Resection and palliation of pancreatic and periampullary carcinoma
van Geenen, R.C.I.

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CHAPTER 3

Impact of Hospital Volume
on In-Hospital Mortality in Pancreatic Surgery

R.C.I. van Geenen, MD, D.J. Gouma, MD

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ABSTRACT

Background. Pancreaticoduodenectomy (PD) is an extensive surgical procedure mostly performed for pancreatic cancer. Hospital volume and surgeon volume can influence in-hospital mortality.

Methods: This study analyses the setting in which pancreatic surgery is performed in the Netherlands, the advantage of expertise in a high volume centre and reviews the literature.

Results: In the Netherlands mortality after PD remained high between 1994 and 1998 (10%) and in-hospital mortality in high volume centres was significantly lower compared to low volume hospitals in 1994 (17.5 vs 0%, resp.) and in 1998 (14.6 vs 0%, resp.). A case history of a patient with subsequent pancreatic leakage, anaphylactic shock, compromised ventilation and bleeding of the hepatic artery showed clearly the need for a multidisciplinary approach in the management of complications after PD. In literature most reports demonstrate an inverse relation between hospital volume and in-hospital mortality. The relation between surgeon volume and in-hospital mortality is not evident. Current data can not identify or exclude case mix because limited parameters are analysed in most studies.

Conclusion: Centralisation of pancreatic surgery has the potential to decrease in-hospital mortality.
Introduction
Pancreaticoduodenectomy, mostly performed for pancreatic cancer, has been associated with considerable morbidity (40-60%) and mortality (20-30%). Even after resection the prognosis is poor, and as a result some physicians kept a nihilistic approach; Gudjonsson concluded in his review that pancreatic resections are a waste of resources. During the last decade mortality has decreased dramatically to less than 5% in centres with experience, which has led to a more optimistic view in favour of resection.

Another development of importance is a gaining knowledge of the effect of the hospital volume and surgeon experience (surgeon volume) on patient outcome. For many different major surgical procedures such as colorectal resections, oesophagectomy, hepatic resection, coronary bypasses, and pancreaticoduodenectomy it has been shown during the past years that a high hospital volume or surgeon volume was associated with a low mortality. These findings lead to a plea for centralisation of major surgery including pancreatic surgery. However nuances have to be made. The patient population of the high and low volume hospitals could be different and other factors than the surgeon or hospital volume might also influence mortality. Expertise of the other disciplines involved in the treatment of patients undergoing pancreatic surgery has been suggested to be of great importance. In this paper different aspects of centralisation will be described. Firstly, the effect of hospital volume on outcome of pancreatic resections nation wide in the Netherlands will be briefly summarised. Secondly, the impact of surgeon experience versus hospital volume on patient outcome after pancreatic resection as studied before in our centre (AMC, Amsterdam) will be described. Finally the literature on these subjects was reviewed and will be summarised.

Pancreaticoduodenectomy in the Netherlands
A recent study in the Netherlands described the relation between hospital volume and in-hospital mortality. The data were obtained from and recorded by an independent central nation wide registration system (Landelijke Medische Registratie). A population-based cohort of 1126 patients underwent pancreaticoduodenectomy in the period between 1994 and 1998. In this period the annual mortality was approximately 10%, much higher than expected, and did not decrease significantly in time (1994: 12.6%, 1998: 10.1%). Furthermore the study demonstrated that centralisation is not generally accepted in the Netherlands; 49% of the pancreaticoduodenectomies were performed in small volume hospitals (< 5 resections / year) in 1994. This was associated with a mortality of 17.5% compared to 0% in high volume centres. At the end of the study period (1998) this pattern remained virtually unchanged; still 32% of the patients were treated in low volume hospitals with 14.6% mortality versus 0% in high volume hospitals (figure 1). There was a clear relation between hospital volume and in-hospital mortality with a relative and absolute risk reduction of 94% and 15% respectively for the high volume centre compared to low volume centres (table 1). Still it has to be mentioned that several low volume hospitals had little or no mortality after pancreaticoduodenectomy (figure 2).
Figure 1. Hospital mortality versus hospital volume after pancreatic resection in the Netherlands, 1994-1998

Figure 2. Percentage of pancreaticoduodenectomies in hospitals classed by annual hospital volume in the Netherlands

