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ORIGINAL ARTICLE

Surgery residency training programmes have greater impact on outcomes after pancreaticoduodenectomy than hospital volume or surgeon frequency

Whalen Clark, Jonathan Hernandez, Bri Anne McKeon, Alyssa Kahn, Connor Morton, Paul Toomey, John Mullinax, Sharona Ross & Alexander Rosemurgy

Digestive Disorders Center, Tampa General Hospital, Tampa, FL, USA and Department of Surgery, University of South Florida, Tampa, FL, USA

Abstract

Background: Hospital volume of pancreaticoduodenectomy (PD) and surgeon frequency of PD have been shown to impact outcomes. The impact of surgery residency training programmes after PD is unknown. This study was undertaken to determine the impact of surgery training programmes on outcomes after PD, as well as their importance relative to hospital volume and surgeon frequency of PD.

Methods: The State of Florida Agency for Healthcare Administration Database was queried for patients undergoing PD during 2002–2007. Measures of outcome were compared for patients undergoing PD at centres with vs. without surgery residency training programmes.

Results: A total of 2345 PDs were identified, of which 1478 (63%) were undertaken at training centres and 867 (37%) were performed at non-training centres. Patients undergoing PD at training centres had shorter lengths of stay, lower hospital charges and lower in-hospital mortality. Relative to surgeon frequency of PD, training centres had a greater favourable impact on hospital length of stay, hospital charges and in-hospital mortality ($P < 0.001$ for each, ANCOVA). Relative to hospital volume of PDs undertaken, training centres had a greater impact on hospital charges ($P < 0.001$, ANCOVA).

Conclusions: Surgery residency training programmes have a favourable effect on outcomes following PD and their impact on outcome is greater than the impact of hospital volume or surgeon frequency of PD.

Keywords

training centre, residency, pancreaticoduodenectomy, hospital volume, surgeon frequency

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Correspondence

Alexander S. Rosemurgy, Division of General Surgery, University of South Florida, Tampa General Hospital, PO Box 1289, Room F145, Tampa, FL 33601, USA. Tel: + 1 813 844 7393. Fax: + 1 813 844 7396. E-mail: arosemur@hsc.usf.edu

Introduction

Pancreaticoduodenectomy (PD) has rapidly evolved over the past century and is generally accepted as a safe, but not benign, procedure in good-risk patients. Outcomes today following PD are far superior to historical figures. As recently as the 1970s and early 1980s, morbidity and mortality rates following PD were reported at 60% and 25%, respectively, at leading centres.[1,2] Longterm outcomes were equally unsatisfactory, with survival rates for patients undergoing pancreatic resection approaching those of patients undergoing palliative bypass.[3] Today, it could be argued that in appropriate candidates mortality rates in excess of 5% are unacceptable. The reasons for improved outcomes following PD are multifactorial and represent changes in technology, medical knowledge, surgical technique, patient selection, antisepsis and hospital care. More recently, outcomes following pancreatic surgery have been tied to surgeon experience and hospital volume.[4–15] In fact, there have been numerous reports demonstrating that surgeon frequency and increased hospital volume correlate with lower mortality rates following PD. Not surprisingly, a learning curve for PD has been demonstrated and outcomes defined by blood loss, operating room time and length of stay

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(LOS) improve as surgeons progress along the curve and gain experience.[16]

Given all that has been written about the impact of frequency with which surgeons undertake PD and hospital volumes of PD on outcome after PD, thoughts about how training programmes in surgery impact outcomes after PD are intriguing. Surgeon volumes and hospital volumes of PD are certainly entangled and possibly inextricably related. Considering the impact of training centres in surgery in addition to these factors increases the complexity of any considerations. Nonetheless, it is possible that procedures carried out by surgeons-in-training would prolong hospitalization or impair outcomes after PD, probably for innumerable but unidentifiable reasons. The purpose of this study was to evaluate the role that training centres in surgery have on conventional short-term measures of outcome after PD and to determine their impact on outcomes after PD relative to the impact of surgeon frequency and hospital volume. We hypothesized that surgery residency training programmes would be associated with better outcomes, specifically, shorter LOS, lower in-house mortality and lower hospital costs, relative to non-training centres after PD. In addition, we hypothesized that the impact of training centres on outcome following PD would be similar to the impact of hospital volume and surgeon frequency.

