HHS Public Access

Author manuscript

J Gastrointest Surg. Author manuscript; available in PMC 2022 May 01.

Published in final edited form as:

J Gastrointest Surg. 2021 May ; 25(5): 1261–1270. doi:10.1007/s11605-020-04614-6.

Pancreatic cancer surgery following emergency department admission: Understanding poor outcomes and disparities in care

Vishes V. Mehta, MD MPH[1,2], **Patricia Friedmann, MS**[1,2], **John C. McAuliffe, MD PhD**[1,2], **Peter Muscarella II, MD FACS**[1,2], **Haejin In, MD MPH MBA**[1,2,3]

[1]Department of Surgery, Montefiore Medical Center, Bronx, NY, USA

[2]Department of Surgery, Albert Einstein College of Medicine, 1300 Morris Park Avenue, Block Building #112, Bronx, NY 10461, USA

[3]Department of Epidemiology and Population Health, Albert Einstein College of Medicine, Bronx, NY, USA

Abstract

Background—The impact of emergency department admission prior to pancreatic resection on perioperative outcomes is not well described. We compared patients who underwent pancreatic cancer surgery following admission through the emergency department (ED-Surgery) with patients receiving elective pancreatic cancer surgery (Elective) and outcomes.

Study Design—The Nationwide Inpatient Sample database was used to identify patients undergoing pancreatectomy for cancer over 5 years (2008–2012). Demographics and hospital characteristics were assessed, along with perioperative outcomes and disposition status.

Results—8,158 patients were identified, of which 516 (6.3%) underwent surgery after admission through the ED. ED-Surgery patients were more often socioeconomically disadvantaged (non-White 39% vs 18%, Medicaid or uninsured 24% vs 7%, from lowest income area 33% vs 21%; all p<.0001), had higher comorbidity (Elixhauser Score >6: 44% vs 26%, p<.0001), and often had pancreatectomy performed at sites with lower annual case volume (<7 resections/year: 53% vs. 24%, p<.0001). ED-Surgery patients were less likely to be discharged home after surgery (70% vs 82%, p<.0001) and had higher mortality (7.4% vs 3.5%, p<.0001). On multivariate analysis, ED-

Correspondence: Haejin In, MD MPH MBA, 1300 Morris Park Avenue, Block Building #112, Bronx, NY 10461, Phone: (718)-379-6865, hin@montefiore.org.

Author Contributions

Study conception and design: Mehta, In

Acquisition of data: Mehta, Friedmann, In

Analysis and interpretation of data: Mehta, Friedmann, In

Drafting of manuscript: Mehta, In

Critical revision: Mehta, McAuliffe, Muscarella, In

Conflict of Interest: None declared (all authors)

Surgery was independently associated with a lower likelihood of being discharged home [aOR: 0.55 (95%CI: 0.43–0.70)].

Conclusion—Patients undergoing pancreatectomy following ED admission experience worse outcomes compared to those who undergo surgery after elective admission. The excess of socioeconomically disadvantaged patients in this group suggests factors other than clinical considerations alone drive this decision. This study demonstrates the need to consider presenting patient circumstances and preoperative oncologic coordination to reduce disparities and improve outcomes for pancreatic cancer surgery.

Keywords

Pancreatic Cancer; Pancreatectomy; Emergency Presentation; Healthcare Disparities

Introduction

Pancreatic cancer represents the 4th leading cause of cancer death in the United States with 5-year relative survival rates of 8%.[1] Surgical resection is the foundation of treatment providing the only potential for cure. As procedural mortality rates have improved over the last several decades,[2–5] attention has shifted to identifying and reducing disparities in surgical care to improve national pancreatic cancer outcomes.

Efforts to improve outcomes have identified demographic barriers to receipt of surgical care, with lower rates of resection in minority populations, patients of lower socioeconomic status, and related to insurance status.[6–8] Hospital characteristics and procedural volume have been shown to improve surgical outcomes in highly complex operations supporting the concept of regionalization and referral to high-volume centers for pancreatic resection.[9–10] However, our understanding of whether the presenting circumstance influences outcomes for pancreatic cancer surgery is limited.

Pancreatic cancer is unique to other gastrointestinal malignancies such as colorectal and gastric cancer in that emergent or urgent surgery is rare and operations can generally be performed on an elective basis.[11,12] For colorectal cancer, emergency department presentation is associated with higher rates of morbidity, in-hospital mortality, and poorer survival.[13] Emergency presentation of gastric cancer patients requiring surgery is less common, but is also associated with worse survival.[12] This association with poor survival is noted even in early stage disease presentations.[12,14] Previous studies in the pancreatic literature have reported high rates of urgent or emergent admission that misrepresent modern surgical practice.[11,15,16] Few past studies have examined the influence of an emergency department (ED) presentation prior to surgery as a determinant of outcomes.

This study compares the outcomes of patients who undergo pancreatic resection after an admission through the emergency department (ED-Surgery) with patients who have surgery performed on an electively scheduled basis (Elective). We hypothesize that patients who undergo pancreatic resection after admission through the emergency department have worse outcomes compared to patients who undergo electively scheduled operations.

