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Utilization and Determinants of Adjuvant Therapy among Older Patients who Receive Curative Surgery for Pancreatic Cancer

Jessica A. Davila, PhD, **Elizabeth Y. Chiao, MD, MPH**, **Jennifer C. Hasche, MS**, **Nancy J. Petersen, PhD**, **Katherine A. McGlynn, PhD**, and **Yasser H. Shaib, MD, MPH**
Sections of Health Services Research (J. Davila, E. Chiao, J. Hasche, N. Petersen, and Y. Shaib), Gastroenterology (Y. Shaib), and Infectious Disease (E. Chiao) at the Houston Veterans Affairs Medical Center, Baylor College of Medicine, Houston, Texas and the Division of Cancer Epidemiology and Genetics, NCI/DHHS (K. McGlynn), Bethesda, Maryland

Abstract

OBJECTIVE—We conducted a population-based study to describe the utilization, determinants, and survival effects of adjuvant therapies following surgery among older patients with pancreatic cancer.

METHODS—Using SEER-Medicare data, we identified patients >65 years who received surgical resection for pancreatic cancer during 1992–2002. We constructed multiple logistic regression models to examine patient, clinical, and hospital factors associated with receiving adjuvant therapy. Cox proportional hazards models were used to examine the effect of therapy on survival.

RESULTS—Approximately 49% of patients received adjuvant therapy following surgery. Patient factors associated with increased receipt of adjuvant therapy included more recent diagnosis, younger age, stage II disease, higher income, and geographic location. Hospital factors associated with increased receipt of adjuvant therapy included cooperative group membership and larger size. Adjuvant treatments associated with a significant reduction in 2-year mortality (relative to surgery alone) were chemoradiation or radiation alone, but not chemotherapy alone.

CONCLUSIONS—Our findings suggest that adjuvant chemoradiation and to a lesser degree radiation only, are associated with a reduction in the risk of mortality among older patients who undergo surgery for pancreatic cancer. However, receipt of adjuvant therapy varied by time period and geography as well as certain patient and hospital factors.

Keywords

Pancreatic cancer; adjuvant therapy; SEER-Medicare

INTRODUCTION

Pancreatic cancer is a common and highly fatal malignancy. Approximately 30,000 cases are diagnosed annually in the United States, and the survival of patients with pancreatic cancer is poor with most patients dying from their disease within 2 years. (1)

Although surgical resection offers the only potential cure for patients with pancreatic cancer, recurrence of local or hepatic disease occurs in the vast majority of patients with pancreatic cancer who receive surgery. Rates of survival following surgery are only 15–20% at 5 years. (2–6) Adjuvant chemotherapy with radiation (chemoradiation) or without may reduce the

Corresponding Author: Jessica A. Davila, Ph.D., The Houston Veterans Affairs Medical Center, 2002 Holcombe Blvd. (152), Houston, TX 77030, Phone (713) 794-8699, Fax (713) 748-7359. jdavila@bcm.tmc.edu.

risk of recurrence. (7) Several recent clinical trials studies and one meta-analysis have reported that adjuvant therapy following surgery is associated with improved outcomes. (8–10) However, there is limited population based data to determine whether adjuvant therapy is utilized or effective in clinical practice.

Data examining treatment practices for pancreatic cancer are especially lacking among older patients. It has been shown that surgical resection for pancreatic cancer can be safely performed among older patients (11), and that rates of surgical complications following pancreatic cancer surgery are similar between those ages >70 compared to those less than 70 years. (12) However, the utilization of adjuvant therapy after surgery in older patients with pancreatic cancer is unknown. Further, the determinants of receiving adjuvant therapy among older patients have not been examined. Therefore, we conducted a population-based retrospective cohort study to determine the effect of patient, clinical, and hospital characteristics on the receipt of adjuvant therapy among older patients with pancreatic cancer and to examine the effect of adjuvant therapy on survival. We used the linked records of patients who were both enrolled in Medicare and the Surveillance, Epidemiology, and End Results (SEER) registry to describe the utilization of curative surgery with and without adjuvant therapy.