Materials and methods

The State of Florida Agency for Healthcare Administration Database was queried to identify patients who underwent PD (ICD-9 codes 52.51 [proximal pancreatectomy] or 52.7 [radical pancreaticoduodenectomy]) during the period from January 2002 to December 2007. Patients were then classified according to whether they had undergone PD at a training centre or at a non-training centre. A 'training centre' was defined as a hospital with a general surgery residency training programme admitting allopathic physicians. Available patient data were assessed for age, gender, LOS, hospital charges, in-hospital mortality, payor status, admission type (elective or non-elective) and severity of co-morbidities. Co-morbidities were categorized by hospital coders at the time of discharge. The Florida Healthcare Administration Database stratifies co-morbidities into one of two groups: minor/moderate or severe/extreme. Co-morbidity status is based on a severity score that is ultimately determined by diagnosis-related groups (DRGs) that are used by coders and Medicare. Similarly, admission status was reported in the database as elective or non-elective as determined by coders at the time of discharge and did not reflect the urgency of the surgery, but, rather, reflected the admission itself. Patients under 30 years of age or patients who underwent PD at a training centre which ran a non-allopathic (e.g. osteopathic) accredited general surgery training programme were excluded from this study.

The data from the Florida Agency for Healthcare Administration Database were entered into and stored as a Microsoft EXCEL spreadsheet. Some of the data were only available grouped by co-morbidities and admission status, so data about individual patients were not always available, which limited some statistical analyses. Numerical data are reported as median (mean ± standard deviation [SD]) for parametric data and as median (range) for non-parametric data. Statistical analysis was undertaken utilizing Graphpad Prism 5.0 and Graphpad Instat 3.0 (Graphpad Software, San Diego, CA, USA). Demographics and outcomes for patients who underwent PD at training centres were compared with those for patients who underwent the procedure at non-training centres by utilizing the chi-squared test or the Mann–Whitney *U*-test. Patient data were then organized according to surgeon frequency and hospital volume, regardless of training centre status. Surgeon frequency was defined as the number of PDs each surgeon undertook from 2002 through 2007. Hospital volume was defined as the number of PDs performed within that training facility from 2002 through 2007. The impact of training centre status compared with surgeon frequency and hospital volume for the outcomes of LOS, hospital charges and in-hospital mortality was determined using analysis of covariance, ANCOVA. Significance was accepted with 95% probability.

Results

Surgeons in the state of Florida undertook 2345 PD procedures during the study period, giving a mean of 391 PDs per year. Of the 2345 patients who underwent PD in Florida from 2002 through 2007, 1478 (63%) patients underwent PD at a training centre and 867 (37%) underwent PD at a non-training centre. The median age of patients treated at training centres was 66 years (65 ± 11.7 years); that of patients undergoing PD at non-training centres was 68 years (66 ± 11.3 years) ($P = 0.002$). A total of 743 (50%) patients at training centres were female, as were 401 (46%) at non-training centres ($P = 0.001$).

Co-morbidities and admission status

At training centres, 1239 of 1478 (84%) patients were admitted electively compared with 518 of 867 (60%) patients at non-training centres ($P < 0.001$).

Of patients receiving treatment at training centres, 1312 of 1478 (89%) had major or extreme co-morbidities compared with 822 of 867 (95%) patients at non-training centres ($P < 0.001$).

Perioperative outcomes following pancreaticoduodenectomy

The median LOS at training centres was significantly shorter, at 12 days (range 1–197 days) vs. 17 days (range 1–85 days) at non-training centres ($P < 0.001$, Mann–Whitney *U*-test). Median hospital charges at training centres were significantly lower at US$87 685 (range US$21 786–1 736 614) than at non-training centres, where the median charge was US$120 367 (range US$30 086–1 215 579) ($P < 0.001$, Mann–Whitney *U*-test).

