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Rates of Complications and Death After Pancreaticoduodenectomy: Risk Factors and the Impact of Hospital Volume

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Objective

To perform a two-part study of pancreaticoduodenectomy in the Netherlands, focusing on the effects of risk factors on outcomes in a single high-volume hospital and the effect of hospital volume on outcomes.

Summary Background Data

Hospital volume and surgeon caseload can be related to the rates of complications and death, and the influence of risk factors can be volume-dependent. Provision of regionalized care should take this into account.

Methods

In part A, a single-institution database on 300 consecutive patients undergoing pancreaticoduodenectomy was divided into two periods with similar numbers of patients. Overall complications, deaths, hospital stay, and risk factors were analyzed in the two periods and compared with an historical reference group. In part B, Netherlands medical registry data on age and postoperative death of patients who underwent partial pancreaticoduodenectomy from 1994 to 1998 were analyzed for the influence of hospital volume on death.

Results

Between the time periods, the institutional death rate decreased from 4.9% to 0.7%, the complication rate from 60% to 41%. Median hospital stay decreased from 24 to 15 days. The death rate was not related to patient age and did not differ between surgeons. Serum creatinine levels, need for blood transfusion, and period of resection were independent risk factors for complications.

The death rate after pancreaticoduodenectomy in the Netherlands was 12.6% in 1994 and 10.1% in 1998; it was greater in patients older than age 65. During the 5-year period, 40% of the procedures were performed in hospitals performing fewer than five resections per year, and the death rate was greater than in hospitals performing more than 25 resections per year.

Conclusions

The overall death rate after pancreaticoduodenectomy did not decrease significantly during the period, and it was greater in low-volume hospitals and older patients. The lower death and complication rates in high-volume hospitals, including the single-center outcomes, were similar to those reported in other countries and may be due to better prevention and management of complications. Pancreaticoduodenectomy should be performed in centers with sufficient experience and resources for support.

In the past, pancreaticoduodenectomy has been associated with a high rate of complications (40–60%) and a high death rate (up to 20%). Combined with a dismal prognosis, in particular for patients with pancreatic carcinoma, this led to a nihilistic approach by some clinicians.[1] In experienced centers, death rates have decreased dramatically,[2–6] which has encouraged other surgeons to perform pancreatic resections in nonspecialized units. The complication and death rates of surgery depend on many variables, including the presence of malignancy, the severity of jaundice, nutritional status, infection, and impaired renal function.[7,8] These factors have allowed better patient selection. In parallel, several reports since 1995 have highlighted the influence of hospital volume on hospital death.[9–14]

Centralization of pancreatic surgery is not routine in most European countries, so data on the impact of hospital vol-

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ume on the death rate are scarce.[11,15] A previous nationwide study in the Netherlands showed that in 1994–95, 46% of pancreaticoduodenectomies were performed in low-volume centers (fewer than five resections per year), with a postoperative death rate as high as 16%, compared with 1.5% in high-volume hospitals.[15] Pancreatic leakage is the most important determinant of postoperative death.

The lower death rate after resection in high-volume hospitals may be related not to the surgeon caseload but to the level of experience in the various departments involved in the detection and management of postoperative complications, such as gastroenterology, radiology, or intensive care.

The goals of the two parts of this study were to determine the effect of risk factors and caseload on complication and death rates and hospital stay in one experienced center and, in the Netherlands, to assess the effect of hospital volume on the death rate of pancreaticoduodenectomy.

METHODS

Part A

The Academic Medical Center Amsterdam database contains detailed information on 300 consecutive patients undergoing pancreaticoduodenectomy for suspected malignancy in the region of the pancreatic head. It was used to analyze overall rates of complications and death and to identify risk factors for postoperative complications.

To evaluate the effect of experience, two periods with comparable volume were chosen (October 1992 to December 1996, period 1, n = 149, and January 1997 to December 1999, period 2, n = 151). The patient outcomes in each period were compared with those of an historical reference group (January 1983 to September 1992, n = 163), which has previously been described.[16] The following factors were collected: age, sex, history of jaundice, preoperative weight loss, cardiopulmonary comorbidities, preoperative biliary drainage, and preoperative laboratory findings as serum albumin, creatinine, bilirubin, hemoglobin, and leukocytes.

Preoperative Diagnostic Procedures

The preoperative diagnostic procedures followed the flowchart from a 1992 consensus in the Netherlands on imaging techniques for patients with distal biliary obstruction.[17] The use of preoperative spiral computed tomography scanning and diagnostic laparoscopy increased from being sporadic in 1992 to standard in 1994. Outcomes of these diagnostic procedures have been described.[18–20]

Surgical Procedure and Histopathologic Diagnoses

In the period 1983–92 (historical controls), the surgical team was different from that of the later groups. Only standard Whipple resections were performed. Reconstruction was achieved using one or two jejunal loops, an end-to-side pancreaticojejunostomy, an end-to-side hepaticojejunostomy, and a gastrojejunostomy, with or without a transanastomotic drain in the pancreatic duct.

