7-1-2022

Socioeconomic Status and Gastric Cancer Surgical Outcomes: A National Cancer Database Study.

Ryan Lamm
Thomas Jefferson University

D Brock Hewitt
The Ohio State University

Michael Li
Thomas Jefferson University

Adam C Powell
Thomas Jefferson University

Adam C Berger
Rutgers Cancer Institute of New Jersey

Recommended Citation

Lamm, Ryan; Hewitt, D Brock; Li, Michael; Powell, Adam C; and Berger, Adam C, "Socioeconomic Status and Gastric Cancer Surgical Outcomes: A National Cancer Database Study." (2022). *Department of Surgery Faculty Papers.* Paper 213.
https://jdc.jefferson.edu/surgeryfp/213

Socioeconomic status and gastric cancer surgical outcomes: A National Cancer Database study

Short Title: Socioeconomic Status and Gastric Cancer

Ryan Lamm MD[a], D. Brock Hewitt MD[b], Michael Li PhD[c], Adam C. Powell PhD[d], Adam C. Berger MD[e]

[a]Department of Surgery, Sidney Kimmel Medical College at Thomas Jefferson University, 111 South 11th Street, Philadelphia, PA, USA 19107

[b]Department of Surgery, Ohio State University Wexner Medical Center, 410 W. 10th Ave. Columbus, OH 43210

[c]Department of Bioinformatics, Sidney Kimmel Medical College at Thomas Jefferson University, 111 South 11th Street, Philadelphia, PA, USA 19107

[d]Thomas Jefferson University, College of Population Health, 111 South 11th Street, Philadelphia, PA 19107

[e]Department of Surgery, Rutgers Cancer Institute of New Jersey, 195 Little Albany St, New Brunswick, NJ 08901

Corresponding author: Ryan Lamm, MD; Department of Surgery, Thomas Jefferson University Hospital, 111 South 11th Street, Philadelphia, PA USA 19107 (email: ryan.lamm@jefferson.edu; Phone Number: 516-547-7676)

Author contributions: RL contributed to study design, data collection, manuscript writing, and manuscript editing. DBH and ACB contributed to study design, data collection, and manuscript editing. AP and ML contributed to statistical analysis and manuscript editing.

ABSTRACT

Background: Gastric cancer (GC) is the third leading cause of cancer-related death worldwide. Surgical resection is the gold standard of treatment. In the US, race and socioeconomic status are associated with the diagnosis of GC, however no studies have examined these as independent risk factors for surgical outcomes. Our study sought to investigate socioeconomic factors and GC surgical outcomes using a national cancer registry.

Methods: GC patients between 2004 and 2016 were identified using the NCDB. Univariate and multivariate logistic regression was used to analyze associations between socioeconomic factors and 30-day mortality, 90-day mortality, and unplanned readmission rate.

Results: 96,990 patients who received non-palliative surgical treatment for GC were identified. When controlling for other clinical and socioeconomic factors, older age, male sex, higher co-morbidities, larger tumor size, advanced stage disease, and inadequate resection were correlated with worse 30- and 90-day mortality. Additionally, 30-day and 90-day mortality was significantly lower the higher the patient's income (OR 0.77 and OR 0.43, respectively for >$63,333/year v <$40.227/year) and percentage of residents with a high school degree (HSD) in their zip code (OR 0.69 and OR 0.52, respectively for <6.3% no HSD v ≥17.6%). No significant disparate trends were identified in terms of race, insurance status, or in unplanned readmissions on multivariate analysis.

Conclusions: Lower income and level of education at place of residence were independently associated with higher 30-day and 90-day mortality in this study highlighting the potential for a major socioeconomic disparity in this population.

Keywords: Gastric Cancer, NCDB, Socioeconomic disparities

INTRODUCTION

Worldwide, gastric cancer (GC) is the third leading cause of cancer death in both sexes with 5-year survival less than 30% [1]. *H. pylori* infection and autoimmune gastritis are the leading causes of GC [2]. Incidence has decreased in the US due to improvements in screening and *H. pylori* treatment. Recent epidemiologic studies suggest that changes in GC causation and the cohort of patients affected have also impacted incidence [3]. Race and ethnicity are independent risk factors for developing GC, with Asian, Hispanic, and non-Hispanic black populations having a 40-50% increased risk of gastric cancer compared to non-Hispanic whites [4, 5]. Furthermore, low socioeconomic status is correlated with a higher incidence of GC [6].