In-house mortality was higher at non-training centres (11%, 95/867) than at training centres (2.7%, 40/1478) ($P < 0.001$, chi-squared test).

Impact of training centres relative to surgeon frequency and hospital volume

Surgery residency training programmes had a greater favourable impact on hospital LOS, hospital charges and in-hospital mortality ($P < 0.001$ for each, ANCOVA) than did surgeon frequency (i.e. the frequency with which a surgeon undertakes PD). In addition, relative to hospital volume of PD, surgery residency training programmes had a greater favourable impact on hospital charges ($P < 0.001$, ANCOVA). However, training centres did not have a more favourable impact on LOS or in-hospital mortality than hospital volume ($P = 0.120$ and $P = 0.117$, respectively) (Table 1).

Discussion

Undoubtedly, many factors impact outcome after PD. For example, volume of PD, by both hospital and surgeon, has been shown to impact outcomes after PD. Consumers are now expected to seek large-volume providers for PD, as well as for a host of other procedures. The impact of surgery residency training programmes on outcomes after PD has not previously been studied. This report documents the finding that medical centres that include surgery residency programmes are associated with better outcomes following PD than centres which do not include such training programmes. This is the first analysis to demonstrate the degree of impact that training centres have on outcomes. Specifically, the impact of a surgery residency 'teaching' centre is greater and more tightly linked to improved outcomes (in-hospital mortality, LOS and cost) after PD than are hospital volume or surgeon frequency.

Most patients undergoing PD in Florida are middle-aged or older, have significant pre-existing co-morbid medical conditions, and are admitted electively. Length of stay at both training centres and non-training centres was substantial, reflecting the magnitude of the procedure and the medical or health status of the patients undergoing the operations. Notably, LOS was significantly lower for PDs carried out at training centres in Florida rather than at non-training centres and was as good as or better than that at some of the high-volume centres in America in other recently published studies.[17–19] Hospital charges were substantial, but were lower at training centres than at non-training centres. In-hospital mortality followed the same path: it was lower at training centres and well below the conventional national standard of nearly 10%.[6]

The more favourable in-hospital mortality rate after PDs completed at training centres is striking. The high mortality seen at non-training centres, 11%, is equally notable. Mortality rates of 4% or lower after PD at high-volume centres or performed by high-frequency surgeons have been consistently documented.[8–10,20–22] An in-hospital mortality rate of 11% in non-training centres is not surprising to us as it is near the number often reported for low-volume centres and centres outside a focused pursuit. The mortality rates and LOS data reported transcend the small differences in the severity of patient co-morbidities or the frequency of elective admissions. The accuracy of data on co-morbidities and admission status must be accepted at face value. There certainly would be no reason for non-training centres to understate the complexity of their patients' health status. Non-training centres may be better at reporting the severe nature of their patients' conditions at admission, but we are not aware of any supporting data for this supposition.

The effects of hospital volume and surgeon frequency after PD have been studied in the past and it is well established that these are linked to outcome. In 1998, Sosa *et al.* reported a retrospective review of patients undergoing pancreatic resection in the state of Maryland. High-volume centres, defined as centres that undertake more than 20 pancreatectomies per year, were associated with decreased risk of mortality, shorter LOS and lower hospital charges. Similar results were found in a study comparing a single high-volume centre in the Netherlands with other smaller centres around the country. In smaller hospitals, in-house mortality was significantly greater than in higher-volume centres (14–20% vs. 0–3%). Complication rates were also lower in the high-volume Netherlands centre.[18] Similarly, a study of 7229 Medicare patients who underwent PD yielded in-house mortality rates at

Table 1 Perioperative outcomes following pancreaticoduodenectomy for patients in Florida during 2002–2007, showing median (mean ± standard deviation) outcomes, and impact of training centre status relative to surgeon frequency and hospital volume, and corresponding *P*-values by ANCOVA analysis