Table 1. Hospital Death Rate versus Volume

<table>
<thead>
<tr>
<th>Hospital Volume</th>
<th>No. of resections</th>
<th>Death Rate (%)</th>
<th>RR</th>
<th>95% CI</th>
<th>RRR (%)</th>
<th>ARR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5</td>
<td>463</td>
<td>16%</td>
<td>1.00</td>
<td>-</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>5 - 9</td>
<td>205</td>
<td>13%</td>
<td>0.79</td>
<td>0.52-1.20</td>
<td>21%</td>
<td>3%</td>
</tr>
<tr>
<td>10 - 24</td>
<td>235</td>
<td>8%</td>
<td>0.48</td>
<td>0.29-0.78</td>
<td>52%</td>
<td>8%</td>
</tr>
<tr>
<td>≥ 25</td>
<td>223</td>
<td>1%</td>
<td>0.06</td>
<td>0.01-0.23</td>
<td>94%</td>
<td>15%</td>
</tr>
</tbody>
</table>

RR, relative risk; CI, confidence interval; RRR, relative risk reduction; ARR, absolute risk reduction.
**Surgeon volume versus hospital volume: a multidisciplinary approach**

Due to data recruitment of the previous study, analysis according to the impact of surgeon volume versus hospital volume could not be made. Therefore we analysed 463 consecutive pancreaticoduodenectomies performed at the AMC during the period 1983-1999. The series was separated in three different periods and the mean number of resections per year increased from 17 in the first period to 50 during the last period with a decrease in mortality from 4.9 to 0.7% (table 3). Morbidity decreased from 60 to 41%, and the median hospital stay decreased from 24 to 15 days in this period. The influence of the surgeon experience was evaluated in a risk factor analysis for complications in the last 300 patients (period: 1993-1999). No significant difference was found between fellows and experienced staff surgeons. Remarkably the 3 deaths after surgery occurred after resection by different experienced staff surgeons. In the study period a staff member was always present during surgery when the fellow was operating. Not only experience of surgeons but also hospital volume, and by that experience of other specialties in the management of complications of these patients after resection, is of great importance. Pancreaticoduodenectomy is a complicated procedure with a high risk of complications. Major complications such as anastomotic leakage of the pancreaticojejunostomy or the hepaticojejunostomy and bleeding are the most serious complications associated with high mortality. Adequate management of complications depends on early detection and “aggressive” multidisciplinary treatment. Well-trained personnel at the intensive care unit (ICU) and the clinical wards, and experts in different fields such as radiology, gastroenterology, intensive care, and surgery are mandatory for successful management of these patients. These demands and benefits of an experienced multidisciplinary setting are clearly illustrated with the following case history.

**Case history**

A 73 years old male with a severe kyphoscoliosis but without other contraindications or comorbidity, underwent a pylorus preserving pancreaticoduodenectomy for a small (2 cm) ampullary adenocarcinoma. On the second postoperative day the drain located in the foramen of Winslow produced bile and a percutaneous transhepatic drainage procedure under ultrasound guidance was performed for leakage of the hepaticojejunostomy (figure 3). Because of low blood pressures (70/30 mmHg) due to the sepsis the patient received Gelofusine® (B. Braun Medical SA, Crissier, Switzerland) after which an anaphylactic shock occurred. The patient had to be resuscitated and was transferred to the ICU. After five days a relaparotomy was performed because of persistent sepsis and leakage of the pancreaticojejunostomy, and necrosis of the pancreatic corpus was found. The anastomosis was broken down, the jejunal blind loop was closed, and pancreatic corpus was resected. A small remnant (3 cm) of the pancreatic tail was left in situ to maintain the endocrine pancreatic function. A drainage catheter was left behind to prevent pancreatic abscess formation. In absence of clinical improvement a second relaparotomy was performed at a later stage and the pancreatic remnant was also resected. Respiratory insufficiency after closing the open abdomen a few weeks later also increased by the kyphoscoliosis resulted in long-term intubation and a prolonged ICU stay. After 88 days (the day before return to the normal ward) rectal blood loss and blood loss through the nasogastric tube occurred. Gastroscopy revealed
old blood in the stomach without an actual bleeding focus. The focus was suspected in the proximal jejunum and because of recurrent blood loss the next day an angiography was performed. A pseudo aneurysm at the site of a branch of the hepatic artery was identified as the bleeding focus (figure 4) and an expandable coated metallic stent was placed which stopped the bleeding (Figure 4b). Eventually the patient recovered and 139 days after resection he was discharged. Close co-operation between different specialties (intesivist, radiologist, gastroenterologist, vascular radiologist, and surgeons) enabled successful management of the complications of these patients illustrating the impact of hospital volume on a well-trained team of different specialists.

**Figure 3.** Leakage of the hepaticojejunostomy (HJ), successfully treated by percutaneous transhepatic cholangiography without leakage during control cholangiography 5 days later.