Methods

Study population

The Nationwide Inpatient Sample (NIS) database was used to identify all patients undergoing pancreatic resection in the United States over a 5-year period from 2008–2012. The NIS database is a representative sample of all inpatient hospitalizations, drawing discharge data from all states, all payers, and across the spectrum of hospital care settings. Diagnostic codes for pancreatic adenocarcinoma (157.0–157.9) and ICD-9 procedural codes for pancreatic resection operations (52.5, 52.51, 52.52, 52.53. 52.59, 52.6, 52.7) were used to identify the target population.

Study Variables

Examined variables included gender, age at admission (< 55, 55–64, 65–74, ≥75), race (White, Black, Hispanic, Asian/Pacific Islander), median household income quartiles based on the patient's zip code (<$38,999, $39,000-$47,999, $48,000-$62,999, ≥$63,000), and insurance status based on expected primary payer for services (Medicare, Medicaid, Private Insurance, Self-pay, and Other). Patient comorbidity was assessed using the Elixhauser Comorbidity Index. Pre-operative comorbidities were then analyzed using a validated weighted scoring system.[17] ICD-9 codes were used to identify the presence of pre-operative biliary obstruction (576.1, 576.2), duodenal obstruction (537.3), and gastrointestinal bleeding (578.1, 578.9). Pancreatic resection type was examined as pancreaticoduodenectomy, distal pancreatectomy, and other (total, subtotal, segmental).

Hospital characteristics were also examined and include bedsize (region-specific stratification into small, medium, large), hospital ownership (government non-federal, private non-profit, and private investor-owned), location and teaching status (rural, urban teaching, urban non-teaching), and region (Northeast, Midwest, South, West). Hospital pancreatectomy volume was stratified into 4 groups by number of pancreatic resections per year (≤2, 3–6, 7–25, ≥26). Patients who underwent pancreatic resection following an ED admission with a nonelective admission type designation were assigned to the ED-Surgery group (ED-Surgery), while all others were assigned to the Elective group (Elective).

The primary outcome was patient discharge home after surgery. This variable captures patients who underwent surgery and were able to be discharged directly home, with or without home health services, providing a comprehensive marker for a patient's outcome after surgery beyond mortality alone. Secondary outcomes included hospital mortality, length of stay, and postoperative complications. Complications included pancreatic fistula, postoperative bleeding, deep vein thrombosis and pulmonary embolism (DVT/PE), cardiac, pulmonary, and neurologic complications, postoperative sepsis, wound infections, and overall surgical complications.

Data Analysis

Univariate analysis was used to compare ED-Surgery and Elective groups. Categorical variables were analyzed using Chi-squared tests and continuous variables were analyzed using either t-test or Wilcoxon-sum rank non-parametric test. A generalized linear mixed

model (GLMM) was used to estimate the odds ratio and 95% confidence interval for the outcome discharge to home after adjusting for relevant covariates. This approach was selected to account for clustering by institution via random effects.[18,19] Significance level was set at $p < 0.05$. Stepwise selection was used to identify the most predictive variable for discharge home at a $p < 0.2$. Statistical analysis was conducted using SAS Version 9.4 (Cary, NC).

Results

Patient Factors

A total of 8,158 patients were identified who underwent pancreatic resection for cancer during the 5-year period from 2008–2012. Among these patients, 8,151 had outcome data and were included in this analysis. These patients were seen in 1,299 hospitals. Overall, 516 (6.3%) were ED-Surgery (Table 1). When compared to Elective patients, ED-Surgery patients were more often Black (20.0% vs. 8.8%, p< 0.0001) or Hispanic (16.2% vs. 6.4%, p< 0.0001), they were younger (<65 years old: 51% vs. 43%; p<0.003), and were less likely to have Medicare (44.8% vs. 52.6%, p< 0.0001) or private insurance (28.1% vs. 37.8%; p< 0.0001). ED-Surgery patients were also more likely to be from lower income areas (household income <$39,000/year: 32.6% vs. 21.2%; p< 0.0001). These patients were more likely to have higher pre-operative comorbidity scores (Score 6–13: 31.8% vs. 20.8%, Score 14+: 12.4% vs. 5.1%; p < 0.0001). ED-Surgery patients also presented more often with biliary obstruction (28.5% vs. 11.4%; p <.0001), duodenal obstruction (4.3% vs. 1.1%; p < 0.0001) and gastrointestinal bleeding (4.5% vs. 1.4%; p < 0.0001) when compared to Elective patients.

Hospital Characteristics

The majority of pancreatic resections were performed in urban settings (98.2%), large bedsize hospitals (80.6%), and private, non-profit hospitals (77.4%). ED-Surgery patients were more likely to be treated in small and medium bedsize hospitals (26.0% vs. 19.00%, p<0.0001), private, investor-owned hospitals (9.3% vs. 5.5%, p-0.0012), and non-teaching hospitals (28.5% vs. 12.4%, p<0.0001).