Nationwide studies have shown a decrease in GC-related mortality from 10% to 6% with an associated increase in health care cost of $1.7 - 2 billion dollars between 2003 and 2014 [7]. Prognostic factors of GC mortality include tumor size, location, stage, histologic classification, and microsatellite instability [8], however a paucity of data exists on the relationship between GC-related morbidity, mortality, and socioeconomic factors. With knowledge of these relationships, improved screening and treatment plans may be developed targeted towards susceptible populations with the goal of decreasing GC-related mortality, readmissions, and health care costs overall.

We hypothesized the GC morbidity and mortality would be adversely affected by race, socioeconomic status, and factors which affected access to quality care such as facility type and proximity to treatment facility. Utilizing a national database, we sought to investigate the nature, if any, of these trends.

METHODS

Inclusion and Exclusion Criteria and Data Collection. Using the National Cancer Database (NCDB) registry, patients diagnosed with gastric cancer between the years of 2004-2016 and received surgical resection as treatment were identified. NCDB is a clinical oncology database sourced from hospital registry data that are collected in over 1,500 Commission on Cancer

(CoC)-accredited facilities jointly sponsored by the American College of Surgeons and the American Cancer Society [9]. The Thomas Jefferson University IRB approved this study as exempt due to a lack of patient identifiers within the dataset. Patients were excluded if they did not receive surgical treatment or their surgical record was incomplete, if they were younger than 18 years of age, and/or if their surgical treatment was for palliative purposes. Patient factors examined were age, sex, race, Charlson comorbidity index (CCI) scores, insurance status, yearly income, % of no high school degree, and distance between residence and treating facility. Clinical factors examined were facility type, tumor size, regional lymph node status, analytic disease stage, surgical resection adequacy, and receipt of chemo-, radio-, hormone-, and/or immunotherapy. The category in race we described as “other” included patients whose database entries identified them as American Indian, Aleutian, or Eskimo. Their individual subgroups had two few entries to independently analyze, thus we created the “other” category.

Outcomes. Outcomes measured in this study included 30-day mortality, 90-day mortality, and unplanned readmissions.

Statistical Analysis. Full surgical cohort analyses were performed in addition to subgroup analyses on the cohorts listed above. Chi-square tests were used for univariate comparisons. Multivariate logistic regression models were used to compare categorical variables and their independent association with 30-day mortality, 90-day mortality, and unplanned readmissions. To control for possible confounding, the aforementioned patient and clinical factors were all included in the multivariable models. Estimated odds ratios (ORs) and corresponding 95% confidence intervals (CIs) were reported. All analysis was performed using SAS 9.4 (SAS Institute Inc., Cary, NC) and significance level was set at <0.0001.

RESULTS

Demographics. We identified 202,216 patients with GC using the NCDB. 96,990 patients met the inclusion criteria and were included for consideration in the univariate and multivariate analysis. Those without complete records for a specific outcome were not included in the analysis (**Figure 1**). The patient and clinical factors (as defined in the methods section) of each patient included in the study population are presented in (**Table 1**)**.**

Univariate analysis

30-day and 90-day mortality. Univariate analysis and mortality rates for socioeconomic variables of interest (race, insurance status, yearly income, level of education in zip code of interest, distance between patient's residence and treatment facility, and facility type) are displayed in **Table 2**. 30-day mortality rate was 3.9% and 90-day mortality rate was 8.4% for the entire cohort studied. All variables were statistically significant in univariate analysis ($p<0.0001$) except race in 30-day mortality ($p=0.0307$).

Unplanned readmissions. Univariate analysis and unplanned readmission rates for aforementioned socioeconomic variables of interest are displayed in **Table 3**. Unplanned readmission rate was 5.8% for the entire cohort studied. None of the variables were statistically significant to the level of $p<0.0001$.

Multivariate analysis

All patient and clinical factors, including the socioeconomic factors of interest mentioned earlier were used in the multivariate analysis including variables which were not significant in univariate analysis.

