	 .04 n.s. .049

Table 8. Preoperative ERCP versus Intraoperative cholangiogram and laparoscopic common bile duct exploration in patients undergoing laparoscopic cholecystectomy in patients with suspected common bile duct stones, randomized trials

Study	N	Population and Interventions	Outcomes	P	Adverse effects, complications	P	Resource utilization	P
Cuschieri, Lezoche, Morino et al., 1999	269	Patients with suspected CBD stones needing cholecystectomy Preoperative ERCP (n=136) versus IOC and laparoscopic CBD exploration (n=133) as initial strategies for removing stones	Stone clearance: Preop ERCP: 84% IOC, LCBDE: 84%	n.s.	Conversion to open cholecystectomy: Preop ERCP: 6% IOC, LCBDE: 13% Overall morbidity: Preop ERCP: 12.8% IOC, LCBDE: 15.8% Mortality: Preop ERCP: 1.5% IOC, LCBDE: 0.75%	.08 n.s. n.s.	Hospital stay, mean days: Preop ERCP: 9 IOC, LCBDE: 6	<.05

Table 9. Postoperative ERCP versus laparoscopic exploration of common bile duct in patients with common duct stones found on intraoperative cholangiography, randomized trials

Study	N	Population and Interventions	Outcomes	P	Adverse effects, complications	P	Resource utilization	P
Rhodes, Sussman, Cohen et al., 1998	80	80 patients with CBD stones found on cholangiography during cholecystectomy Laparoscopic CBD exploration (LCBDE) (n=40) versus postoperative ERCP (n=40)	Initial clearance of CBD stones: LCBDE: 75% Postop ERCP: 75% Final clearance of CBD stones: LCBDE: 100% Postop ERCP: 93%	n.s. n.s.	Overall Morbidity: LCBDE: 18% Postop ERCP: 15%	n.s.	Hospital stay, median days: LCBDE: 1 Postop ERCP: 3.5	<.01

Table 10. Endoscopic sphincterotomy alone versus open cholecystectomy in high risk surgical patients as primary treatment for common bile duct stones, randomized trials

Study	N	Population and Interventions	Outcomes	P	Adverse effects, complications	P	Resource utilization	P
Targarona, Ayuso, Bordas et al., 1996	98	Surgical high risk patients presenting with symptoms consistent with CBD stones Endoscopic sphincterotomy only (n=50) versus open cholecystectomy and CBD exploration if necessary (n=48)	Initial failure of treatment: ES: 12% Surgery: 6% Immediate mortality: ES: 6% Surgery: 4%	0.3 .5	Immediate morbidity: ES: 16% Surgery: 23% LONG TERM Biliary complications: ES (n=46): 21% Surgery(n=43): 6% Readmissions: ES: 23% Surgery: 4% Cholecystectomy: ES: 15% Surgery: 0% Need for sphincterotomy: ES: 2% Surgery: 4%	0.4 .04 .01 .01 .9	Post-treatment length of stay, mean days: ES: 5 Surgery: 11	 .001

Table 11. Endoscopic sphincterotomy alone versus laparoscopic cholecystectomy (with or without preoperative ERCP) in high risk surgical patients as primary treatment for common bile duct stones, observational studies

Study	N	Population and Interventions	Outcomes	P	Adverse effects, complications	P	Resource utilization	P
Trias, Targarona, Ros et al., 1997	110	Surgical high risk patients presenting with symptoms consistent with CBD stones Endoscopic sphincterotomy only (n=50) versus laparoscopic cholecystectomy and with preoperative ERCP if necessary (n=60)	Initial failure of treatment: ES: 12% Surgery: 11% Immediate mortality: ES: 6% Surgery: 3%	n.s. 0.5	Immediate morbidity: ES: 16% Surgery: 18% LONG TERM Biliary complications: ES (n=46): 21% Surgery(n=53): 4% P Readmissions: ES: 23% Surgery: 2% P Need for reoperation: ES: 15% Surgery: 2%	n.s. <.04 <.01 <.01	Post-treatment length of stay, mean days: ES: 5 Surgery: 4.4	n.s.

Table 12. Endoscopic sphincterotomy alone versus open cholecystectomy and CBD exploration in non-high risk surgical patients as primary treatment for common bile duct stones, randomized trials

Study	N	Population and Interventions	Outcomes	P	Adverse effects, complications	P	Resource utilization	P
Hammarstrom, Holman, Stridbeck et al., 1995	80	Patients presenting with CBD stones on ERCP with intact gall bladder Endoscopic sphincterotomy only (n=39) versus open cholecystectomy and CBD exploration if necessary (n=41)	Biliary outcomes not coherently tabulated		Biliary complications not coherently tabulated Deaths from non-biliary related disease ES: 30% Surgery: 10% 13 patients in ES group required cholecystectomy on follow up	0.02	Total hospitalization days, median ES: 13 Surgery: 16	NS

Table 13. Endoscopic drainage for treatment of acute cholangitis due to common bile duct stones, randomized trials

Study	N	Population and Interventions	Outcomes	P	Adverse effects, complications	P	Resource utilization	P
Lai, Mok, Tan et al., 1992	82	82 patients with acute severe cholangitis due to CBD stones diagnosed with diagnostic ERCP Nasobiliary drainage placed by ERCP (n=41) versus open CBD exploration (n=41)	Hospital mortality rate: ERCP: 10% Surgery: 32%	<.03	Overall complication rate: ERCP: 34% Surgery: 66%	>.05		

Table 14. Sphincterotomy for treatment of acute cholangitis due to common bile duct stones, observational studies

Study	N	Population and Interventions	Outcomes	P	Adverse effects, complications	P	Resource utilization	P
Leese, Neoptolemos, Baker et al., 1986	71	Retrospective review of patients with acute cholangitis due to CBD stones Early sphincterotomy (n=43) versus early surgery (n=28)	30 day mortality ERCP: 5% Surgery: 21%	<.02	Total % of patients with complications: ERCP: 28% Surgery: 57%	N/A	Hospital stay, median days: ERCP: 20 Surgery 23	n.s.

Patients receiving ERCP had greater baseline medical risk factors than patients having surgery (2 vs. 1, P<.05)

Table 15. Intracorporeal vs. extracorporeal lithotripsy for common bile duct stones, randomized trials

Study	N	Population and Interventions	Outcomes	P	Adverse effects, complications	P	Resource utilization	P
Neuhaus, Zillinger, Born et al. 1998	60	Patients with stones not removable with ERCP techniques due to impacted stones or inaccessable bile duct. 33 patients with endoscope access, 27 patients with percutaneous access Extracorporeal shock wave lithotripsy (ESWL) (n=30) versus intracorporeal laser lithotripsy (ILL) (n=30)	Bile duct clearance: ESWL: 73% ILL: 97%	<.05	Not formally enumerated, appeared to be mild		Treatment sessions needed, mean: ESWL: 3.0 ILL: 1.2 Duration of treatment, mean days: ESWL: 3.9 ILL: 0.9	<.001 <.001

Table 16. Intracorporeal vs. extracorporeal lithotripsy for common bile duct stones, observational studies

Study	N	Population and Interventions	Outcomes	P	Adverse effects, complications	P	Resource utilization	P
Adamek, Maier, Jakobs et al., 1996	125	Patients with stones not removeable with ERCP techniques due to large stone size, impaction, biliary stricture, inaccessable bile duct Extracorporeal shock wave lithotripsy (ESWL) (n=79) versus intracorporeal electrohydraulic lithotripsy (EHL) (n=46)	Fragmentation of stones: ESWL: 97% EHL: 93% Bile duct clearance: ESWL: 79% EHL: 74%	n.s. n.s.	Not formally compared between treatments		Treatment sessions needed, mean: ESWL: 2.0 EHL: 1.1 Hospital stay, mean days: ESWL: 13 EHL: 11	 N/A N/A

Characteristics of patients, stone size, number of stones, stone location not statistically significantly different between treatment groups.

Table 17. Endoscopic balloon dilation versus endoscopic sphincterotomy for removal of bile duct stones, randomized trials

Study	N	Population and Interventions	Outcomes	P	Adverse effects, complications	P	Resource utilization	P
Bergman, Rauws, Fockens et al., 1997	202	Patients referred for ERCP for removal of CBD stones, stones visualized Balloon dilation and stone removal versus sphincterotomy and stone removal	Stone removal in one session: Balloon: 89% Sphincterotomy: 91% *9 patients in Balloon group required sphincterotomy to remove stones	n.s.	Early complications: Balloon: 17% Sphincterotomy: 24% Follow-up complications: Balloon: 18% Sphincterotomy: 23%	n.s. n.s.		
Ochi, Mukawa, Kiyosawa et al., 1999	110	Patients referred for ERCP for removal of CBD stones, stones visualized, < 15 mm and less than 10 stones Balloon dilation and stone removal versus sphincterotomy and stone removal	Stone removal, final: Balloon: 93% Sphincterotomy: 98% Stone removal after initial procedure (before lithotripsy): Balloon: 78% Sphincterotomy: 94%	.36 .02	Early complications: Balloon: 2% Sphincterotomy: 6% Late complications: Balloon: 4% Sphincterotomy: 15%	n.s. n/a		

Table 18. Needle-knife fistulotomy versus needle-knife precut papillotomy for the treatment of common bile duct stones

Study	N	Population and Interventions	Outcomes	P	Adverse effects, complications	P	Resource utilization	P
Mavrogiannis, Liatsos, Romanos et al., 1999	153	Consecutive patients who required treatment of suspected choledocholithiasis who had difficulty achieving selective CBD cannulation were randomized to either needle-knife fistulotomy (NKF, n=74) or needle-knife precut papillotomy (NKPP, n=79). All patients had biochemical cholestasis and one or more of the following: biliary pain, bile duct cannulation, and gallbladder stones.	Cannulation success rates (overall): NKF=90.5% NKPP=88.6% Successful stone extraction without lithotripsy NKF (40/48) = 83% NKPP (45/46) =98% Overall stone extraction NKF =100% NKPP =100%	n.s. .05 n.s.	Comp (%): NKF NKPP Bleeding 6.75 5.06 Perforation 2.7 2.53 Cholangitis 1.35 0 Pancreatitis 0 7.59 Total 10.81 15.18 Hyperamylasemia 2.7 17.72 Death 0 1.26	 n.s. n.s. n.s .05 n.s. .01 n.s.		

Table 19. Jaundice or elevated bilirubin as a risk factor for CBD stone

Study	Population	% prevalence of stone in population	n	Rule tested	Predictive Value	Sensitivity	Specificity	Comments
Alponat, Kum, Rajnakova et al., 1997	Patients with risk factors for CBD stones having ERCP	32	192	jaundice	67	56	87	
Barkun, Barkun, Fried et al., 1994	Patients undergoing lap cholecystectomy who had ERCP	48	139	bilirubin>1.8	57	48	48	
Bergamaschi, Tuech, Braconier et al., 1999	Patients undergoing lap cholecystectomy	15	990	jaundice	76	24	99	
Hauer-Jensen, Karesen, Nygaard et al., 1985	Patients undergoing cholecystectomy	12	319	jaundice bilirubin>1.5	29 42	26 45	91 91	
Kim, Kim, Lee et al., 1997a	Patients undergoing lap cholecystectomy	17	561	jaundice bilirubin >2	52 53	36 41	93 92	
Koo and Traverso 1996	Patients undergoing lap cholecystectomy	12	420	bilirubin>1.2	47	31	93	
Menezes, Marson, Debeaux et al. 2000	Patients undergoing lap cholecystectomy	33	233	bilirubin>nl bilirubin>2xnl	95 92	48 31	98 99	
Santucci, Natalini, Sarpi et al., 1996	Patients undergoing lap cholecystectomy	9	697	bilirubin>3	83	56	82	
Trondsen, Edwin, Reiertsen et al., 1995	Patients undergoing lap cholecystectomy	38	599	jaundice	86	46	95	

Table 20. Elevated liver function tests as a risk factor for CBD stone

Study	Population	% prevalence of stone in population	n	Rule tested	Predictive Value	Sensitivity	Specificity	Comments
Alponat, Kum, Rajnakova et al., 1997	Patients with risk factors for CBD stones having ERCP	32	192	Any LFT>2xnl AST > 2xnl ALT > 2xnl Alk phos >2xnl GGT > 2xnl LDH > 2xnl	37 41 40 43 35 38	84 89 87 84 87 68	33 40 38 46 22 46	Numbers for any LFT do not make sense, cannot be less sensitive
Barkun, Barkun, Fried et al., 1994	Patients undergoing lap cholecystectomy who had ERCP	48	139	AST>120 Alk phos>300	49 53	81 79	25 35	
Bergamaschi, Tuech, Braconier et al., 1999	Patients undergoing lap cholecystectomy	15	990	Alk phos >400 and GGT>200	87	58	99	
Hauer-Jensen, Karesen, Nygaard et al., 1985	Patients undergoing cholecystectomy	12	319	Alk phos>250	37	58	87	
Kim, Kim, Lee et al., 1997a	Patients undergoing lap cholecystectomy	17	561	SGOT>50 SGPT>50 Alk phos>160	43 39 50	65 67 75	82 79 85	
Koo and Traverso 1996	Patients undergoing lap cholecystectomy	12	420	SGOT>44 Alk phos>140	48 48	40 31	94 93	
Menezes, Marson, Debeaux et al. 2000	Patients undergoing lap cholecystectomy	33	233	SGOT>nl SGOT>2xnl Alkphos>nl Alkphos>2xnl	88 93 77 97	47 35 66 44	97 99 90 99	
Santucci, Natalini, Sarpi et al., 1996	Patients undergoing lap cholecystectomy	9	697	ALT> 40 AST> 40 GGT>150 Alk phos>300	88 76 75 94	94 78 80 72	79 78 76 90	Cutoffs established by ROC analysis, maximize sensitivity and specificity

Table 21. Dilated CBD as a risk factor for CBD stone

Study	Population	% prevalence of stone in population	n	Rule tested	Predictive Value	Sensitivity	Specificity	Comments
Alponat, Kum, Rajnakova et al., 1997	Patients with risk factors for CBD stones having ERCP	32	192	Dilated CBD with stone on ultrasound Dilated CBD without stone on ultrasound	72 36	42 31	92 74	
Barkun, Barkun, Fried et al., 1994	Patients undergoing lap cholecystectomy who had ERCP	48	139	Dilated CBD, subjective	64	53	73	
Bergamaschi, Tuech, Braconier et al., 1999	Patients undergoing lap cholecystectomy	15	990	CBD > 8mm	75	28	98	
Hauer-Jensen, Karesen, Nygaard et al., 1985	Patients undergoing cholecystectomy	12	319	CBD >10 mm	34	63	92	
Kim, Kim, Lee et al., 1997a	Patients undergoing lap cholecystectomy	17	561	CBD > 10 mm	61	94	88	
Koo and Traverso 1996	Patients undergoing lap cholecystectomy	12	420	CBD> 5mm + 1 mm per decade over age 50	28	22	92	
Menezes, Marson, Debeaux et al. 2000	Patients undergoing lap cholecystectomy	33	233	CBD dilated (not defined)	91	51	97	
Santucci, Natalini, Sarpi et al., 1996	Patients undergoing lap cholecystectomy	9	697	CBD> 8 mm	74	59	72	

Table 21. Dilated CBD as a risk factor for CBD stone (cont'd)

Study	Population	% prevalence of stone in population	n	Rule tested	Predictive Value	Sensitivity	Specificity	Comments
Trondsen, Edwin, Reiertsen et al., 1998	Patients undergoing lap cholecystectomy	15	171	CBD > 6 mm	35	64	79	
Trondsen, Edwin, Reiertsen et al., 1995	Patients undergoing lap cholecystectomy	38	599	CBD dilated (not defined)	85	31	96	

Table 22. Decision rules for prediction of stones

Study	population	% prevalence of stone in population	n	Rule tested	Predictive value	Sensitivity	Specificity	Comments
Hawasli, Lloyd, Pozios et al., 1993	Patients undergoing lap cholecystectomy	4	459	High suspicion combination	75	83	99	
Menezes, Marson, Debeaux et al. 2000	Patients undergoing lap cholecystectomy	15	211	Score>= 2 Score>=3 Based on logistic regress	56 67	86 82	66 80	
Trondsen, Edwin, Reiertsen et al., 1995	Patients undergoing lap cholecystectomy	38	599	Discriminant function	91	95	94	Rule applied to same data used to develop function
Trondsen, Edwin, Reiertsen et al., 1998	Patients undergoing lap cholecystectomy	17	192	Discriminant function	60	94	88	Same 2 by 2 data as Trondsen, Edwin, Reiertsen et al., 1995, above

Table 23. Rules ruling out stones, absence of stone is the outcome

Study	population	% prevalence of stones in population	n	Rule tested	Prevalence of stone in those ruled out by rule (1 – PPV)	Sensitivity--% of stone-free patients detected by rule	Specificity--% of patients with stones ruled out by rule	Comments
Carroll, Phillips, Rosenthal et al., 1996	Patients undergoing lap cholecystectomy	15	100	Normal LFTs, CBD, past history	4	61	87	
Hawasli, Lloyd, and Cacucci 2000	Patients undergoing lap cholecystectomy	5	2834	Normal LFTs, CBD, past history	0.25	89	96	Hawasli, Lloyd, Pozios et al. 1993 results of this same question included in these data
Khaira, Ridings, and Gompertz 1999	Patients undergoing lap cholecystectomy	5	154	Normal LFTs, CBD, past history	1	60	88	
Koo and Traverso 1996	Patients undergoing lap cholecystectomy	12	420	Normal LFTs, US, past history	7	78	60	
Santucci, Natalini, Sarpi et al., 1996	Patients undergoing lap cholecystectomy	9	697	Normal LFTs, US, past history	1.4	98	86	Clinical followup to detect stones in patients with no indications
Trondsen, Edwin, Reiertsen et al., 1998	Patients undergoing lap cholecystectomy	17	192	Discriminant function value negative	1.4	88	94	Rule applied to validation set of patients
Trondsen, Edwin, Reiertsen et al., 1995	Patients undergoing lap cholecystectomy	38	599	Discriminant function value negative	3	94	95	Rule applied to same data used to develop function

Table 24. Quality Assessment

Study Author, Year	**Patient Enrollment**	**Diagnostic performance of ERCP determined without knowledge of other test results**	**Diagnostic Performance of other test(s) determined without knowledge of ERCP results**	**Summary Evaluation**
Jaiwala, Fogel, Sherman et al., 2000	(n=133 pts) Prospective Study Enrollment of subjects stated to be selected and nonconsecutive and reasons for exclusion were stated.	No	No	**Fair**
Kurzawinski, Deery, Dooley et al., 1993	(n=46 pts) Prospective study of 37 of 46 consecutive pts w/ biliary tract stricture had ERCP and 9 had PTC cytology. Reasons for exclusions provided.	No	No	**Fair**
de Peralta-Venturina, Wong, Purslow et al., 1996	(n=74 pts; 104 spec) Retrospective review of all eligible cytology specimens during 1990 to mid 1994 in pts with verified diangosis.	Yes	Yes	**Good**
Foutch et al. 1991	(n=30 pts; 78 specimens) Prospective study 30 consecutive patients with bile duct stricture	Yes	Yes	**Good**
Mansfield et al. 1997	(n=43 pts; 54 procedures) Prospective study All pts with biliary stricture suspicious for malignancy	Yes	Yes	**Good**

Table 24. Quality Assessment (cont'd)

Study Author, Year	Patient Enrollment	Diagnostic performance of ERCP determined without knowledge of other test results	Diagnostic Performance of other test(s) determined without knowledge of ERCP results	Summary Evaluation
Sugiyama, Atomi, Wada et al., 1996	(n= 43 pts) Prospective study 52 Consecutive pts with stricture (n=48) or filling defect (n=4) Papillary lesions excluded. Analysis includes 43 pts with all 3 techniques	No	No	**Fair**
Howell, Beveridge, Bosco et al., 1992	?Prospective 31 consecutive patients with malignant appearing strictures	No	No	**Fair**
Ferrari, Lichtenstein, Slivka et al., 1994	(n=74) Retrospective study of all pts who had ERCP with brush cytology of biliary or pancreatic duct stricture	No	No	**Fair**
Ponchon, Gagnon, Berger et al., 1995	(n=193) Prospective study Enrolled subjects meeting entry criteria. Complete explanation of enrollment process provided.	Yes	Yes	**Good**
Schoefl, Haefner, Wrba et al., 1997	119 consecutive pts (133 samples) ?retrospective	No	No	**Fair**

Table 24. Quality Assessment (cont'd)

Study Author, Year	Patient Enrollment	Diagnostic performance of ERCP determined without knowledge of other test results	Diagnostic Performance of other test(s) determined without knowledge of ERCP results	Summary Evaluation
Pugliese, Antonelli, Vincenti et al., 1997	(n=52) Prospective enrollment of consecutive biliary strictures at ERCP Excluded strictures associated with bile duct stones, periampullary tumors, or postop stricture	Yes	Yes	**Good**
Gmelin and Weiss 1981	(n=32) 32 proven malignant or benign tumors in papillary region out of 36 consecutive cases.	Uncertain	Uncertain	**Fair**