At the end of 1992, the surgical team changed. Four staff surgeons performed or supervised the procedures. The preferred surgical resection gradually changed to the pylorus-preserving pancreaticoduodenectomy (PPPD). A standard Whipple procedure was performed only when tumor growth into the proximal duodenum was suspected during surgery. After PPPD, reconstruction included a duodenojejunostomy. From 1993, octreotide (100 μg given subcutaneously) was given routinely for 7 days to inhibit pancreatic secretion.

Enteral nutrition given by a needle catheter jejunostomy was started routinely on the first postoperative day. The postoperative feeding regimen was changed in 1997 from continuous to cyclic (18 hours per day), which gives faster return to a normal diet and slightly shortens the hospital stay.[21] The histopathologic diagnosis was assessed. Resection was considered radical when resection and dissection margins of the resectional specimen were microscopically tumor-free.

Postoperative Complications

Surgical complications were classified as procedure-related (pancreatic leakage, biliary leakage, intraabdominal abscesses, hemorrhage, delayed gastric emptying) or general (pulmonary and cardiac). Delayed gastric emptying was defined as either the need for nasogastric intubation for 10 days or more or the inability to tolerate regular food before or on the 14th postoperative day. Death was defined as death during hospital stay. Previously described risk factors for postoperative complications were analyzed in the data from October 1992 to December 1999.

Part B

Hospitals in the Netherlands must provide the national medical registry, the Landelijke Medische Registratie, with information on all patients admitted. Registry data on postoperative deaths after pancreatic resection from 1994 to 1998 were obtained from the Department of SIG-Care Information, Utrecht. At the national registry, independent staff record hospital classifications and patient data, including primary and secondary diagnoses, interventions, age, destination at discharge (either home or to another center), and in-hospital death. The information was supplied anonymously (every hospital is coded) and covered all hospitals in the Netherlands, except two cancer institutes that performed fewer than 1% of the procedures during the 5-year period.[15]

The causes of death and postoperative complications cannot be identified through the registry data. Death does not have to be directly related to the surgical procedure, and deaths after discharge or after transfer to another hospital are not registered. The actual number of deaths could therefore be slightly higher because 4% of patients were referred to another center after surgery. The codes used by the SIG

Table 1. PATIENT CHARACTERISTICS

	Historical Reference Group	Period 1	Period 2
Number of patients undergoing surgery	163	149	151
Gender (M/F)	105/58	76/73*	86/65
Age (median and range)	60 (25–74)	63 (36–79)	65 (31–84)
Weight loss (kg) (median and range)	5 (0–23)	6 (0–25)	6 (0–20)
Jaundice	—	128 (86%)	119 (79%)
Cardiopulmonary comorbidity	—	34 (23%)	30 (20%)
Preoperative biliary drainage	123 (75%)	127 (85%)	115 (76%)
Preoperative laboratory values (median and range)			
Albumin (g/L)	41 (21–52)	43 (22–59)	44 (25–52)
Hemoglobin (mmol/L)	8.2 (5.0–11.0)	8.3 (4.5–10.1)	8.2 (5.8–10.7)
Leukocytes (10^{-9}/L)	—	7.5 (3.4–27.0)	7.3 (3.9–13.8)
Bilirubin (μmol/L)	23 (5–710)†‡	13 (0–231)*	12 (3–151)*
Creatinine (μmol/L)	—	61 (17–128)	63 (32–237)

$P < .05$ compared with * historical reference group (Jan. 1983–Sep. 1992), † period 1, ‡ period 2.

are based on the International Classification of Diseases, 9th revision, Clinical Modification (ICD-9-CM).[22] In the national surgical procedure list, the Classificatie van Verrichtingen, version 2.2, Code 5–524 in the section on surgical interventions on the pancreas lists several poorly defined procedures. Consequently, we evaluated only Code 5–526 (pancreaticoduodenectomies/Whipple's resections).

Hospitals were divided into four categories based on the number of resections performed per year: fewer than 5, 5 to 9, 10 to 24, and 25 or more. Deaths were also analyzed for several age categories.

Statistical Analysis

Groups were compared using the chi-square statistic, the two-tailed Fisher exact test, and the Mann-Whitney test, where applicable. Correlation between factors was calculated with the Pearson correlation test. The influence of hospital volume on death in each year was calculated with the chi-square statistic and expressed as relative risk, relative risk reduction, and absolute risk reduction. The impact of patient characteristics and surgical factors on the development of complications after surgery was univariately analyzed with the chi-square statistic. Variables significantly ($P < .4$) associated with the development of complications were used in a multiple logistic regression model to assess their independent prognostic value for complications. Risk factors were identified with a forward selection strategy using the likelihood ratio statistic, with $P = .05$ as the level for selecting the criterion. The independent prognostic values of the variables were expressed in odds ratios (ORs) with their 95% confidence intervals (CI). The OR can be interpreted as an estimation of the relative risk of the development of complications.