METHODS

Data source

Data for this study was obtained from the SEER-Medicare database, which is the linkage of Surveillance, Epidemiology, and End-Results (SEER) registry information with Medicare claims data. Since 1992, the SEER program has collected data on incident cancer cases from 11 cancer registries in 5 states (Connecticut, Hawaii, Iowa, New Mexico, and Utah) and 6 metropolitan areas (Los Angeles, San Francisco/Oakland, San Jose, Detroit, Seattle, and Atlanta) that account for approximately 14% of the population in the US (13). For each case identified, the SEER program collects demographic features, date of cancer diagnosis, cancer site, and method of diagnosis (histology, cytology, microscopic confirmation (method not specified), laboratory test/marker study, direct visualization or positive radiology tests).

Medicare is the primary health insurer for approximately 97% of individuals age 65 years and older in the US. Medicare claims data are collected for both Medicare Part A and Part B benefits. Approximately 95% of Medicare beneficiaries are covered by both Part A and Part B benefits. Claims information from inpatient hospitalizations covered by Medicare Part A benefits are included in the Medicare Provider Analysis and Review (MEDPAR) files. This file contains up to 10 diagnosis and 10 procedure codes using ICD-9-CM codes. Medicare claims data for all Part B covered benefits include physician/supplier services, and contain ICD-9-CM diagnosis codes and Current Procedural Terminology (CPT)-4 codes for all billed claims.

We obtained data for this study from the SEER-Medicare database, which is the linkage of SEER registry information with Medicare claims data. The linked SEER-Medicare data is a collaborative effort by the National Cancer Institute, the SEER registries, and Centers for Medicare and Medicaid Services. This database contains Medicare Part A and Part B claims data beginning in 1991 for all Medicare-enrolled patients identified by SEER registries. Additional details regarding this linkage are described elsewhere. (13)

Study population

All patients over age 65 years diagnosed with pancreatic cancer who were identified in one of the eleven SEER registries and also enrolled in Medicare between 1992 and 2002 were

eligible for inclusion in this study. ICD-O-2 codes used to identify patients diagnosed with pancreatic cancer included: 8000–8003, 8010, 8012, 8020–8022, 8030–8033, 8041–8042, 8050, 8052, 8140–8141, 8143–8144, 8211, 8230, 8260–8263, 8310, 8440–8441, 8450, 8452, 8470–8471, 8480–8481, 8490, 8500, 8503–8504, 8510, 8521, 8550, 8560, 8570. Only patients with diagnostically confirmed pancreatic cancer, defined as having positive histology, cytology, laboratory test/marker study, direct visualization or positive radiology tests, were eligible for our study cohort. Those with clinical diagnoses only or unknown method of confirmation were excluded. Patients whose pancreatic cancer diagnoses were reported exclusively by death certificate or at autopsy were also excluded. Among all patients who met the above eligibility criteria, we included only those patients who received curative surgery as indicated by the presence of specific CPT or ICD-9 codes (Table 1).

To include patients with equal treatment information, we selected only those with continuous enrollment in Medicare Parts A and B for the year prior to their cancer diagnosis. We excluded patients enrolled in health maintenance organizations (HMOs) during this time period since Medicare HMO plans have not been required to submit individual claims for specific services to the Centers for Medicare and Medicaid Services. (13) Finally, to eliminate the effects of post-operative mortality on our analyses, we excluded patients who died within 30 days following the date of surgery.

Adjuvant chemotherapy and radiation treatment information

We determined patients' receipt of adjuvant chemotherapy and radiation therapy for pancreatic cancer based on the presence of CPT codes ascertained from the MedPAR, Physician/Supplier, and Outpatient Medicare Claims Files (Table 1). Receipt of therapy was defined as having at least one CPT code indicating treatment during the 6 months following receipt of surgery. Patients were classified into one of the following treatment categories: 1) surgery only; 2) surgery and chemotherapy only; 3) surgery and radiation only; and 4) surgery and chemoradiation.

Demographic information

We collected information on year of diagnosis (1992–1995, 1996–1999, 2000–2002), age (<75, ≥75) sex (male, female), race (white, black, Hispanic, other race), stage of disease (I, II, III, unknown), comorbidity score (0, 1, ≥2), and income (median ZIP code income as obtained from U.S. Census files).