Table 25. Comparisons of Bile Cytology and Brush Cytology

Study	N Pts	N Spec	Diagnostic test	Prevalence (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Adequate Specimens (%)	Quality Rating and Comments
Kurzawinski, Deery, Dooley et al., 1993	37 31	37 31	ERCP-Bile cytology ERCP-Brush cytology	81 77	33[a] 71[b]	100 100	100 100	26 50		**Fair** p< 0.05 a vs. b p< 0.01 c vs. d
	9 15	9 15	PTC-Bile cytology PTC-Brush cytology	?	0[c] 67[d]	n.r. n.r.				
de Peralta-Venturina, Wong, Purslow et al., 1996	74	13 61	Bile cytology Brush cytology[10]	? ?	50 100	100 95	100 95	40 100	69 98	**Good**
		55 19	ERCP PTC	? ?	100 43	95 100	96 100	100 57	98 79	Stratified results for bile vs. brushing not reported by ERCP vs. PTC technique

Table 26. Comparisons of Bile Cytology, Brush Cytology, and Other Technique

Study	N Pt	N Sp	Diagnostic test	Prevalence (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Adequate Specimens (%)	Quality Rating and Comments
Foutch et al. 1991	30	31	Bile cytology	58	6	100	100	43		**Good**
		31	Brush cytology[1]	58	33	100	100	52		
		16	Stent cytology	69	36	100	100	42		
Mansfield et al. 1997	43	54	Bile cytology	96	12	100	100	4	44	**Good**
		54	Brush cytology[2]	96	42	100	100	6	96	Clearly malignant or
		19	Soehendra stent retriever screw head	?	25	?	?	?	70	suspicious cytology = (+)
		19	Stent	?	37	?	?	?	84	
		54	Combined	?	54	100	100	8		
Sugiyama, Atomi, Wada et al., 1996[3]	43	43	Bile cytology	72	32[a]	100	100	36	100	**Fair**
	43	43	Brush cytology[4]	72	48[b]	100	100	43	88	$p<0.01$, a vs c; $p<0.05$, b vs.
	43	43	Forceps biopsy	72	81[c]	100	100	67	87	c; p = n.r., a vs b

[1] Milrose Lab, 230 cm, 2.5-mm diameter
[2] Combocath, Microvasive, Boston Scientific
[3] Specifically excluded patients with papillary tumor.
[4] BC-23Q cytology brush (outer diameter, 1.8 mm, Olympus, Tokyo, Japan)

Table 27. Comparisons of Brush Cytology and Biopsy Technique

Study	N Pt	N Sp	Diagnostic test	Prevalence (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Adequate Specimens (%)	Quality Rating and Comments
Howell, Beveridge, Bosco et al., 1992	31		Brush cytology FNA – ERCP Combined	84 84 84	8 62 65	100 100 100	100 100 100	17 33 36		**Fair**
Ferrari, Lichtenstein, Slivka et al., 1994	 70 51 19 29		Brush cytology – Overall – Biliary – Pancreatic FNA – percutaneous	 76 ?	 56 54 64 91	 100 100 100 75	 100 100 100 95	 51 45 67 60	 93	**Fair**
Ponchon, Gagnon, Berger et al., 1995	233	193 118 105	Brush cytology Forceps biopsy[5] Combination	66 69 70	35[a] 43[b] 63[c]	97 97 97	96 97 98	66 69 70	90 57	**Good** p= n.s. for a vs b p<0.001 for a vs c p<0.05 for b vs. c
Schoefl, Haefner, Wrba et al., 1997	59 106 48	65 119 51	Brush cytology[6] Forceps biopsy[7] Combination	?	47 65 70	100 100 100	100 100 100	62 69 71		**Fair**
Pugliese, Antonelli, Vincenti et al., 1997	52	52	Brush cytology[8] Forceps biopsy[9] Combination	69 69 69	53 53 61	100 100 100	100 100 100	48 48 53		**Good** Uncertain cytology was considered negative.
Gmelin and Weiss 1981	32	32 26 26	Papillary tumors Brush cytology Forceps biopsy	 85 81	 18 71 55 86	 100 100 100 100	 100 100 100 100	 18 45 29 63		**Fair** Suspicious cells considered negative Suspicious cells considered positive

[5] Either Biomed 31010 (Paris, France: 175 cm length, 2mm diameter, round and fenestrated jaw with 2mm diameter, flexible tip, no needle) or Olympus prototype (Scop Medecine; 180cm length, 2.2mm diameter, round and fenestrated jaw with 2mm diameter, teflon sheath, no needle)
[6] Endo-Flex 42 22E-A
[7] Olympus FB-19N for about 60% and FB26N for about 30% and FB-39Q for about 10%
[8] Olympus mod. BC-19Q or Wilson-Cook Medical Inc., Winston-Salem, NC, Mod. GBC-200-3-3.5
[9] Olympus FB-19K or FB-39Q

Table 28. Comparison of Brush Cytology, FNA cytology, and Forceps biopsy in biliary strictures

Study	N Pts	N Spec	Diagnostic test	Prevalence (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Adequate Specimens (%)	Quality Rating and Comments
Jaiwala, Fogel, Sherman et al., 2000	133	133	Brush cytology[10]	78	48[a]	90	94	33	n.r.	**Fair**
			FNA cytology[11]		38[b]	97	98	30	n.r.	Any atypia on cytology was considered equivalent to cancer.
			Forceps biopsy[12 or 13]		54[c]	76	89	31	n.r.	
			Brush + FNA		57[d]	86	94	36	n.r.	
			Brush + Biopsy		71[e]	69	89	40	n.r.	P<0.05 for: a vs. e, f, g;
			Biopsy + FNA		64[f]	72	89	36	n.r.	b vs. c, d, e, f, g; c vs. e, f, g;
			Brush+Biopsy+FNA		77[g]	66	89	44	n.r.	d vs. e, g; f vs. g
			Brush cytology		30[a]	100	100	28		
			FNA cytology		30[b]	100	100	28		Only high-grade atypia considered equivalent to cancer.
			Forceps biopsy		43[c]	90	94	31		
			Brush + FNA		39[d]	100	100	32		
			Brush + Biopsy		55[e]	90	95	36		P<0.05 for: a vs. c, d, e, f, g;
			Biopsy + FNA		53[f]	90	95	35		b vs. c, d, e, f, g; c vs. e, f, g;
			Brush+Biopsy+FNA		62[g]	90	96	39		d vs. e, f, g
			Brush cytology		26[a]	100	100	27		
			FNA cytology		25[b]	100	100	27		All atypia on cytology considered negative.
			Forceps biopsy		37[c]	100	100	31		
			Brush + FNA		34[d]	100	100	30		P<0.05 for: a vs. c, e, f, g; b
			Brush + Biopsy		48[e]	100	100	35		vs. c, e, f, g; c vs. e, d, f; d
			Biopsy + FNA		46[f]	100	100	34		vs. e, f, g.
			Brush+Biopsy+FNA		52[g]	100	100	37		

[10] Geenan brush system (Wilson-Cook Medical, Inc. Winston-Salem, N.C.)
[11] Howell needle system (Wilson-Cook)
[12] Malleable forceps (Olympus America, Inc., Melville, N.Y.)
[13] Standard colonoscopic pinch forceps (Ballard Medical Products, Draper, Utah)

Table 29. Supplemental Analysis: Single Arm Studies Reporting Diagnostic Operating Characteristics of EUS-FNA in Pancreatic Mass

Study	N Enr	N Res	Diagnostic test Population setting	Prev (%)	Sens (%)	Spec (%)	PPV (%)	NPV (%)	Adequate Specimens (%)	Comments
Wiersema, Vilmann, Giovannini et al., 1997 Multicenter – Including Indiana University and University of California	124	124	EUS-FNA Subgroup with pancreatic mass	74	89	100	100	76	97	**Prospective** 4 inadequate specimens excluded. Results in article are unclear regarding 5 cases of suspicious or atypical cytology.
Gress, Gottlieb, Sherman et al., 2001[14] Indiana University	102	94	EUS-FNA Suspected pancreatic ca after negative CT-FNA or ERCP cytology	64	88	100	100	92		**Prospective** 8 inconclusive or nondiagnostic results excluded
Gress, Hawes, Savides et al., 1997[14] Indiana University	121	121	EUS-FNA Pancreatic mass	42	80	100	100	88		**Prospective**
Brandwein, Farrell, Centano et al., 2001 Massachusetts General Hospital	96	93	EUS-FNA Suspected pancreatic ca underwent surgery	85 23 58	60 50 60	100 100 100	100 100 100	29 60 60		**Retrospective** Solid lesions (n=43) Cystic Lesions (n=26) Dilated duct (n=24)
Williams, Sahai, Aabakken et al., 1999 University of South Carolina	144	144	EUS-FNA All EUS-FNA referrals to single center	85	72 73 70	100 100 100	100 100 100	38 34 45		**Retrospective** All pancreatic masses Pancreatic mass $\geq$ 3 cm Pancreatic mass < 3 cm
Bentz, Kochman, Faigel et al., 1998 University of Pennsylvania	45	38	EUS-FNA Pancreatic mass	82	94	100	100	78	84	**Prospective**

[14] Both studies by Gress et al. are reported from the same institution, but patient selection criteria differ with the 2001 report choosing only the subset with persistently high clinical suspicion of pancreatic cancer following otherwise negative workup. The earlier study provides more generally selected patients.

Table 29. Supplemental Analysis: Single Arm Studies Reporting Diagnostic Operating Characteristics of EUS-FNA in Pancreatic Mass (cont'd)

Study	N Enr	N Res	Diagnostic test Population setting	Prev (%)	Sens (%)	Spec (%)	PPV (%)	NPV (%)	Adequate Specimens (%)	Comments
Chang, Nguyen, Erickson et al., 1997 University of California	44 pts 47 les	44	EUS-FNA Pancreatic mass	70	92	100	100	75	95	**Retrospective**

Table 30. Quality Assessment

Study **Author, Year**	**Patient Enrollment**	**Diagnostic performance of ERCP determined without knowledge of other test results**	**Diagnostic Performance of other test(s) determined without knowledge of ERCP results**	**Summary Evaluation**
MRCP Studies				
Varghese, Farrell, Courtney et al., 1999	Prospective (n=100) Complete explanation provided of 113 consecutive enrolled and 13 excluded subjects	Yes	Yes	**Good**
Adamek, Albert, Weitz et al., 1998	Prospective (n=60) 60 of 86 pts w/ suspected biliary obstruction Reasons for exclusions fully explained	Yes	Yes	**Good**
Arslan, Geitung, Viktil et al., 2000	Retrospective (n=135) 135 of 153 consecutive patients had diagnostic MRCP and ERCP Results reported in 78 patients with diagnostic quality MRCP and ERCP among of 85 patients with obstruction	Uncertain	Uncertain	**Fair**
Lee, Lee, Kim et al., 1997	? Retrospective (n=46) Complete explanation of 71 consecutive eligible patients and 25 exclusions	Yes	No	**Fair** MRCP results seem to factor into the reference standard determination
Holzknecht, Gauger, Sackmann et al., 1998	Prospective (n=61) Complete explanation provided of 66 consecutive enrolled patients and 5 excluded subjects	Yes	Yes	**Good**
Lomas, Bearcroft, and Gimson 1999	Prospective (n=69) Complete explanation provided of 76 enrolled and 7 excluded subjects	Yes	Uncertain	**Fair**

Table 30. Quality Assessment (cont'd)

Study Author, Year	Patient Enrollment	Diagnostic performance of ERCP determined without knowledge of other test results	Diagnostic Performance of other test(s) determined without knowledge of ERCP results	Summary Evaluation
MRCP Studies (cont'd)				
Adamek, Albert, Breer et al., 2000	Prospective (n=124) 124 of 141 pts w/ suspected pancreatic malignancy Reasons for exclusion fully explained	Yes	Yes	**Good**
Guibaud, Bret, Reinhold et al., 1995	Prospective (n=126) Some exclusions because of no ERCP confirmation	Uncertain	Yes	**Fair**
EUS Studies				
Kaneko, Nakao, Inoue et al., 2001	Prospective (n=27) Consecutive patients with no reported exclusions	No	No	**Fair**
Glasbrenner, Schwarz, Pauls et al., 2000	Prospective (n=95) Consecutive patients referred for surgical resection of pancreatic mass	Yes	Yes	**Good**
Rosch, Schusdziarra, Born et al., 2000	Retrospective (n=184) Full explanation of 18 exclusions provided but selection based on having all 3 diagnostic tests creates a potential bias.	Yes	Yes	**Fair**
Cellier, Cuillerier, Palazzo et al., 1998	Retrospective (n=47) Consecutive patients with partial explanations for 17 excluded patients.	Uncertain	Yes	**Fair**
Burtin. Palazzo, Canard et al., 1997	Prospective (n=68) Consecutive patients enrolled	Yes	Yes	**Fair**—unorthodox reporting of data, uncertain of data
Dancygier and Nattermann 1994	Prospective (n=41) Unstated whether consecutive	Uncertain	Yes	**Fair**
Snady, Cooperman, Siegel et al., 1992	Retrospective (n=60) Methods not well described other than pts were "diagnostically problematic"	No	No	**Fair**

Table 31. Comparison of MRCP and ERCP

Study	N Pt	N Res	Diag test	Outcome	Prev (%)	Sens (%)	Spec (%)	PPV (%)	NPV (%)	Adeq Studies (%)	Comments
Independent Reference Standard[15]											
Adamek, Albert, Weitz et al., 1998	86	60	MRCP ERCP	Presence of malignant stricture	45 45	81 93	100 94	100 93	87 94	97 79	**Good, prospective** p=n.r., but "equivalent"
Arslan, Geitung, Viktil et al., 2000	153	78	MRCP ERCP	Presence of malignant stricture		86 (74-94) 89 (77-96)	82 (67-93) 94 (82-99)			98.7 90	**Fair, retrospective** Kappa = 0.82
Lee, Lee, Kim et al., 1997 [16]	71	46	MRCP ERCP	Presence of malignant stricture	46 46	81 71	92 92	89 88	85 79	98 n.r.	**Fair, ?retrospective** McNemar p>0.05
Adamek, Albert, Breer et al., 2000	141	124	MRCP ERCP	Presence of pancreatic cancer	30 30	84 70	97 94	91 84	93 88	n.r. n.r.	**Good, prospective** McNemar p=0.059
Varghese, Farrell, Courtney et al., 1999[17]	113 113	100 98 100 98	MRCP ERCP MRCP ERCP	Presence of stricture Level of stricture	28 28 28 28	100 100 100 100	100 100 100 100	100 100 100 100	100 100 100 100	97 89 97 89	**Good, prospective** No statistical analysis

[15] Independent reference standards relied on best available information from surgery, biopsy, cytology, imaging, and clinical follow-up.
[16] Reference standard also took into consideration MRCP and ERCP results as well as surgery
[17] MRCP provided additional information over ERCP regarding cause of stricture in one case of 1.5 cm periampullary adenocarcinoma

Table 31. Comparison of MRCP and ERCP (cont'd)

Study	N Pt	N Res	Diag test	Outcome	Prev (%)	Sens (%)	Spec (%)	PPV (%)	NPV (%)	Adeq Studies (%)	Comments
ERCP Reference Standard											
Guibaud, Bret, Reinhold et al., 1995	126	126	MRCP	Presence of malignant stricture	11	86 (67-100)	98 (96-100)	86	97	99	**Fair, prospective**
Lomas, Bearcroft, and Gimson 1999	76	69	MRCP	Presence of malignant stricture	17	92	100	100	98	97	**Fair, prospective** Kappa = 0.88
	76	69		Presence of stricture	29	100	98 (94-100)	95 (85-100)	100	97	
	76	69		Level of stricture	n.r.	100	100	100	100		
Holzknecht, Gauger, Sackmann et al., 1998	66	61	MRCP[18]	Presence of stricture	59	89	84	89	84		**Good, prospective** No statistical analysis

[18] This study performed MRCP using only "snapshot" techniques (RARE and half-Fourier RARE) in the coronal and angles sagittal planes. It is unclear whether axial images were routinely obtained.

Table 32. Comparison of EUS and ERCP

Study	N Pt	N Res	Diag test	Outcome	Prev (%)	Sens (%)	Spec (%)	PPV (%)	NPV (%)	Adeq Stud (%)	Comments
Population with obstructive jaundice											
Independent Reference Standard											
Burtin. Palazzo, Canard et al., 1997	34	34	EUS ERCP	Presence of malignant lesion	36 36	89 89	96 92	89 80	96 96	97 97	**Fair, prospective** data not clearly reported p=n.s., diagnostic accuracy
Snady, Cooperman, Siegel et al., 1992	60	60 54	EUS ERCP+CT	Presence of malignant lesion	67 67	85 75	80 65	89 81	73 57		**Fair, retrospective** p=n.s.
ERCP Reference Standard											
Dancygier and Nattermann 1994	41	41	EUS	Presence of malignant lesion	100	100	100	100	100		**Fair, prospective** No statistical analysis
	41	41	EUS	Level of stricture	100	100	100	100	100		
Population with suspected pancreatic disease											
Independent Reference Standard											
Glasbrenner, Schwarz, Pauls et al., 2000	95	90 91 90	EUS ERCP Combo	Presence of pancreatic cancer	54 53 53	78 81 92	93 88 86	93 89 88	78 80 90		**Good, prospective** p=n.s. for all comparisons
Rosch, Schusdziarra, Born et al., 2000	184	184 184	EUS ERCP Clinical	Presence of pancreatic cancer vs. chronic pancreatitis	42	86 81 81	87 85 85				**Fair, retrospective** p=n.s. p=n.s.
	184	184 184	EUS ERCP Clinical	Presence of pancreatic cancer vs. inflammatory tumor	42	86 81 81	72 61 72				
Population with IPMT											
Independent Reference Standard[19]											
Kaneko, Nakao, Inoue et al., 2001	27	27 27	EUS ERP	Presence of mural nodules[20]	81 81	59 50	100 100	100 100	36 31		**Fair, prospective** p=n.s.
Cellier, Cuillerier, Palazzo et al., 1998	47	21 29	EUS ERCP	Presence of invasive tumor[21]	43 31	78 55	75 90	70 71	82 82		**Fair, retrospective** No statistical analysis

[19] Reference standard consists of surgical specimen histology and/or pancreatography
[20] Population of patients with suspected intraductal papillary mucinous tumors of the pancreas
[21] population of patients with histologically proven diagnosis of intraductal papillary mucinous tumors of the pancreas

Table 33. Quality Assessment

Study Author, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Smith, Dowsett, Russell et al., 1994	RCT (n=204) Good comparability – Randomization by computer minimization on age, bilirubin, albumin, urea, and Hb conc. – Patient characteristics not significantly different	Surgery: (n=103) 2 excluded due to benign disease 7 did not get surgery (2 technical failures, 1 elected crossover, 3 deteriorated clinically and got stents, 1 deteriorated and got no further rx) Stent: (n=101) 1 excluded due to benign disease 5 did not get stents (1 elected crossover, 3 technical failures got surgery, 1 technical failure got no further rx)	Adequate for comparison	Adequate outcome measures used. Outcomes were not assessed blindly.	Intention-to-treat analysis used	**Good**
Andersen, Sorensen, Kruse et al., 1989	RCT (n=50) Good comparability – Sealed envelopes – Patient characteristics not significantly different	Surgery: n=25 6 did not undergo surgery (2 wanted crossed over, 1 found inoperable at surgery, 2 psychological compromise, 1 surgeon not available) Endoprosthesis: n=25 None	Adequate for comparison	Adequate outcome measures used. Outcomes were not assessed blindly.	Intention-to-treat analysis used Results also analyzed by treatment received and findings were consistent.	**Good**

Table 33. Quality Assessment (cont'd)

Study Author, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Shepherd, Royal, Ross et al., 1988	RCT (n=52) Fair comparability – Randomization method not specified – Patient characteristics mostly comparable	Surgical: n=27 4 total: 2 withdrawn (1 died pre-op and 1 had attempted curative surgery). 2 technical failures crossed over to endoprosthesis. Endoprosthesis: n=25 6 total: 1 had benign biopsies but later found to have cancer at surgery; 4 failed and crossed-over to surgery; 1 failed both stent and surgery	Adequate for comparison	Adequate outcome measures used. Outcomes were not assessed blindly.	Does not clearly state method of analysis	**Fair**

Table 33. Quality Assessment (cont'd)

Study Author, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Raikar, Melin, Ress et al., 1996	Retrospective series (n=66) Fair to Poor comparability Baseline patient characteristics show no SSD but differences in performance status distribution noted with ERCP subjects having relatively higher percentages of good and poor PS while surgery had relatively higher midrange PS.	All subjects included in analysis	Adequate for comparison	Adequate outcome measures used. Outcomes were not assessed blindly.	Univariate analysis does not account for important confounders	**Poor**
Leung, Emergy, Cotton et al., 1983	Retrospective series (n=98) Poor comparability Baseline patient characteristics show differences in age and lesion location.	All subjects included in analysis	Adequate for comparison	Adequate outcome measures used. Outcomes were not assessed blindly.	Univariate analysis does not account for important confounders	**Poor**