In the univariate analysis of individual risk factors, if there was no patient in one of the cells of the 2×2 table (chi-square statistic), a value of 1 was added to each cell to allow calculation of the likelihood ratio in the multiple logistic regression model (required only for serum creatinine).

Calibration of the final regression model was assessed with the Hosmer-Lemeshow goodness-of-fit test. This compares the observed and expected frequencies of the outcome in groups based on the values of the estimated probabilities, using the logistic model. In this test, a high probability value indicates that the model is performing well—that is, that there is not a large discrepancy between observed and expected outcomes. All analyses were performed with SPSS for Windows, version 9.0 (SPSS Inc., Chicago, IL).

RESULTS

Part A

Table 1 gives the characteristics of the patients in the two study periods and the historical reference group. Preoperative serum albumin, serum creatinine, leukocyte, and hemoglobin levels were not different, but bilirubin levels were higher in the historical reference group (23 vs. 13 and 12 μmol/L for periods 1 and 2, $P < .05$). Overall, 78% of all patients underwent preoperative endoscopic biliary drainage, with no real change in the periods observed. Table 2 summarizes the surgical procedures and histopathologic diagnoses. All patients in the historical reference group underwent pancreaticoduodenectomy, but PPPD was used in 72% of the patients in period 1 and 92% in period 2. A two-layer pancreatic anastomosis was used in all patients in the historical reference group, but a one-layer anastomosis was used in periods 1 and 2. Internal drainage of the pancreatic duct was performed only in the historical reference group. Octreotide was used in 99% of the patients during period 2.

Table 2. SURGICAL DETAILS

	Historical Reference Group	Period 1	Period 2
Resection and reconstruction			
PD	163 (100)†‡	41 (28)*‡	12 (8)*†
PPPD	0	108 (72)	139 (92)
Vein resection			
Yes	20 (12)	21 (14)	17 (11)
No	143 (88)	128 (86)	134 (89)
Pancreatic anastomosis			
One layer	0†‡	137 (92)*‡	151 (100)*†
Two layers	163 (100)	12 (8)	0
Pancreatic duct drainage			
Yes	145 (89)†‡	6 (4)*‡	0*†
No	18 (11)	143 (96)	151 (100)
Medication with octreotide			
Yes	8 (5)†‡	85 (57)*‡	149 (99)*†
No	155 (95)	62 (42)	2 (1)
Histopathology			
Benign	16 (10)	18 (12)	25 (17)
Malignant	147 (90)	131 (88)	126 (83)
Pancreatic head	51 (31)†	72 (55)*	54 (43)
Distal bile duct	33 (20)†	16 (12)*	22 (18)
Ampulla	62 (38)†‡	35 (27)*	41 (33)*
Other	4 (2)	8 (6)	9 (6)
Extent of resection (in case of malignancy)			
Radical	89 (61)	87 (66)	90 (71)
Nonradical	58 (39)	44 (34)	36 (29)

PD, pancreaticoduodenectomy; PPPD, pylorus-preserving pancreaticoduodenectomy.
$P < .05$ compared with * historical reference group (Jan. 1983–Sep. 1992), † period 1, ‡period 2.

Carcinoma of the head of the pancreas was the most common indication, with a higher percentage of patients in period 1. Despite improved diagnostic workup, there was no significant increase in the number of patients who underwent radical resection. The number of patients who underwent resection for benign disease, mainly chronic (focal) pancreatitis and cyst adenomas, was slightly higher in period 2.

Postoperative Complications and Deaths

The average number of resections per year in the study periods increased from 17 to 50 (Table 3). The proportion of patients with at least one complication decreased from 60% in the historical reference group to 41% in period 2 ($P < .05$). Delayed gastric emptying was not analyzed in the historical reference group but was included afterward; it decreased in period 2. The incidence of pancreatic leakage was 10% in the reference group and 5.3% in period 2, but this was not significant. The incidence of other complications did not change significantly except for intraabdominal abscess, which decreased compared with the historical reference group.

The number of repeat laparotomies decreased significantly in period 2. The median hospital stay decreased from 24 days in period 1 to 15 days in period 2 ($P < .05$).

The hospital death rate was 4.9% in the historical reference group, 1.3% in period 1, and 0.7% in period 2, with no deaths in the last 120 consecutive patients. The causes of death in the three patients who died since October 1992 were pancreatic leakage and sepsis; severe intraabdominal bleeding, probably due to a false aneurysm, in a patient with sepsis; and acute pancreatitis in the pancreatic remnant, without leakage.