30-day mortality. The odds of 30-day mortality significantly increased as age increased (OR 2.49, CI 1.99-3.11 for age >80 years v <50 years), in males (OR 1.36, 1.26-1.47 v females), in those with higher CCI scores (OR 1.77, CI 1.49-2.12 for CCI 3+ v 0), larger tumors (OR 1.45, CI 1.24-1.7 for tumors >10 millimeters v <0-3 millimeters), higher analytic disease stage (OR 3.59, CI 2.58-4.99 for stage 4 v stage 0), and those who did not receive adequate resections (OR 1.8, CI 1.41-2.3 for R2 v R0 resection), chemotherapy (OR 4.6), radiotherapy (OR 1.28), and immunotherapy (OR 4.25). Additionally, 30-day mortality was significantly decreased in patients with private insurance (OR 0.86, CI 0.77-0.95 v Medicare) as yearly salary increased (OR 0.77, CI 0.66-0.88 for >$63,333/year v <$40,227/year) and as percentage of residents without a high school degree (HSD) in patient’s zip code decreased (OR 0.69, CI 0.6-0.81 for <6.3% v >17.6%). Race other than White appeared protective, except in the other category. All covariates utilized in the analyses are listed in **Table 4**.

90-day mortality. The odds of 90-day mortality significantly increased as age increased (OR 1.74, CI 1.52-1.99 for age >80 years v <50 years), in males (OR 1.17, 1.11-1.24 v females), in those with higher CCI scores (OR 1.49, CI 1.28-1.73 for CCI 3+ v 0), larger tumors (OR 1.28, CI 1.14-1.44 for tumors >10 millimeters v <0-3 millimeters), higher analytic disease stage (OR 1.94, CI 1.59-2.36 for stage 4 v stage 0), and those who did not receive adequate resections (OR 1.6, CI 1.28-2.0 for R2 v R0 resection), chemotherapy (OR 2.42. Additionally, 90-day mortality was significantly decreased as yearly salary increased (OR 0.43, CI 0.39-0.48 for >$63,333/year v <$40,227/year) and as percentage of residents without a high school degree (HSD) in patient’s zip code decreased (OR 0.52, CI 0.47-0.58 for <6.3% v >17.6%). Race other than White, again, appeared protective except in the other category. All covariates utilized in the analyses are listed in **Table 4**.

Unplanned readmission. No significant correlation was found in the unplanned readmissions multivariate analyses. All covariates utilized in the analyses are listed in **Table 4**.

DISCUSSION

While many studies have identified non-modifiable demographic and socioeconomic risk factors for the development of gastric cancer in the US and worldwide, few have explored the notion that they may represent independent risk factors for poor outcomes. The novelty of our study is the identification of specific socioeconomic factors, namely yearly income and education level in zip code of residence, as strong independent risk factors for poor surgical outcomes when controlling for all other patient and clinical factors in GC. While other studies performed did identify socioeconomic inequality as an independent risk factor for lower survival in patients diagnosed with various solid tumors, none to our knowledge have specifically studied gastric cancer using a large national cancer dataset [10]. The fact that patients with the lowest quartile of income and living in the lowest educated zip codes are up to 57% and 48%, respectively, more likely to die within 90-days of surgery is an alarming and serious socioeconomic disparity which needs to be addressed. This will be the remainder of a majority of this discussion.

Part of the explanation for this observation could be lack of available resources and patient support in certain socioeconomic subpopulations of patients. This leads to poorer patient compliance, worse postoperative outcomes, and loss of adequate outpatient care that could contribute to the mortality relationships we observed. One potential sequelae of this disparity may be related to why we observed no significant relationships in the unplanned readmissions outcome: these patients do not have the resources to return to the hospital and seek care, thus increasing the mortality rate, but not the unplanned readmission rate. This is speculative and out of the scope of this study, but warrants further population-level inquiry.

Identifying intervenable opportunities in the effort to eradicate socioeconomic differences in morbidity and mortality will be key to closing this inequality gap. One study identified differences in treatment recommendations based on the race and geographic location of patients diagnosed with GC which correlated with the overall survival of these patients [11]. Recommendations for patients should be standardized regardless of race and location, unless racial or geographic differences exist in the natural history of the disease, of which there have been no reports for GC. This treatment difference must be eradicated with continued education and outreach programs for not only GC patients, but physicians who would diagnose and treat these patients. Also, for patients specifically treated with gastric resection, compliance post-operatively has been shown to be lower in patients with lower socioeconomic statuses [12]. This creates another opportunity for intervention, by coordinating and protocolizing post-operative care in post-gastrectomy patients, especially in low socioeconomic populations.