Table 34. Overview of studies and reported outcomes

Study	Population	Procedure	N ERCP Surg (treated)	Outcome Measures Reported									Study Quality
				Total Hospital Days	Initial Hospital Days	Readmissions	Need for Add'l Procedure	Survival	Jaundice Relief	Quality of Life	Perioperative Mortality	Perioperative Morbidity	
Randomized Controlled Trials													
Smith, Dowsett, Russell et al., 1994	Malignant distal CBD obstruction and jaundice Mean age 70	10 Fr stents[22] vs. Bypass Surgery	101 (100) 103 (101)	X			**X**	**X**		**X**	**X**	**X**	Good
Andersen, Sorensen, Kruse et al., 1989	Malignant distal CBD obstruction and jaundice Age>60y	7-10 Fr stents vs. Bypass Surgery	25 (19) 25 (30)	**X**			**X**	**X**		**X**	**X**	**X**	Good
Shepherd, Royal, Ross et al., 1988	Malignant distal CBD obstruction Mean age 73	10 Fr stents vs. Bypass Surgery	27 (23) 25	**X**	**X**	**X**	**X**	**X**	**X**		**X**	**X**	Fair

[22] 19 of 101 stent patients required combined ERCP and percutaneous transhepatic approach to place stent

Table 34. Overview of studies and reported outcomes (cont'd)

Study	Population	Procedure	N ERCP Surg (treated)	Outcome Measures Reported									Study Quality
				Total Hospital Days	Initial Hospital Days	Readmissions	Need for Add'l Procedure	Survival	Jaundice Relief	Quality of Life	Perioperative Mortality	Perioperative Morbidity	
Retrospective Studies													
Raikar, Melin, Ress et al., 1996	Unresectable pancreatic carcinoma	10-12 Fr stents vs. Bypass Surgery	34 32			**X**	**X**	**X**			**X**	**X**	Poor
Leung, Emergy, Cotton et al., 1983	Malignant obstructive jaundice (CBD location not specific)	8-10 Fr stents vs. Bypass Surgery	64 34			**X**	**X**	**X**			**X**		Poor

Table 35. Treatment Outcomes

Study	Study arm N Enrolled/ (treated or results)	Survival (median) (*mean) (**Life Table Analysis)	P	Relief of Jaundice	p	Quality of Life	p
Randomized Controlled Trials							
Smith, Dowsett, Russell et al., 1994	ERCP[23] 101 (100)	21 weeks	ns	97%	ns		
	Surgery 103 (101)	26 weeks		98%			
Andersen, Sorensen, Kruse et al., 1989	ERCP 25 (19)	**84 days (3-498)[24]	ns			57% survival time mean normal activity or limited, no aid	ns
	Surgery 25 (30)	**100 days (10-642)				51% survival time mean normal activity or limited, no aid	
Shepherd, Royal, Ross et al., 1988	ERCP 27 (23)	**152 days (39-411)	ns	91%	nr		
	Surgery 25	**125 days (52-354)		92%			

[23] Stent placement was attempted first with ERCP approach. In 19 patients a combined transhepatic-endoscopic approach was required when initial ERCP failed.
[24] No significant difference when analyzed by treatment received.

Table 35. Treatment Outcomes (cont'd)

Study	Study arm N Enrolled/ (treated or results)	Survival (median) (*mean) (**Life Table Analysis)	P	Relief of Jaundice	p	Quality of Life	p
Retrospective Studies							
Raikar, Melin, Ress et al., 1996	ERCP 34	*9.7 months (10d-35)	0.13				
	Surgery 32	*7.3 month (7d-29)					
Leung, Emergy, Cotton et al., 1983	ERCP 64	6 mos. approximate	Ns				
	Surgery 34	6 mos. approximate					

Table 36. Adverse Outcomes

Study	Study arm N Enrolled/ (treated or results)	Perioperative Mortality	P	Perioperative Complications	p
Randomized Controlled Trials					
Andersen, Sorensen, Kruse et al., 1989	ERCP 25 (19)	5 (20%)	Nr	36% (total severe infection)	Ns
	Surgery 25 (30)	6 (24%)		20% (total severe infection)	
Shepherd, Royal, Ross et al., 1988	ERCP 27 (23)	2 (9)%	Ns	7 procedure-related complication events	Ns
	Surgery 25	5 (20%)		14 procedure-related complication events	
Smith, Dowsett, Russell et al., 1994	ERCP[25] 101 (100)	8%[26]	Ns	11% major complications	0.02
	Surgery 103 (101)2 (n)	15%		29% major complications	
Retrospective Studies					
Leung, Emergy, Cotton et al., 1983	ERCP 64	1 (3%)	Nr	21%	ns
	Surgery 34	1 (4%)		33%	
Raikar, Melin, Ress et al., 1996	ERCP 34	10 (16%)	Nr		
	Surgery 32	3 (9%)			

[25] Stent placement was attempted first with ERCP approach. In 19 patients a combined transhepatic-endoscopic approach was required when initial ERCP failed.
[26] Procedure related mortality was significantly higher in the surgery group (14% vs. 3% , p=0.006). Also of note, 3 deaths in the surgical group were in patients who did not undergo surgery.

Table 37. Resource Utilization Outcomes

Study	Study arm N Enrolled/ (Treated or Results)	Total Hospital Days median[27] (range)	p	Initial Hospital Days (median) (*mean)	p	Readmission to Hospital N (%)	p	Need for Additional Procedure	p
Randomized Controlled Trials									
Smith, Dowsett, Russell et al., 1994	ERCP[28] 101 (100)	19 (4-59)	ns					Recurrent obstructive jaundice requiring stent replacement in 36 (36%) Late gastric outlet obstruction requiring gastric bypass in 10 (10%)	ns ns
	Surgery 103 (101)	26 (8-85)						Recurrent obstructive jaundice in 2 (2%). One required stent. Late gastric outlet obstruction requiring gastric bypass in 5 (5%)	
Andersen, Sorensen, Kruse et al., 1989	ERCP 25 (19)	26 (3-210)	ns[29]					1 (4%) early failure requiring surgical bypass.	nr
	Surgery 25 (30)	27 (10-202)						3 (12%) early failure requiring stent placement.	
Shepherd, Royal, Ross et al.,1988	ERCP 27 (23)	8 [30] (2-30)	<0.01	5 (2-16)	<0.002	10 (43%)	nr	Gastric outlet obstruction developed in 2 (9%)	nr
	Surgery 25	13 (8-49)		13 (8-49)		3 (12%)		Gastric outlet obstruction developed in 1 (4%)	

[27] Results generally reported as median. Results reported as mean are demarcated by an asterisk (*)
[28] Stent placement was attempted first with ERCP approach. In 19 patients a combined transhepatic-endoscopic approach was required when initial ERCP failed.
[29] Comparison of hospital stay was not statistically significant when analyzed by treatment received.
[30] Calculated only in patients who were alive 30 days post-op.

Table 37. Resource Utilization Outcomes (cont'd)

Study	Study arm N Enrolled/ (Treated or Results)	Total Hospital Days median[31] (range)	p	Initial Hospital Days (median) (*mean)	p	Readmission to Hospital N (%)	p	Need for Additional Procedure	p
Retrospective Studies									
Raikar, Melin, Ress et al., 1996	ERCP 34	$17,738	.05	7*	<0.001	12 (35%)	nr	Average of 1.7 stent replacements per patient One patient developed gastric outlet obstruction requiring surgical gastric bypass.	nr nr
	Surgery 32	$25,101		14*		8 (25%)		Two patients required stent placement for recurrent jaundice. No report of surgical patients developing gastric outlet obstruction.	
Leung, Emergy, Cotton et al., 1983	ERCP 64			14* (4-30)	Nr	8 (13%)[32]	nr	Recurrent jaundice developed in 3 (5%) Gastric outlet obstruction developed in 2 (3%)	nr nr
	Surgery 34			30* (14-79)		3 (9%)		Recurrent jaundice developed in 1 (3%) Gastric outlet obstruction developed in 2 (6%)	

[31] Results generally reported as median. Results reported as mean are demarcated by an asterisk (*)
[32] Local complications included cholangitis, recurrent jaundice, duodenal obstruction, or chest wall metastasis

Table 38. Study Quality Assessment

Study Author, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Davids, Groen, Rauws et al., 1992	RCT (n=105) Good comparability - Randomization by computer generated random number - patient characteristics well-balanced	115 initially randomized and 105 included in analysis 10 patients excluded. 5 due to prior history of malignancy in past 10 years and 5 due to selection for surgical therapy. None lost to follow-up	Adequate for comparison.	Adequate outcome measures used. Outcomes were not assessed blindly.	Method of analysis not clearly stated.	Fair
Prat, Chapat, Ducot et al., 1998	RCT (n=101) Good comparability - Randomization by blocks of six and stratified for gender and investigation center - patient characteristics well-balanced	4 of 105 excluded Three for failed endoprosthesis insertion and one for not complying with required quarterly stent changes for group 2 Four lost to follow-up (3 moved away and 1 no follow-up information)	Adequate for comparison.	Adequate outcome measures used. Outcomes were not assessed blindly.	Method of analysis not clearly stated	Fair

Table 38. Study Quality Assessment (cont'd)

Study Author, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Schmassmann, Von Gunten, Knuchel et al., 1996	Retrospective study (n=165) Fair comparability Baseline patient characteristics similar for age, gender, bilirubin, type of tumor and stage, location of stricture, or associated procedures	All subjects included in analysis	Adequate for comparison 87% of metal stent and 100% of plastic stent patients had sphincterotomy	Adequate outcome measures used. Outcomes were not assessed blindly.	Univariate analysis does not account for confounders	Poor

Table 39. Overview of studies and reported outcomes

Study	Population	Procedure	N (treated) Metal Plastic	Outcome Measures Reported									STUDY QUALITY
				Total Hospital Days	Initial Hospital Days	Cost Utilization	Need for Add'l Procedure	Survival	Jaundice Relief	Stent Patency	Periop Mortality	Periop Morbidity	
Randomized Controlled Trials													
Davids, Groen, Rauws et al., 1992	Patients with irresectable distal bile-duct malignancy Pancreatic ca = 93 Papillary ca = 12	Metal stent[33] Straight 10 Fr polyethylene stent[34]	49 56				X	X	X	X	X	X	Fair
Prat, Chapat, Ducot et al., 1998	Patients with malignant CBD strictures Not involving hilum Pancreatic ca = 65 Cholangioca = 21 Ampullary ca = 3 Metastatic = 12	Metal stent Polyethylene 11.5 Fr stent[35] w/ routine exchange Polyethylene 11.5 Fr stent w/ as needed exchange	34 33 34	X		X	X	X	X		X	X	Fair
Retrospective Studies													
Schmassmann, Von Gunten, Knuchel et al., 1996	Consecutive patients with unresectable malignant biliary obstruction	Metal stent Straight 12 Fr or 10 Fr polyethylene stent[36]	95 70				X	X	X	X	X		Poor

[33] Metal stents were of the Wallstent type (Schneider, Switzerland (Davids et al.; Schmassmann et al.)) or (Schneider-Howmedical, Lyons, France (Prat et al.)).
[34] Polyethylene stents were made by PBN Medicals (Stenlose, Denmark)
[35] Polyethylene stents were made by Wilson-Cook (Winston-Salen, N.C.)
[36] Polyethylene stents 12 Fr were made by Olympus (Volketswil, Switzerland) and 10 Fr Huibregtse (Cook, Nottwil, Switzerland)

Table 40. Treatment Outcomes

Study	Study arm N Enrolled/ (treated or results)	Survival (median)	P	Relief of Jaundice N (%)	p	First Stent Patency (median)	p
Randomized Controlled Trials							
Davids, Groen, Rauws et al., 1992	Metal 49	5.8 months[37]	0.45	47/49 (96%)	n.r.	9.1 months	0.006
	Plastic 56	4.9 months		53/56 (95%)		4.2 months	
Prat, Chapat, Ducot et al., 1998	Metal 34	4.5 months	n.s.	48h Decrease in bilirubin: 41%	n.s.	4.8 months	<0.05
	Plastic-routine 33	5.6 months		34.3%		Not reported separately	
	Plastic-as needed 34	4.8 months		35.4%		3.2 months	
Retrospective Studies							
Schmassmann, Von Gunten, Knuchel et al. 1996	**Metal 95**	6.5 months[38]	<0.05	95%	n.s.	10 months[39]	<0.001
	Plastic 70	4 months		88%		4 months	

[37] Data were converted to months from reported days by dividing by 30.
[38] When 29 subjects (8 metal stent, 21 plastic stent) who died related to untreated stent dysfunction were excluded from the analysis, the remaining 136 subjects had similar survival between the two groups.
[39] Subgroup analysis did not show any significant difference between different locations (common bile duct vs. hilar or intrahepatic stricture) but numbers were small in the hilar and intrahepatic subgroups.

Table 41. Adverse Outcomes

Study	Study arm N Enrolled/ (treated or results)	Perioperative Mortality	P	Complications	p
Randomized Controlled Trials					
Davids, Groen, Rauws et al., 1992	Metal 49	7 (14%)[40]	0.047	6 (12%)[41]	n.r.
	Plastic 56	2 (4%)[42]		6 (11%)	
Prat, Chapat, Ducot et al., 1998	Metal 34	Overall rate was 3.9% No significant difference between groups		Overall rate was 11.9% No significant difference between groups	
	Plastic-routine 33				
	Plastic-as needed 34				
Retrospective Studies					
Schmassmann, Von Gunten, Knuchel et al. 1996	Metal 95	2%	n.s.		
	Plastic 70	3%			

[40] Causes of death were sepsis after recurrent cholangitis (1); cardiac failure (2); cachexia (4).
[41] Complications in Davids et al. were measured in 7 days after procedure.
[42] Causes of death were cachexia (2).

Table 42. Resource Utilization Outcomes

Study	Study arm N Enrolled/ (Treated or Results)	Total Hospital Days median (range)	p	Resource Utilization Costs	p	Need for Additional Procedure	p
Randomized Controlled Trials							
Davids, Groen, Rauws et al., 1992	Metal 49					1.3 per person	n.r.
	Plastic 56					1.8 per person	
Prat, Chapat, Ducot et al., 1998	Metal 34	5.5 ± 1.4*	*0.01 others n.s.	Mean costs (95% CI) $4643 (4207-5079)	n.r.	1.2 ± 0.4 per patient	0.01 ANOVA
	Plastic-routine 33	10.6 ± 1.7*		$6770 (5394-8146)		2.5 ± 1.9 per patient	
	Plastic-as needed 34	7.4 ± 1.5		$5547 (4082-7013)		1.7 ± 1.3 per patient	
Retrospective Studies							
Schmassmann, Von Gunten, Knuchel et al., 1996	Metal 95					1.2 per patient	<0.005
	Plastic 70					1.58 per patient	

Table 43. Quality Assessment

Study Author, Year Record Number	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
van Berkel, Boland, Redekop et al., 1998	RCT (n=84) Good comparability - Randomization by computer generated numbers in sealed envelopes - Patient characteristics similar	97 consecutive patients enrolled. 13 excluded for protocol violations (11 had surgical resection, 1 had PTH drainage, 1 refused treatment). Details about which treatment arm patients were assigned to were not provided. None lost to follow-up.	Adequate for comparison.	Adequate outcome measures used. Outcomes were not assessed blindly.	Method of analysis not stated but all 84 included in analysis.	**Fair**
Pedersen 1993	Prospective study (n=89) Fair comparability Differences in age noted with younger 7Fr group. No SSD in stenosis location, gender, or type of cancer.	All subjects included in analysis	Adequate for comparison. Adjunctive sphincterotomy was performed equally in 7Fr and 10Fr groups.	Adequate outcome measures used. Outcomes were not assessed blindly.	Univariate analysis does not account for important confounders	**Poor**
Speer, Cotton, MacRae et al., 1988	Retrospective study (n=79) Fair comparability Baseline patient characteristics similar for age and site of obstruction.	All subjects included in analysis	Limitations for comparison 8 Fr stents had pigtails whereas 10Fr stents were straight	Adequate outcome measures used. Outcomes were not assessed blindly.	Univariate analysis does not account for important confounders	**Poor**

Table 43. Quality Assessment (cont'd)

Study Author, Year Record Number	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Sung, Chung, Tsui et al., 1994	RCT (n=70) Good comparability - Sealed envelopes - Patient characteristics show no SSD	SH: (n=35) NSH: (n=35) 3 subjects dropped out before 4 week f/u and were excluded from analysis	Adequate for comparison	Adequate outcome measures used. Patient and follow-up physician were blinded to type of stent placed.	Method of analysis not reported but no crossover reported.	**Good**
Speer, Cotton, Russell et al., 1987	RCT (n=75) Good comparability - Computer generated random numbers and stratified by referring center - Patient characteristics similar for age, ASA[43] grade, duration of jaundice, bilirubin, albumin, creatinine, and Hb, but ERCP group had more proximal obstructions, more unrelated medical problems, and more elevated WBC. No statistical results reported.	ERCP: (n=39) No dropouts 4 failures Percutaneous: (n=36) No dropouts 8 failures	Percutaneous stents were initially 6Fr and exchanged 2-3 days later to 12 Fr while endoscopic stents were 10 Fr in size	Adequate outcome measures used. Outcomes were not assessed blindly.	Intention-to-treat analysis used. Results were also analyzed taking into account relevant confounders that were not balanced.	**Good**

[43] American Society of Anesthesiology's performance status classification

Table 43. Quality Assessment (cont'd)

Study Author, Year Record Number	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Pedersen, Lassen, De Muckadell et al., 1998	RCT (n=34) Good comparability - Randomization by computer generated numbers and sealed numbered envelopes - Baseline characteristics similar for age, type of cancer, and no SSD for gender	<u>Stent above SO (n=22)</u> 22 randomized - 5 technical failures crossed over. Final n=17. No other dropouts. <u>Stent across SO (n=19)</u> 19 randomized - 2 withdrawn for curative surgery. Final n=17. No other dropouts.	Adequate for comparison.	Adequate outcome measures used. Outcomes were not assessed blindly.	Method of analysis primarily based on treatment received. Results for one outcome reported using intention-to-treat.	**Fair**
DePalma, Galloro, Iovino et al., 2001	RCT (n=157) Good comparability - Randomization by sealed opaque envelopes - Baseline characteristics similar	<u>Unilateral stent (n=79)</u> No dropouts <u>Bilateral stent (n=78)</u> No dropouts	Adequate for comparison.	Adequate outcome measures used. Outcomes were not assessed blindly.	Intention to treat used.	**Good**
Chang, Kortan, and Haber 1998	Retrospective study (n=141) Baseline patient characteristics were comparable for age, gender, and tumor type	All subjects included in analysis	Adequate for comparison.	Adequate outcome measures used. Outcomes were not assessed blindly.	Analysis made some attempts to stratify results by Bismuth type, but did not fully consider possible confounders.	**Fair**

Table 43. Quality Assessment (cont'd)

Study Author, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Deviere, Baize, de Toeuf et al., 1988	Retrospective study (n=70) Baseline patient characteristics were not reported other than stricture type	All subjects included in analysis	Adequate for comparison.	Adequate outcome measures used. Outcomes were not assessed blindly.	Analysis made some attempts to stratify results by Bismuth type, but did not fully consider possible confounders.	**Poor**

Table 44. Comparison of Plastic versus Teflon™ stents

Study	N	Population and Interventions	Outcomes	Adverse Events	Comments
Randomized Controlled Trials					
van Berkel, Boland, Redekop et al., 1998	84	Patients with distal malignant biliary stricture. No previous drainage procedure. Pancreas ca = 76 Papilla ca = 1 Bile duct ca = 5 Metastasis = 2 42 Teflon™ stents 42 polyethylene stents (Amsterdam-type) All stents 10Fr and 9cm Baseline characteristics comparable.	Median survival (days) Teflon™ 165 Poly 140 p=0.6 Successful biliary drainage Teflon™ 90% Poly 92% Median stent patency (days) Teflon™ 83 Poly 80 p=0.93 No significant differences found in: Mean weight gain for 26 removed stents	<u>Perioperative mortality</u> Teflon™ 14% Poly 14% Early procedure-related complications Teflon™ 4 (10%) Poly 4 (10%) Late complications Stent dysfunc / Repeat ERCP / # ERCP Teflon™ 28 / 24 / 79 Poly 29 / 25 / 75	Univariate analysis of factors associated with reduced stent patency was reported. Previous failure of cannulation (p=0.03) Previous CBD contrast injection without papillotomy (p=0.004) Previous papillotomy (p=0.08) Gender, age>75, jaundice> 14 days, bilirubin > 300 μmol/L not significant factors.