Hospital characteristics

Hospital characteristics were obtained from the SEER-Medicare Hospital files. These files contain information collected from the Healthcare Cost Report and the Provider of Service survey obtained from the Centers for Medicare and Medicaid Services. Hospital characteristics included membership in a cooperative group (0, ≥1, unknown), National Cancer Institute Cancer Center designation (None, clinical, comprehensive, unknown), hospital type (non-profit, proprietary, government, unknown), location (urban, rural, unknown), teaching status (yes, no, unknown), and hospital size. Hospital size was determined by the total number of hospital beds at each facility.

Statistical analysis

We compared patient, clinical, and hospital characteristics across the four treatment categories described above. Univariate and multiple logistic regression analyses were conducted to examine the associations between these characteristics and receipt of any adjuvant therapy following surgery (14).

Unadjusted Cox proportional hazards models were constructed to examine the effect of receipt of adjuvant chemotherapy with and without radiation on the risk of 2-year mortality. We constructed additional Cox proportional hazards models to adjust for patient, clinical, and hospital factors. Adjusted odds ratios and 95% confidence intervals were calculated for each parameter estimate. (15) The Institutional Review Board (IRB) affiliated with Baylor College of Medicine approved the study protocol.

RESULTS

Characteristics of the study cohort

We identified 1,516 patients over age 65 in the SEER-Medicare database diagnosed with pancreatic cancer between 1992 and 2002 who received surgical resection. Of these cases, 1,383 patients satisfied our criteria for inclusion in the study cohort. We excluded patients who received curative surgery more than 60 days prior to their date of pancreatic cancer diagnosis (n=14) and those who died within 30-days following surgery (n=119). For analyses that included hospital factors, patients with missing hospital data were excluded from the analyses (n=44).

Approximately 59% of patients were younger than 75 years of age at diagnosis. Over half were female (51%). The vast majority of patients were white (85%), and the remaining were black (7%), Hispanic (1%) and other race (7%). Most patients had stage II disease at diagnosis (56%) and a comorbidity score less than 2 (88%). Among all diagnostic testing modalities (histology, cytology, microscopic confirmation (method not specified), laboratory test/marker study, direct visualization or positive radiology tests), the majority of patients were diagnosed by histology (n=1,363; 98.5%), followed by cytology (n=10; 0.7%), radiology (n=7; 0.5%), laboratory test/marker study (n=1; 0.1%), microscopic confirmation (method not specified) (n=1; 0.1%), and direct visualization (n=1; 0.1%).

Utilization and determinants of adjuvant therapy for pancreatic cancer

The most frequent treatment in this cohort was curative surgery only (51%), followed by surgery and chemoradiation (31%), surgery and chemotherapy only (9%), and surgery and radiation only (9%). The mean age was not significantly different across these groups. However, patients younger than 75 years of age were significantly more likely to receive adjuvant chemotherapy or chemoradiation compared to patients 75 years and older ($p<0.001$). Compared to women, a greater proportion of men received adjuvant chemotherapy or chemoradiation following surgery ($p=0.034$). Patients who received adjuvant chemotherapy or chemoradiation were also significantly more likely to have stage II or III disease at diagnosis ($p=0.004$). Finally, patients residing in ZIP code areas with higher median incomes were more likely to receive adjuvant chemotherapy after surgery, with 48.2% of residents in the top quartile receiving adjuvant chemotherapy compared to 30.8% in the lowest quartile. Patients in the four treatment categories did not differ significantly with respect to year of diagnosis, race, or co-morbidity score (Table 2).

We also examined differences in hospital characteristics between patients who received surgery only, surgery with radiation, surgery and chemotherapy only, and surgery and chemoradiation. Patients who received care at hospitals that were members of a cooperative group ($p=0.005$), located in urban settings ($p=0.033$), or were teaching hospitals ($p=0.006$) were more likely to receive adjuvant chemotherapy or chemoradiation (Table 3).

In the unadjusted logistic regression analyses examining determinants of receiving adjuvant therapy (chemotherapy, radiation, or chemoradiation), likelihood of receiving adjuvant therapy was increased with more recent year of diagnosis, stage II disease, and greater income (Table 4). Patients diagnosed during 1996–1999 and 2000–2002 were 29% and 43%

more likely, respectively, to receive adjuvant therapy than patients diagnosed during 1992–1995. Patients with stage II disease were almost twice as likely to receive adjuvant therapy compared to patients diagnosed with stage I disease. Patients with median incomes in Quartile 4 were more than twice as likely to receive adjuvant therapy compared to those in Quartile 1, and those in Quartile 3 were 62% more likely to receive adjuvant therapy compared to patients in Quartile 1. On the other hand, patients who were older, who belonged to other racial groups other than white, black, or Hispanic, and who resided in specific geographic regions were less likely to receive adjuvant therapy.