Potential preoperative and intraoperative variables associated with complications are summarized in Table 4. Uni-

Table 3. OUTCOMES AND COMPLICATIONS

	Historical Reference Group	Period 1	Period 2
Mean no. of resections/yr	17	35	50
No. (%) of patients with complications	97 (60)‡	81 (54)‡	62 (41)*†
Surgery-related complications			
Pancreatic leakage	17 (10)	15 (10)	8 (5)
Biliary leakage	9 (6)†	2 (1)*	5 (3)
Intraabdominal	48 (29)†‡	25 (17)*	23 (15)*
Hemorrhage	22 (14)‡	16 (11)	8 (5)*
Delayed gastric emptying	—	56 (38)‡	31 (21)†
General complications			
Pulmonary	27 (17)	18 (12)	15 (10)
Cardiac	13 (8)	13 (9)	6 (4)
Repeat laparotomy	22 (13)	25 (17)‡	12 (8)†
Median (range) days of hospital stay	24 (5–293)†‡	18 (7–222)*‡	15 (6–167)*†
Hospital deaths, n (%)	8 (4.9)‡	2 (1.3)	1 (0.7)*

$P < .05$ compared with * historical reference group, † period 1, ‡ period 2.

variate analysis of the risk factors showed that the preoperative serum creatinine level, need for blood transfusion, and period 1 were significantly associated with postoperative complications. No relation was found between age and complications or death, or with the type of surgeon or the type of surgical procedure. Data for the multiple logistic regression model was obtained for 248 of the 300 patients. The model showed that the OR for complications was 8.53 (95% CI, 1.00–74.16) ($P = .05$) when the preoperative serum creatinine level was at least 115 μmol/L. The OR was 1.74 (95% CI, 1.02–3.00) ($P = .04$) for surgical procedures in period 1. The OR was 1.74 (95% CI, 1.02–2.99) ($P = .04$) when blood transfusion was required.

Part B

From January 1994 to December 1998, 1,126 partial pancreaticoduodenectomy patients were registered. The annual number of resections ranged from 199 to 257, with a slight increase during the 5-year period. The nationwide death rate was 10.1% overall, without significant change during this time (Fig. 1). The death rate in patients 65 years and older was 16.9%, significantly higher than the 6% in patients younger than 55. There was no significant change in the relative numbers of interventions in low-volume and high-volume hospitals (Fig. 2).

Table 5 shows the hospital death rate versus annual volume for each year of data. Small-volume hospitals accounted for 463 resections (41%), with annual death rates ranging from 13.6% to 20%. High-volume hospitals accounted for 223 resections (20%), with significantly lower death rates ($P < .05$), ranging from 0% in three of the years to 2.9% in 1995. Compared with low-volume hospitals, both relative risk and absolute risk were significantly lower in high-volume hospitals (Table 6). A plot of the in-hospital death rate versus hospital volume for each hospital in the study (Fig. 3) confirms the relative risks, with death rates ranging from 0% to 100%.

Table 4. RISK FACTORS FOR COMPLICATIONS

	No. With Complications	No. Without Complications	*P*
Gender			
Male	83	79	.23
Female	60	88	
Age			
<65	71	82	.73
≥65	72	75	
Bilirubin			
<100 μmol/L	119	127	.56
≥100 μmol/L	10	7	
Hemoglobin			
≥7.0 mmol/L	122	133	1.00
<7.0 mmol/L	15	16	
Leukocytes			
$<10 \times 10^{-9}$/L	80	83	.70
$\geq 10 \times 10^{-9}$/L	14	18	
Alkaline phosphatase			
<100 U/L	45	40	.37
≥100 U/L	82	96	
Creatinine			
≥115 μmol/L	6	0	<.01
<115 μmol/L	116	143	
Albumin			
≥30 g/L	80	75	1.00
<30 g/L	6	6	
Preoperative biliary drainage			
Yes	112	130	.38
No	31	27	
Period of resection			
Period 2	81	68	.03
Period 1	62	89	
Surgeon			
Experienced	100	109	.80
Fellow	38	45	
Type of resection			
PPPD	114	133	.29
PD	29	24	
Venous resection			
No	128	134	.30
Yes	15	23	
Malignant			
No	20	23	1.00
Yes	123	134	
Blood loss			
<1 L	53	54	.53
≥1 L	74	90	
Blood transfusion			
No	79	108	.02
Yes	64	49	

PD, pancreaticoduodenectomy; PPPD, pylorus-preserving pancreaticoduodenectomy.

DISCUSSION

This study shows that pancreaticoduodenectomy can be performed with a low death rate, approximately 1% in experienced centers. The complication rate of the procedure has decreased but remains relatively high, 41% in our center. During the past decade, the annual hospital caseload has increased from 17 to more than 50 resections, which might contribute in part to the improved outcome.