ED-Surgery patients often had their pancreatic surgery performed at sites with lower annual case volume (<7 resections/year: 52.9% vs. 23.6%, p<0.0001) (Table 1). The most commonly performed operations were pancreaticoduodenectomy (69.3%) and distal pancreatectomy (21.6%) with no significant differences in resection type based on admission status (p=0.1367).

Outcomes

Unadjusted univariate analysis of outcome variables of interest are shown in Table 3. Overall, 82% of patients were discharged home after surgery. The in-hospital mortality rate for the cohort was 3.75%. ED-Surgery patients were less likely to be discharged to home after surgery (70.2% vs. 82.4%, p< 0.0001) and had higher in-hospital mortality (7.4% vs. 3.5%, p< 0.0001), longer overall median length of hospital admission (19 days vs. 9 days, p<.0001) and postoperative length of stay (12 days vs. 9 days, p<.0001) as compared to

Elective. There was no significant difference in overall surgical complications (5.4% vs. 5.1%, p=0.76). In examination of individual complications, we found no significant differences in rates of pancreatic fistula, perioperative cardiac, pulmonary, neurologic, or thromboembolic events. ED-Surgery patients had lower rates of wound infection (4.26% vs. 8.15%, p=0.0009), but higher rates of bleeding complications (7.75% vs. 4.39%, p=0.0004). (Table 3)

Multivariate analysis showed that ED-Surgery was independently associated with a lower likelihood of discharge to home (OR 0.551, 95% CI 0.434–0.699) (Table 4) after adjusting for relevant patient and hospital covariates. As expected, increasing age (55–64: OR 0.58,95% CI 0.436–0.759; 65–74: OR 0.39, 95% CI 0.290–0.524; ≥ 75: OR 0.14, 95% CI 0.102–0.187) and comorbidity (Elixhauser Comorbidity Score 1–5: OR 0.59, 95% CI 0.471–0.750; Score 6–13: OR 0.51, 95% CI 0.416–0.624; Score 14+: OR 0.37, 95% CI 0.300–0.456) were associated with progressively lower likelihood of home discharge. Male gender (OR 1.45, 95% CI 1.281–1.651) was associated with a higher likelihood of home discharge. The demographic variable of race was not independently predictive, however being from the lowest median income strata by ZIP (<$38,999/year: OR 0.79, 95% CI 0.652–0.955) and having Medicare insurance (OR 0.62, 95% CI 0.508–0.764) was predictive of a lower likelihood of discharge home after surgery.

Having surgery in a high-volume hospital was associated with an improved likelihood of being discharged to home (≥ 26 cases/year: OR 1.42, 95% CI 1.126–1.798) compared to hospitals performing less than 2 resections per year. Having a postoperative complication including overall surgical complications, wound infection, bleeding, sepsis, and cardiac complications was predictive of lower likelihood of home discharge.

Discussion

This study provides an evaluation of patients undergoing pancreatectomy for cancer after presentation through the ED and the potential mechanisms responsible for their worse outcomes. These patients were nearly half as likely to be discharged to home after surgery and had in-hospital mortality rates that were twice that of patients who had elective admission for surgery. These patients were more often socioeconomically disadvantaged and had their pancreatic surgery performed at sites with lower annual case volume.

Prior to this study, an understanding of how patient presentation might influence outcomes has not been well studied in the pancreatic literature. Lieberman et al examined a statespecific cohort and demonstrated significantly higher mortality after unscheduled versus planned admissions (16% vs. 10%, p <0.001).[20] However, after adjusting for hospital volume in their logistic regression model, they reported that method of presentation was not a significant predictor of mortality. In a prior study using older NIS (national) data from 1988–1995, ED presentation was shown to be an independent predictor of mortality after pancreaticoduodenectomy with an OR 1.5 (95% CI 1.3–1.6).[16] However, the study reported rates of ED presentation for pancreatic cancer surgery from 42–50%, which is considerably higher than the rate of 6.3% demonstrated in our investigation. The study used data from a different era in pancreatic surgery and did not include comorbidity in the regression model,

but it is one of the few to recognize the independent association of ED presentation on outcomes in pancreatectomy. In a landmark study by Birkmeyer et al on the volume-outcomes relationship in pancreatic surgery, an inverse relationship between ED presentation and hospital volume was observed, with 50.6% of all admissions through the ED in the lowest volume group compared to 18.6% in the highest volume group.[9] While ED presentation was accounted for in their multivariate model for postoperative mortality, comorbidities were not included, and the absence of case-mix data was acknowledged as a limitation of their analysis.