Hospital factors were also found to be important determinants of receiving adjuvant therapy following surgery. In unadjusted logistic regression models, membership in a cooperative group and larger hospital size were associated with an increased likelihood of receiving adjuvant therapy, while government status and rural location were associated with a decreased likelihood of receiving adjuvant therapy (Table 5).

These results remained consistent in the multiple logistic regression analysis. In addition to factors significant in the unadjusted analysis, black race and greater co-morbidity score became significantly associated with a decreased likelihood of receiving adjuvant therapy (Table 4). In the multivariable model, black patients were 39% less likely than white patients to receive adjuvant therapy, while a co-morbidity score of >2 was associated with a 32% decline in the likelihood of receiving adjuvant therapy. In the multivariable model examining hospital characteristics (Table 4), only hospital size and government status remained significant predictors of adjuvant therapy after adjusting for year of diagnosis, age, gender, race, registry, and income.

Survival following receipt of adjuvant therapy for pancreatic cancer

In the unadjusted 2-year Cox proportional hazards model, patients who received adjuvant chemoradiation after surgery had a 23% lower risk of mortality compared to those who received surgery alone (HR=0.77, 95% CI: 0.66–0.89), while patients who received only radiation after surgery had a 20% lower risk of mortality (HR=0.80, 95% CI: 0.93–1.45). The risk of mortality was not significantly different between patients who received surgery and chemotherapy only and those who received surgery alone (HR=1.16; 95%CI: 0.93–1.45).

These findings persisted in the 2-year Cox proportional hazards model after adjusting for patient and clinical factors (year of diagnosis, age at diagnosis, sex, race, co-morbidity score, stage of disease, SEER registry location, and income). In the adjusted model, patients who received adjuvant chemoradiation after surgery had a 25% lower risk of mortality compared to patients who received surgery alone (HR=0.75, 95% CI: 0.64–0.88) and patients who received surgery and radiation only had a 22% lower risk of mortality (HR=0.78, 95% CI: 0.61–0.99). No differences in the risk of mortality were observed between patients who received surgery and chemotherapy alone and patients who received only surgery.

We also examined a similar Cox Proportional Hazards model that examined the effect of adjuvant therapy on the risk of 2-year mortality, adjusting for hospital characteristics in addition to patient and clinical factors (Table 6). Consistent with the previous model, adjuvant chemotherapy with radiation (HR=0.76; 95% CI: 0.65–0.89) and radiation alone (HR=0.78; 95% CI: 0.61–0.99) were associated with improvements in 2-year mortality. No differences in mortality were observed between patients who received surgery and chemotherapy only (HR=1.18; 95% CI: 0.94–1.49) compared to those who received surgery alone.

DISCUSSION

In this study, we examined the utilization, determinants, and survival outcomes of adjuvant chemotherapy and radiation following receipt of curative surgery in older adults with pancreatic cancer in the United States. Several clinical trials, including a recent meta-analysis, have reported that adjuvant therapy following surgery is associated with improved outcomes (8–10), yet only 49% of our population received adjuvant therapy after surgery. Patients diagnosed during more recent years, as well as those who were younger, had stage II disease, and had higher incomes were more likely to receive adjuvant therapy following surgery, while those who were non-white and resided in certain SEER regions were less likely to receive any adjuvant therapy. It appears that although less than half of our cohort received adjuvant therapy, the most likely patients to receive therapy were individuals with regional disease who benefit most from adjuvant therapy, as well as younger individuals who have the lowest risk from adjuvant therapy. However, we also found that certain non-patient characteristics such as receiving care at larger hospitals, was consistently associated with receipt of adjuvant therapy.