Table 45. Comparison of different caliber stents

Study	N	Population and Interventions	Outcomes	Adverse Events	Comments
Prospective observational studies					
Pedersen 1993	89	Pts with malignant biliary strictures 31 Single 7 Fr (S7) 45 Single 10 Fr (S10) 13 Double 7Fr (D7) 85% of all patients also had sphincterotomy, evenly distributed between 7 and 10 Fr. 7 Fr stent chosen when no large bore ERCP scope available. Baseline patient characteristics were different for age (7Fr group younger than 10Fr group). No SSD in stenosis location, gender, or type of cancer.	Median Stent Patency (days) Median, 25%-75% range S7 67 (20-336) S10 144 (39-237) D7 110 (62-145) Total 110 (33-237) P=0.11, comparing 7Fr vs. 10Fr	<u>Mortality (2-week)</u> S7 (n=31) 4 (13%) S10 (n=45) 4 (9%) D7 (n=13) 2 (15%) p=0.84 Total Early Complications S7 (n=31) 13% S10 (n=45) 22.1% D7 (n=13) 23.1% p=n.s. <u>Fever</u> S7 (n=31) 9.7% S10 (n=45) 17.7% D7 (n=13) 23.1% p=n.r. Bleeding S7 (n=31) 6.5% S10 (n=45) 4.4% D7 (n=13) 0% p=n.r. <u>Perforation</u> S7 (n=31) 3.2% S10 (n=45) 0% D7 (n=13) 0% p=n.r.	

Table 45. Comparison of different caliber stents (cont'd)

Study	N	Population and Interventions	Outcomes	Adverse Events	Comments
Retrospective studies					
Speer, Cotton, MacRae et al., 1988	79	All patients receiving stent palliation for malignant obstructive jaundice 28 8Fr pigtail stents 51 10Fr straight stents Baseline patient characteristics similar for age and site of obstruction.	Median Stent Patency (weeks) 8 Fr 12 10 Fr 32 p<0.001 Patency advantage of 10Fr stents primarily in first month.	Early complications (2 week) Cholangitis 8 Fr (n=28) 13 (34%) 10 Fr (n=51) 3 (5%) p<0.01 (text) Local perforation 8 Fr (n=28) 2 (5%) 10 Fr (n=51) 4 (5%) p=n.s. Stent migration 8 Fr (n=28) 3 (8%) 10 Fr (n=51) 2 (3%) p=n.s. Late complications Need for stent replacement 8 Fr 12 (43%) 10 Fr 13 (25%) p=n.r.	

Table 46. Comparison of stents with or without sideholes

Study	N	Population and Interventions	Outcomes	Adverse Events	Comments
Randomized Controlled Trials					
Sung, Chung, Tsui et al., 1994	70	Most pts (93%) had malignant obstruction SH= side-hole stent (n=35) NSH = no side-hole (n=35) 10Fr stents Patient characteristics show no SSD for age, gender, diagnosis, location of stent, prior stent	Biochemical improvement at 4 weeks SH (n=35) 95% NSH (n=32) 78% p>0.1 All stent patency (weeks), median (range) SH (n=35) 7.8 (2.6-28) NSH (n=32) 7.9 (0.6-28) p>0.1 Initial stent patency (weeks), median (range) SH (n=35) 9.5 (6.3-28) NSH (n=32) 8.0 (0.6-28) p>0.1 Second stent patency (weeks), median (range) SH (n=35) 6.6 (2.6-19.9) NSH (n=32) 5.6 (0.9-23.3) p>0.1	<u>Mortality</u> SH (n=35) 8 (23%) NSH (n=32) 8 (25%) p=n.r. <u>Fever</u> SH (n=35) 82% NSH (n=32) 83% p=n.r.	

Table 47. Comparison of Percutaneous versus Endoscopic Stent Insertion

Study	N	Population and Interventions	Outcomes	Adverse Events	Comments
Randomized Controlled Trials					
Speer, Cotton, Russell et al., 1987	75	Malignant biliary obstruction, unresectable Stents: 39 ERCP 10 Fr 36 Percutaneous 12 Fr Patient characteristics similar for age, ASA[44] grade, duration of jaundice, bilirubin, albumin, creatinine, and Hb, but ERCP group had more proximal obstructions, more unrelated medical problems, and more elevated WBC. No statistical results reported.	**Survival** (days), median (range) Hilar / Low bile duct / Total ERCP 65 (8-623) / 160 (14-598) / 119 (9-623) PTH 24 (2-351) / 94 (4-391) / 88 (2-391) p=0.35 **Stent patency** (days) No significant difference in median time to blockage, p=0.16 **Failed Insertion** ERCP (n=37) 4 PTH (n=33) 8 **Successful Insertion but No Drainage** ERCP (n=37) 3 PTH (n=33) 5 **Relief of Jaundice** ERCP (n=37) 30 (81%) PTH (n=33) 20 (61%) p=0.017 **Initial Hospitalization** (days) (for those surviving at least 30 days) ERCP 11 (2-49) PTH 17 (3-24) p=0.4	<u>Early complications</u> ERCP (n=37) 7 (19%) PTH (n=33) 22 (67%) <u>Perioperative Mortality</u> ERCP 6 (15%) PTH 12 (33%) p=0.016 And Cox regression analysis confirmed that ERCP had significantly lower 30-day mortality (p=0.008). Cox proportional hazards model was performed. Predictors of 30-day mortality were ASA grade of 3 or more (p=0.002), randomization to PTH (p=0.008), WBC > 10 $x10^9$ cells/l (p=0.018), hilar obstruction (p=0.01), and age 69-76 y (p=0.016). Predictors of decreased overall survival were WBC > 10 $x10^9$ cells/l (p=0.01) and hilar obstruction (p=0.05)	This trial was originally planned to enroll 200 patients. After the 1st of 3 planned interim data analyses, the trial was halted based on prospectively defined statistical criteria.

[44] American Society of Anesthesiology's performance status classification

Table 48. Comparison of stent placement above versus across sphincter of Oddi

Study	N	Population and Interventions	Outcomes	Adverse Events	Comments
Randomized Controlled Trial					
Pedersen, Lassen, De Muckadell et al., 1998	34	Pts with unresectable CBD biliary obstruction 17 placed above SO 17 placed across SO 10 Fr straight stents Baseline characteristics Similar for age, type of cancer, and no SSD for gender	<u>Patient survival (days)</u> Median (25%-75% range) Above SO (n=17) 144 (82-347) Across SO (n=17) 46 (35-155) p=n.s. Median stent patency (days) Median (25%-75% range) Above SO (n=17) 110 (61-320) Across SO (n=17) 126 (89-175) p=n.s. Intent-to-treat analysis: <u>Median stent patency (days)</u> Above SO (n=17) 99 (53-320) Across SO (n=17) 126 (89-175) p=n.s. <u>Stent Function</u> \# w/ Stent Dysfunction / Time to dysfunction Above SO 10 / 82 (31-185) Across SO 5 / 89 (13-150) p=n.s.	<u>Mortality (2 weeks)</u> Above SO (n=17) 2 (12%) Across SO (n=17) 1 (12%) p=n.s. <u>Early complications (1 week)</u> Above SO (n=17) 2 (12%) Across SO (n=17) 4 (24%) p=n.s. <u>Dislocation of stent</u> Above SO (n=17) 9 (53%) Across SO (n=17) 2 (12%) p=0.026	

Table 49. Comparison of unilateral versus bilateral drainage in hilar malignancy

Study	N	Population and Interventions	Outcomes	Adverse Events	Comments
Randomized Controlled Trials					
DePalma, Galloro, Iovino et al., 2001	157	Pts w/ hilar obstruction due to cholangio-carcinoma, gallbladder cancer, or lymph node metastasis Type I (n=49) Type II (n=56) Type III (n=52) Randomized to unilateral (group A) or bilateral (Group B) stents	Median Survival (days) A 140 (21-612) B 142 (24-498) p=0.48 Technical Success Drainage Success A 88.6 % 81% B 76.9 % 73% p= 0.041 0.049	Perioperative Mortality A 11.3% B 14.1% p=0.638 Procedure-related Mortality A 2.5% B 3.8% p=0.681 Early complications A 18.9% B 26.9% p=0.026 Cholangitis A 8.8% B 16.6% p=0.013 Late complications A 39.7% B 39.1% p=0.735	

Table 49. Comparison of unilateral versus bilateral drainage in hilar malignancy (cont'd)

Study	N	Population and Interventions	Outcomes	Adverse Events	Comments
Retrospective Studies					
Chang, Kortan, and Haber 1998	141	Pts w/ bifurcation tumors Bismuth Type: Type I (n=43) Type II (n=58) Type III (n=40) Types II and III were divided into 3 groups: N=32 A= one lobe of liver opacified with contrast and 1 side drained N=29 B = both lobes liver opacified and both drained N=37 C = both lobes liver opacified and one drained Single stents (n=104) 11 – 7 Fr; 40 – 10 Fr 53 – 11.5 Fr 3 – metal stents Double ERCP stents (n=15) 21 – 7 Fr; 7 – 10 Fr 2 – 11.5 Fr 18 technical failures drained percutaneously Among those with double drains, 15 ERCP only, 3 PTH only, and 11 ERCP and PTH	Median survival (days) I 160 A 145 B 225 C 46 p<0.001 Comparing single drains (groups A + C) versus double drains (group B), double drains had significantly better survival p<0.0001	<u>Perioperative Mortality</u> I 2 (5%) A 0 B 1 (3%) C 11 (30%) p<0.01 <u>Early complications</u> Acute cholangitis I 2 (5%) A 2 (6%) B 0 C 12 (32%) p<0.01 Stent migration I 1 (2%) A 0 B 0 C 1 (3%) p=n.s. Pancreatitis I 0 A 0 B 1 (3%) C 1 (3%) p=n.s. <u>Total early complications</u> I 3 (7%) A 2 (6%) B 1 (3%) C 14 (38%) p=n.s. <u>Late complications</u> Need for stent replacement I 19 (44%) A 16 (50%) B 12 (41%) C 2 (5%) p=n.r.	This is a study comparing unilateral versus bilateral drainage of bifurcation tumors

Table 49. Comparison of unilateral versus bilateral drainage in hilar malignancy (cont'd)

Study	N	Population and Interventions	Outcomes	Adverse Events	Comments
Retrospective Studies (cont'd)					
Deviere, Baize, de Toeuf et al., 1988	70	Deceased pts with hilar tumors and biliary obstruction Type I stricture (n=20) 1 stent (Gr I-1) Type II or III (n=50) 24 w/ 1 stent (Gr II/III-1) 24 w/ 2 stent (Gr II/III-2) 2 w/ failed (Gr II/III-0)	Mean Survival (days) Median[45] Gr I-1 156 (6-570) 156 Gr II/III-1 119[a] (2-760) 162 Gr II/III-2 176[a] (4-660) 198 Gr II/III-0 16 (6-26) [a] = p<0.01	<u>Perioperative Mortality</u> Gr I-1 0% Gr II/III-1 29% Gr II/III-2 8% Gr II/III-0 100%	

[45] Median survival after exclusion of patients who died within 30 days

Table 50. Quality Assessment

Study Author, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Randomized Controlled Trials						
Lygidakis, van der Heyde, Lubbers et al., 1987	RCT (n=38) Patient characteristics similar. Method of randomization not specified	All subjects included in analysis	Adequate for comparison	Adequate outcome measures used. Outcomes were not assessed blindly.	All subjects enrolled were included in analysis. Inappropriate statistical tests used[46]	**Poor**
Lai, Mok, Fan et al., 1994	RCT (n=87) Fair comparability – Randomization: Consecutive numbered envelopes – Patient characteristics showed no SSD but early surgery w/o stent group tended to be higher risk with more medical problems	Preop Stent: (n=43) 6 technical failures crossed over 2 refused surgery after successful stent placement. No Stent: (n=44) No changes reported.	Adequate for comparison	Adequate outcome measures used. Outcomes were not assessed blindly.	Intention-to-treat analysis used in most comparisons. This trial was terminated because interim analysis showed that planned sample size was inadequate.	Fair

[46] Soreide O and Eide GE, Letter to the Editor: Preoperative Biliary Drainage. Acta Chir Scand 156:251-252 1990.

Table 50. Quality Assessment (cont'd)

Study Author, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Prospective Studies						
Sewnath, Birjmohun, Rauws et al., 2001 Same series as Karsten, Allema, Reinders et al., 1996, but subjects accrued June 1992 – Dec 2000	Prospective series (n=290) Excluded 21 patients who had external biliary drainage Fair comparability of baseline patient characteristics Patients without preop drainage were usually not jaundiced	All subjects included in analysis	Adequate for comparison	Adequate outcome measures used. Outcomes were not assessed blindly.	Analysis did compare preop drainage and no drainage for primary outcomes. Additional analysis by subgroups based on degree of preop jaundice	**Poor**

Table 50. Quality Assessment (cont'd)

Study Author, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Retrospective Studies						
Karsten, Allema, Reinders et al., 1996 Subjects accrued Oct 1983 – June 1992	Retrospective series (n=241) Patients without preop drainage were usually not jaundiced; patients with jaundice assigned to ERCP Fair comparability of other baseline patient characteristics	All subjects included in analysis except for bile culture results obtained only in 195/241 (81%).	Adequate for comparison ERCP group received stent only if papillotomy alone was insufficient	Adequate outcome measures used. Outcomes were not assessed blindly.	Comparison of pre-op ERCP vs. immediate surgery outcomes lacking for most outcomes	**Poor**

Table 50. Quality Assessment (cont'd)

Study Author, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Retrospective Studies (cont'd)						
Heslin, Brooks, Hochwald et al., 1998	Retrospective series (n=74) Patients undergoing pancreaticoduodenectomy Slight imbalances in baseline patient characteristics such as gender and presence of positive nodes	All subjects included in analysis	Adequate for comparison	Adequate outcome measures used. Complications were assessed by an independent physician.	Analysis considered important outcomes. Secondary multivariable analysis did consider potential confounding factors. However, multivariable model may include too many candidate variables making it susceptible to overfitting.	**Poor**
ten Hoopen-Neumann, Gerhards, van Gulik et al., 1998	Retrospective series (n=52) Fair comparability Baseline patient characteristics showed no SSD for age, gender, tumor classification, type of surgery	All subjects included in analysis	No stent group included ERCP technical failures Post-operative radiation therapy performed in 37% of stent patients vs. 27% of immediate surgery patients.	Adequate outcome measures used. Outcomes were not assessed blindly.	Analysis did qualitatively identify possible confounding factors such as radiation therapy.	**Poor**

Table 51. Overview of studies and outcomes reported

Study	Population	Procedure	N Stent No Stent	Outcome Measures Reported						STUDY QUALITY
				Hospital Days	Laboratory Values	Technical Success	Perioperative Mortality	Perioperative Complications	Implantation Metastases	
Randomized Controlled Trials										
Lygidakis, van der Heyde, Lubbers et al., 1987	Patient with resectable pancreatic head carcinoma	preop ERCP placed stent vs. no pre-op stent	19 19	**X**	**X**		**X**	**X**		**Poor**
Lai, Mok, Fan et al., 1994	Malignant obstructive jaundice	preop ERCP placed stent vs. no pre-op stent	43 44		**X**	**X**	**X**	**X**		**Fair**
Prospective Studies										
Sewnath, Birjmohun, Rauws et al., 2001 Same series as Karsten, Allema, Reinders et al., 1996, but subjects accrued June 1992 – Dec 2000	Patients with presumed resectable tumor in pancreatic head region	232 had preop drainage - 192 stent+papillotomy - 27 papillotomy alone - 13 required percutaneous combined drainage procedure 58 with no drainage were - 25 had dx ERCP only - 24 not jaundiced - 9 failed drainage and got immediate surgery	232 58	**X**	**X**		**X**	**X**		**Poor**

Table 51. Overview of studies and outcomes reported (cont'd)

Study	Population	Procedure	N Stent No Stent	Outcome Measures Reported						STUDY QUALITY
				Hospital Days	Laboratory Values	Technical Success	Perioperative Mortality	Perioperative Complications	Implantation Metastases	
Retrospective Studies										
Karsten, Allema, Reinders et al., 1996 Subjects accrued Oct 1983 – June 1992	Patients with presumed resectable tumor in pancreatic head region	184 had preop drainage - 149 stent + papillotomy when papillotomy alone not sufficient - 25 papillotomy alone - 10 external drainage when ERCP stent not possible 57 with no drainage were not jaundiced (n=33) or had immediate operation planned (n=24)	149 57		**X**			**X**		**Poor**
Heslin, Brooks, Hochwald et al., 1998	Patients undergoing pancreaticoduodenectomy	39 had preop drainage 35 had no drainage preop	39 35	**X**	**X**		**X**	**X**		**Poor**
ten Hoopen-Neumann, Gerhards, van Gulik et al., 1998	Patients with Klatskin tumor with planned resection	41 of 52 had preop stent Main reasons for no stent were technical failure or lack of proximal congestion of bile	41 11		**X**				**X**	**Poor**

Table 52. Treatment Outcomes and Adverse Outcomes

Study	Study arm N	Hospital Days	p	Laboratory Values	p	Technical Success	p	Periop Mortality	p	Periop Complications	p	Implantation Metastases	p
Randomized Controlled Trials													
Lygidakis, van der Heyde, Lubbers et al., 1987	ERCP 19	Preop: 7 Total: 23 (Days for group/n)	**nr**	Significant reduction in Serum bilirubin, alkaline phosphatase, AST/SGOT, ALT/SGPT after stent Significant increase in white blood cell count after stent Hct, creatinine, albumin, and clotting parameters unchanged	<.002 <.001			0 (0%)		3 (16%)	[47]		
	No stent 19	Preop: 3.7 Total: 26.7 (Days for group/n)		No significant change in laboratory values between baseline and preoperative testing				2 (11%) (1 sepsis; 1 aneurysm)		14 (74%)[48]			

[47] Inappropriate statistical tests reported raising concerns over appropriateness of conclusions reported.

[48] This study has a high baseline rate of cholangitis in the no stent group, which may contribute to the higher rate of complications in this group. Perioperative blood loss (800+/-100 vs/ 1800+/-200 ml.) and operative time (5+/- 2 vs. 7+/-2 h) were greater in the no stent group. Tests of statistical significance were not reported for these outcomes.

Table 52. Treatment Outcomes and Adverse Outcomes (cont'd)

Study	Study arm N	Hospital Days	p	Laboratory Values	p	Technical Success	p	Periop Mortality	p	Periop Complications		p	Implantation Metastases	p
Randomized Controlled Trials (cont'd)														
Lai, Mok, Fan et al., 1994	Stent 43			Serum bilirubin, alkaline phosphatase, ALT/SGPT but not AST/SGOT significantly lower than no stent group Hb, Hct, BUN, creatinine, albumin no different. WBC not reported.	<0.05	86%		6 (14%)	**ns**	Post-op:	16 (39)%	**ns**		
										Total[49]	23 (56%)			
	No Stent 44							6 (14%)		Post-op	18 (41%)			
										Total	18 (41%)			

[49] In addition, 7 of the 23 patients had complications from both procedures (preoperative stenting and surgery.)

Table 52. Treatment Outcomes and Adverse Outcomes (cont'd)

Study	Study arm N	Hospital Days	p	Laboratory Values	p	Technical Success	p	Perioperative Mortality	p	Perioperative Complications	p	Implantation Metastases	p
Prospective Studies													
Sewnath, Birjmohun, Rauws et al., 2001 Same series as Karsten, Allema, Reinders et al., 1996, but subjects accrued June 1992 – Dec 2000	Pre-op Drain (n=232) 177 relieved of jaundice 32 with moderate jaundice 23 with severe jaundice	 13 (6-167) 15 (12-39) 15 (10-70)	0.09	Median decrease in bilirubin 82%* 57% 37%* * p<0.01				1.3%	n.r.	50%	0.69		
	No drainage 58	16 (8-222)		None reported				0%		55%			

Table 52. Treatment Outcomes and Adverse Outcomes (cont'd)

Study	Study arm N	Hospital Days	p	Laboratory Values	p	Technical Success	p	Perioperative Mortality	p	Perioperative Complications	p	Implantation Metastases	p
Retrospective Studies													
Karsten, Allema, Reinders et al., 1996 Subjects accrued Oct 1983 – June 1992	Pre-op Drain (n=184) 149 stent+papillotomy 25 papillotomy alone 10 external drainage			Median decrease in bilirubin 82% 74% 50%	nr					Infectious Complication[50] Stent 49/149 (33%) Papillotomy 11/25 (44%) External drain 6/10 (60%)	nr		
	No drainage 57			None reported						No drainage 18/57 (32%)			

[50] The relationship between use of pre-operative drainage and postoperative complications was not significant when analyzed by preoperative bilirubin level.