Finally, efforts like the “Stomach Cancer Pooling (StoP) project,” a collection of case–control and cohort studies from various areas of the world allowing its participants to study the relation between socioeconomic position and GC according to cancer subsite and histological subtype, should be mirrored across the US and worldwide [13, 14]. Using these data, we can target the most at-risk populations and not only increase awareness to lead to higher early-disease identification, but also increase patient compliance and healthcare provider accountability. Stress should be placed on treating these populations efficiently and effectively to close inequality gaps currently in existence.

We feel it is important to mention our study identified known risk factors such as older age and male sex to be correlated higher rates of GC mortality [6, 15]. We also identified additional previously studied risk factors, such as tumor size and analytic stage as independent risk factors for worse surgical outcomes [16]. Interestingly, however we did not identify regional lymph node status as an independent risk factor for worse surgical outcomes, despite it being well published that lymph node status is highly prognostic in GC [17]. One potential reason for this is the fact that these studies are usually on patients with later stages of GC (stage III and IV) and our cohort consisted of earlier stage patients recommended for surgery. These corroborative findings give confidence to the identification of the aforementioned socioeconomic variables as risk factors.

Limitations of the study include the fact that it is a retrospective database study and, thus, although NCDB abstractors are able to contact treating physicians to clarify missing data points, not every data point for all patients was collected. NCDB itself is a strong clinical database, but does not include every clinical datapoint which may influence clinical decision making, patient specific concerns, etc. [18]. In addition, many patients treated in the United States for GC are not included in this database. However, we believe for the purposes of our study which looked at mortality and unplanned readmission the data set was large and comprehensive enough to reliably observe the trends.

While other significant, and non-significant, relationships were observed in our study, many of these require further analysis and are outside of the scope of discussion we hoped to focus on. Notably, our study found no difference in mortality based on race, and even provided evidence of a protective correlation for non-White patients, which has been previously reported [19]. Finally, some interesting findings from our study which warrant more granular studies and may play a role in the socioeconomic gap in GC is the fact that 30-day mortality was significantly lower in patients who lived >20 miles from treatment facilities (OR 0.71), but significantly higher in 90-day mortality (OR 5.0) and all facility types seemed to put patients at higher risk for 30-day mortality, but lower for 90-day mortality, as compared to an academic/research institution. These findings suggest that more work needs to be done to identify care gaps and pitfalls, and that these care gaps may not be addressed with the same solution in the immediate postoperative period compared to the short-term postoperative period.

CONCLUSIONS

In our study, lower income and lack of education were significantly associated with higher 30-day mortality and 90-day mortality. This represents an alarming socioeconomic gap which warrants attention. While socioeconomic factors are considered largely *non-modifiable* within the realm of surgery, it *is* possible to modify protocols and programs to address the disparity and attempt to close the gap. This includes efforts to standardize screening and treatment protocols across different facility types and socioeconomic regions in the United States. These protocols could mirror previous recommendations to screen patients, via esophagogastroduodenoscopy, with known risk factors for gastric cancer (GC) in the US, such as history of *H. pylori* and/or Asian or Hispanic background, which have been shown to be cost-effective and life-saving [20]. Additionally, since our study specifically identified inequality in post-operative mortality, programs which focus on increasing follow-up adherence, via investment in outreach programs to remind patients to see their physicians, satellite clinics, and/or transportation programs which can help patients get to their appointments, in these disparate subgroups should be established. Only with efforts such as these, will the disparity gap in gastric cancer outcomes identified in our study begin to close in the United States.

ACKNOWLEDGEMENTS

We would like to acknowledge the support from Thomas Jefferson University Hospital and Rutgers Cancer Institute of New Jersey.

DISCLOSURE

The authors report no proprietary or commercial interest in any product mentioned or concept discussed in this article.