Over half of the patients in this study did not receive adjuvant chemotherapy or radiation following surgery. However, our study examined an older population and thus patients may have had more comorbid disease than those enrolled in clinical trials. Therefore, physicians may have been less likely to offer adjuvant therapy to our study population. Also, clinical practice patterns for pancreatic cancer were changing during our study period. The focus on adjuvant therapy following surgery began to increase following the approval of Gemcitabine in 1998. Prior to this time, 5-Fluoracil was the only standard chemotherapy treatment available to patients with pancreatic cancer. Further, results from several landmark clinical trials demonstrating the efficacy of adjuvant therapy following surgery were published during the study period, resulting in better standardization of treatment during more recent years. This may also partially explain the large variation of treatment patterns by geography and hospital characteristics observed in our study.

Another possible explanation for the low rates of adjuvant therapy observed in this study could be low rates of referral to oncologists. In most cases, the oncologist is responsible for determining who is eligible to receive adjuvant therapy. The input of the oncologist is important for deciding on the appropriate course of adjuvant therapy, but it maybe even important before surgery for certain patients who could be eligible for neoadjuvant therapy. However, in this study, we did not have physician level data to quantify the percent of patients seen by an oncologist or examine treatment referral patterns.

When we examined the association between survival and receipt of adjuvant therapy, we observed a significant reduction in the risk of 2-year mortality among patients who received chemoradiation compared to those who received no adjuvant therapy at all. These findings are consistent with several randomized controlled trials published in the literature. (16,17) In the Gastrointestional Tumor Study Group (GITSG), median survival was 20 months among patients who received chemotherapy and radiation compared to 11 months among patients who received surgery only (17).

However, several other trials found no benefit for adjuvant chemoradiation. In particular, the European Organization for Research and Treatment of Cancer, the ESPAC trial, and a large meta-analysis did not detect a survival advantage for those receiving adjuvant chemoradiation compared to those receiving surgery only. (9,16,17) However, there have been critiques of this study because a substantial proportion of patients did not complete the full number of protocol cycles of treatment. (18) In addition, in a sub-analysis of the meta-analysis, chemoradiation appeared to benefit those individuals with positive surgical

margins after surgery. (10) Our findings of decreased 2-year mortality associated with chemoradiation, but not chemotherapy alone following surgery may reflect the long-term benefit for patients with poorer prognostic factors, such as positive surgical margins. (17) Although we did not have access to surgical margin status in this study, patients with stage II disease were more likely to receive adjuvant therapy, and these patients may have been more likely to have positive surgical margins after therapy. In addition, we were not able to examine the type of chemotherapy received and whether a complete course of chemotherapy was administered. Yet, this study reflects what was actually occurring in clinical practice, particularly among older patients with pancreatic cancer.

Interestingly, we observed a survival advantage among those patients who received surgery followed by radiation therapy alone. Although 9% of our study cohort received radiation therapy only after surgery, this treatment strategy is not widely recommended. It is possible that patients who did not have access to a medical oncologist but were good candidates for adjuvant therapy received radiation only. Thus we are observing the effect of patient selection. In addition, these patients may have been able to complete or tolerate a longer course of radiation treatment resulting in improved survival.

It is important to recognize that our study reflects actual practice patterns and outcomes. Since our study is not a randomized clinical trial, comparisons between treatment options need to be made with caution. Although we adjusted for possible confounders in our multivariable model, we could not completely eliminate the potential bias that healthier patients were more likely to receive more aggressive therapy (chemotherapy plus radiation) rather than chemotherapy alone.

Our findings must be interpreted within the potential limitations of our data source. First, the use of diagnostic and procedure codes to identify therapy may vary by facility or provider. Second, we were unable to account for patient treatment preferences. Third, we did not examine cancer-specific mortality in this study, although it is likely that the overall mortality from pancreatic cancer would be similar to cancer-specific mortality. Fourth, we did not have access to variables such as resection margin status that have been shown to be prognostic indicators in other studies.

Our data source has several notable strengths. First, the SEER registries are selected to represent the entire US population, and therefore our overall findings should be generalizable to the entire US population age 65 years and older. (13) Second, we have complete ascertainment of patients with pancreatic cancer, which also facilitates the generalizability of our results because the SEER program maintains at least a 98% completeness rate for case ascertainment. Third, all cases of pancreatic cancer included in this analysis were confirmed by pathology, radiology, and/or laboratory testing. Fourth, we selected our cohort to obtain complete Medicare claims data, thus minimizing the possibility of losing any recorded encounters with the health care system.