Table 52. Treatment Outcomes and Adverse Outcomes (cont'd)

Study	Study arm N	Hospital Days	p	Laboratory Values	p	Technical Success	p	Perioperative Mortality	p	Perioperative Complications	p	Implantation Metastases	p
Retrospective Studies (cont'd)													
Heslin, Brooks, Hochwald et al., 1998	Stent 39	11	0.04	Serum bilirubin, AST/SGOT significantly lower than no stent group. Albumin and alkaline phosphatase trended lower. BUN, creatinine, albumin, WBC no different.				2.6%	0.34	23 (59%)	0.04		
	No stent 35	10						0		12 (34%)			

Table 52. Treatment Outcomes and Adverse Outcomes (cont'd)

Study	Study arm N	Hospital Days	p	Laboratory Values	p	Technical Success	p	Perioperative Mortality	p	Perioperative Complications	p	Implantation Metastases	p
Retrospective Studies (cont'd)													
ten Hoopen-Neumann, Gerhards, van Gulik et al., 1998	Stent 41			Bilirubin, mean (range) 117 (12-511)	0.008							8/41 (20%)[51]	0.18
	No stent 11			235 (14-412)								0	

[51] At 1 year, 4 of 8 patients with implantation metastases did not receive any postoperative radiation therapy. Overall, 37% of stented patients and 27% of non-stented patients did not receive radiotherapy (p=not reported)

Table 53. Quality Assessment

Study Author, Year	**Patient Enrollment**	**Diagnostic performance of ERCP determined without knowledge of other test results**	**Diagnostic Performance of other test(s) determined without knowledge of ERCP results**	**Summary Evaluation**
Duvnjak, Rotkvic, Vucelic et al., 1991	Prospective (n=43) States that patients were "randomly" selected, but otherwise not stated	Uncertain	Percutaneous pancreatography- Uncertain Amylase concentration- uncertain if 64 WU cutoff determined prospectively or post-hoc	Fair to poor
Bret, Reinhold, Taourel et al., 1996	Prospective (n=108) Most patients prospectively recruited, uncertain number with referral bias	Yes	Yes	Good
Takehara, Ichijo, Tooyama et al., 1994	Prospective (n=39) Not stated whether consecutive	Yes	Yes	Fair, small sample size

Table 54. Percutaneous pseudocystogram or percutaneous amylase measurement versus ERCP to diagnose communication between pseudocyst and pancreatic duct

Study	N	Population	Diagnostic test	Prevalence (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Comments
Duvnjak, Rotkvic, Vucelic et al., 1991	43	Patients with persistent pseudocysts >25 cm area on cross-section image	Percutaneous cystogram Amylase> 64 WU	51% communication	59 100	100 90	100 92	70 100	ERCP was the reference standard

Table 55. MRCP versus ERCP to diagnose pancreas divisum

Study	N	Population	Diagnostic test	Prevalence (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Comments
Bret, Reinhold, Taourel et al., 1996	108	Patients referred for ERCP for pancreatic disease	MRCP	6	100	100	100	100	ERCP was the reference standard

Table 56. MRCP versus ERCP to diagnose pancreatic duct stenoses and filling defects in patients with pancreatitis

Study	N	Population	Outcome studied	Prevalence (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Comments
Takehara, Ichijo, Tooyama et al., 1994	39	Patients with chronic pancreatitis	Stenosis head:	18	100	81	36	100	ERCP reference standard for all comparisons.
			Stenosis body:	31	57	73	31	89	
			Stenosis Tail:	6	50	91	25	97	2 sets of data presented in paper, each observer compared with ERCP, only 1 set abstracted
			Filling defect head:	5	100	100	100	100	
			Filling defect body:	6	100	100	100	100	
			Filling defect Tail:	5	50	94	33	97	

Table 57. ERCP in the treatment of pancreatitis: Overview of the literature by indication and study type

		Comparative studies			Single arm studies		
Indication	**Status**	**RCT**	**Prospective non-randomized**	**Retrospective**	**Prospective**	**Retrospective**	**Total**
Acute Pancreatitis							
Acute biliary pancreatitis	Reviewed	3	--	2	1	2	8
	Included	3	--	1	--	--	4
Acute non-biliary pancreatitis	Reviewed	--	--	--	--	--	--
	Included	--	--	--	--	--	--
Acute recurrent pancreatitis							
Pancreas divisum	Reviewed	1	--	--	--	7	8
	Included	1	--	--	--	2	3
Sphincter of Oddi dysfunction	Reviewed	--	--	--	--	--	--
	Included	--	--	--	--	--	--
Idiopathic ARP	Reviewed	1	1	--	1	1	4
	Included	1	0	--	--	--	1
Chronic pancreatitis							
Drainage of pseudocyst	Reviewed	--	--	1	1	3	5
	Included	--	--	1	1	1	3
Pancreatic duct stones (ERCP plus ESWL)	Reviewed	--	--	--	--	9	9
	Included	--	--	--	--	--	--
Pancreatic duct stricture (ERCP plus stenting)	Reviewed	--	--	--	--	11	11
	Included	--	--	--	--	--	--
Other chronic pancreatitis	Reviewed	--	--	--	--	6	6
	Included	--	--	--	--	--	--
Total	Reviewed	5	1	3	3	39	51
	Included	5	1	2	1	3	11

Table 58. Quality Assessment

Study, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Randomized controlled trials						
Neoptolemos, Carr-Locke, London et al., 1988	No • Randomization process not well described • Some baseline group differences present	No	Yes	Yes	Yes Intent-to-treat analysis not performed, but exclusions <10% overall and ratio less than 2:1 between arms	FAIR Does not meet all quality indicators, but does not contain any fatal flaws
Fan, Lai, Mok et al., 1993	Yes (?) • Randomization process not well-described • groups appear balanced	Yes	Yes Adequate for comparison	Yes	Yes Intent-to-treat analysis not performed, but exclusions <10% overall and ratio less than 2:1 between arms	GOOD Meets all quality indicators
Folsch, Nitsche, Ludtke et al., 1997	Yes	Yes	Yes	Yes	Yes	GOOD Meets all quality indicators
Lans, Geenen, Johanson et al., 1992	Yes (?) • Randomization by 'card selection', ? adequate • Small numbers make prone to selection bias • Comparability of groups not demonstrated	Yes (?) No dropouts	Yes	No • Pt reported outcomes, no blinding to treatment • No blinded outcome assessment	Yes	FAIR Does not meet all quality indicators, but does not contain any fatal flaws

Table 58. Quality Assessment (cont'd)

Study, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Randomized controlled trials (cont'd)						
Jacob, Geenen, Catalano et al., 2001	Yes (?) • Randomization process not described • Small numbers make prone to selection bias • Comparability of groups not demonstrated	Yes (?) No dropouts	Yes	No • Pt reported outcomes, no blinding to treatment • No blinded outcome assessment	Yes	FAIR Does not meet all quality indicators, but does not contain any fatal flaws
Non-randomized, retrospective comparative studies						
Aiyer, Burdick, Sonnenberg et al., 1999	No • Database study, no randomized treatment assignment • Highly prone to selection bias • Comparability of groups not demonstrated	No	No Cannot control for unequal intensity of treatment	Yes	Yes	POOR Lack of comparability of groups is a fatal flaw
Froeschle, Meyer-Pannwitt, Brueckner et al., 1993	No • No randomized treatment assignment • Highly prone to selection bias • Comparability of groups not demonstrated • Located 76% of treated patients	No	No Cannot control for unequal intensity of treatment	Yes	No Statistical analysis not described or reported	POOR Lack of comparability of groups is a fatal flaw

Table 59. excluded articles

Study/yr.	Study description	Reason for exclusion
Acute pancreatitis		
Rosseland and Solhaug 1984	Retrospective comparative clinical series Compared early ERCP with delayed ERCP (historical controls) in acute biliary pancreatitis	No objective pre and post measurements
Uomo, Galloro, Rabitti et al., 1991	Prospective clinical series 50 patients with acute biliary pancreatitis treated with early ERCP	No comparison group
al Karawi, el Shiekh Mohamed, al Shahri et al. 1993 1062	Retrospective clinical series 35 patients with acute biliary pancreatitis treated with ERCP and EX at one institution	No comparison group
Chronic pancreatitis (not otherwise specified)		
Ell, Rabenstein, Schneider 1998	Retrospective clinical series 118 patients with chronic pancreatitis treated with guidewire versus needle-knife pancreatic sphincterotomy	Only short term complications reported Techniques not randomized, needle knife used if guidewire failed
Kim, Myung, Kim et al., 1998	Clinical trial 60 patients with chronic pancreatitis, treated with dual sphincterotomy vs. pancreatic sphincterotomy only	Only short term complications reported Only outcomes on small (n<25) subgroups reported
Kozarek and Terrance 1994	Retrospective clinical series 56 patients with chronic pancreatitis who were treated with ERCP and pancreatic duct sphincterotomy.	NR study question Primarily evaluated complications of stenting
Treacy and Worthley 1996	Retrospective (?) clinical series 9 patients with chronic pancreatitis treated with stents over a 3yr period at one institution	<25 patients
Guelrud, Mujica, Jaen et al., 1994	Retrospective clinical series 51 children and adolescents with acute recurrent pancreatitis over an 8-year period at one institution. 18 patients treated endoscopically	No objective pre and post measurements <25 patients (therapeutic)
Festen, Severijnen, vd Staak et al., 1991	Case reports of two children with chronic relapsing pancreatitis evaluated and treated with ERCP	<25 patients
Fuji, Amano, Ohmura et al., 1989	Retrospective clinical series 21 patients with chronic pancreatitis from one institution, treated with ERCP and endoscopic sphincterotomy	No objective pre and post measurements <25 patients
Bornman, Marks, Girdwood et al., 1980	Retrospective clinical series 52 patients with calcific pancreatitis who underwent ERCP	NR study question Evaluated the association of obstruction and pain in this population

Table 59. excluded articles (cont'd)

Study/yr.	Study description	Reason for exclusion
Stent treatment in chronic pancreatitis with stricture		
Grimm, Meyer, Nam et al., 1989	Retrospective clinical series 70 patients with obstructive chronic pancreatitis treated with ERCP with or without ESWL	No objective pre and post measurements
Ashby and Lo 1995	Retrospective, clinical series 21 patients with chronic pancreatitis and stricture, treated with ERCP and stent at one institution	<25 patients
Binmoeller, Jue, Seifert et al., 1995	Retrospective, clinical series 93 patients with chronic pancreatitis and stricture, treated with endoscopic stent at one institution over a 9-year period	No objective pre and post measurements
Smits, Badiga, Rauws et al., 1995	Retrospective clinical series. 51 patients with chronic pancreatitis and stricture of pancreatic duct, treated with ERCP over an 11-year period at one institution	No objective pre and post measurements
Cremer, Deviere, Delhaye et al., 1991	Retrospective clinical series. 76 patients with severe chronic pancreatitis and stricture, treated with endoscopic stent at one institution over a 4-year period.	No objective pre and post measurements
Kozarek, Patterson, Ball et al., 1989	Retrospective clinical series. 17 patients with chronic pancreatitis treated endoscopically with either stents or drains	Mixture of stents and drains for different indications
McCarthy, Geenen, and Hogan 1988	Retrospective clinical series. 35 patients with benign pancreatic disease and suspected obstruction treated with endoscopic stent	No objective pre and post measurements Mixed population (CP, pancreas divisum, unexplained pain)
Ponchon, Gagnon, Berger et al., 1995	Retrospective clinical series 23 patients with chronic pancreatitis, pain and MPD stricture treated with ERCP stenting	No objective pre and post measurements <25 patients
Smith and Sherman 1996	Retrospective clinical series 61 patients treated with pancreatic stenting at one institution	NR study question Primarily evaluated complications of stenting
Sherman, Hawes, Savides, et al., 1996	Retrospective clinical series 61 patients with stent treatment who had long term follow-up after stent removal	NR study question Primarily evaluated complications of stenting
Vitale, Reed, Nguyen, et al., 2000	Retrospective clinical series 25 patients with chronic pancreatitis and CBD stricture, treated with ERCP stent	No objective pre and post measurements

Table 59. Excluded articles (cont'd)

Study/yr.	Study description	Reason for exclusion
Endoscopic treatment of pancreatic pseudocysts		
Kolars, Allen, Ansel, et al., 1989	Retrospective clinical series 51 patients with pseudocyst, treated either with surgery alone, ERCP alone, or ERCP followed by surgery	No relevant outcome data No objective pre and post measurements
Ahearne, Baillie, Cotton, et al., 1992	Retrospective clinical series 102 patients with pseudocysts, treated according to algorithm at one institution. Most patients (69/102) received surgical drainage	NR study question Did not evaluate outcomes of ERCP treatment
Endoscopic treatment of pancreatic duct stones		
Smits, Rauws, Tytgat, et al. 1996	Retrospective clinical series. 53 patients with chronic pancreatitis and pancreatic stones treated with ERCP from one institution over a 9-year period	No objective pre and post measurements
Dumonceau, Deviere, Le Moine, et al., 1996	Retrospective clinical series 70 patients with chronic pancreatitis and pancreatic stones, treated with ERCP at one institution over a 15-year period	No objective pre and post measurements
Kozarek, Ball, Patterson, et al., 1992	Retrospective clinical series. 12 patients with chronic pancreatitis and pancreatic duct stones treated with ERCP at one institution	No objective pre and post measurements <25 patients
Sherman, Lehman, Hawes, et al., 1991	Retrospective clinical series. 32 patients with chronic pancreatitis and pancreatic stones treated with ERCP at two institutions	No objective pre and post measurements
Ponsky and Duppler 1987	Case report Description of technique and response to therapy by patient	<25 patients No objective pre and post measurements
ERCP plus lithotripsy for pancreatic stones		
Ohara and Oshino 1996	Retrospective clinical series 32 patients with chronic pancreatitis and pancreatic duct stones, treated with ERCP and lithotripsy at one institution over a 4-year period	No objective pre and post measurements
Schreiber, Gurakuqi, Pristautz, et al., 1996	Retrospective clinical series. 10 patients with pancreatic stones and chronic pancreatitis treated with ERCP and lithotripsy over a 2-year period from a single institution	No objective pre and post measurements <25 patients
Schneider and May 1994	Retrospective clinical series 50 patients with chronic pancreatitis and pancreatic stones treated with ERCP and lithotripsy at one institution	No objective pre and post measurements
Delhaye, Vandermeeren, Baize, et al., 1992	Retrospective clinical series 123 patients referred for chronic pancreatitis who were treated with ERCP and lithotripsy at one institution over a 2-year period	No objective pre and post measurements

Table 59. excluded articles (cont'd)

Study/yr.	Study description	Reason for exclusion
Pancreas divisum		
Satterfield, McCarthy, Geenen, et al., 1988	Retrospective clinical series 82 patients with pancreas divisum seen at 2 institutions over a 4-year period Descriptive analysis of multiple subgroups	Outcomes not reported for all patients Reported outcome data on only 10/33 patients with pancreatitis
Chevillotte, Sahel, Pietri, et al., 1984 (French with English abstract)	Retrospective clinical series Descriptive analysis of 63 cases of pancreas divisum, from a series of 2800 ERCP procedures over a 6-year period at one institution	No objective pre and post measurements
Warshaw, Richter, and Schapiro, 1983	Retrospective clinical series 40 patients with pancreas divisum and recurrent pancreatitis or refractory pain, treated endoscopically over an 8-year period at one institution	No objective pre and post measurements
Keith, Shapero, and Sabil, 1982	Retrospective case series 5 patients with chronic or recurrent acute pancreatitis and pancreas divisum treated with ERCP and sphincterotomy, from 480 patients seen with pancreatitis at one institution over a 5 year period.	No objective pre and post measurements
Other studies		
Guelrud, Morera, Rodriguez, et al., 1999	Retrospective clinical series 128 children with pancreatobiliary disease who underwent ERCP at one institution over a 14-year period	NR study question (evaluated prevalence of sphincter of Oddi dysfunction in children with recurrent pancreatitis) Mixed population of patients with pancreatobiliary pathology
Hammarstrom, Stridbeck, and Ihse, 1997	Retrospective clinical series 28 patients who received ERCP treatment for benign pancreatic disease, from 319 patients who underwent ERCP at one institution for suspected pancreatic disease over a 13-year period	Mixed population of patients with benign pancreatic disease No objective pre and post measurements
He, Zheng, Zhang, et al., 2000	Retrospective clinical series 56 patients with congenital choledochal cysts, 39 evaluated and treated with ERCP	No objective pre and post measurements
Kozarek and Traverso 1996	Review and expert opinion	No primary data
Mori, Nagakawa, Ohta, et al., 1991	Retrospective clinical series 48 patients with anomalous union of pancreatic ducts, identified over an 11-year period at one institution	NR study question Evaluated prevalence of pancreatitis in patients with anomalous union of the ductal system
Malfertheiner and Buchler 1991	Review	No primary data

Table 59. excluded articles (cont'd)

Study/yr.	Study description	Reason for exclusion
Other studies (cont'd)		
Venu, Geenen, Hogan, et al., 1989	Retrospective clinical series 116 patients with idiopathic recurrent pancreatitis referred for ERCP at one institution	NR study question (yield study) Evaluated diagnostic yield of ERCP in this population
Ammann, Akovbiantz, Larglader, et al., 1984	Prospective cohort study 163 patients with chronic pancreatitis at two hospitals over a 19-year period.	NR study question Evaluated natural history of chronic pancreatitis
Himal 1999	Retrospective clinical series 55 patients with mild biliary pancreatitis. Evaluated ERCP preoperatively prior to cholecystectomy	NR study question
Testoni, Caporuscio, Bagnolo, et al., 2000	Prospective (?) clinical series 40 patients with idiopathic recurrent pancreatitis. Evaluated yield of ERCP for etiology and follow-up after treatment. Microlithiasis (n=11), sphincter of Oddi dysfunction (n=14), pancreas divisum (n=3), no etiology (n=12)	<25 patients for any one category

Table 60. Comparison of population and intervention in RCTs of ERCP for acute biliary pancreatitis

	Patient population	Early ERCP	Delayed/selective ERCP	Severity Pancreatitis	
				mild	severe
Neoptolemos, Carr-Locke, London et al., 1988	• Patients hospitalized with acute biliary pancreatitis • No other cause for pancreatitis	ERCP ± ES within 72 hours of admission for all patients	No patient received ERCP within first five days. Selective ERCP performed in 23% of control patients after day five for clinical indications (not specified).	56%	44%
Fan, Lai, Mok et al., 1993	• Patients hospitalized with acute pancreatitis (all causes) • No prior work-up for biliary stones • Pancreatitis not induced by ERCP	ERCP ± ES within 24 hours of admission for all patients	Selective ERCP performed in 28% of control patients for rising fever, leukocytosis or tachycardia; increasing jaundice or bilirubin; shock	58%	42%
Folsch, Nitsche, Ludtke et al., 1997	• Patients hospitalized with acute pancreatitis • No signs of obstructive jaundice • No other potential causes of pancreatitis	ERCP ± ES within 72 hours of onset of symptoms in all patients	Selective ERCP performed in 20% of control patients for signs of obstructive jaundice	78%	22%

Table 61. Early ERCP for treatment of acute biliary pancreatitis – study characteristics

Study	Population	Study design	Interventions(s)	Outcomes	Comments
Early ERCP vs. delayed/selective ERCP					
Neoptolemos, Carr-Locke, London et al., 1988	131 pts with suspected acute biliary pancreatitis, drawn from 223 consecutive pts admitted with acute pancreatitis Exclusions: 1) age less than 18yrs, 2) chronic alcoholism or acute alcohol intake, 3) pregnancy, and 4) identifiable secondary cause for pancreatitis.	Single center RCT Patients randomized to immediate ERCP or conventional management. Patients followed until discharged from hospital. All ERCP procedures performed by one "highly skilled" endoscopist.	Immediate ERCP – ERCP +/- ES within 72hrs of hospitalization. Control – Conventional management for first five days. Patients in conventional management group offered ERCP + ES after 5 days if clinically indicated.	Mortality Local complications (pseudocysts, ascites, duodenal obstruction) Systemic complications (respiratory failure, cardiovascular failure, stroke, DIC, renal failure)	No patients in control group got ERCP until at least day 5.
Fan, Lai, Mok et al., 1993	195 pts with acute biliary pancreatitis, selected from 206 consecutive patients with acute pancreatitis Exclusions: 1) prior workup for biliary stones 2) iatrogenic pancreatitis	Single center RCT Patients randomized to immediate ERCP or selective ERCP. Patients followed until discharge from hospital.	Immediate ERCP – ERCP +/- ES within 24hrs of hospitalization. Control – Selective ERCP for: rising fever, leukocytosis, or tachycardia; increasing jaundice or bilirubin; shock. All control patients had elective ERCP after acute attack resolved if selective ERCP not performed.	Mortality Local complications (pseudocysts, abscess, phlegmon, bleeding) Systemic complications (respiratory failure, cardiovascular failure, sepsis, DIC, renal failure, GI bleeding)	ERCP performed selectively in 27/98 (28%) control patients. Study included patients with etiologies for pancreatitis other than biliary stones. 64% of patients in study had documented biliary stones.
Folsch, Nitsche, Ludtke et al., 1997	238 adult patients with suspected acute biliary pancreatitis, selected from 339 consecutive patients Exclusions: 1) Indications for early ERCP (bilirubin >5, temp >39°), 2) age <18yrs, 3) pregnancy, 4) inability to perform ERCP within 72hrs of onset of symptoms.	Multi-center RCT, 22 clinical centers Patients randomized to immediate ERCP or selective ERCP. Patients followed for three months	Immediate ERCP – ERCP +/- ES within 72hrs of onset of symptoms. Control – Conventional management. ERCP performed for persistent biliary colic, temp >39°, or increased bilirubin. After 3 weeks, ERCP could be performed in any patient if indicated.	Mortality Local complications (pseudocysts, ascites, duodenal obstruction) Systemic complications (respiratory failure, cardiovascular failure, stroke, DIC, renal failure)	ERCP performed selectively in 22/112 (20%) of patients. Study terminated early due to inability to shoe a benefit in the early ERCP group.