**Figure 4.** Bleeding from a branch (arrow) of the hepatic artery (HA) demonstrated by angiography. A. Bleeding focus, B. Occlusion by insertion of an expandable coated metal stent (arrows).
**Review of the literature**

During the last years different papers have been reported describing the relation between hospital volume or surgeon volume and mortality after pancreatic resection. In an attempt to obtain an overview of the data available a Medline search was conducted using the following keywords: pancreatic neoplasm or pancreaticoduodenectomy combined with mortality, and experience, hospital volume, case load, regionalisation, or centralisation. This data set was limited to English language and human studies in the period between 1990 and January 2001. This search provided 151 hits. All studies were analysed and finally only ten studies adequately described the relation between hospital volume or surgeon volume and mortality after pancreatic resection (table 3).

The following parameters were investigated: The setting, type of resection, the number of patients included in the studies, definition of high and low volume and their related in-hospital mortality, the number of high volume centers, case mix, and the impact of surgeon volume on in-hospital mortality.

The majority of the studies were performed in the USA and two were performed in European countries\textsuperscript{10, 11}. All studies described patients undergoing subtotal pancreaticoduodenectomy or total pancreatectomy, and generally included large numbers of patients. Only two studies included less than 250 patients\textsuperscript{12, 13}. The definition of low and high volume centers varies greatly and is based on personal preference in most studies. Only one study used approximate quartiles to divide the hospital into different volume categories\textsuperscript{14}. In 3 of the 10 studies the high volume category contained only one high volume center.

Most studies described a clear inverse relation between hospital volume and in-hospital mortality. Only one study described an opposite relation between hospital volume and in-hospital mortality\textsuperscript{13}, and one study found no relation between hospital volume and mortality. In these studies relatively limited numbers of patients were included (130 and 223 patients respectively)\textsuperscript{8, 12} and the definition of high volume (\textgreater;2/year)\textsuperscript{8} was actually low volume compared most other studies. Data on case mix was available in only 4 studies and showed that gender and age were equality divided among the hospital volume categories. Two studies\textsuperscript{6, 14} showed that patients included in high volume centers had more co-morbidity compared to low volume hospitals. In one study co-morbidity seems to be higher in high volume hospitals because of a higher prevalence of hypertension but on the other hand pulmonary disease was more frequent at low volume centers\textsuperscript{7}. Patient complexity was measured using the All Patient Refined DRG Grouper (3M Health Information Systems, Provo, Utah) in one study\textsuperscript{15} and was less in high volume centers. Two studies\textsuperscript{6, 12} analysed the influence of surgeon volume and one showed that high volume surgeons, who performed more than 41 resections in seven years had significantly less mortality than low volume surgeons who performed less than 9 resections (6.0 versus 13.0, respectively)\textsuperscript{6}. But in a logistic regression analysis no relation was found between surgeon volume and hospital mortality.

The data from this review strongly suggest that centralisation of pancreatic surgery could further decrease mortality. State wide regionalisation of pancreaticoduodenectomy seems already to be responsible for a great part of the mortality reduction (61\%) in Maryland USA\textsuperscript{15}. In other countries such as the Netherlands such an impact was not found.
However, there is still controversy about the scientific value of these studies. Some large studies\textsuperscript{7,10,15} describe only one high volume centre, and the authors are from that centre. Therefore outcome might be biased. Many studies used national or regional health care databases. These databases are not conclusive and carry limited data. As a result, in some studies case mix can not be identified and might partially be responsible for the relation between hospital volume and mortality\textsuperscript{6,10-13}. Referral patterns can result in higher prevalence of co-morbidity in high volume centres\textsuperscript{4,14} while others found less patient complexity in high volume centres\textsuperscript{15}. There is no evidence of case mix for gender and age\textsuperscript{4,7,8,14} and the inverse relation of hospital volume and mortality can not be explained by case mix, however it can neither be excluded.

Although centralisation seems beneficial there are some downsides to this concept. In rural areas centralisation would lead to increasing travel distance for patients with malignant disease that are in poor condition and need support of relatives and friends. Therefore it is not surprising that a recent study\textsuperscript{16} demonstrated that many patients prefer to undergo surgery in local centres even when travel to a regional centre would result in a lower operative mortality. The majority of patients with pancreatic cancer are no candidate for resection and palliative procedures that do not prolong their limited survival time may as well be provided in the patients' own environment. Still some demonstrated that palliative procedures such as bypass surgery or stent insertion performed at high volume centres result in less mortality compared to low volume centres\textsuperscript{17}. Others stated that centralisation could endanger the financial viability of smaller hospitals and their ability to recruit general surgeons\textsuperscript{18}.

To date, pancreaticoduodenectomy can be performed with limited morbidity and mortality provided that patients are carefully selected, and that the resection is performed in a high volume centre with sufficient support of other experienced disciplines that are involved in the treatment of postoperative complications. Palliative treatment is merely non-surgical and can preferably be performed in the patients' own environment or in one-day referrals to central hospitals (stent insertion). These insights have the potential to further improve outcome of the management of pancreatic cancer.