Our results accord with those of other major centers, which report death rates of 0% to 5% and complication rates of approximately 40%.[2–6] Pancreatic leakage is the factor most strongly linked with death in most case series. It was responsible for 80% of the deaths in the reference group,[23] but of only one patient (0.3%) in the study periods, possibly because of a more aggressive treatment of this complication.[23] Early resection of the pancreatic remnant (salvage pancreatectomy) reduced the death rate after leakage from 28% to 0%, but it had the disadvantage of causing insulin-dependent diabetes mellitus.[2,3,23] More recently, we modified this approach. After undoing the anastomosis and closing the jejunal loop, the pancreatic body and tail are

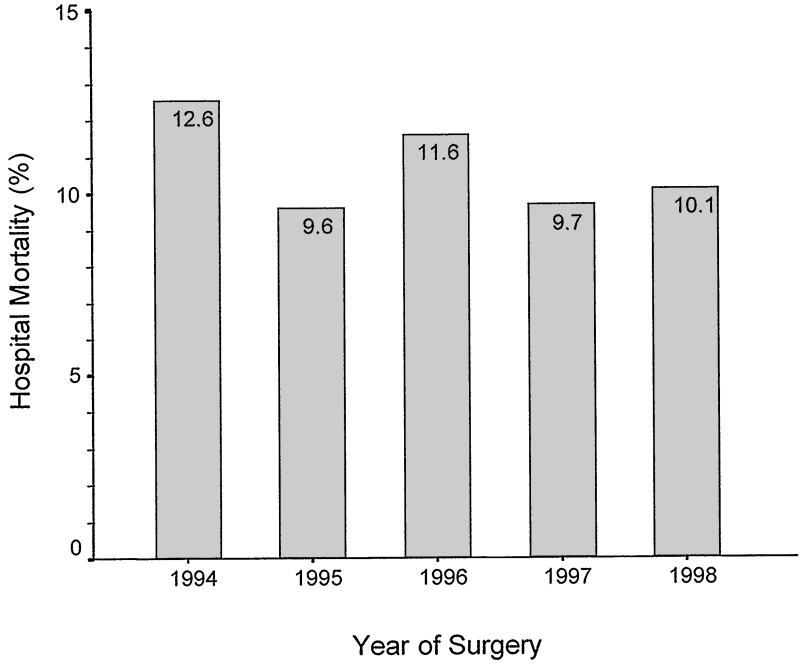

Figure 1. Hospital death rate for subtotal pancreaticoduodenectomy in the Netherlands, 1994–1998.

resected, but with preservation of a small remnant of the pancreas (approximately 4 cm) after occlusion of the pancreatic duct. This approach has reduced the incidence of diabetes, but a pseudocyst formed in one patient. Compared with the literature, our overall repeat laparotomy rate was high, but this rate decreased to 8% in period 2.

Median duration of hospital stay decreased significantly throughout the study. The hospital stay for patients with complications decreased from 25 to 21 days, but there was also a decrease from 14 to 13 days in patients without complications. The reduced median stay might result from fewer postoperative complications, but other contributing factors might include a trend toward sending patients home earlier after surgery.

In the analysis of risk factors for complications, the significant predictive factors were serum creatinine level, the need for blood transfusion, and the time period of resection. A low serum albumin level and similar historical risk factors were uncommon in the present series because of better patient selection.

Preoperative biliary drainage was not a risk factor for complications, but it did not reduce postoperative complications, as has been suggested by experimental findings.[24,25] Infectious complications were even increased after preop-

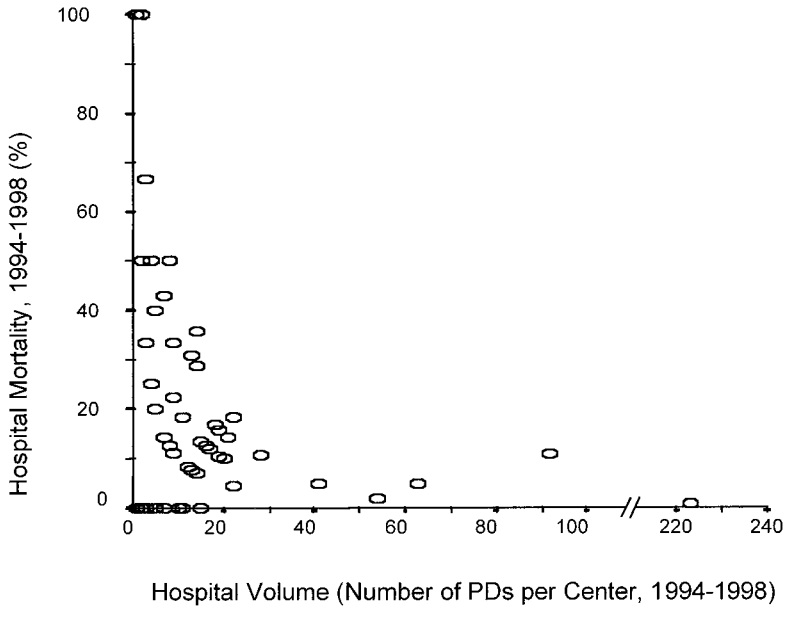

Figure 2. Percentages of pancreaticoduodenectomies in hospitals classed by annual hospital volume in the Netherlands, 1994–1998.