In conclusion, we found that almost half of all patients with pancreatic cancer who received surgical resection also received adjuvant treatment. Further, our findings indicated that chemoradiation is associated with an improvement in survival among older patients. While clinical trials have demonstrated the efficacy of adjuvant chemotherapy and radiation early stage pancreatic cancer, our study further demonstrates that these therapies may also be effective in the elderly population. Further studies are needed to examine the utilization of specific chemotherapy agents, and specific adjuvant therapies for pancreatic cancer in older adults, and to evaluate the effectiveness of these agents on improving outcomes.

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Table 1

ICD-9 and CPT codes used to identify patients who received curative surgery, chemotherapy, or radiation therapy.

	Codes used to identify patients who received therapy
Curative Surgery	
ICD-9	527, 5251, 5253
CPT procedure codes	48140, 48145–48146, 48148, 48150, 48152–48155
Chemotherapy	
ICD-9	9925, V581, V662, V672
CPT drug codes	J8520–8521, J9000, J9010, J9015, J9020, J9031, J9040, J9045, J9050, J9060, J9062, J9065, J9070, J9080, J9090–9097, J9100, J9110, J9120, J9130, J9140, J9150, J9165, J9181–9182, J9185, J9190, J9200–9202, J9208–9209, J9211–9215, J9216–9218, J9230, J9245, J9250, J9260, J9265, J9266, J9268, J9270, J9280, J9290–9291, J9293, J9320, J9340, J9360, J9370, J9375, J9380, J9390, J9999
CPT procedure codes	0331–0332, 0335, 96400, 96405, 96408, 96410, 96412, 96414, 96420, 96422, 96423, 96425, 96440, 96445, 96450, 96520, 96530, 96542, 96545, 96549, Q0083, Q0085
Radiation therapy	
CPT procedure codes	77401–77416

Table 2

Patient and clinical characteristics among Medicare enrolled-patients diagnosed with pancreatic cancer who received curative surgery with or without adjuvant therapy. (N=1,383)

	Surgery only (n=709)		Surgery and radiation only (n=126)		Surgery and chemotherapy only (n=126)		Surgery and chemoradiation (n=422)		*P*
	N	%	N	%	N	%	N	%	
Diagnosis year (%)									
1992–1995	254	56	48	11	40	9	115	25	0.073
1996–1999	245	51	42	3	43	9	155	32	
2000–2002	210	48	36	8	43	10	152	34	
Age									
<75 years	353	44	85	10	81	10	292	36	<0.001
≥75 years	356	62	41	7	45	8	130	23	
Gender									
Men	335	50	50	7	71	11	216	32	0.034
Women	374	53	76	11	55	7	206	29	
Race									
White	585	50	102	9	111	10	371	32	0.157
Black	60	58	13	13	7	7	23	22	
Hispanic	5	33	*	*	*	*	6	40	
Other	59	61	9	9	6	6	22	23	
Stage of disease									
I	121	62	14	7	13	7	48	25	0.004
II	359	46	72	9	68	9	277	36	
III	26	52	*	*	5	10	15	30	
Unknown	203	56	23	10	40	11	82	23	
Co-morbidity score									
0	426	50	85	10	86	10	256	30	0.427
1	189	52	29	8	26	21	117	32	
≥2	94	56	12	7	14	11	49	29	
SEER registry									

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	Surgery only (n=709)		Surgery and radiation only (n=126)		Surgery and chemotherapy only (n=126)		Surgery and chemoradiation (n=422)		*P*
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	
San Francisco	52	63	8	10	11	13	12	14	<0.001
Connecticut	97	45	11	5	19	9	89	41	
Detroit	128	44	34	12	31	11	99	34	
Hawaii	29	52	*	*	*	*	21	38	
Iowa	99	57	17	10	7	4	51	29	
New Mexico	29	63	*	*	5	11	9	20	
Seattle	56	53	8	8	11	10	31	29	
Utah	51	71	*	*	5	7	14	19	
Atlanta	35	44	9	11	6	8	30	38	
San Jose	28	40	17	24	5	7	20	29	
Los Angeles	105	56	14	7	23	12	46	24	
Income									
Quartile 1	197	59	32	10	26	8	76	23	0.001
Quartile 2	184	56	26	8	24	7	95	29	
Quartile 3	160	48	29	9	32	10	113	34	
Quartile 4	137	41	35	10	41	12	119	36	
Unknown	31	54	*	*	*	*	19	33	