FUNDING

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

REFERENCES

1. Rugge, M., et al., *Gastric Cancer as Preventable Disease.* Clin Gastroenterol Hepatol, 2017. **15**(12): p. 1833-1843.
2. Venerito, M., et al., *Gastric cancer: epidemiology, prevention, and therapy.* Helicobacter, 2018. **23 Suppl 1**: p. e12518.
3. Anderson, W.F., et al., *The Changing Face of Noncardia Gastric Cancer Incidence Among US Non-Hispanic Whites.* J Natl Cancer Inst, 2018. **110**(6): p. 608-615.
4. Dong, E., L. Duan, and B.U. Wu, *Racial and Ethnic Minorities at Increased Risk for Gastric Cancer in a Regional US Population Study.* Clin Gastroenterol Hepatol, 2017. **15**(4): p. 511-517.
5. Lyons, K., et al., *Gastric cancer: epidemiology, biology, and prevention: a mini review.* Eur J Cancer Prev, 2019. **28**(5): p. 397-412.
6. Song, M., C.S. Rabkin, and M.C. Camargo, *Gastric Cancer: an Evolving Disease.* Curr Treat Options Gastroenterol, 2018. **16**(4): p. 561-569.
7. Liu, D., et al., *Decreasing mortality and hospitalizations with rising costs related to gastric cancer in the USA: an epidemiological perspective.* J Hematol Oncol, 2018. **11**(1): p. 138.
8. Polom, K., et al., *Meta-analysis of microsatellite instability in relation to clinicopathological characteristics and overall survival in gastric cancer.* Br J Surg, 2018. **105**(3): p. 159-167.
9. Kumar, A., et al., *Evaluation of the Use of Cancer Registry Data for Comparative Effectiveness Research.* JAMA Netw Open, 2020. **3**(7): p. e2011985.
10. Tron, L., et al., *Socioeconomic environment and disparities in cancer survival for 19 solid tumor sites: An analysis of the French Network of Cancer Registries (FRANCIM) data.* Int J Cancer, 2019. **144**(6): p. 1262-1274.
11. Ulanja, M.B., et al., *Influence of race and geographic setting on the management of gastric adenocarcinoma.* J Surg Oncol, 2019. **120**(2): p. 270-279.
12. Liu, G., et al., *Surgical Compliance and Outcomes in Gastric Cancer: a population-based cohort study.* J Cancer, 2019. **10**(4): p. 779-788.
13. Rota, M., et al., *Education and gastric cancer risk-An individual participant data meta-analysis in the StoP project consortium.* Int J Cancer, 2020. **146**(3): p. 671-681.
14. Pelucchi, C., et al., *The stomach cancer pooling (StoP) project: study design and presentation.* Eur J Cancer Prev, 2015. **24**(1): p. 16-23.
15. Lou, L., et al., *Sex difference in incidence of gastric cancer: an international comparative study based on the Global Burden of Disease Study 2017.* BMJ Open, 2020. **10**(1): p. e033323.
16. Guo, P., et al., *Prognostic value of tumor size in gastric cancer: an analysis of 2,379 patients.* Tumour Biol, 2013. **34**(2): p. 1027-35.
17. Kwon, S.J. and G.S. Kim, *Prognostic significance of lymph node metastasis in advanced carcinoma of the stomach.* Br J Surg, 1996. **83**(11): p. 1600-3.
18. Boffa, D.J., et al., *Using the National Cancer Database for Outcomes Research: A Review.* JAMA Oncol, 2017. **3**(12): p. 1722-1728.
19. Tsao, M.W., et al., *The impact of race and socioeconomic status on the presentation, management and outcomes for gastric cancer patients: Analysis from a metropolitan area in the southeast United States.* J Surg Oncol, 2020. **121**(3): p. 494-502.
20. Saumoy, M., et al., *Cost effectiveness of gastric cancer screening according to race and ethnicity.* Gastroenterology, 2018. **155**(3): p. 648-660.