In our research, demographic differences between study groups suggest that disparities in healthcare access could explain differing methods of presentation. ED-Surgery patients were more than twice as likely to be Black or Hispanic. They were also more likely to have Medicaid or be uninsured and live in areas of the lowest income quartile. Prior literature implicates racial and socioeconomic factors in differing survival outcomes for patients with otherwise resectable disease.[6,21,22] Some of these disparities arise due to lower rates of resection among disadvantaged populations including Black patients, the uninsured, and lower income.[6,8,21,23] Ultimately, receiving surgery is the key as several studies have shown that survival disparities based on race, socioeconomic status, and insurance type are diminished after resection with equivalent rates of long-term survival.[7,22–24]

Clinically, we found patients who present for surgery after admission through the ED were less healthy at baseline and carried significantly more comorbid conditions. Preexisting comorbidity as an independent predictor of worse outcomes has been supported in previous research.[25] We also found these patients present with biliary obstruction, duodenal obstruction and gastrointestinal bleeding more often. These factors suggest more advanced disease presentations may have warranted the emergent ED admission. Presumably, the choice of presenting hospital should be the same for emergency presentations, and we should not find differences based on hospital characteristics. However, we found these patients have more often undergone surgery following ED presentation in lower volume, small bedsize, and non-academic centers. This raises concerns that these patients are not offered the same complex pancreas management expertise such as advanced endoscopists and interventional radiologists, leading to patients getting emergent surgery instead of other less invasive options for acute symptom management.

Hospital characteristics are particularly relevant in pancreatic surgery, given the technical complexity and multidisciplinary services required to achieve good outcomes. Literature has shown higher rates of perioperative mortality in non-university hospitals and in rural settings.[16, 22] Major focus has been placed on procedural volume, where surgeries performed in low-volume hospitals have been shown to have higher rates of mortality, longer lengths of stay, and worse long-term survival rates.[9,10,25–29] Higher mortality rates in pancreatectomy have also been attributed to failure-to-rescue, where a complication sustained in a low volume hospital is more likely to result in death. [30,31] Our finding of similar complication rates for both groups, despite worse outcomes and higher mortality in the ED-Surgery group indicates this may also be an explanation of findings. We found that ED-Surgery patients were more likely to present to small and medium bedsize hospitals, private hospitals, non-teaching institutions, and low-volume hospitals. The volume

relationship was Substantial, with the lowest volume hospital group having the highest rates of ED presentation (29%), nearly 5 times higher than the cohort rate (6.3%). These data suggest two circumstances surrounding an ED admission: (1) sicker and socioeconomically disadvantaged patients present to smaller, low-volume hospitals more often and/or (2) these smaller, low-volume hospitals are more readily performing surgery after an ED admission. While surgery performed on the same index admission as the ED visit may be due to an emergency presentation that necessitates surgery, most pancreatic emergencies are best treated non-surgically when advanced endoscopists and interventional radiologists are available. The characteristics of the hospitals performing surgery after ED admission suggests that these multidisciplinary teams and services may not be as readily be available, and surgery prevails as the leading option for management.

Surgeries being performed after admission through the ED may reflect the lack of care coordination for these patients and highlights a major opportunity for improvement. Given the extensive body of literature on volume-outcomes relationships for patients undergoing pancreatectomy, it is inadvisable for smaller, low-volume hospitals to be performing complex cancer surgery in high-risk patients and we must continue to encourage centralization of care for the patients who can tolerate transfer to a specialized, high volume center. Lessons on patient triage and transfer can be gleaned from trauma systems literature, where barriers related to clinical status and insurance coverage can be overcome to limit preventable deaths.[32] The value of centralization to improve perioperative mortality in pancreatectomy has gained traction, and stakeholders in pancreatic surgical care should recognize the importance of ED presentation to build a framework to advance this agenda.[33, 34]

This study has several limitations. The NIS is an administrative database that lacks granular details on the operative course or the use of preoperative biliary stenting that influence short-term surgical outcomes. Other data such as tumor stage, chemotherapy use, resection margins, and nodal status that influence long-term outcomes important in cancer outcomes research are not available.[35–37] We were also unable to examine various social reasons that might influence ED admission prior to surgery such as lack of family support, housing instability, poor health literacy, or mental health issues.

The ED-Surgery group exhibited high-risk features and experienced worse outcomes for most of the measures evaluated. However, surgical complication rates of 5% seem low in this patient population where morbidity rates ranging from 23% to 55% are cited.[38,39] Complications that are unique to pancreatectomy, such as postoperative pancreatic fistula, reported at 2% in this study, and delayed gastric emptying are underreported in the database. The finding that there were no differences in complications, and counterintuitively less infectious complications for the ED-Surgery group despite a two-fold difference in mortality between the two groups is consistent with known limitations of this database. Administrative coding data has been shown to underestimate a range of healthcare-associated infections and surgical complication rates despite higher demonstrated mortality. [40–43] Despite these limitations, the poor outcomes observed for patients undergoing surgery after an admission through the ED provide important insights and should be considered in assessments of patient and hospital outcomes for pancreatic cancer surgery.

Conclusion

Patients who present through the emergency department for pancreatic cancer resections have lower rates of discharge to home and higher mortality rates. These patients tend to be from socioeconomically disadvantaged populations and carry a higher comorbidity burden, with implications of disparate health access. This study demonstrates the need to consider presenting patient circumstances and preoperative oncologic coordination to reduce disparities and improve outcomes for pancreatic cancer surgery.

Acknowledgments

The authors would like to thank the National Cancer Institute of the National Institutes for Health and the Montefiore Medical Center Department of Surgery for financial support with database acquisition and statistical analysis software.