* Indicates cell size of n<5

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Table 3

Hospital characteristics among Medicare enrolled-patients diagnosed with pancreatic cancer who received curative surgery with or without adjuvant therapy. (N=1,383)

	Surgery only (n=709)		Surgery and radiation only (n=126)		Surgery and chemotherapy only (n=126)		Surgery and chemoradiation (n=423)		*P*
	N	%	N	%	N	%	N	%	
Membership in a cooperative group									
Yes	548	49	97	8	108	10	360	32	0.005
No	134	59	24	11	12	5	56	25	
Unknown	*	*	*	*	*	*	*	*	
Missing	27	61	5	11	6	14	6	14	
NCI Cancer Center Designation									
Comprehensive	100	47	24	11	24	11	67	31	0.143
Clinical	14	56	*	*	*	*	10	40	
None	568	52	97	9	95	9	339	31	
Unknown	*	*	*	*	*	*	*	*	
Missing	27	61	5	11	6	14	6	14	
Hospital Type									
Non-profit	541	49	101	9	99	9	357	33	0.069
Proprietary	40	55	6	8	9	12	18	25	
Government	101	60	14	8	12	7	41	24	
Unknown	*	*	*	*	*	*	*	*	
Missing	27	61	5	11	6	14	6	14	
Urban/Rural Status									
Urban	644	50	116	9	114	9	406	32	0.033
Rural	31	65	*	*	*	*	9	19	
Unknown	34	62	6	11	8	15	7	13	
Missing	*	*	*	*	*	*	*	*	
Teaching Hospital									
Yes	499	49	84	8	94	9	336	33	0.006

	Surgery only (n=709)		Surgery and radiation only (n=126)		Surgery and chemotherapy only (n=126)		Surgery and chemoradiation (n=423)		*P*
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	
No	32	53	*	*	5	8	19	32	
Unknown	178	57	38	12	27	9	67	22	
Missing	*	*	*	*	*	*	*	*	

* Indicates cell size of n<5

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Table 4

Results from logistic regression models examining patient and clinical factors associated with receipt of any adjuvant therapy among patients who received curative surgery for pancreatic cancer. (N=1,383).

	Unadjusted models			Full model		
	Odds ratio	**95% CI**	***P***	**Odds ratio**	**95% CI**	***P***
Year of diagnosis						
1992–1995	1.00	-	Reference	1.00	-	Reference
1996–1999	1.29	0.99–1.68	0.054	1.30	0.96–1.75	0.092
2000–2002	1.43	1.10–1.87	0.008	1.48	1.08–2.02	0.014
Age at diagnosis						
< 75 years	1.00	-	Reference	1.00	-	Reference
≥ 75 years	0.46	0.37–0.57	<0.001	0.43	0.34–0.54	<0.001
Gender						
Female	1.00	-	Reference	1.00	-	Reference
Male	1.11	0.90–1.38	0.324	1.17	0.93–1.47	0.189
Race						
White	1.00	-	Reference	1.00	-	Reference
Black	0.75	0.50–1.13	0.167	0.61	0.38–0.99	0.046
Hispanic	1.98	0.67–5.84	0.214	2.36	0.74–7.55	0.149
Other	0.63	0.41–0.97	0.034	0.47	0.25–0.86	0.015
Stage of disease						
I	1.00	-	Reference	1.00	-	Reference
II	1.92	1.39–2.65	<0.001	1.89	1.35–2.66	0.002
III	1.44	0.76–2.73	0.267	1.46	0.74–2.88	0.278
Unknown	1.32	0.92–1.89	0.137	1.30	0.88–1.91	0.187
Co-morbidity score						
0	1.00	-	Reference	1.00	-	Reference
1	0.88	0.69–1.13	0.314	0.88	0.68–1.16	0.367
≥2	0.78	0.56–1.09	0.150	0.68	0.48–0.98	0.038
SEER Registry						