TABLES

		Patients, N (%)
	Total	96,990
Age (y)	< 50	11,047 (11.4)
	50-60	18,336 (18.9)
	61-70	26,780 (27.6)
	71-80	26,496 (27.3)
	> 80	14,331 (14.8)
Sex	Female	38,257 (39.4)
Race	White	64,395 (66.4)
	Black	14,948 (15.4)
	Asian	6,172 (6.4)
	Hispanic	8,856 (9.1)
	Other	1,667 (1.7)
	Unknown	952 (1.0)
Charlson Comorbidity Index	0	65,691 (67.7)
	1	22,162 (22.9)
	2	6,406 (6.6)
	3+	2,731 (2.8)
Insurance Status	Medicare	49,629 (51.2)
	Uninsured	2,926 (3.0)
	Private	35,257 (36.4)
	Medicaid	6,161 (6.4)
	Other	1,109 (1.1)
	Unknown	1,908 (1.9)
Income ($/year)	≤ 40,227	19,360 (20.0)
	40,227-50,353	20,492 (21.2)
	50,354-63,332	22,219 (22.9)
	≥ 63,333	33,444 (34.5)
	Unknown	1,323 (1.4)
No High School Degree in Zip Code (%)	≥ 17.6	21,397 (22.1)
	10.9-17.5	26,045 (26.9)
	6.3-10.8	24,885 (25.7)
	< 6.3	23,339 (24.1)
	Unknown	1,324 (1.4)
Distance Between Patient's Residence and Treating Facility (miles)	10-20	17,979 (18.5)
	< 10	48,320 (49.8)
	>20	30,297 (31.2)
	Unknown	394 (0.5)
Facility Type	Academic/Research	41,431 (42.7)
	Integrated Network	12,733 (13.1)
	Comprehensive Community	32,815 (33.8)
	Community	6,969 (7.3)
	Unknown	3,051 (3.1)
Tumor Size (mm)	0-3	25,784 (26.6)
	4-6	27,358 (28.2)
	7-10	15,076 (15.5)
	> 10	6,581 (6.8)
	Unknown	22,191 (22.9)

Number of Positive Regional Lymph Nodes	0	32,962 (34.0)
	1-2	13,625 (14.0)
	3-6	11,394 (11.7)
	> 7	13,836 (14.3)
	Unknown	25,173 (26.0)
Analytic Disease Stage	0	2,354 (2.4)
	1	31,303 (32.3)
	2	18,713 (19.3)
	3	23,171 (23.9)
	4	9,894 (10.2)
Surgical Resection	R0	77,466 (79.9)
	R1	7,210 (7.4)
	R2	944 (1.0)
	Unknown	11,370 (11.7)
Chemotherapy	Yes	43,644 (45.0)
	No	49,600 (51.1)
	Unknown	3,746 (3.9)
Radiotherapy	Yes	25,323 (26.1)
	No	70,883 (73.1)
	Unknown	784 (0.8)
Hormonotherapy	Yes	216 (0.3)
	No	93,752 (96.7)
	Unknown	3,022 (3.1)
Immunotherapy	Yes	473 (0.6)
	No	95,561 (98.5)
	Unknown	956 (0.9)

Table 1. Descriptive Statistics. *Abbreviations. y = years; $/year = dollars per year; mm = millimeters.*

		30-day Mortality, N (%)	90-day Mortality, N (%)	*P-values*
	Total	3,413 (3.9)	7,049 (8.4)	
Race	White	2,376 (4.1)	5,349 (9.3)	0.0307, <0.0001*
	Black	483 (3.6)	720 (5.4)	
	Asian	203 (3.6)	302 (5.5)	
	Hispanic	289 (3.6)	513 (6.5)	
	Other	62 (4.2)	165 (11.3)	
Insurance Status	Medicare	2,248 (5.0)	4,018 (9.1)	<0.0001*, <0.0001*
	Uninsured	95 (3.5)	161 (6.1)	
	Private	802 (2.5)	2,234 (7.0)	
	Medicaid	143 (2.6)	311 (5.9)	
	Other	95 (2.2)	106 (10.9)	
Income ($/year)	≤ 40,227	625 (3.6)	1,611 (9.3)	<0.0001*, <0.0001*
	40,227-50,353	666 (3.6)	1,847 (10.1)	
	50,354-63,332	762 (3.8)	1,640 (9.0)	
	≥ 63,333	992 (3.3)	1,605 (5.4)	
No High School Degree in Zip Code (%)	≥ 17.6	700 (3.6)	1,391 (7.3)	<0.0001*, <0.0001*
	10.9-17.5	857 (3.6)	1,933 (8.3)	
	6.3-10.8	803 (3.6)	1,908 (8.6)	
	< 6.3	687 (3.3)	1,491 (7.2)	
Distance Between Patient's Residence and Treating Facility (miles)	10-20	518 (3.2)	518 (3.2)	<0.0001*, <0.0001*
	< 10	1978 (4.4)	1,978 (4.5)	
	>20	593 (2.2)	4,331 (16.6)	
Facility Type	Academic/ Research	1210 (3.3)	3,996 (10.9)	<0.0001*, <0.0001*
	Integrated Network	484 (4.2)	700 (4.0)	
	Comprehensive Community	1330 (4.5)	1,862 (6.3)	
	Community	365 (5.7)	426 (6.7)	