Grant Support: Effort by HI was supported by the National Cancer Institute of the National Institutes of Health under the award number 2K12 CA132783-06 (Paul Calabresi Career Development Award for Clinical Oncology).

References

1. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2018. CA Cancer J Clin. 2018;68(l):7–30. doi:10.3322/caac.21442. [PubMed: 29313949]
2. Crist DW, Sitzmann JV, Cameron JL. Improved hospital morbidity, mortality, and survival after the Whipple procedure. Ann Surg. 1987;206(3):358–65. [PubMed: 3632096]
3. Geer RJ, Brennan MF. Prognostic indicators for survival after rejection of pancreatic adenocarcinoma. Am J Surg. 1993;165(l):68–72; discussion -3. [PubMed: 8380315]
4. Yeo CJ, Cameron JL, Sohn TA, Lillemoe KD, Pitt HA, Talamini MA et al. Six hundred fifty consecutive pancreaticoduodenectomies in the 1990s: pathology, complications, and outcomes. Ann Surg. 1997;226(3):248–57; discussion 57–60. [PubMed: 9339931]
5. Cameron JL, Pitt HA, Yeo CJ, Lillemoe KD, Kaufman HS, Coleman J. One hundred and fortyfive consecutive pancreaticoduodenectomies without mortality. Ann Surg. 1993;217(5):430–5; discussion 5–8. [PubMed: 8098202]
6. Shapiro M, Chen Q, Huang Q, Boosalis VA, Yoon CH, Saund MS et al. Associations of Socioeconomic Variables With Resection, Stage, and Survival in Patients With Early-Stage Pancreatic Cancer. JAMA Surg. 2016; 151(4):338–45. doi:10.1001/jamasurg.2015.4239. [PubMed: 26581025]
7. Abraham A, Al-Refaie WB, Parsons HM, Dudeja V, Vickers SM, Habermann EB. Disparities in pancreas cancer care. Ann Surg Oncol. 2013;20(6):2078–87. doi:10.1245/s10434-012-2843-z. [PubMed: 23579872]
8. Seyedin S, Luu C, Stabile BF, Lee B. Effect of socioeconomic status on surgery for pancreatic adenocarcinoma. Am Sure. 2012;78(10):1128–31.
9. Birkmeyer JD, Siewers AE, Finlayson EV, Stukel TA, Lucas FL, Batista I et al. Hospital volume and surgical mortality in the United States. N Engl J Med. 2002;346(15): 1128–37. doi:10.1056/NEJMsa012337. [PubMed: 11948273]
10. van Heek NT, Kuhlmann KF, Scholten RJ, de Castro SM, Busch OR, van Gulik TM et al. Hospital volume and mortality after pancreatic resection: a systematic review and an evaluation of intervention in the Netherlands. Ann Surg. 2005;242(6):781–8, discussion 8–90. [PubMed: 16327488]
11. Scott NA, Jeacock J, Kingston RD. Risk factors in patients presenting as an emergency with colorectal cancer. Br J Surg. 1995;82(3):321–3. [PubMed: 7795995]
12. Vasas P, Wiggins T, Chaudry A, Bryant C, Hughes FS. Emergency presentation of the gastric cancer; prognosis and implications for service planning. World J Emerg Surg. 2012;7(1):31. doi:10.1186/1749-7922-7-31. [PubMed: 23009085]

13. Kundes F, Kement M, Cetin K, Kaptanoglu L, Kocaoglu A, Karahan M et al. Evaluation of the patients with colorectal cancer undergoing emergent curative surgery. Springerplus. 2016;5(1):2024. doi:10.1186/s40064-016-3725-9. [PubMed: 27995001]

14. Oliphant R, Mansouri D, Nicholson GA, McMillan DC, Horgan PG, Morrison DS et al. Emergency presentation of node-negative colorectal cancer treated with curative surgery is associated with poorer short and longer-term survival. Int J Colorectal Dis. 2014;29(5):591–8. doi:10.1007/s00384-014-1847-5. [PubMed: 24651957]

15. Simunovic M, To T, Theriault M, Langer B. Relation between hospital surgical volume and outcome for pancreatic resection for neoplasm in a publicly funded health care system. CMAJ. 1999; 160(5): 643–8. [PubMed: 10101998]

16. Kotwall CA, Maxwell JG, Blinker CC, Koch GG, Covington DL. National estimates of mortality rates for radical pancreaticoduodenectomy in 25,000 patients. Ann Surg Oncol. 2002;9(9):847–54. [PubMed: 12417505]

17. van Walraven C, Austin PC, Jennings A, Quan H, Forster AJ. A modification of the Elixhauser comorbidity measures into a point system for hospital death using administrative data. Med Care. 2009;47(6):626–33. doi:10.1097/MLR.0b013e31819432e5. [PubMed: 19433995]

18. Wolfinger R, O'Connell M. Generalized linear mixed models a pseudo-likelihood approach. Journal of Statistical Computation and Simulation. 1993;48(3–4):233–43. doi:10.1080/00949659308811554.