Table 5. HOSPITAL DEATH RATES

Hospital Volume	1994		1995		1996		1997		1998	
	Ratio	%	Ratio	%	Ratio	%	Ratio	%	Ratio	%
<5	17/97	17.5†	14/96	14.6	17/85	20.0†	14/103	13.6†	12/82	14.6†
5–9	4/42	9.5	4/45	8.9	5/35	14.3†	4/36	11.1†	9/47	19.1†
10–24	4/28	14.3†	3/53	5.7	3/51	5.9*	3/31	9.7	5/72	6.9
≥25	0/32	0*	1/35	2.9	1/53	1.9*	0/47	0*	0/56	0*
Total	25/199	12.6	22/229	9.6	26/224	11.6	21/217	9.7	26/257	10.1

* $P < .05$ vs. low-volume hospital (<5 resections/yr).
† $P < .05$ vs. high-volume hospital (≥25 resections/yr).

erative biliary drainage in a recent clinical study and were a strong argument against it.[6,26] Preoperative drainage has the advantage of providing extra time when other investigations are needed or when surgery is delayed because of a waiting list. Also, extra time may be needed to organize a second referral, as mentioned by Lillemoe.[26]

Patient age was not related to complications and death in our series, as was observed recently in another center.[5] However, nationwide, a significantly higher death rate was found in older patients. Age appears to be an important predictor for death in low-volume centers but not in high-volume centers.[5]

The national study showed a death rate of 16% in small-volume hospitals and 1% in high-volume hospitals. A correlation between the hospital death rate and hospital volume was found in studies from two regions in the United

Table 6. HOSPITAL DEATH RATES VERSUS VOLUME

Hospital Volume	No. of Resections	Death Rate (%)	RR	95% CI	RRR (%)	ARR (%)
<5	463	16	1.00	—	—	—
5–9	205	13	0.79	0.52–1.20	21	3
10–24	235	8	0.48	0.29–0.78	52	8
≥25	223	1	0.06	0.01–0.23	94	15

ARR, absolute risk reduction; CI, confidence interval; RR, relative risk; RRR, relative risk reduction.

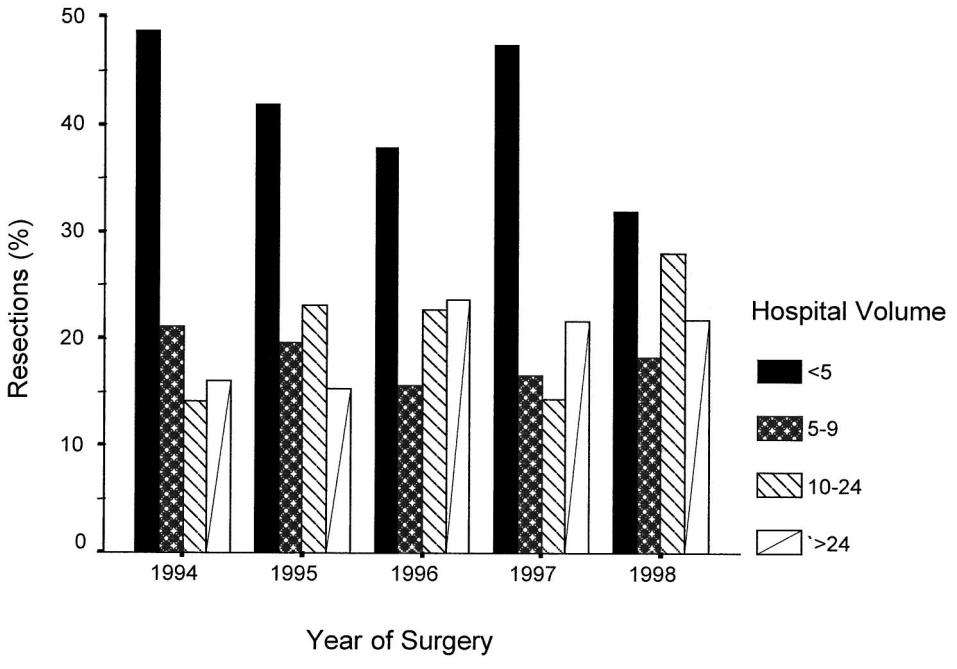

Figure 3. Hospital death rate versus hospital volume in the Netherlands, 1994–1998.

States.[9,10] These studies, and ours, might have bias as a result of a referral pattern. In a recent database study of health insurance in persons older than 65 years, a similar impact of hospital volume on the surgical death rate was shown.[12] Similar relations have been shown for other high-risk surgical interventions, including esophagectomy, liver resection, and liver transplantation.[12,27] Late survival after pancreaticoduodenectomy is also related to hospital volume.[28]

Most volume/outcome studies show the average death rate for each category of hospital volume, but there can be large variations that are independent of volume. Some small-volume hospitals have excellent results, as can be seen in Figure 3 and in the literature,[10] but the number of resections (approximately two per year) is too limited to allow analysis of their treatment policies. More population-based studies of surgical outcomes are needed to prove the relation with surgeon or hospital caseloads to determine the cutoff values for caseload.