Table 62. Early ERCP for treatment of acute biliary pancreatitis – outcomes

Study/yr.	Severity	Mortality		P value	Complications								
					Overall		P value	Systemic		P value	Local		P value
		Early[1]	D/S[2]		Early[1]	D/S[2]		Early[1]	D/S[2]		Early[1]	D/S[2]	
Early ERCP vs. delayed/selective ERCP													
Neoptolemos, Carr-Locke, London et al., 1988	Overall (n=121)	1.7% (1/59)	8.1% (5/62)	0.23	17% (10/59)	34% (17/62)	0.03	7% (4/59)	19% (12/62)	0.08	12% (7/59)	24% (15/62)	0.08
	Mild (n=68)	0% (0/34)	0% (0/34)	NS	12% (4/34)	12% (4/34)	NS	2.9% (1/34)	0% (0/34)	NR	12% (4/34)	12% (4/34)	NS
	Severe (n=53)	4% (1/25)	18% (5/28)	NR	24% (6/25)	61% (17/28)	<0.01	12% (3/25)	43% (12/28)	NR	12% (3/25)	39% (11/28)	NR
Fan, Lai, Mok et al., 1993	Overall (n=195)	5.2% (5/97)	9.2% (9/98)	0.40	18% (17/97)	29% (28/98)	NR	10% (10/97)	14% (14/98)	NS	10% (10/97)	12% (12/98)	NS
	Mild (n=114)	0% (0/56)	0% (0/58)	NS	8 total/ 56 pts	6 total/ 58 pts		1 total/ 56 pts	5 total/ 58 pts		7 total/ 56 pts	1 total/ 58 pts	
	Severe (n=81)	12% (5/41)	23% (9/40)	NR	22 total/ 41 pts	44 total 40 pts		16 total/ 41 pts	33 total/ 40 pts		6 total/ 41 pts	11 total/ 40 pts	
Folsch, Nitsche, Ludtke et al., 1997	Overall (n=238)	11% (14/126)	6.3% (7/112)	0.10	46% (58/126)	51% (57/112)	NS	91 total/ 126 pts	89 total/ 112 pts		25% (31/126)	25% (28/112)	
	Mild (n=160)												
	Severe (n=46)												

[1] Early ERCP group
[2] Delayed and/or selective ERCP group

Table 63. ERCP vs. surgery for treatment of acute biliary pancreatitis – study characteristics

Study	Population	Study design	Interventions(s)	Outcomes	Comments
ERCP vs. surgery					
Aiyer, Burdick, Sonnenberg et al., 1999	2075 pts with acute biliary pancreatitis from VA system, 650 treated with endoscopy and 1425 treated with surgery.	Retrospective analysis of VA database, comparing outcomes and complications of endoscopy versus surgery	ERCP – Received ERCP as initial intervention during hospitalization for acute biliary pancreatitis Surgery – Had cholecystectomy and/or other biliary/pancreatic surgery as initial intervention during hospitalization for acute biliary pancreatitis	Mortality Local complications (pseudocysts) Systemic complications (respiratory failure, sepsis, GI bleed, DIC, renal failure, hypocalcemia) Complications from therapy (hemorrhage, laceration/puncture of viscus organ)	

Table 64. ERCP vs. surgery for treatment of acute biliary pancreatitis – outcomes

Study/yr.	Populations/Severity	Mortality	P value	Complications (overall)	P value
ERCP vs. surgery					
Aiyer, Burdick, Sonnenberg et al., 1999	ERCP: (n=650) average SOI by Charlsson score 0.9 Surgery: (n=1425) average SOI by Charlsson score 0.8	2% (15/650) 4% (56/1425)	0.08	2% (14/650) 2% (33/1425)	0.94

*32 patients had undefined severity level

Table 65. ERCP for treatment of acute recurrent pancreatitis

Study	Population	Study design	Interventions(s)	Outcomes	Comments
Acute recurrent pancreatitis associated with pancreas divisum					
Lans, Geenen, Johanson et al., 1992	19 patients with pancreas divisum and recurrent acute pancreatitis at one institution over a 5yr period Exclusions: other potential causes of pancreatitis; prior pancreatic resection or sphincterotomy	Randomized controlled trial ERCP alone vs. ERCP plus stent. F/U every 4 mos. in both groups Mean F/U 28.6 mos. for stent group, 31.5 mos. for controls	Stent placement in dorsal pancreatic duct. Stent replaced every 4 mos. in stent group. Stents removed after one year	1) Number of hospitalizations ER visits Stent (n=10) 0 Control (n=9) 7 p<0.05 2) Number of episodes acute pancreatitis Stent (n=10) 1 Control (n=9) 7 p<0.05 3) Number of pts with subjective improvement on visual analogue scale Stent (n=10) 9 Control (n=9) 1 p<0.05	
Kozarek, Ball, Patterson et al., 1995	39 pts with pancreas divisum and chronic pancreatitis (CP) (n=19), acute relapsing pancreatitis (ARP) (n=15), or chronic abdominal pain (CAP) (n=5)	Retrospective (?) single arm case series	ERCP treatment determined at time of treatment: Stent 13 pts Sphincterotomy 4 pts Stent + Sphinct 22 pts	1) Pain (0-10 scale) Pre / Post / p value* CP 9.4 / 4.8 / <0.001 Pain 8.3 / 7.3 ARP NR / NR * pre vs. post 2) number of episodes pancreatitis/year Pre / Post / p value* CP 2.0 / 1.6 / 0.025 Pain NR / NR ARP 2.1 / 0.3 / 0.016 * pre vs. post	

Table 65. ERCP for treatment of acute recurrent pancreatitis (cont'd)

Study	Population	Study design	Interventions(s)	Outcomes	Comments
Acute recurrent pancreatitis associated with pancreas divisum (cont'd)					
Lehman, Sherman, Nisi et al., 1993	52 previously untreated pts with pancreas divisum and chronic pancreatitis (CP) (n=11), acute recurrent pancreatitis (ARP) (n=17), or disabling pancreatic pain (Pain) (n=24)	Retrospective (?) single arm case series	ERCP plus sphincterotomy of minor papilla	1) Pain (0-10 scale) Pre / Post / p value* CP 9.5 ± 0.3 / 6.6 ± 1.3 / NS Pain 8.4 ± 0.2 / 6.6 ± 0.8 / 0.02 ARP 9.1 ± 0.3 / 2.1 ± 0.8** / <0.001 * pre vs. post ** significantly greater change in symptom score as compared to CP (p=0.007) and pain (p<0.001) 2) number of hospital days/month Pre / Post / p value* CP 1.7 ± 0.3 / 1.5 ± 0.5 / NS Pain 1.4 ± 0.4 / 1.0 ± 0.2 / NS ARP 1.6 ± 0.4 / 0.1 ± 0.1** / <0.001 * pre vs. post ** significantly greater change in hospital days as compared to CP (p<0.05) and pain (p=0.003)	

Table 65. ERCP for treatment of acute recurrent pancreatitis (cont'd)

Study	Population	Study design	Interventions(s)	Outcomes	Comments
Idiopathic acute recurrent pancreatitis					
Jacob, Geenen, Catalano et al., 2001	34 patients with idiopathic acute recurrent pancreatitis randomized to ERCP alone or ERCP plus stenting of pancreatic duct	Prospective, randomized, non-blinded clinical trial	ERCP alone: diagnostic ERCP and pancreatogram at baseline and every 3 mos. for 9 mos. Mean follow-up 35 mos. ERCP plus stent: ERCP plus stenting of pancreatic duct, stent changed every 3 mos. for 9 mos.. Mean follow-up 33 mos.	Recurrent episodes of pancreatitis: P value ERCP alone 53% (8/15) ERCP plus stent 11% (2/19) <0.02 Persistence of pain*: P value ERCP alone 40% (6/15) ERCP plus stent 32% (6/19) NS *Presence of pancreatic type pain of at least moderate intensity (4 or greater on 0-10 scale) post-treatment	

Table 66. ERCP for treatment of chronic pancreatitis

Study	Population	Study design	Interventions(s)	Outcomes	Comments
Endoscopic drainage of pseudocysts					
Libera, Siqueira, Morais et al., 2000	30 pts referred for drainage of pseudocysts. Inclusion: 1) Pseudo-cyst >4cm for at least 6 weeks with persistent abdominal pain, 2) progressive increase in size, 3) complications from pseudocyst	Retrospective (?) single arm case series	ERCP drainage performed in one of four ways: 1) transpapillary 2) cyst-gastrostomy 3) cyst-duodenoscopy 4) combined procedure Drainage performed with or without stent, as clinically indicated Treatments were repeated, or alternate drainage attempted, if clinically indicated.	**1) Abdominal pain (0-3 scale):** Pre: 2.48 ± 0.51; Post: 0.28 ± 0.64; p value: <0.001 Complete pain relief in 17/30 pts (57%) 2) Regression of pseudocyst on CT: 21/30 (70%) pts had regression. 21/25 (84%) pts with successful procedure had regression 3) Complications: 6 complications among 37 procedures (16.2%) 2 stent migration 1 duodenal perforation 1 bleeding 1 pancreatitis 1 pneumoperitoneum	
Barthet, Sahel, Bodiou-Bertei et al., 1995	30 pts with pancreatic pseudocyst amenable to drainage by ERCP. Exclusions: none	Prospective single arm clinical series	Transpapillary ERCP performed in all cases. Serial US and/or CT at 4 mo. intervals. F/U ERCP performed if cyst no longer present on imaging	Early resolution of pseudocyst: 26/30 (87%) Recurrence of pseudocyst: 3/26 (12%) Complications: 4/30 (13%)	7/30 patients needed surgical intervention, 3 for failure of pseudocyst to resolve and 4 for recurrence

Table 66. ERCP for treatment of chronic pancreatitis (cont'd)

Study	Population	Study design	Interventions(s)	Outcomes	Comments
Endoscopic drainage of pseudocysts (cont'd)					
Froeschle, Meyer-Pannwitt, Brueckner et al., 1993	127 pts treated for pancreatic pseudocysts from one hospital. 35% treated surgically, 29% endoscopically, 6% percutaneously	Retrospective comparative analysis of outcomes and complications among the three approaches used	Surgery (n=44) Endoscopy (n=37) Percutaneous (n=7) Combined procedure (n=26) No procedure (n=13) F/U performed a mean of 33 mos. after intervention 30/127 (23.6%) lost to F/U.	1) Mortality Post-op / F/U / p value Surgery 6.8% 13.6% NR Endoscopy 0 2.7% NR Combined 0 15.4% NR 2) Percent of patients free of pain at F/U p value Surgery 50% (16/32) NR Endoscopy 52% (16/31) NR Combined 54% (10/18) NR	

Table 67. Quality Assessment

Study Author, Year	**Patient Enrollment**	**Diagnostic performance of ERCP determined without knowledge of other test results**	**Diagnostic Performance of other test(s) determined without knowledge of ERCP results**	**Summary Evaluation**
Peng, Lai, Tsay et al., 1994	Retrospective study Partial description provided of method of enrollment of 60 patients.	No	No	**Fair**
Sostre, Kalloo, Spiegler et al., 1992	Prospective study 26 consecutive patients	Yes	Yes	**Good**
Kloiber, AuCoin, Hershfield et al., 1988	Retrospective study (?) Partial description provided of method of enrollment of 50 consecutive patients	No	No	**Fair**

Table 68. Study Details

Study	Pt population N enrolled	N evaluable	Diagnostic Test criterion	Prev (%)	Sens (%)	Spec (%)	PPV (%)	NPV (%)	Adeq Studies (%)	Comments
ERCP + Manometry Reference Standard										
Peng, Lai, Tsay et al., 1994	34 pts with: • Postcholecystectomy • RUQ symptoms • Normal LFT's • No other pathology on UGI, US, ERCP 26 control pts: • Postcholecystectomy • Asymptomatic • Normal LFT's	26	Quantitative scintigraphy Time activity curve Common bile duct dynamics	62 62	69 69	80 90	85 92	62 64	n.r. n.r.	
Sostre, Kalloo, Spiegler et al., 1992	26 consecutive postcholecystectomy patients, some with biliary pain, some with non-biliary pain and some with no symptoms	26	Quantitative scintigraphy Liver peak Biliary visualization Biliary prominence Bowel visualization CBD emptying CBD-to-Liver ratio Final scintigraphic score	 46 46 46 46 46 46 46	 83 50 100 92 100 100 100	 79 100 79 71 93 86 100	 77 100 80 73 92 86 100	 85 70 100 91 100 100 100	n.r.	This study administered CCK routinely to all patients before scintigraphy. 12/26 pts thought to have SOD
ERCP Reference Standard										
Kloiber, AuCoin, Hershfield et al., 1988	50 consecutive pts with • Postcholecystectomy • RUQ pain	50	Quantitative scintigraphy Time to peak bile duct activity	18	93	64	n.r.	n.r.	n.r.	Scintigraphy was used to assess presence of obstruction in post-choly syndrome. 9/50 pts thought to have SOD

Table 69. Quality Assessment in studies comparing endoscopic treatment in patients with abdominal pain of suspected pancreaticobiliary origin

Study Author, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Geenen, Hogan, Dodds, et al., 1989	RCT (n=47) Unknown comparability - Randomization by sealed opaque envelopes - patient characteristics not reported	All subjects included in one-year outcome analysis Four-year follow-up only in 40 of 47. All 7 had normal SO pressure (5 ES; 2 sham). Four lost to f/u and 3 dropped out.	Adequate for comparison.	Double-blinded assessment for 1-year outcomes. Outcome measurement instruments for pain not well described.	Method of first-year outcomes analysis not stated but equivalent to intention-to-treat because all subjects enrolled were included in analysis. Four-year analysis equivalent to treatment received because sham cross-overs were analyzed with ES group.	Good
Toouli, Robert-Thomson, Kellow et al., 2000	RCT (n=81) Comparability - randomized by draw of cards - patient characteristics not reported	One lost to follow-up and 1 dropout due to pancreatitis x 2.	Adequate for comparison.	Double-blinded assessment for two-year outcomes. Outcome measurement instruments for pain not well described.	Does not clearly state method of analysis	Good

Table 70. Randomized Controlled Trials

Study	N	Study Group	Improved Pain Scores	P	Mean Symptom Score	P	Objective Abnormalities[1]	P	Complications	P
Geenen, Hogan, Dodds, et al., 1989[2] Group II Biliary patients			One-Year:				Baseline 1-year			
		Overall:	Good/fair improvement						1 Hemorrhage	
	23	ES	15/23 (65%)	<0.01			37 6	n.r.	1 Perforation	
	24	Sham	7/17 (30%)				49 30		2 Pancreatitis	
		SOM >40 mmHg[3]			Baseline 1-year					
			10/11 (91%)		10 1.8		21 1			
		ES	3/12 (25%)	<0.005	10 6.7	n.r.	30 22	n.r.		
	11	Sham								
	12									
		SOM <40 mmHg[3]								
			5/12 (42%)		10 5.7		16 5			
	12	ES	4/12 (33%)	n.r.	10 6.3	n.r.	19 8	n.r.		
	12	Sham								
			Four-Year:							
		Overall:	Good/fair improvement							
	30	ES[3]	21/30 (70%)	n.r.						
	10	Sham	4/10 (40%)							
		SOM >40 mmHg								
	18		17/18 (94%)							
	5	ES	2/5 (40%)	<0.005						
		Sham								

[1] Summary score of presence of abnormal liver function tests, enlarged common bile duct (>12 mm), delayed drainage of contrast/bile (>45 minutes).
[2] Common bile duct dilatation (≥12mm), abnormal liver function tests, or delayed drainage of contrast/bile (>45 minutes) were not statistically significant predictors of treatment response after ES; however, sample size was small limiting statistical power to detect a difference.
[3] At 1-year, 17 sham subjects were considered treatment failures and were offered cross-over treatment with ES. 7 of 9 sham subjects w/ SO pressure > 40 mm Hg crossed over to ES. After 3 years follow-up, 7 of 7 (100%) were virtually symptom free. Five of 8 sham subjects w/ SO pressure <40 mmHG crossed over to ES. After 3 years follow-up, 2 of 5 (40%) showed Good or Fair improvement in pain scores.

Table 70. Randomized Controlled Trials (cont'd)

Study	N	Study Group	Improved Pain Scores	P	Mean Symptom Score	P	Objective Abnormalities[4]	P	Complications	P
Toouli, Robert-Thomson, Kellow et al., 2000(n=79)	13 13	SOM >40mmHg ES Sham	2-year 11 (85%) 5 (38%)	0.041					7 Mild pancreatitis 1 Perforation	
	11 10	SO Dyskinesia ES Sham	4 (36%) 5 (50%)	0.67						
	13 19	Normal SOM ES Sham	8 (62%) 8 (42%)	0.473						

[4] Summary score of presence of abnormal liver function tests, enlarged common bile duct (>12 mm), delayed drainage of contrast/bile (>45 minutes).

Table 71. Single-arm studies of results of endoscopic sphincterotomy for abdominal pain of suspected pancreaticobiliary origin

Study	N1	N2	Study Group	Improved Pain Scores	P	Objective Abnormalities[5]	P	Complications	P
Brand, Wiese, Thonke, et al., 2001		29	29 consecutive patients with: abd pain of suspected pancreatobiliary origin. Elevated liver enzymes No other pathology on diagnostic ERCP	Pre-treatment: median pain score 8 (0-10) Post-treatment: 26/28 (93%) pts pain-free at 12wks (1 pt lost to f/u)	n.r.	Normalization of liver enzymes post-treatment: 22/29 (76%)		procedure induced pancreatitis in 1/29 pts (3%)	
Wehrmann, Wiemer, Lembcke, et al., 1996	108	33	33 of 108 consecutive pts w/ unexplained abdominal pain referred for workup 35 type II SOD - 20 got ES 29 type III SOD - 13 got ES ES performed only in those with SO pressure > 40mmHg	Mean pain score (0-10) Pre-treatment Type II: 7.2+/-1.4 Type III: 6.8+/-1.3 Post-treatment 4-6 weeks Type II: 2.3+/-2.6 Type III: 3.7+/-2.6 Post-treatment Median f/u 2.5 y Type II: 2.5+/-2.8 Type III: 5.1+/-2.0 Type II SOD 12/20 (60%) improved Type III SOD 1/13 (8%) improved	n.s. <0.01 <0.01	Bile duct dilatation (>9mm) Type II SOD Pre ES = 5 pts Post ES = 2 pts Type III SOD No significant changes	n.s.	Pancreatitis 15% No perforation	

[5] Summary score of presence of abnormal liver function tests, enlarged common bile duct (>12 mm), delayed drainage of contrast/bile (>45 minutes).

Table 71. Single-arm studies of results of endoscopic sphincterotomy for abdominal pain of suspected pancreaticobiliary origin (cont'd)

Study	N1	N2	Study Group	Improved Pain Scores	P	Objective Abnormalities[6]	P	Complications	P
Botoman, Kozarek, Novell, et al., 1994[7]		 19 16	SO Pressure >40 mm Hg Type II Type III	Mean f/u 3.1 y 13/19 (68%) 9/16 (56%)	 n.s.				
Choudhry, Ruffolo, Jamidar, et al., 1993		35	SO Pressure >40mmHg	**1 Month** 43% pain-free 34% good 0% fair 23% no response **During follow-up** 56% of responders stayed well 44% relapsed					
		  1 18 16	SO Pressure >40mmHg Type I Type II Type III	 0% 38% 56%	 >0.05				

[6] Summary score of presence of abnormal liver function tests, enlarged common bile duct (>12 mm), delayed drainage of contrast/bile (>45 minutes).
[7] Common bile duct dilatation (≥12mm) and presence of cholecystectomy were not statistically significant predictors of treatment response after ES; however, sample size was small limiting statistical power to detect a difference.