19. Liao JG, Lipsitz SR. A type of restricted maximum likelihood estimator of variance components in generalised linear mixed models. Biometrika. 2002;89(2):401–9. doi:10.1093/biomet/89.2.401.

20. Lieberman MD, Kilburn H, Lindsey M, Brennan MF. Relation of perioperative deaths to hospital volume among patients undergoing pancreatic resection for malignancy. Ann Surg. 1995:222(5):638–45. [PubMed: 7487211]

21. Shah A, Chao KS, Ostbye T, Castleberry AW, Pietrobon R, Gloor B et al. Trends in racial disparities in pancreatic cancer surgery. J Gastrointest Surg. 2012,17(11):1897–906. doi:10.1007/s11605-013-2304-4.

22. van Roest MH, van der Aa MA, van der Geest LG, de Jong KP. The Impact of Socioeconomic Status, Surgical Resection and Type of Hospital on Survival in Patients with Pancreatic Cancer. A Population-Based Study in The Netherlands. PLoS One. 2016;11(11):e0166449. doi:10.1371/journal.pone.0166449. [PubMed: 27832174]

23. Murphy MM, Simons JP, Hill JS, McDade TP, Chau Ng S, Whalen GF et al. Pancreatic resection: a key component to reducing racial disparities in pancreatic adenocarcinoma. Cancer. 2009;115(17):3979–90. doi:10.1002/cncr.24433. [PubMed: 19514091]

24. Murphy MM, Simons JP, Ng SC, McDade Tp, Smith JK, Shah SA et al. Racial differences in cancer specialist consultation, treatment, and outcomes for locoregional pancreatic adenocarcinoma. Ann Surg Oncol. 2009;16(11):2968–77. doi:10.1245/s10434-009-0656-5. [PubMed: 19669839]

25. Teh SH, Diggs BS, Deveney CW, Sheppard BC. Patient and hospital characteristics on the variance of perioperative outcomes for pancreatic resection in the United States: a plea for outcome-based and not volume-based referral guidelines. Arch Surg. 2009;144(8):713–21. doi:10.1001/archsurg.2009.67. [PubMed: 19687374]

26. Fong Y, Gonen M, Rubin D, Radzyner M, Brennan MF. Long-term survival is superior after resection for cancer in high-volume centers. Ann Surg. 2005;242(4):540–4; discussion 4–7. [PubMed: 16192814]

27. Birkmeyer JD, Warshaw AL, Finlayson SR, Grove MR, Tosteson AN. Relationship between hospital volume and late survival after pancreaticoduodenectomy. Surgery. 1999;126(2):178–83. [PubMed: 10455881]

28. van der Geest LG, van Rijssen LB, Molenaar IQ, de Hingh IH, Groot Koerkamp B, Busch OR et al. Volume-outcome relationships in pancreatoduodenectomy for cancer. HPB (Oxford). 2016;18(4):317–24. doi:10.1016/j.hpb.2016.01.515. [PubMed: 27037200]

29. Healy MA, Yin H, Wong SL. Multimodal cancer care in poor prognosis cancers: Resection drives long-term outcomes. J Surg Oncol. 2016;113(6):599–604. doi:10.1002/jso.24217. [PubMed: 26953166]

30. El Amrani M, Clement G, Lenne X, Farges O, Delpero JR, Theis D et al. Failure-to-rescue in Patients Undergoing Pancreatectomy: Is Hospital Volume a Standard for Quality Improvement Programs? Nationwide Analysis of 12,333 Patients. Ann Surg. 2018;268(5):799–807. doi:10.1097/SLA.0000000000002945. [PubMed: 30048329]

31. Sheetz KH, Dimick JB, Ghaferi AA. Impact of Hospital Characteristics on Failure to Rescue Following Major Surgery. Ann Surg. 2016;263(4):692–7. doi:10.1097/SLA.0000000000001414. [PubMed: 26501706]

32. DiBrito SR, Jones C. What Are Ethical Implications of Regionalization of Trauma Care? AMA J Ethics. 2018;20(5):439–46. doi:10.1001/journalofethics.2018.20.5.ecas3-1805. [PubMed: 29763390]

33. Gooiker GA, Lemmens VE, Besselink MG, Busch OR, Bonsing BA, Molenaar IQ et al. Impact of centralization of pancreatic cancer surgery on resection rates and survival. Br J Surg. 2014; 101(8): 1000–5. doi:10.1002/bjs.9468. [PubMed: 24844590]

34. Sheetz KH, Dimick JB, Nathan H. Centralization of High-Risk Cancer Surgery Within Existing Hospital Systems. J Clin Oncol. 2019:JCO1802035. doi:10.1200/JCO.18.02035.