Early publications on the impact of hospital volume on death started a debate in the Netherlands on the need for regionalization.[9,10] Discussion in national surgical meetings started in early 1996[15] but has not yet led to measurable regionalization. Probably the time interval is too short to observe a decrease in the nationwide death rate as a result of this knowledge. A positive effect on the statewide hospital death rate followed publication of the early results and those of regionalization in one state in the United States.[13] The concept of regional provision of specialist care might influence the delivery of healthcare in several countries.[29] Referral to centers outside the state can occur in the United States, whereas referral of patients to a center in another country in Europe does not yet occur.

It is important that the effect on outcome of hospital volume was more important than the surgeon volume, which probably indicates the availability of hospital facilities and specialist care. In our series of 300 consecutive patients undergoing pancreaticoduodenectomy at the Academic Medical Center Amsterdam, five different surgical fellows, supervised by one of the four staff surgeons, performed 83 resections without a single death or increase in complications. A multidisciplinary approach and active management of complications for 7 days a week might be important factors.

The superiority of hospital volume over surgeon volume in determining outcomes is important, particularly in the Netherlands, where recently it has been suggested that experienced surgeons should consider working in networks, performing resections in different low-volume hospitals. With this approach, the positive effect on the death rate from surgical experience could be counteracted by inadequate prevention and management of postoperative complications in the absence of equally experienced nonsurgical support. More data are needed from detailed population-based studies on aspects such as transport of patients between hospitals and the effects on healthcare costs before any definitive decision on regionalization can be made.

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Discussion

PROF. H. BEGER (Ulm, Germany): In this paper about morbidity and mortality after pancreaticoduodenectomy, the impact of hospital volume carries an important European message, namely that treatment in a high-volume center results in a significant reduction of hospital morbidity and hospital mortality compared to treatment in low-volume hospitals. This paper confirms recently published results from American institutions. The benefits of centralization are provided by the highly experienced surgeons and the institutional competence in the management of early postoperative complications. I wonder what is behind the network mentioned in the paper and the travelling surgeon. It does not seem convincing to transport the highly experienced surgeon to the patient's local hospital to do his surgical work.

The comparison of the three periods from 1983 to 1999 in a high-volume center, the Academic Medical Center Amsterdam, certainly reflects the learning curve in terms of the reduction in postoperative morbidity of 60% in the first period to 46% in the last period. However, in comparison to recently published series, this is still a high figure for postoperative morbidity. Pancreatic leakage occurred in 10% in the first period and 5% in the last period. However, there was a high frequency of intraabdominal abscesses with the need for reintervention. What is the definition of pancreatic leakage? What was the surgical management of pancreatic fistulas in the three periods? I would speculate that the reduction in pancreatic leakage in the last period and the increase in the occurrence of abdominal abscesses with the need of interventional or surgical management are somehow linked. What is the explanation for the high frequency of intraabdominal abscesses?

In the last period, the reconstruction was performed using, almost exclusively, the pylorus-preserving approach rather than the Kausch-Whipple resection. In a certain percentage of patients, you observed a delayed gastric emptying following pylorus-preserving resection. Did you measure the gastric emptying? If you found a delay in gastric emptying on the basis of the need of a gastric drainage, and a delayed start of oral feeding in the postoperative period, this might be related to the high frequency of intraabdominal abscesses in your patients. In our series of more than 200 pylorus-preserving pancreatic head resections, we found a correlation between the length of postpyloric duodenum and the decrease in delay of gastric emptying. The preservation of a postpyloric duodenal segment of 5 cm was related to almost no clinical symptoms of gastric retention, or to delay of oral food intake in the early postoperative period. Would you please comment on this?

PROF. D. GOUMA (Amsterdam, The Netherlands): First, concerning the comment or the question about centralization and networks, which the President also addressed in the opening lecture—networks and the sending-out of surgeons to other hospitals could be helpful not only for relatively small procedures, but also for technically demanding procedures in which the surgery is the essential part. For example, major postoperative complications are not frequent after breast cancer or thyroid surgery. Pancreatic resection is a different subject. Not only does the surgeon have to have experience to perform the procedure, but adequate management of postoperative complications has been shown to be important for the reduction of mortality. Most patients who die from resection do so between the first and second postoperative week because of leakage from the anastomosis. So you need skills and experience to manage complications also in the first and second week after surgery, not just of the surgeon, but especially in the ICU, and also of the endoscopist and the radiologist. So I am afraid that sending out surgeons to perform a pancreatic resection in small-volume hospitals does not solve the problem and will not reduce mortality.