Table 71. Single-arm studies of results of endoscopic sphincterotomy for abdominal pain of suspected pancreaticobiliary origin (cont'd)

Study	N1	N2	Study Group	Improved Pain Scores	P	Objective Abnormalities[8]	P	Complications	P
Thatcher, Sivak, Tedesco, et al., 1987[9]	34 17	31 15	Group 1[10] Group 2	Pain-free at 3-months n=N2 27/31 (87%) 10/15 (67%)	n.r.			N=N1 4 perforations 2 pancreatitis 2 hemorrhage	
			Group 1 Group 2	Pain free at 12-months 25/31 (81%) 7/15 (47%)	n.r.				
			Group 1 Group 2	Pain free at Last evaluation Mean f/u=12.5 m 24/31 (77%) Mean f/u=20.3 m 7/15 (47%)	0.05				

[8] Summary score of presence of abnormal liver function tests, enlarged common bile duct (>12 mm), delayed drainage of contrast/bile (>45 minutes).
[9] Stastistically significant associations were noted between satisfactory response to ES and dilated CBD (p=0.02), delayed drainage of contrast (p=0.04), and combination of both of these (p=0.01). No significant association was seen for abnormal manometry or abnormal biochemical parameters.
[10] Group 1 (roughly similar to Type II) had "a dilated bile duct and a clinical history compatible with sphincter dysfunction. These patients had evidence of bile duct obstruction which was defined as either a dilated common bile duct (CBD) at ERCP or CT scan (greater than 12 mm in diameter) and/or delayed drainage of contrast material (greater than 45 min in the absence of a gallbladder)." Group 2 (roughly similar to Type III) "did not have CBD dilation or delayed contrast drainage at ERCP. The sphincter of Oddi dysfunction was based on a typical history combined with abnormal sphincter of Oddi manometry."

Table 72. Overview Table

Study	N Pts	Pop	Patient Factors	Procedure Factors	Operator Factors	Outcomes Analyzed
Fair Quality						
Masci, Toti, Mariani, et al., 2001	2444	M	X	X		Total complications (121) Pancreatitis (44) Hemorrhage (30)
Freeman, DiSario, Nelson, et al., 2001	1963	M	X	X	X	Pancreatitis (131)
Freeman, Nelson, Sherman, et al., 1996	2347	T (ES)	X	X	X	Total complications (229) Pancreatitis (127) Hemorrhage (48)
Fair Minus Quality						
Rabenstein, Schneider, Bulling, et al., 2000	438	T (ES)	X	X	X	Total complications (33) Pancreatitis (19)
Loperfido, Angelini, Benedetti, et al., 1998	1827	T[1]	X	X	X	Total complications (98) Pancreatitis (29) Hemorrhage (21) Cholangitis (21) Retroperitoneal perforation (12)
Mehta, Pavone, Barkun, et al., 1998	535	M	X	X		Pancreatitis (34)
Neoptolemos, Shaw, and Carr-Locke, 1989	190	T (ES)	X			Total complications (32)
Motte, Deviere, Dumonceau, et al., 1991	105	T (ST)	X	X		Septicemia (34)
Tzovaras, Shukla, Kow, et al., 2000	372	M	X	X		Total complications (21)
Lai, Lo, Choi, et al., 1989	323	D	X			Acute cholangitis (21)
Boender, Nix, de Ridder, et al., 1994	242	T (ES)	X	X		Total complications (34)
Nelson and Freeman, 1994	189	T (ES)	X	X		Hemorrhage (10)
Maldonado, Brady, Mamel, et al., 1999	100	M[2]	X	X		Pancreatitis (17)

[1] Loperfido included a broad population of both diagnostic and therapeutic ERCP. However, multivariate analysis of risk factors was reported only for therapeutic subpopulation.
[2] Maldonado was restricted to a specific population with suspected sphincter of Oddi dysfunction who were undergoing sphincter of Oddi manometry

Table 73. Quality Assessment

Study	N	No. candidate variables	Total complications	Pancreatitis	Hemorrhage	Cholangitis	Retroperitoneal perforation	Septicemia	Ratio of group size/# variables	Degree of Overfitting	Statistical reporting	Internal validity	Overall Quality Rating
Masci, Toti, Mariani, et al., 2001	2444	16	121	44	30	--	--	--	7.6 – 1.9	Mild to Severe	S	No	Fair
Freeman, DiSario, Nelson, et al., 2001	1963	32	--	131	--	--	--	--	4.1	Moderate	S	No	Fair
Freeman, Nelson, Sherman, et al., 1996	2347	22	229	127	48	--	--	--	10.4 - 2.2	Satisfactory to Severe	S	No	Fair
Rabenstein, Schneider, Bulling, et al., 2000	438	26	33	19	--	--	--	--	1.3 - 0.7	Severe	S	No	Fair Minus
Loperfido, Angelini, Benedetti, et al., 1998	1827	13	98	29	21	21	12	--	7.5 - 0.9	Mild to Severe	U	No	Fair Minus
Mehta, Pavone, Barkun, et al., 1998	535	9	--	34	--	--	--	--	3.7	Severe	U	No	Fair Minus
Neoptolemos, Shaw, and Carr-Locke, 1989	190	19	32	--	--	--	--	--	1.7	Severe	U	No	Fair Minus
Motte, Deviere, Dumonceau, et al., 1991	105	13	--	--	--	--	--	34	2.6	Severe	U	No	Fair Minus
Tzovaras, Shukla, Kow, et al., 2000	372	16	21	--	--	--	--	--	1.3	Severe	S	No	Fair Minus
Lai, Lo, Choi, et al., 1989	323	9	--	--	--	21	--	--	2.3	Severe	S	No	Fair Minus

Table 73. Quality Assessment (cont'd)

Study	N	No. candidate variables	Total complications	Pancreatitis	Hemorrhage	Cholangitis	Retroperitoneal perforation	Septicemia	Ratio of group size/# variables	Degree of Overfitting	Statistical reporting	Internal validity	Overall Quality Rating
Boender, Nix, de Ridder, et al., 1994	242	9	34	--	--	--	--	--	3.7	Severe	S	No	Fair Minus
Nelson and Freeman, 1994	189	7	--	--	10	--	--	--	0.14	Severe	S	No	Fair Minus
Maldonado, Brady, Mamel, et al., 1999	100	9	--	17	--	--	--	--	1.9	Severe	U	No	Fair Minus

Explanation of categorization:
Degree of Overfitting assessed using the ratio of number of endpoints over number of candidate variables: Satisfactory, ratio $\geq$ 10; Mild, ratio – 7 to 10; Moderate, ratio 4-7; Severe, ratio <4.
Statistical reporting: S=satisfactory, reported both magnitude of effect estimates as well as associated confidence intervals or p-value for statistically significant findings; U = unsatisfactory, did not report both magnitude of effect estimate and statistical significance information for statistically significant findings.
Internal validity: Yes = the study used procedures (e.g., test-validation split samples or bootstrapping) to guard against overfitting the model and spurious results; No = the study did not utilize such procedures

Quality Rating:
Good = use of procedures to guard against overfitting the model and spurious results, degree of overfitting not severe for at least one analysis, and satisfactory statistical reporting
Fair = degree of overfitting not severe for at least one analysis, satisfactory statistical reporting, but no use of procedures to guard against overfitting the model and spurious results.
Fair Minus = Severe degree of overfitting

Table 74. Relationship between Patient Factors and Total Complications[3]

Study	N Pts Cx	Age	Gender	CBD Size\Diameter	Cholangitis	Anatomic variation/ features[4]	Coagulopathy[5]	Laboratory values	Other[6] Comorbidities	Indication for ERCP proc[7]	Previous Gastrectomy	Hx Jaundice	Hx Contrast Allergy
Fair Quality													
Masci, Toti, Mariani, et al., 2001	2444 121	Age ≤60 years OR=1.53 (1.06-2.2)	X	X		X Stone size Papilla features GB stones				X			
Freeman, Nelson, Sherman, et al., 1996	2347 229	X	X	X	X	X	X		Cirrhosis OR=2.93 (1.48-5.90)	Susp. SOD OR=2.9 (1.70-4.94) All pts had ES	X		
Fair Minus Quality													
Rabenstein, Schneider, Bulling, et al., 2000	438 33	Age ≤60 years OR=2.9 (1.33-6.21)	X			Pancreas divisium OR=7.6 (1.56-36.6)	Coagulopathy OR=9.7 (1.95-48.10)		X	Pancreatic obstruction OR=0.07 (0.01-0.59) All pts had ES	X		

[3] Independent variables reported to be statistically significant risk factors for complications are listed for each study along with an estimate of the magnitude of the effect when available (i.e., odds ratio and confidence interval). Independent variables that were considered in the study but not found to be significantly associated with complications are denoted by an "X" under the appropriate category for that factor

[4] Summary of pancreas divisum, juxtapapillary diverticulum, acinarization

[5] Summary of related factors – anticoagulation, coagulopathy, PT time, ASA/NSAID use, bleeding

[6] "Comorbidities" includes reports of cirrhosis diabetes, anemia, hemodialysis etc.

[7] Summary of related factors - Pancreatitis or Obstruction, sphincter of Oddi dysfunction, indication of than bile duct stone

Table 74. Relationship between Patient Factors and Total Complications (cont'd)

Study	N Pts Cx	Age	Gender	CBD Size\Diameter	Cholangitis	Anatomic variation/ features[8]	Coagulopathy[9]	Laboratory values	Other[10] Comorbidities	Indication for ERCP proc[11]	Previous Gastrectomy	Hx Jaundice	Hx Contrast Allergy
Fair Minus Quality													
Loperfido, Angelini, Benedetti, et al., 1998	1827 98	X	X	X		X					X	X	
Neoptolemos, Shaw, and Carr-Locke, 1989	190 32	X	X		X		X	elevated bilirubin elevated serum albumin	X	X All pts had ES			
Tzovaras, Shukla, Kow, et al., 2000	372 21	X	X							Suspected SOD OR=8.57 (2.59-28.43); Malignant jaundice OR=4.76 (1.46-15.58)			

[8] Summary of pancreas divisum, juxtapapillary diverticulum, acinarization
[9] Summary of related factors – anticoagulation, coagulopathy, PT time, ASA/NSAID use, bleeding
[10] "Comorbidities" includes reports of cirrhosis diabetes, anemia, hemodialysis etc.
[11] Summary of related factors - Pancreatitis or Obstruction, sphincter of Oddi dysfunction, indication of than bile duct stone

Table 74. Relationship between Patient Factors and Total Complications (cont'd)

Study	N Pts Cx	Age	Gender	CBD Size\Diameter	Cholangitis	Anatomic variation/ features[12]	Coagulopathy[13]	Laboratory values	Other[14] Comorbidities	Indication for ERCP proc[15]	Previous Gastrectomy	Hx Jaundice	Hx Contrast Allergy
Fair Minus Quality													
Boender, Nix, de Ridder, et al., 1994	242 34	X		X		JPD Outside OR=3.1 (p=.072) Lower rim OR=4.3 (p=.015) Inside OR=9.4 (p=.002) Presence of GB NS				All pts had ES			

[12] Summary of pancreas divisum, juxtapapillary diverticulum, acinarization
[13] Summary of related factors – anticoagulation, coagulopathy, PT time, ASA/NSAID use, bleeding
[14] "Comorbidities" includes reports of cirrhosis diabetes, anemia, hemodialysis etc.
[15] Summary of related factors - Pancreatitis or Obstruction, sphincter of Oddi dysfunction, indication of than bile duct stone

Table 75. Relationship between Patient Factors and Pancreatitis

Study	N Pts Cx	Age	Gender	CBD Size\Diameter	Cholangitis	Anatomic variation/ features[1]	Coagulopathy[2]	Laboratory values	Other[3] Comorbidities	Indication for ERCP proc[4]	Previous Gastrectomy	Hx Jaundice	Hx Contrast Allergy
Fair Quality													
Masci, Toti, Mariani, et al., 2001	2444 44	Age ≤60y OR=2.11 (1.16-3.8)	X	X		X				X			
Freeman, DiSario, Nelson, et al., 2001	1963 131	X	Female OR=2.51 (1.49-4.24)	X		X		Normal bilirubin OR=1.89 (1.22-2.93)	Absence of CP OR=1.87 (1.00-3.48) Hx post-ERCP pancreatitis OR=5.35 (2.97-9.66)	Susp. SOD OR=2.6 (1.59-4.26)			
Freeman, Nelson, Sherman, et al., 1996	2347 127	Age 30 vs. Age 70y OR=2.14 (1.41-3.25)	X	X	X	X	X		X	Susp. SOD OR=5.01 (2.73-9.22)	X		
Fair Minus Quality													
Rabenstein, Schneider, Bulling, et al., 2000	438 19	X	X			Pancreas divisium OR=8.2 (1.91-34.79)	X		X	X	X		

Table 75. Relationship between Patient Factors and Pancreatitis (cont'd)

Study	N Pts Cx	Age	Gender	CBD Size\Diameter	Cholangitis	Anatomic variation/ features[1]	Coagulopathy[2]	Laboratory values	Other[3] Comorbidities	Indication for ERCP proc[4]	Previous Gastrectomy	Hx Jaundice	Hx Contrast Allergy
Fair Minus Quality													
Loperfido, Angelini, Benedetti, et al., 1998	1827 29	Age <70 OR=1.11 n.r.	X	Nondilated duct OR=2.85 n.r.		X						X	
Mehta, Pavone, Barkun, et al., 1998	535 34	Age <59 years (p=0.04)	X	X		Absence of a CBD stone at ERCP (p=0.004)		X	X History of pancrea-titis	X Pre-lap choly			
Maldonado, Brady, Mamel, et al., 1999	100 17	X	X							X			

Table 76. Relationship between Patient Factors and Hemorrhage

Study	N Pts Cx	Age	Gender	CBD Size\Diameter	Cholangitis	Anatomic variation/ features[1]	Coagulopathy[2]	Laboratory values	Other[3] Comorbidities	Indication for ERCP proc[4]	Previous Gastrectomy	Hx Jaundice	Hx Contrast Allergy
Fair Quality													
Masci, Toti, Mariani, et al., 2001	2444 30	X	X	X		Obstructed orifice of papilla of Vater OR=2.57 (1.69-6.17)				X			
Freeman, Nelson, Sherman, et al., 1996	2347 48	X	X	X	OR=2.59 (1.38-4.86)	X	OR=3.32 (1.54-7.18)		X	X	X		
Fair Minus Quality													
Loperfido, Angelini, Benedetti, et al., 1998	1827 21	X	X	X		X					X	X	
Nelson and Freeman, 1994	189 10			X			Prothrombin time 2x > control OR=12.1 (1.8-90.9)		Hemodialysis OR=16.4 (2.9-93.1)	X All pts had ES			

Table 77. Relationship between Patient Factors and Cholangitis

Study	N Pts Cx	Age	Gender	CBD Size\Diameter	Cholangitis	Anatomic variation/ features[1]	Coagulopathy[2]	Laboratory values	Other[3] Comorbidities	Indication for ERCP proc[4]	Previous Gastrectomy	Hx Jaundice	Hx Contrast Allergy
Fair Minus Quality													
Loperfido, Angelini, Benedetti, et al., 1998	1827 21	X	X	X		X					X	OR=4.14	
Lai, Lo, Choi, et al., 1989	323 21							Subgroup analysis excluding 43 febrile patients Serum AST ≤70IU (discriminant coefficient= 2.09, p<0.04)	Fever (>37.5° C) within 72 hours prior to examination (discriminant coefficient= 2.73, p<0.0001)	Pathologic nature of the obstructive lesion, malignant vs. benign (discriminant coefficient= 1.75, p<0.002)			

Table 78. Relationship between Patient Factors and Septicemia

Study	N Pts Cx	Age	Gender	CBD Size\Diameter	Cholangitis	Anatomic variation/ features[1]	Coagulopathy[2]	Laboratory values	Other[3] Comorbidities	Indication for ERCP proc[4]	Previous Gastrectomy	Hx Jaundice	Hx Contrast Allergy
Fair Minus Quality													
Motte, Deviere, Dumonceau, et al., 1991	105 34	**X**	**X**		Prior Cholangitis (F=7.1)	X		WBC count (F=6.6) Alk Phos n.s.	**X**			**X**	

Table 79. Relationship between Patient Factors and Retroperitoneal Perforation

Study	N Pts Cx	Age	Gender	CBD Size\Diameter	Cholangitis	Anatomic variation/ features[1]	Coagulopathy[2]	Laboratory values	Other[3] Comorbidities	Indication for ERCP proc[4]	Previous Gastrectomy	Hx Jaundice	Hx Contrast Allergy
Fair Minus Quality													
Loperfido, Angelini, Benedetti, et al., 1998	1827 12	X	X	X		X					OR=11.7 n.r.	X	

Table 80. Relationship between Procedure Factors and Total Complications

Study	N Pts Cx	Standard Papillotomy/ ES	Precut ES	Biliary drainage	Failed Procedure	ES length	Bleeding during ES	Combined with other procedures	Difficulty of cannulation	Pancreatic opacification	Postprocedure Care	Sphincter Manometry	Emergency procedure
Fair Quality													
Masci, Toti, Mariani, et al., 2001	2444 121		OR=1.70 (1.10-2.68)	X	No stone removal OR=2.52 (1.44-4.53)					X			
Freeman, Nelson, Sherman, et al., 1996	2347 229	All pts had ES	OR=3.61 (1.78-7.34)		X		X	Comb. percut.-endo. proc. OR=3.40 (1.04-11.13)	OR=3.05 (1.83-5.08)				X
Fair Minus Quality													
Rabenstein, Schneider, Bulling, et al., 2000	438 33	All pts had ES			X								X
Loperfido, Angelini, Benedetti, et al., 1998	1827 98		OR=1.73							X			X
Tzovaras, Shukla, Kow, et al., 2000	372 21				Previous failed ERCP OR=4.66 (1-21.80)			Need for PTC OR=10.3 (2.30-45.83)				X	X
Boender, Nix, de Ridder, et al., 1994	242 34	All pts had ES	OR=4.9 p=0.001	X	Failed biliary drainage OR=34.8 p=0.007	X							

Table 81. Relationship between Procedure Factors and Pancreatitis

Study	N Pts Cx	Standard Papillotomy/ ES	Precut ES	Biliary drainage	Failed Procedure	ES length	Bleeding during ES	Combined with other procedures	Difficulty of cannulation	Pancreatic opacification	Postprocedure Care	Sphincter Manometry	Emergency procedure
Fair Quality													
Masci, Toti, Mariani, et al., 2001	2444 44		OR=2.8 (1.38-5.84)	X	No stone removal OR=3.35 (1.33-9.1)					X			
Freeman, DiSario, Nelson, et al., 2001	1963 131	Pancreatic ES OR=3.07 (1.64-5.75)	X		X			Biliary Balloon Sphincter Dilation OR=4.51 (1.51-13.46)	Moderate to Difficult OR=3.41 (2.13-5.47)	>1 pancreatic contrast injection OR=2.72 (1.43-5.17)		X	
Freeman, Nelson, Sherman, et al., 1996	2347 127	All pts had ES	OR=4.34 (1.73-10.88)		X		X	X	OR=2.4 (1.07-5.36)	OR=1.35 (1.04-1.75)			X
Fair Minus Quality													
Rabenstein, Schneider, Bulling, et al., 2000	438 19	All pts had ES			X								X
Loperfido, Angelini, Benedetti, et al., 1998	1827 29		X							OR=2.84 n.r.			X

Table 81. Relationship between Procedure Factors and Pancreatitis (cont'd)

Study	N Pts Cx	Standard Papillotomy/ ES	Precut ES	Biliary drainage	Failed Procedure	ES length	Bleeding during ES	Combined with other procedures	Difficulty of cannulation	Pancreatic opacification	Postprocedure Care	Sphincter Manometry	Emergency procedure
Fair Minus Quality													
Mehta, Pavone, Barkun, et al., 1998	535 34	X						X		Subgroup with ES n.s. Subgroup without ES p=0.05			
Maldonado, Brady, Mamel, et al., 1999	100 17	X ES no added risk						X	Length of procedure			X ERCP was risk factor but not SOM	

Table 82. Relationship between Procedure Factors and Hemorrhage

Study	N Pts Cx	Standard Papillotomy/ ES	Precut ES	Biliary drainage	Failed Procedure	ES length	Bleeding during ES	Combined with other procedures	Difficulty of cannulation	Pancreatic opacification	Postprocedure Care	Sphincter Manometry	Emergency procedure
Fair Quality													
Masci, Toti, Mariani, et al., 2001	2444 30		OR=2.45 (1.6-5.39)	X	X					X			
Freeman, Nelson, Sherman, et al., 1996	2347 48	All pts had ES	X		X		OR=1.74 (1.15-2.65)	X	X	X	Anticoag <3d after procedure OR=5.11 (1.57-16.68)		X
Fair Minus Quality													
Loperfido, Angelini, Benedetti, et al., 1998	1827 21		X							X			X
Nelson and Freeman, 1994	189 10	All pts had ES				X	OR=13.7 (2.2-87.3)						

Table 83. Relationship between Procedure Factors and Cholangitis

Study	N Pts Cx	Standard Papillotomy/ ES	Precut ES	Biliary drainage	Failed Procedure	ES length	Bleeding during ES	Combined with other procedures	Difficulty of cannulation	Pancreatic opacification	Postprocedure Care	Sphincter Manometry	Emergency procedure
Fair Minus Quality													
Loperfido, Angelini, Benedetti, et al., 1998	1827 21		X							X			X

Table 84. Relationship between Procedure Factors and Septicemia

Study	N Pts Cx	Standard Papillotomy/ ES	Precut ES	Biliary drainage	Failed Procedure	ES length	Bleeding during ES	Combined with other procedures	Difficulty of cannulation	Pancreatic opacification	Postprocedure Care	Sphincter Manometry	Emergency procedure
Fair Minus Quality													
Motte, Deviere, Dumonceau, et al., 1991	105 34			Incomplete Drainage (F=319.2)				X					

Table 85. Relationship between Procedure Factors and Retroperitoneal Perforation

Study	N Pts Cx	Standard Papillotomy/ ES	Precut ES	Biliary drainage	Failed Procedure	ES length	Bleeding during ES	Combined with other procedures	Difficulty of cannulation	Pancreatic opacification	Intramural Injection	Sphincter Manometry	Emergency procedure
Fair Minus Quality													
Loperfido, Angelini, Benedetti, et al., 1998	1827 12		OR=7.19 n.r.							X	OR=6.86		X

Table 86. Relationship between Operator Factors and Total Complications

Study	N Pts Cx	Case volume	Participation of a trainee	University affiliated center	Center size
Fair Quality					
Freeman, Nelson, Sherman, et al., 1996	2347 229	X[16]	X	X	
Fair Minus Quality					
Rabenstein, Schneider, Bulling, et al., 2000	438 33	X	X		
Loperfido, Angelini, Benedetti, et al., 1998	1827 98	Centers which performed <200 ERCPs per year OR=2.93			X

[16] Case volume was not independently significant in the primary multivariate analysis of total complications conducted by Freeman 1996, probably because of the close relationship with intraoperative technique. In a multivariable model that was based solely on data available prior to the procedure, lower case volume (average <1 case/week per endoscopist vs > 1 case) was independently associated with higher complications (OR 1.43, CI=1.07-1.89).