35. Fu SJ, Shen SL, Li SQ, Hu WJ, Hua YP, Kuang M et al. Risk factors and outcomes of postoperative pancreatic fistula after pancreatico-duodenectomy: an audit of 532 consecutive cases. BMC Surg. 2015;15:34. doi:10.1186/sl2893-015-0011-7. [PubMed: 25887526]

36. Winter JM, Cameron JL, Campbell KA, Arnold MA, Chang DC, Coleman J et al. 1423 pancreaticoduodenectomies for pancreatic cancer: A single-institution experience. J Gastrointest Surg. 2006;10(9):1199–210; discussion 210–1. doi:10.1016/j.gassur.2006.08.018. [PubMed: 17114007]

37. Yang YM, Tian XD, Zhuang Y, Wang WM, Wan YL, Huang YT. Risk factors of pancreatic leakage after pancreaticoduodenectomy. World J Gastroenterol. 2005;11(16):2456–61. [PubMed: 15832417]

38. Bassi C, Dervenis C, Butturini G, Fingerhut A, Yeo C, Izbicki J et al. Postoperative pancreatic fistula: an international study group (ISGPF) definition. Surgery. 2005; 138(1):8–13. doi:10.1016/j.surg.2005.05.001. [PubMed: 16003309]

39. Simons JP, Shah SA, Ng SC, Whalen GF, Tseng JF. National complication rates after pancreatectomy: beyond mere mortality. J Gastrointest Surg. 2009:13(10):1798–805. doi:10.1007/s11605-009-0936-1. [PubMed: 19506975]

40. van Rijssen LB, Zwart MJ, van Dieren S, de Rooij T, Bonsing BA, Bosscha K et al. Variation in hospital mortality after pancreatoduodenectomy is related to failure to rescue rather than major complications: a nationwide audit. HPB (Oxford). 2018;20(8):759–67. doi:10.1016/j.hpb.2018.02.640. [PubMed: 29571615]

41. Jhung MA, Banerjee SN. Administrative coding data and health care-associated infections. Clin Infect Dis. 2009;49(6):949–55. doi:10.1086/605086. [PubMed: 19663692]

42. Alluri RK, Leland H, Heckmann N. Surgical research using national databases. Ann Transl Med. 2016;4(20):393. doi:10.21037/atm.2016.10.49. [PubMed: 27867945]

43. van Mourik MS, van Duijn PJ, Moons KG, Bonten MJ, Lee GM. Accuracy of administrative data for surveillance of healthcare-associated infections: a systematic review. BMJ Open. 2015;5(8):e008424. doi:10.1136/bmjopen-2015-008424.

Synopsis

Patients who undergo pancreatectomy after an ED admission represent a socioeconomic and clinically disadvantaged population. Method of presentation is an important indicator of cancer patients at risk for poor outcomes.

Table 1.

Patient Demographics

Variable (%)	ED-Surgery (n=516)	Elective (n=7635)	All (n =8151)	p-value
Method of Presentation	6.33	93.67	100.0	<.0001
Gender				0.8896
Male	50.39	50.07	50.09	
Female	49.61	49.93	49.91	
Race				<.0001
White	60.09	82.23	80.80	
Black	19.96	8.81	9.53	
Hispanic	16.23	6.37	7.00	
Asian or Pacific Islander	3.73	2.59	2.67	
Age (years)				0.0034
<55	19.96	16.75	16.95	
55–65	31.01	26.08	26.39	
65–75	27.71	33.84	33.46	
>75	21.32	23.33	23.20	
Median Household Income (by patient ZIP Code)				<.0001
$1–$38,999	32.60	21.16	21.87	
$39,000–$47,999	22.33	24.64	24.50	
$48,000–$62,999	27.16	25.98	26.06	
$63,000+	17.91	28.22	27.58	
Expected Primary Payer				<.0001
Medicare	44.77	52.64	52.14	
Medicaid	18.60	4.73	5.61	
Private Insurance	28.10	37.80	37.19	
Self-pay	5.62	2.13	2.36	
Other	2.91	2.70	2.71	
Elixhauser Comorbidity Score				<.0001
<0	9.11	13.31	13.04	
0	19.77	36.32	35.27	
1–5	26.94	24.49	24.65	
6–13	31.78	20.76	21.46	
14+	12.40	5.12	5.58	
Condition Present at Admission				
Biliary Obstruction	28.49	11.38	12.46	<.0001
Duodenal Obstruction	4.26	1.11	1.31	<.0001
Gastrointestinal Bleeding	4.46	1.39	1.58	<.0001

Table 2.

Hospital Characteristics

Variable (%)	ED-Surgery (n=516)	Elective (n=7635)	All (n =8151)	p-value
Hospital Bedsize				<.0001
Small	5.24	6.78	6.69	
Medium	20.78	12.17	12.72	
Large	73.98	81.05	80.60	
Ownership of Hospital				0.0011
Government, Non-federal	17.28	16.83	16.86	
Private, Non-profit	73.40	77.70	77.42	
Private, Investor-owned	9.32	5.48	5.72	
Hospital Location/ Teaching Status				<.0001
Rural	1.94	1.74	1.75	
Urban, Nonteaching	28.54	12.37	13.40	
Urban, Teaching	69.51	85.89	84.85	
Region of Hospital				<.0001
Northeast	25.00	20.94	21.20	
Midwest	10.85	24.49	23.63	
South	44.77	33.92	34.61	
West	19.38	20.64	20.56	
Hospital Case Volume				<.0001
≤2	29.26	10.43	11.62	
3–6	23.64	13.20	13.86	
7–25	29.46	33.78	33.51	
≥26	17.64	42.59	41.01	
Resection Type				0.1367
Whipple	73.84	68.95	69.26	
Distal	18.02	21.82	21.58	
Other	8.14	9.24	9.16	

Table 3.