Concerning the incidence and treatment of pancreatic fistulae, in the earlier days we were more aggressive. We operated on all these patients and performed surgical drainage. Of course, now we are trying to perform nonsurgical drainage by the percutaneous approach. In the second study period, we had a phase of being more aggressive in removing the pancreatic remnant. The advantage is that if the pancreatic remnant is removed, patients generally recover quickly, without mortality. However, these patients will become diabetic, and that is still a major burden. Recently, we again changed our strategy. If there is a severe leakage that cannot be solved by percutaneous drainage or surgical drainage, we will break down the anastomosis and partly remove the pancreatic remnant, leaving 2 to 4 cm of the pancreatic tail in situ to prevent diabetes. This policy seems to work well, so far.

Probably the incidence of abscesses is high. We generally perform percutaneous drainage, and I do not have a particular reason for why this incidence is higher than other series. It does not influence the overall outcome in terms of mortality or overall morbidity. Concerning your last question about the delayed gastric emptying (DGE), we previously performed a study in which we compared 100 standard Whipple procedures with 100 pylorus-preserving procedures. The overall incidence of DGE in this series was 34% versus 37%, respectively, and the only risk factor for

delayed emptying was intraabdominal complications after surgery (65%).

Concerning the last remark, we did not measure the length in centimeters after the pylorus, but you should leave at least 3 cm to reduce the incidence of DGE, which went down to 20% in the last 150 patients, probably because we slightly increased the length of the duodenum.

PROF. I. IHSE (Lund, Sweden): Your study is certainly an important one. It is based on two large separate cohorts, as we heard, one from a national registry and another from your own department. I had the opportunity to read the paper, and my general impression is that the study is a little bit split because the objectives of the two parts of it were different. Of special interest is the observed correlation between the hospital volume of pancreaticoduodenectomies and hospital mortality. This is, however, not new knowledge. As we heard, it has been described earlier in at least a handful of reports. Still, this is an essential contribution. It corroborates the previous results, and it is the first large study from Europe on this topic. The study of your own early results of pancreaticoduodenectomies over time is perhaps not so interesting, even if it is a good example of quality control, and the early surgical outcome is certainly outstanding. I have two questions related to the registry study. What is the building-up of your national registry? How valid is it? Do surgeons have an obligation to report, or is it voluntary? Can the registry provide survival data as well? I ask this because Andy Warshaw recently reported longer survival in patients operated on in high-volume hospitals. Did you observe any certain characteristics of low-volume hospitals with bad results, as compared to low-volume hospitals with good results? I also have two minor questions related to your own patient series. Among the independent factors you found was blood transfusion. Am I right if I say that transfusion per se probably is not a prognostic factor, but rather reflects other factors necessitating the transfusions? In contrast to you, I do not like enteral feeding via needle jejunostomy. Did you see any complications attributable to the jejunostomy itself?

PROF. GOUMA : Concerning the registration in the Netherlands, it has to be done by every hospital. It includes 100% of the patients who are operated on, except for patients operated in the two national cancer centers, but in a previous study it was shown that only 1% of the Whipple procedures are performed in these centers.

The reason that I did not go into detail for patient characteristics, morbidity, and survival was that these data are not available for all patients. The only adequate recorded data are patient age and the destination at discharge from the hospital. So that is the reason why the second part of the study focused only on the influence of age on mortality and did not analyze in detail the effect of risk factors for morbidity. It is also the reason why we included the second part of the study, the Academic Medical Center Amsterdam data, because that is a well-documented prospective database including details of morbidity. It is therefore impossible to answer your question about correlation of survival and hospital load, as suggested by Warshaw.

Concerning the question on feeding jejunostomy, indeed we had two severe complications. One patient had the feeding tube pulled away before discharge on the postoperative day 7 and was readmitted the same night with leakage from his feeding jejunostomy, or at least from the remaining hole in the small bowel. The second patient underwent an emergency operation because of ileus due to herniation of the small bowel. We did routinely feed the patients until recently. A study from New York by Brennan has shown that in well-nourished patients, feeding is not indicated because there is no difference in morbidity.

PROF. A. JOHNSON (Sheffield, United Kingdom): Did you stratify by operative risk factors? Excellent results can be obtained by surgeons doing a small number of operations per year, but we need better indicators of risk so that comparisons are valid.

PROF. GOUMA (Closing Discussion): The last question is a difficult one. In the literature, the number of procedures varies between 15 and 25 in most series. That was the reason why I included the last slide in which all hospitals were shown with the number of procedures and mortality, but you should realize that these procedures have been performed during the last 5 years. If you look at that slide in more detail, you will see that the change towards a lower mortality is between 10 and 20 patients per year, but there is not an exact number of patients. There are indeed some hospitals with small volume which have low or no mortality. Unfortunately, I cannot provide details about the patient selection or hospitals because the data were supplied anonymously. Concerning the last part of your question about risk factors, we could not analyze this for the same reason, but the study of Begg on esophageal cancers mentioned earlier by the president included patients with pancreatic cancers and it analyzed risk factors. Independent of risk factors, there was still a correlation between hospital volume and mortality.