	Length of stay, days	Hospital charges, US$	In-hospital mortality
Training centres	12 (15 ± 11.8)	87 685 (111 703 ± 98 146)	2.7%
Non-training centres	17 (20 ± 12.3)	120 367 (150 451 ± 113 557)	11.0%
P-value	$P < 0.001$*	$P < 0.001$*	$P < 0.001$†
Impact of training centres relative to:			
i) surgeon frequency	$P < 0.001$	$P < 0.001$	$P < 0.001$
ii) hospital volume	NS	$P < 0.001$	NS

Less in training centres than in non-training centres by *Mann–Whitney *U*-test or †chi-squared test
NS, non-significant

low-volume (<2 cases/year) and very low-volume (<1 case/year) centres of 12% and 16%, respectively. These mortality rates were significantly higher than mortality rates at high-volume centres (≥5 cases/year, 4%). When the nation's 10 highest-volume centres were compared with other high-volume centres (≥5 cases/year) mortality was significantly lower at the former.[5] Hospital volume and outcome after pancreatic resection share a positive relationship of which there can be no question.

Surgeon frequency has also been linked to favourable outcome following PD. Greater surgeon frequency or experience has been shown to be associated with shorter LOS, lower in-house mortality and decreased hospital charges.[8,9] These data are independent of hospital volume. Although the effect of surgeon frequency on outcome is directly related to hospital volume, it has been shown that high-volume centres are high volume because a small number of surgeons undertake a large number of resections. It is these surgeons who demonstrate improved outcomes, independently of low-volume providers in high-volume hospitals.[8,9] A study in 2007,[16] found outcomes, measured by blood loss, LOS and margin status, to be more favourable after relatively 'green' attending surgeons had undertaken more than 60 pancreatic resections. Thus, as with other procedure-based skills, there is a learning curve associated with PD.

This study has identified an important variable closely linked to perioperative outcomes following PD: surgery residency training programmes. The impact that training centres have on outcome, specifically relative to LOS, hospital charges and in-hospital mortality, is greater than the impacts of hospital volume and surgeon frequency. Importantly, it becomes apparent that not all high-volume centres are training centres and not all high-frequency surgeons are 'trainers'. Associated with surgery residency training programmes are interfaces, namely, other residency training programmes, large hospitals, academic surgeons, surgical educators and trainees, all of which represent parts of the academic 'system'. It is the sum of these interfaces, the processes that occur in a teaching hospital, that constitute the key element driving the differences seen in outcomes described in this manuscript. At training centres, it seems that patients are seen more often, by multiple levels of residents, an attending surgeon(s), and usually twice daily on rounds. In addition, training centres are usually relatively high-volume centres with a large staff and many resources, services and technologies, including high-tech imaging, interventional radiology, specialized anaesthesiology and experienced intensive care unit nurses.

The importance of a 'system' cannot be overemphasized, however informal it might be. Recently, outcomes following pancreatic resections have been tied to 'health care delivery systems'. The setting of an academic health care system has yielded favourable and comparable results in both low- and high-volume hospitals after PD.[20] At the University of California San Francisco, a small-volume hospital averaging three PDs per year was compared with a tertiary large-volume centre averaging 23 resections per year. Surgeons differed between the two hospitals. The perioperative mortality rate was 4% at both hospitals. Five-year survival rates were 19.0% and 18.3%, respectively. Despite the difference in volume, similar results were hypothesized to occur because of care pathways and expertise that are shared, transmitted and engrained within the university institution or academic training centre. Our data corroborate these findings and suggest that academic training centres provide a medium which fosters and supports the existence of optimal health care delivery systems. This supports educational programmes for what they are: the ground upon which future (and thereby better) surgeons, in this example, are trained.

This study demonstrated improved outcomes after PD undertaken in training centres and found that the degree of effect on outcome is greater than that of surgeon frequency or hospital volume. The notion that trainees (residents) may affect patient care or detract from the highest level of care in the operating room or on the ward is not supported. The data from this study suggest the opposite: the presence of both trainers and trainees working in collaboration may actually achieve superior care of patients following PD. Any apprehension patients or providers may have about receiving or recommending care at a residency training centre is unfounded. Teaching hospitals will continue to serve as cornerstones for improvements in outcome following pancreatic surgery in the future.

Conflicts of interest

None declared.

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