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ORIGINAL ARTICLE

Assessment of health care cost for complex surgical patients: review of cost, re-imbursement and revenue involved in pancreatic surgery at a high-volume academic medical centre

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Abstract

Background: Pancreatic surgery is complex with the potential for costly hospitalization.

Methods: A retrospective review of patients undergoing a pancreatic resection was performed.

Results: The median age of the study population was 64 years. Half of the cohort was female (51%), and the majority were white (62%). Most patients underwent a pancreaticoduodenectomy (PD) (69%). The pre-operative age-adjusted Charlson comorbidity index was zero for 36% ($n = 50$), 1 for 31% ($n = 43$) and ≥2 for 33% ($n = 45$). The Clavien–Dindo grading system for post-operative complication was grade I in 17% ($n = 24$), whereas 45% ($n = 62$) were higher grades. The medians direct fixed, direct variable, fixed indirect and total costs were $2476, $15 397, $13 207 and $31 631, respectively. There was a positive contribution margin of $7108, whereas the net margin was a loss of $6790. On univariate analyses, age, type of operation and complication grade were associated with total cost ($P \leq 0.05$), whereas operation type and complication grade were associated with a net margin ($P = 0.01$). These findings remained significant on multivariate analysis ($P < 0.05$).

Conclusions: Increased cost, reimbursement and revenue were associated with type of operation and post-operative complications.

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Introduction

The United States of America has the most expensive healthcare delivery system in the world.[1] A significant portion of this cost (29%) is spent on the care of surgical patients. Surgery cost is expected to reach $912 billion/year, 7.3% of the US GDP, by 2025.[2] In response to rising health care costs, the *Affordable Care Act* has placed significant emphasis on cost control including the development of bundled payment systems led by the Center for Medicare and Medicaid Innovation.[3,4] In spite of the emphasis on cost control, there is little data on the factors associated with the cost, reimbursement and revenue for complex surgical procedures. In this context, investigating pancreatic surgical procedures, in terms of cost factors, may provide some insights.[5–8]

Limited data exist describing the interaction between costs, charges and reimbursement involved in pancreatic surgery. Most of the earlier reports, investigating the expenses related to pancreatic surgery, report charges. However, this is an inaccurate representation of hospital financials, because charges do not reflect actual costs and can significantly vary between institutions.[9,10] Current literature provides information on total costs associated with pancreatic surgery;[11–13] however, there is sparse data showing the cost breakdown and even fewer data on reimbursement and revenue.

The cost of pancreatic surgery has been found to be associated with complications, surgeon experience, post-operative pathways, volume and type of operation. For example, post-operative complications have been found to be consistently associated with increased hospital costs.[8,14,15] In contrast, factors associated with decreased costs include hospital volume,[15] clinical pathways[16] and surgeon experience.[17]

Although Vollmer reported significant programmatic revenue for a high-volume programme, he did not describe the

Table 1 Cost and revenue for patients undergoing pancreatic surgery, 2008–2012

Cost variable	Range (in $)	Median (in $)	Mean ± SD (in $)
Direct Fixed	543–16 080	2 476	3 205 ± 2 467
Direct Variable	3 944–169 431	15 397	21 198 ± 22 759
Fixed Indirect	3 365–133 591	13 207	18 467 ± 17 376
Total Cost	8 487–319 102	31 631	42 869 ± 42 218
Contribution Margin[a]	45 024–71 592	7 108	7 350 ± 14 380
Net Margin[a]	161 040–32 168	(6 790)	(11 467) ± 25 843

[a]For Medicare patients only.

relationship between clinical factors and revenue.[18] To the best of our knowledge, we report here the first study to examine the association between clinical factors and revenue in patients undergoing a pancreatic resection. Given the limited data in the literature on cost, reimbursement and revenue for patients undergoing a major pancreatic resection, we sought better definitions of these factors. We studied patients in a prospective database from a high-volume tertiary teaching hospital. The objective of the study was to investigate whether there is any association of patients and provider characteristics with cost of *hospital* care.

Methods

Data source and collection

A retrospective chart review was performed identifying all patients who underwent pancreatic surgery between 2008 and 2012 at Vidant Medical Center (VMC), Greenville, North Carolina. Patients who underwent pancreatic surgery for both non-malignant and malignant processes were included. Patient demographics, operative factors and financial data were obtained. Patient demographics included age, gender, ethnicity, body mass index (BMI), history of tobacco use and comorbidities. The age-adjusted Charlson comorbidity index (ACCI) was calculated for each patient. Operative factors included type of surgery [pancreaticoduodenectomy (PD) or distal pancreatectomy splenectomy (DPS)], operating surgeon, length of stay (LOS), post-operative complications and discharge *destination*. The Clavien–Dindo grading system was used to classify surgical complications.[19] The cost variables, including direct fixed cost, direct variable cost, indirect fixed cost and total cost (defined below), were obtained for each patient from Allscripts EPSi software (Allscript, Raleigh, NC, USA). Cost only includes those accrued at index admission (both pre- and post-operatively). Readmission data are not included. Hospital reimbursement data were only available for Medicare patients.

ACCI is a scoring method for comorbid conditions described by Charlson,[20] with additional points added for every decade over 40 years of age.[21] The Clavien–Dindo grading system classifies post-operative complications as degree of complication from I–V and the level of therapy required in managing the complication. A grade I complication is defined as any deviation from the normal post-operative course, not requiring any interventions. Grade II and grade III complications require either pharmacological or procedural interventions, respectively. Grade IV complication are life-threatening complications, while patient death is assigned as grade V.[5]

Direct costs are the expenses directly related to patient care. Direct fixed costs are non-variable expenses inherent to running a functioning hospital (i.e. buildings, salaries and equipment). Variable direct costs are those that vary with patient activity (i.e. medications, medical tests or surgical equipment). Indirect costs are expenses not directly related to patient care, but associated with non-revenue producing areas of the hospital (i.e. financial services department and informational technology).[22,23] Total costs are the sum total of direct fixed costs, direct variable cost and indirect cost. The contribution margin is the reimbursement minus the direct costs. Net margin is the contribution margin minus indirect costs.

Statistical analysis

Patient demographic, operative and financial variables are represented as mean, median and/or percentage as necessary. Student's t-test or χ^2-test were used to perform univariate analyses where appropriate. Variables with a $P \leq 0.20$ on univariate analysis were included in logistic regression models. A value of $P \leq 0.05$ was defined as statistically significant. Analysis was conducted using JMP® Pro version 10.0.0; 2012 (SAS Institute Inc., Cary, NC, USA).

Results

Patient population

In the period between 2008 and 2012, 138 patients met the inclusion criteria. Table 1 summarizes the characteristics of the study population. The mean and median ages of the patient population were 63 ± 12.8 and 64 years (range 17–90), respectively. Patients were divided based on age into the following groups: <50 ($n = 18$, 13%), 50–59 ($n = 32$, 23%), 60–69 ($n = 42$, 30%), 70–79 ($n = 30$, 22%) and ≥80 years ($n = 16$, 12%). The majority of the patients were female (51%), white (62%) and smokers (57%). The mean and median BMI were 28 ± 6.5 and 28 kg/m^2 (range 12–49), respectively. There was a nearly equal representation of patients in each of the ACCI categories: 0 (36%), 1 (31%) and ≥2 (33%).