Outcomes

Variable (%)	ED Surgery (n=516)	Elective (n=7635)	All (n =8151)	p-value
Discharged Home	70.16 (362)	82.42 (6293)	81.65	<.0001
Mortality	7.36 (38)	3.51 (268)	3.75	<.0001
Postoperative LOS (*median*)	12 days	9 days	10 days	<.0001
Total Hospital LOS (*median*)	19 days	9 days	9 days	<.0001
Complication				
Surgical Complication	5.43 (28)	5.11 (390)	5.13	0.7510
Pancreatic Fistula	2.91 (15)	1.99 (152)	2.05	0.1551
Wound Infection	4.26 (22)	8.15 (622)	7.90	0.0016
Bleeding	7.75 (40)	4.39 (335)	4.60	0.0004
DVT/PE	0.19 (1)	0.63 (48)	0.60	0.3705
Cardiac	2.33 (12)	3.42 (261)	3.35	0.2065
Neurologic	0.00 (0)	0.12 (9)	0.11	1.000
Pulmonary	3.10 (16)	2.11 (161)	2.17	0.1345
Sepsis	0.19 (1)	0.08 (6)	0.09	0.3872

Table 4.

Multivariate Analysis of Factors Associated with Discharge Home

Variable	Odds Ratio	95% Confidence Interval	p-value
Patient Demographics			
Method of Presentation			
Elective	Ref	--	--
ED Surgery	0.551	0.434–0.699	<.0001
Gender			
Female	Ref	--	--
Male	1.454	1.281–1.651	<.0001
Race			
White	Ref	--	--
Black	0.929	0.729–1.183	0.5496
Hispanic	1.182	0.888–1.573	0.2530
Asian/ Pacific-Islander	1.077	0.704–1.646	0.7335
Age			
<55	Ref	--	--
55–64	0.575	0.436–0.759	<.0001
65–74	0.390	0.290–0.524	<.0001
>75	0.138	0.102–0.187	<.0001
Elixhauser Comorbidity Score			
<0	0.879	0.634–1.219	0.4393
0	Ref	--	--
1–5	0.594	0.471–0.750	<.0001
6–13	0.509	0.416–0.624	<.0001
14+	0.370	0.300–0.456	<.0001
Biliary Obstruction			
No	Ref	--	--
Yes	1.056	0.878–1.272	0.5612
Duodenal Obstruction			
No	Ref	--	--
Yes	0.600	0.326–1.104	0.1005
Gastrointestinal Bleeding			
No	Ref	--	--
Yes	0.562	0.371–0.851	0.0065
Primary Payer			
Medicare	0.623	0.508–0.764	<.0001
Medicaid	0.765	0.549–1.067	0.1144
Private Insurance	Ref	--	--
Self-Pay	1.193	0.679–2.098	0.5391

Variable	Odds Ratio	95% Confidence Interval	p-value
Other	1.489	0.843–2.631	0.1703
Median Household Income (by Pt ZIP)			
$1–$38,999	0.789	0.652–0.955	0.0150
$39,000–$47,999	0.842	0.704–1.006	0.0579
$48,000–$62,999	0.925	0.775–1.104	0.3894
$63,000+	Ref	--	--
Hospital Characteristics			
Hospital Bedsize			
Small	1.165	0.891–1.522	0.2645
Medium	1.022	0.838–1.245	0.8313
Large	Ref	--	--
Ownership of Hospital			
Government, Non-federal	0.912	0.754–1.103	0.3426
Private, Non-profit	Ref	--	--
Private, Investor-owned	0.703	0.543–0.911	0.0077
Hospital Location/ Teaching Status			
Rural	0.765	0.487–1.201	0.2449
Urban, Non-teaching	0.680	0.559–0.826	0.0001
Urban, Teaching	Ref	--	--
Hospital Region			
Northeast	Ref	--	--
Midwest	0.867	0.716–1.051	0.1463
South	1.347	1.199–1.621	0.0017
West	1.143	0.930–1.406	0.2038
Surgery Type			
Whipple	0.502	0.420–0.600	<.0001
Distal	Ref	--	--
Hospital Case Volume			
≤2	Ref	--	--
3–6	1.022	0.805–1.296	0.8601
7–25	1.248	0.998–1.561	0.0516
≥26	1.423	1.126–1.798	0.0031
Complications			
Surgical Comp	0.567	0.443–0.726	<.0001
Pancreatic Fistula	0.880	0.573–1.351	0.5591
Wound Infection	0.484	0.394–0.596	<.0001
Bleeding	0.387	0.302–0.497	<.0001
CNS/Sepsis	0.067	0.015–0.287	0.0003
Cardiac	0.582	0.432–0.782	0.0003

Variable	Odds Ratio	95% Confidence Interval	p-value
Pulmonary	0.778	0.529–1.142	0.2000