Table 2. Univariate analysis for 30- and 90-day mortality. *Abbreviations. y = years; $/year = dollars per year.*

** denotes statistical significance*

		Unplanned Readmissions, N (%)	***P-value***
	Total	5,435 (5.8)	
Race	White	3,680 (5.9)	0.045
	Black	799 (5.5)	
	Asian	320 (5.4)	
	Hispanic	520 (6.1)	
	Other	116 (7.2)	
Insurance Status	Medicare	2,758 (5.7)	0.282
	Uninsured	172 (6.1)	
	Private	2,008 (5.9)	
	Medicaid	380 (6.4)	
	Other	56 (5.2)	
Income ($/year)	≤ 40,227	1,077 (5.7)	0.098
	40,227-50,353	1,213 (6.1)	
	50,354-63,332	1,203 (5.6)	
	≥ 63,333	1,902 (5.9)	
No High School Degree in Zip Code (%)	≥ 17.6	1,194 (5.7)	0.652
	10.9-17.5	1,379 (5.7)	
	6.3-10.8	1,495 (5.9)	
	< 6.3	1,341 (5.9)	
Distance Between Patient's Residence and Treating Facility (miles)	10-20	963 (5.5)	0.066
	< 10	2,708 (5.8)	
	>20	1,801 (6.1)	
Facility Type	Academic/ Research	2,427 (6.0)	0.151
	Integrated Network	703 (5.7)	
	Comprehensive Community	1,785 (5.6)	
	Community	404 (6.0)	

Table 3. Univariate analysis for unplanned readmissions. *Abbreviations. y = years; $/year = dollars per year.*

		30-day Mortality, OR (95% CI)	90-day Mortality, OR (95% CI)	Unplanned Readmission, OR (95% CI)
Age (y)	< 50		*Reference Value*	
	50-60	1.2 (0.96-1.5)	1.08 (0.96-1.22)	1.04 (0.93-1.16)
	61-70	**1.52 (1.22-1.88)**	**1.24 (1.1-1.4)**	1.0 (0.89-1.12)
	71-80	**1.9 (1.52-2.37)**	**1.3 (1.15-1.48)**	1.03 (0.91-1.16)
	> 80	**2.49 (1.99-3.11)**	**1.74 (1.52-1.99)**	1.0 (0.88-1.15)
Sex	Female		*Reference Value*	
	Male	**1.36 (1.26-1.47)**	**1.17 (1.11-1.24)**	0.97 (0.92-1.03)
Race	White		*Reference Value*	
	Black	**0.82 (0.73-0.92)**	**0.7 (0.64-0.77)**	0.94 (0.86-1.02)
	Asian	**0.82 (0.7-0.97)**	**0.83 (0.73-0.95)**	0.88 (0.78-1.0)
	Hispanic	**0.82 (0.71-0.95)**	**0.85 (0.76-0.95)**	1.01 (0.91-1.12)
	Other	1.06 (0.8-1.4)	**1.24 (1.03-1.48)**	1.22 (1.0-1.48)
Charlson Comorbidity Index	0		*Reference Value*	
	1	**1.12 (1.02-1.22)**	1.02 (0.96-1.09)	0.96 (0.9-1.03)
	2	**1.29 (1.13-1.47)**	**1.14 (1.03-1.27)**	0.98 (0.88-1.1)
	3+	**1.77 (1.49-2.12)**	**1.49 (1.28-1.73)**	0.85 (0.71-1.02)
Insurance Status	Medicare		*Reference Value*	
	Uninsured	1.09 (0.86-1.39)	0.87 (0.72-1.04)	1.08 (0.91-1.28)
	Private	**0.86 (0.77-0.95)**	0.97 (0.9-1.04)	1.02 (0.95-1.1)
	Medicaid	0.82 (0.68-1.01)	**0.87 (0.75-0.99)**	1.12 (0.99-1.26)
	Other	0.71 (0.44-1.14)	0.96 (0.77-1.19)	0.9 (0.69-1.19)
Income ($/year)	≤ 40,227		*Reference Value*	
	40,227-50,353	0.95 (0.84-1.08)	**0.82 (0.75-0.89)**	1.07 (0.98-1.17)
	50,354-63,332	0.94 (0.83-1.07)	**0.68 (0.62-0.75)**	0.98 (0.88-1.08)
	≥ 63,333	**0.77 (0.66-0.88)**	**0.43 (0.39-0.48)**	1.04 (0.94-1.16)
No High School Degree in Zip Code (%)	≥ 17.6		*Reference Value*	
	10.9-17.5	0.91 (0.81-1.02)	**0.86 (0.79-0.94)**	1.0 (0.91-1.11)
	6.3-10.8	**0.82 (0.72-0.93)**	**0.7 (0.64-0.76)**	1.04 (0.96-1.13)
	< 6.3	**0.69 (0.6-0.81)**	**0.52 (0.47-0.58)**	1.05 (0.94-1.18)
Distance Between Patient’s Residence and Treating Facility (miles)	10-20		*Reference Value*	
	< 10	**1.23 (1.11-1.37)**	**1.35 (1.22-1.5)**	1.06 (0.98-1.14)
	>20	**0.71 (0.63-0.81)**	**5.0 (4.52-5.49)**	1.09 (1.0-1.19)
Facility Type	Academic/ Research		*Reference Value*	
	Integrated Network	1.05 (0.93-1.19)	**0.65 (0.59-0.71)**	0.96 (0.88-1.05)
	Comprehensive Community	1.09 (1.0-1.2)	**0.56 (0.53-0.6)**	0.94 (0.88-1.0)
	Community	**1.37 (1.2-1.57)**	**0.78 (0.69-0.87)**	1.01 (0.9-1.13)
Tumor Size (mm)	0-3		*Reference Value*	
	4-6	1.12 (1.0-1.24)	1.0 (0.93-1.07)	0.88 (0.82-0.95)
	7-10	**1.22 (1.07-1.38)**	1.08 (0.99-1.18)	0.97 (0.88-1.06)
	> 10	**1.45 (1.24-1.7)**	**1.28 (1.14-1.44)**	0.96 (0.85-1.1)
	0		*Reference Value*	
	1-2	1.09 (0.95-1.25)	1.0 (0.92-1.1)	0.95 (0.86-1.04)