	Unadjusted models			Full model		
	Odds ratio	**95% CI**	***P***	**Odds ratio**	**95% CI**	***P***
Detroit	1.00	-	Reference	1.00	-	Reference
San Francisco	0.48	0.29–0.79	0.004	0.37	0.22–0.64	0.004
Connecticut	0.97	0.68–1.39	0.881	0.78	0.53–1.15	0.211
Hawaii	0.69	0.39–1.23	0.212	1.08	0.49–2.38	0.852
Iowa	0.58	0.40–0.85	0.005	0.55	0.35–0.85	0.007
New Mexico	0.45	0.24–0.86	0.016	0.42	0.21–0.84	0.022
Seattle	0.69	0.44–1.08	0.103	0.62	0.38–1.00	0.051
Utah	0.32	0.19–0.57	<0.001	0.26	0.14–0.47	<0.001
Atlanta	1.04	0.62–1.73	0.744	0.97	0.56–1.66	0.897
San Jose	1.10	0.65–1.89	0.722	0.98	0.55–1.74	0.932
Los Angeles	0.64	0.44–0.94	0.052	0.62	0.41–0.93	0.022
Income						
Quartile 1	1.00	-	Reference	1.00	-	Reference
Quartile 2	1.18	0.87–1.63	0.284	1.04	0.74–1.47	0.825
Quartile 3	1.62	1.19–2.21	0.002	1.30	0.89–1.88	0.172
Quartile 4	2.20	1.61–3.02	<0.001	1.64	1.10–2.47	0.016
Unknown	1.29	0.73–2.28	0.386	1.15	0.62–2.13	0.667

Table 5

Results from logistic regression models examining effects of hospital characteristics on the receipt of any adjuvant therapy among patients who received curative surgery for pancreatic cancer. This model exclude patients with missing hospital characteristics (N=1,339).

	Unadjusted Models			Full Model*		
	Odds ratio	**95% CI**	***P***	**Odds ratio**	**95% CI**	***P***
Membership in a cooperative group						
No	1.00	-	-	1.00	-	-
Yes	1.50	1.12–2.01	0.006	0.95	0.66–1.36	0.764
NCI Cancer Center Designation						
None	1.00	-	-	1.00	-	-
Comprehensive	1.23	0.92–1.65	0.166	0.95	0.65–1.40	0.803
Clinical	0.84	0.38–1.87	0.672	3.26	1.13–9.42	0.029
Hospital Type						
Non-profit	1.00	-	-	1.00	-	-
Proprietary	0.80	0.50–1.29	0.362	1.46	0.82–2.61	0.199
Government	0.64	0.46–0.90	0.009	0.66	0.45–0.99	0.046
Urban/Rural Status						
Urban	1.00	-	-	1.00	-	-
Rural	0.55	0.30–1.01	0.055	1.19	0.57–2.45	0.646
Unknown	0.58	0.17–1.99	0.385	0.92	0.23–3.76	0.913
Teaching Hospital						
No	1.00	-	-	1.00	-	-
Yes	1.18	0.70–1.98	0.540	1.20	0.64–2.26	0.565
Unknown	0.87	0.50–1.53	0.628	1.36	0.70–2.64	0.369
Hospital Size						
Quartile 1	1.00	-	-	1.00	-	-
Quartile 2	1.44	1.06–1.96	0.020	1.49	1.03–2.17	0.037
Quartile 3	1.46	1.07–1.98	0.016	1.61	1.08–2.40	0.021
Quartile 4	1.97	1.45–2.68	<0.001	1.85	1.20–2.86	0.006

*Model adjusted for year of diagnosis, age, gender, race, stage, comorbidity, registry, and income.

Table 6

Results from a Cox Proportional Hazards Model examining the effect of adjuvant therapy on the risk of 2-year mortality, adjusting for patient, clinical, and hospital characteristics among patients who received curative surgery. This model excludes patients with missing hospital characteristics (N=1,339).

	Unadjusted models			Full model*		
	Hazard ratio	**95% CI**	***P***	**Hazard ratio**	**95% CI**	***P***
Receipt of adjuvant therapy						
None	1.00	-	Reference	1.00	-	Reference
Radiation only	0.80	0.63–1.02	0.074	0.78	0.61–0.99	0.047
Chemotherapy only	1.16	0.93–1.45	0.188	1.18	0.94–1.49	0.151
Chemoradiation	0.77	0.66–0.89	0.001	0.76	0.65–0.89	0.001

*Model adjusted for year of diagnosis, age, gender, race, stage, comorbidity, registry, income, and hospital characteristics