References

Table 3. Studies between 1990 and 2001 addressing mortality of pancreatic resection in relation to hospital volume or surgeon volume.

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Setting</th>
<th>Resection type</th>
<th>No. pts</th>
<th>No. of resections / yr</th>
<th>No. of high volume hosp.</th>
<th>In-hospital mortality</th>
<th>Case mix</th>
<th>statistical significance of high volume hospitals</th>
<th>statistical significance of surgeon volume</th>
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<tr>
<td>Edge SB&lt;sup&gt;12&lt;/sup&gt;</td>
<td>1993</td>
<td>University hs</td>
<td>PD/TP</td>
<td>223</td>
<td>≤5 vs. ≥14</td>
<td>10</td>
<td>7.4 vs. 5.1</td>
<td>no</td>
<td>not analysed</td>
<td>no</td>
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<tr>
<td>Lieberman MD&lt;sup&gt;6&lt;/sup&gt;</td>
<td>1995</td>
<td>New York</td>
<td>PD/TP</td>
<td>1972</td>
<td>&lt;1.3 vs. &gt;10.1</td>
<td>?</td>
<td>18.9 vs. 5.5</td>
<td>yes</td>
<td>not analysed</td>
<td>no</td>
</tr>
<tr>
<td>Gordon TA&lt;sup&gt;7&lt;/sup&gt;</td>
<td>1995</td>
<td>Maryland</td>
<td>PD</td>
<td>502</td>
<td>local vs. referral hosp.</td>
<td>1</td>
<td>13.5 vs. 2.2</td>
<td>yes</td>
<td>&gt; whites, &gt;Hypertension, &lt; pulmonary disease</td>
<td>not analysed</td>
</tr>
<tr>
<td>Glasgow RE&lt;sup&gt;8&lt;/sup&gt;</td>
<td>1996</td>
<td>California</td>
<td>PD</td>
<td>1705</td>
<td>&lt;2 vs. &gt;50</td>
<td>2</td>
<td>14 vs. 3.5</td>
<td>yes</td>
<td>= age, = gender, = comorbidity</td>
<td>not analysed</td>
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<tr>
<td>Wade TP&lt;sup&gt;13&lt;/sup&gt;</td>
<td>1996</td>
<td>DOD hosp.</td>
<td>PD</td>
<td>130</td>
<td>&lt;1 vs. &gt;2</td>
<td>3</td>
<td>6 vs. 9</td>
<td>yes</td>
<td>not analysed</td>
<td>not analysed</td>
</tr>
<tr>
<td>Neoptolemos JP&lt;sup&gt;11&lt;/sup&gt;</td>
<td>1997</td>
<td>UK</td>
<td>PD/TP</td>
<td>1026</td>
<td>logistic regression with individual hospital data</td>
<td>yes</td>
<td>not analysed</td>
<td>not analysed</td>
<td></td>
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<tr>
<td>Begg CB&lt;sup&gt;4&lt;/sup&gt;</td>
<td>1998</td>
<td>USA</td>
<td>PD</td>
<td>742</td>
<td>≤5 vs. ≥11</td>
<td>10</td>
<td>12.9 vs. 5.8</td>
<td>yes</td>
<td>&gt; comorbidity</td>
<td>not analysed</td>
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<tr>
<td>Gordon TA&lt;sup&gt;15&lt;/sup&gt;</td>
<td>1998</td>
<td>Maryland</td>
<td>PD</td>
<td>795</td>
<td>&lt;20 vs. ≥20</td>
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<td>'84: 19.5 vs. 3.2</td>
<td>yes</td>
<td>= gender, = age</td>
<td>not analysed</td>
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<td></td>
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<td>'95: 12.4 vs. 1</td>
<td>yes</td>
<td>&gt; whites</td>
<td></td>
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<tr>
<td>Brikmeyer JD&lt;sup&gt;14&lt;/sup&gt;</td>
<td>1999</td>
<td>USA</td>
<td>PD</td>
<td>7229</td>
<td>&lt;1 vs. ≥5</td>
<td>40</td>
<td>16.1 vs. 4.1</td>
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<td>&gt; comorbidity</td>
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<td></td>
<td>yes</td>
<td>= age, = gender, = comorbidity</td>
<td></td>
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<tr>
<td>Gouma DJ&lt;sup&gt;10&lt;/sup&gt;</td>
<td>2000</td>
<td>Netherlands</td>
<td>PD/TP</td>
<td>1126</td>
<td>&lt;5 vs. ≥25</td>
<td>1</td>
<td>16 vs. 1</td>
<td>yes</td>
<td>not analysed</td>
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</table>

DOD hosp. = Department of Defence hospitals