Number of Positive Regional Lymph Nodes	3-6	1.06 (0.92-1.22)	0.95 (0.85-1.05)	1.02 (0.92-1.13)
	> 7	1.03 (0.9-1.19)	0.93 (0.84-1.03)	0.92 (0.82-1.03)
Analytic Disease Stage	0		*Reference Value*	
	1	1.14 (0.83-1.56)	0.87 (0.73-1.04)	1.0 (0.83-1.21)
	2	**1.79 (1.29-2.48)**	1.17 (0.97-1.41)	1.04 (0.86-1.27)
	3	**2.37 (1.7-3.29)**	**1.4 (1.16-1.69)**	1.03 (0.84-1.26)
	4	**3.59 (2.58-4.99)**	**1.94 (1.59-2.36)**	1.05 (0.84-1.3)
Surgical Resection	R0		*Reference Value*	
	R1	**1.26 (1.11-1.43)**	**1.19 (1.08-1.32)**	1.06 (0.95-1.18)
	R2	**1.8 (1.41-2.3)**	**1.6 (1.28-2.0)**	0.85 (0.63-1.14)
Chemotherapy	Yes		*Reference Value*	
	No	**4.6 (4.1-5.24)**	**2.42 (2.24-2.62)**	1.0 (0.93-1.09)
Radiotherapy	Yes		*Reference Value*	
	No	**1.28 (1.06-1.49)**	0.92 (0.84-1.0)	0.95 (0.88-1.03)
Hormonotherapy	Yes		*Reference Value*	
	No	1.52 (0.5-4.6)	1.42 (0.75-2.68)	0.87 (0.51-1.51)
Immunotherapy	Yes		*Reference Value*	
	No	**4.25 (1.05-17.2)**	1.4 (0.87-2.22)	1.0 (0.68-1.5)

Table 4. Multivariate regression analysis for 30- and 90-day mortality and unplanned readmissions. *Abbreviations. OR = odds ratio; CI = confidence interval; y = years; $/year = dollars per year; mm = millimeters.*

Bold numbering indicates significance

FIGURE TITLES and LEGENDS:

Figure 1. Flow Diagram displaying study population