Table 87. Relationship between Operator Factors and Hemorrhage

Study	N Pts Cx	Case volume	Participation of a trainee	University affiliated center	Center size
Fair Quality					
Freeman, Nelson, Sherman, et al., 1996	2347 48	Endoscopist volume ≤1/week OR=2.17 (1.12-4.17)	X	X	
Fair Minus Quality					
Loperfido, Angelini, Benedetti, et al., 1998	1827 21	Centers which performed <200 ERCPs per year OR=2.98			X

Table 88. Relationship between Operator Factors and Pancreatitis

Study	N Pts Cx	Case volume	Participation of a trainee	University affiliated center	Center size
Fair Quality					
Freeman, DiSario, Nelson, et al., 2001	1963 131	X	X		
Freeman, Nelson, Sherman, et al., 1996	2347 127	X	X	X	
Fair Minus Quality					
Rabenstein, Schneider, Bulling, et al., 2000	438 19	Endoscopist ES case load <40/year OR=3.8 (1.44-10.00)	X		
Loperfido, Angelini, Benedetti, et al., 1998	1827 29	X			X

Table 89. Relationship between Operator Factors and Cholangitis

Study	N Pts Cx	Case volume	Participation of a trainee	University affiliated center	Center size
Fair Minus Quality					
Loperfido, Angelini, Benedetti, et al., 1998	1827 21	Centers which performed <200 ERCPs per year OR=4.22			X

Table 90. Relationship between Operator Factors and Retroperitoneal Perforation

Study	N Pts Cx	Case volume	Participation of a trainee	University affiliated center	Center size
Fair Minus Quality					
Loperfido, Angelini, Benedetti, et al., 1998	1827 12	X			X

Table 91. Quality Assessment

Study Author, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Randomized Controlled Trials						
Schwacha, Allgaier, Deibert, et al., 2000	RCT (n=100) Good comparability - Randomization not described - Patient characteristics similar	Standard catheter (n=50): 19 crossed over to GS Guidewire Sphincterotome (n=50): 8 crossed over to SC	Adequate for comparison.	Adequate outcome measures used. Outcomes were not assessed blindly.	Method of analysis not clearly stated to be intention to treat Complications reported only in those with primary success	Fair
Cortas, Mehta, Abraham, et al., 1999	RCT (n=47) Good comparability - Randomization method not fully described - Patient characteristics not reported	Standard catheter (n=18) 6 crossed over Sphincterotome (n=29)	Adequate for comparison.	Adequate outcome measures used. Outcomes were not assessed blindly.	Intention to treat analysis was used.	Good
Elta, Barnett, Wille, et al., 1998	RCT (n=170) Good comparability - Randomization by even or odd calendar date - Patient characteristics similar for age, gender, reason for ES	Pure cut (n=86) 8 crossed over to BC Blended current (n=84) No crossover reported	Adequate for comparison.	Adequate outcome measures used. Outcomes reported to be assessed blindly.	Method of analysis not clearly stated to be intention to treat	Fair

Table 91. Quality Assessment (cont'd)

Study Author, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Randomized Controlled Trials						
Kohler, Maier, Benz et al., 1998	RCT (n=100) Good comparability – Randomization method not fully described – Patient characteristics similar for age, gender, and indication for sphincterotomy	Conventional Current (n=50) No dropouts or exclusion Controlled Current (n=50) No dropouts or exclusion	Adequate for comparison.	Adequate outcome measures used. Outcomes were not assessed blindly.	Method of analysis not clearly stated but equivalent to intent to treat	Good
Siegel, Veerappan, and Tucker, 1994	RCT (n=100) Fair comparability – Randomization method not fully described – Baseline characteristics similar for biliary diagnosis and reason for ES	Monopolar (n=50) 3 crossed over to BP Bipolar (n=50) 5 crossed over to MP	Adequate for comparison	Adequate outcome measures used. Complication outcomes were reportedly assessed blindly.	Method of analysis not clearly reported.	Fair

Table 91. Quality Assessment (cont'd)

Study Author, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Randomized Controlled Trials						
Kim, Lee, Lee, et al., 1997	RCT (n=45) Fair comparability – Randomization technique not specified – Baseline characteristics similar for age, gender, type of Billroth II anastomosis	No crossovers or exclusions from analysis reported	Adequate for comparison	Adequate outcome measures used. Outcomes were not assessed blindly.	Method of analysis not stated.	Fair
Bergman, Rauws, Fockens, et al., 1997	RCT (n=202) Good comparability – blinded computer-generated randomization – patients comparable on all measured characteristics	16 out of 218 excluded after randomization because of ineligibility	Adequate for comparison	Adequate outcome measures used. Outcomes were not assessed blindly.	All patients retained for analysis	Good

Table 91. Quality Assessment (cont'd)

Study Author, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Randomized Controlled Trials						
Tarnasky, Palesch, Cunningham et al., 1998	RCT (n=80) Fair comparability – Randomization method not reported – Baseline characteristics were similar except for two areas: biliary cannulation more difficult in No stent group (p=0.03) and longer mean time to repeat pancreatic access in the No stent group (p=0.04)	Stent (n=41) No Stent (n=39) No crossovers or loss to follow-up reported	Adequate for comparison.	Adequate outcome measures used. Outcomes were not assessed blindly.	Analysis not stated to be intention to treat but equivalent because all subjects included in analysis. Analysis did include multivariate adjustment to account for baseline differences.	Good

Table 91. Quality Assessment (cont'd)

Study Author, Year	Comparable Initial Groups?	Comparable Groups Maintained?	Comparable Performance of Intervention?	Comparable Measurement of Outcomes?	Appropriate Analysis	Summary Evaluation
Randomized Controlled Trials						
Smithline, Silverman, Rogers, et al., 1993	RCT (n=98) Fair comparability – Randomization method not reported – Patient characteristics similar for age, gender, clinical history of pancreatitis, suspected SOD, abnormal SOM	Stent (n=48) 5 technical failures excluded 8 who required pre-cut were assigned out of sequence to stent placement No Stent (n=50) No dropouts or exclusions. No crossovers reported.	Adequate for comparison	Adequate outcome measures used. Outcomes were not assessed blindly	Method of analysis not stated.	Fair
Ochi, Mukawa, Kiyosawa, et al., 1999	RCT (n=110) Good comparability – randomization not described – patients comparable on all measured characteristics	All patients retained for analysis	Adequate for comparison	Outcomes were not assessed blindly	All patients retained for short-term outcome analysis 105/110 patients retained for long-term outcome analysis	Good

Table 92. Randomized Clinical Trials Comparing Different ERCP Methods

Article	N	Population and Interventions	Complications/Outcomes
Schwacha, Allgaier, Deibert, et al., 2000 Research Issue: Techniques to achieve selective CBD cannulation Standard catheter vs. sphincterotome	100	100 consecutive patients randomized to a group undergoing CBD and PD cannulation using and SC with a metallic tip or a GS without guidewire. Exclusion criteria: ERCP within 1 week before randomization Emergency ERCP Previous therapeutic ERCP Previous surgery of the upper GI tract Indications*: SC GS Choledocholithiasis 9 13 Pancreato-biliary Malignancy 11 9 Acute pancreatitis 6 4 Chronic pancreatitis 5 3 Cholestasis of unknown origin 13 13 PSC 2 3 Cholangitis 0 2 Tumor of papilla 1 1 Others 3 2 * No statistical difference between groups	**Initial Success rates (4 to 5 attempts with assigned technique)** Standard catheter (SC) =62% Guidewire sphincterotome (GS)=84% P=0.023 Final Success rates (crossovers, needle-knife attempted on failures) Standard catheter (SC)=91% Guidewire sphincterotome (GS)=91% Complications (%)** SC GS None 65 69 n.s. Clinical pancreatitis 10 5 n.s Biochemical pancreatitis 10 12 n.s. Intramural injection 3 5 n.s Other, not relevant 12 9 n.s. ** Among patients for whom ERCP was primarily successful (SC n=31; GS n=42)

Table 92. Randomized Clinical Trials Comparing Different ERCP Methods (cont'd)

Article	N	Population and Interventions	Complications/Outcomes
Cortas, Mehta, Abraham, et al., 1999 Research Issue: Techniques to achieve selective CBD cannulation Standard catheter vs. sphincterotome	47	Consecutive patients undergoing ERCP with the intent to selectively cannulate the CBD. Patients randomized to cannulation of the CBD with either a standard catheter (n=18) or a sphincterome (standard or guidewire) (n=29). There were 6 crossovers from SC to SS after initial attempt (15 tries) Exclusion criteria: Patients who had undergone a previous therapeutic ERCP, selective cannulation was not sought as first intention, or a gastroduodenal anatomic anomaly was present. Indication (N): Suspected CBD stones=41 Pancreatico-biliary malignancies=4 Bile leak=2	Initial CBD cannulation success (%, 95% CI): Standard catheter=67% (41-87) Sphincterotome=97% (82-100) p=0.009 After crossovers, Final selective CBD cannulation (%, 95% CI): Standard catheter=94% (73-99) Sphincterotome=97% (82-100) P= n.s. Complications: Pancreatitis (%, CI):* SC=5.6 (0.1-27) SS/WS=10.3 (2.2-27.4) *Numbers too small to assess statistical significance

Table 92. Randomized Clinical Trials Comparing Different ERCP Methods (cont'd)

Article	N	Population and Interventions	Complications/Outcomes
Elta, Barnett, Wille, et al., 1998 Research Issue: Techniques of ES Pure cute vs. blended current	170	170 consecutive patients undergoing biliary endoscopic sphincterotomy between November 1994 and June 1995 were randomized to either blended or pure cut current. Patients undergoing sphincterotomy on even calendar dates received blended current, whereas patients receiving sphincterotomy on odd calendar dates received pure cut* Indication: Pure Blended Choledocholithiasis 55 56 SOD 18 18 Stent placement 9 6 Miscellaneous 4 4 Total 86 84 * The study was stopped after interim analysis showed a lower pancreatitis rate in the pure cut group.	Complications (N): Pure Blended Mild pancreatitis* 3 7 Moderate pancreatitis* 0 2 Severe pancreatitis* 0 1 Bleeding 1 1 Cholangitis 0 1 Total 4 12 *Patients with SOD (n=36) actually had a higher rate of pancreatitis (17% vs. 28%), but not significantly different due to low numbers. Difference in the proportion of patients who developed pancreatitis (including SOD patients) was statistically significant ($p<0.05$). When SOD patients were excluded, the difference in the rate of pancreatitis was still statistically different ($p=0.018$).

Table 92. Randomized Clinical Trials Comparing Different ERCP Methods (cont'd)

Article	N	Population and Interventions	Complications/Outcomes
Siegel, Veerappan, and Tucker, 1994 Research Issue: Techniques of ES Monopolar vs. Bipolar device using blended current for both	100	Consecutive patients requiring ERCP and sphincterotomy at one institution were randomly assigned to either standard monopolar electrocautery current (n=50) or the bipolar system (n=50).* Indication: Monopolar Bipolar CBD stones 21 23 Pancreatitis 7 6 Pancreatic CA 7 6 SOD 11 6 CBD stricture 3 7 Ampullary CA 1 0 Biliary fistula 0 2 Total 50 50 *5 patients assigned to the bipolar group were switched to monopolar group due to difficulties in the insertion of the sphincterome. 3 patients assigned to the monopolar group were crossed over to the bipolar group. The first 50 patients in each group in whom sphincterotomy was performed were included in the study.	Complications (N): MP BP Pancreatitis 6 0 p<0.047 Bleeding 1 0 n.s. Cholangitis 4 3 n.s. Perforation 0 0 n.s. Death 1 0 n.s.

Table 92. Randomized Clinical Trials Comparing Different ERCP Methods (cont'd)

Article	N	Population and Interventions	Complications/Outcomes
Kim, Lee, Lee, et al., 1997 Research Issue: Techniques to achieve ERCP and ES in Billroth II patients Forward vs. Side viewing scope	45	Patients s/p Billroth II gastrectomy who required ERCP with sphincterotomy. Patients were randomized to either a forward-viewing (FV) endoscope (n=23) or a side-viewing (SV) endoscope (n=22). Exclusion criteria: Cases of Roux-en Y surgery	Successful cannulation of the papulla*(%): FV= 20 of 23 (87%) SV= 15 of 22 (68%) p= n.s. Successful endoscopic sphincterotomy (%): FV= 10 of 12 (83%) SV= 8 of 10 (80%) p= n.s. Complications advancing endoscope (%): FV=0 of 23 (0%) SV= 4 of 22 (18%) p<0.05 * Among the causes of failure to cannulate the papulla, jejunal perforation occurred in 0 patients in the FV group and 4 patients in the SV group. Complications of endoscopic needle-knife sphincterotomy FV n=12 SV n=10 Pancreatitis 1 2 n.s. Retroperitoneal perforation 0 1 n.s.

Table 92. Randomized Clinical Trials Comparing Different ERCP Methods (cont'd)

Article	N	Population and Interventions	Complications/Outcomes
Bergman, Rauws, Fockens, et al., 1997 Research Issue: Techniques to remove CBD stone Balloon dilation vs. ES	202	Consecutive patients referred for ERCP because of symptoms of CBD stones. Patients meeting inclusion and exclusion criteria were randomized to either endoscopic sphincterotomy (n=101) or endoscopic balloon dilation (n=101). Eligibility criteria: Over age 18 years BDS visualized at ERCP Deep cannulation of the BD achieved without sphincterotomy Exclusion criteria: Signs of acute cholangitis Acute pancreatitis Acute cholecystitis History of previous sphincterotomy Choledochoduodenal fistula Hemostatic disorders Intrahepatic stone disease Hemolytic anemia Concomitant pancreatic or biliary malignant disorders Coexisting bile leakage or choledochoduodenal fistula Previous participation in this study Life expectancy of less than 1 month	Complete stone removal in one endoscopic session (%): EBD=89 EST=91 n.s. Early Complications (N): EBD EST Pancreatits 7 7 Fever 4 5 Bleeding 0 4 Perforation 2 1 Pain in right upper abdomen 0 4 Slow resolution of jaundice 2 1 Bile leakage 1 1 Cardiopulmonary 1 1 Total 17 24 n.s. (continued next page)

Table 92. Randomized Clinical Trials Comparing Different ERCP Methods (cont'd)

Article	N	Population and Interventions	Complications/Outcomes
Bergman, Rauws, Fockens, et al., 1997 (cont'd) Research Issue: Techniques to remove CBD stone Balloon dilation vs. ES	202	(see previous page)	**Complications during follow-up (N):** Recurrence of symptoms 14 14 Stones on repeat ERCP 8 7 No stones on repeat ERCP 6 5 No repeat ERCP done 0 2 Acute cholecystitis* 1 7 Symptomatic cholecystolithiasis 2 1 Liver abscess 0 1 Abnormal liver function at follow-up 1 0 Total 18 23 n.s. * Statistically significantly lower in the EBD group Logistic regression analysis of treatment allocation, stone size, stone number, gender, periampullary diverticulum, and Billroth II gastrectomy on successful stone removal identified stone size (p=0.0008), and stone number (p=0.0216) as the only significant predictors of this outcome. Further subgroup analyses were undertaken (not reported in this table).

Table 92. Randomized Clinical Trials Comparing Different ERCP Methods (cont'd)

Article	N	Population and Interventions	Complications/Outcomes
Ochi, Mukawa, Kiyosawa, et al., 1999 Research Issue: Techniques to remove CBD stone Balloon dilation vs. ES	110	Patients with bile duct stones up to 15 mm in diameter and less than 10 in number as indicated by ERCP were randomly treated with either endoscopic papillary dilation (n=55) or endoscopic sphincterotomy (n=55). Exclusion criteria: Recurrent stones following previous procedures Intrahepatic stone disease Acute cholangitis Cholecystitis Pancreatitis Pancreatic or biliary malignant disorders	Successful bile duct clearance (%): EPD=92.7 EST=98.1 n.s. Successful bile duct clearance achieved in the initial procedure (%): EPD=78.4 EST=94.4 p=0.02 Early complications (total)(%) (EPD n=51, EST n=54): EPD=2.0 EST=5.6 n.s. Specific complications (N) EPD EST Progression of jaundice 1 0 Perforation 0 2 Late complications (total/eligible for follow-up)(N): EPD=2/51 EST=8/54 n.s. Specific complications (N) EPD EST Recurrence of BDS 2 3 n.s. Acute cholangitis 2 2 n.s. Acute cholecystitis 1/30 5/27 n.s. Acute cholecystitis in patients with gallbladder stones in situ 1/22 5/17 p<0.03

Table 92. Randomized Clinical Trials Comparing Different ERCP Methods (cont'd)

Article	N	Population and Interventions	Complications/Outcomes
Tarnasky, Palesch, Cunningham et al., 1998 Research Issue: Pancreatic stenting to reduce pancreatitis after ES	80	Consecutive adult patients scheduled for ERCP with SOD manometry, for evaluation of unexplained pancreatobiliary pain or pancreatitis, were randomized to either pancreatic duct stents (n=41) or no stents (n=39). Exclusions: Pancreatic SOM results normal SOM failure or not attempted Severe chronic pancreatitis Pancreas divisum Prior gastric surgery PSH No sphincterotomy Both biliary and pancreatic sphincterotomy Precut sphincterotomy required to achieve biliary access Preference of physician or patient not to participate Failure to gain repeat pancreatic access after biliary sphincterotomy Indications (%): Stent No Stent Pancreatobiliary pain (gallbladder out) 51 72 Pancreatobiliary pain (gallbladder in) 20 5 Prior acute pancreatitis 29 23	**Complications:** **Incidence of post-ERCP pancreatitis (%):** Stent=2 No Stent=26 p=0.003 RR of post-ERCP pancreatitis after biliary sphincerotomy in the no stent group=10.5, 95% CI=1.4-78.3 Logistic regression analysis controlling for differences in baseline data (difficulty of biliary cannulation and time to repeat pancreatic access) resulted in an AOR=14.4, 95% CI=1.7-125.0 for the risk of post-ERCP pancreatitis among patients in the no stent group.

Table 92. Randomized Clinical Trials Comparing Different ERCP Methods (cont'd)

Article	N	Population and Interventions	Complications/Outcomes
Smithline, Silverman, Rogers, et al., 1993 Research Issue: Pancreatic stenting to reduce pancreatitis after ES	98	High risk patients (those with SOD or CBD <10 mm and patients requiring pre-cut biliary ES) were randomized to receive a main pancreatic duct stent or no stent following biliary sphincterotomy. Exclusions: Patients with pancreatic divisum, pancreatobiliary tumors, or those undergoing pancreatic septotomy	<u>Complications:</u> Incidence of pancreatitis (%): MPD Stent=14 No Stent=18 n.s. * Severity of pancreatitis (%): Mild MPD Stent=13 No Stent=12 n.s. Moderate MPD Stent=0 No Stent=6 n.s. Severe MPD Stent=0 No Stent=6 n.s. Other suspected risk factors for pancreatitis were examined including acinarization, precut ES, and history of pancreatitis. None of these risk factors were found to be independent risk factors of pancreatitis in high-risk patients. * Pancreatitis developed in 2 of 5 patients in whom stent placement failed