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Potential Impact on Spatial Access to Surgery Under a Low Volume Pledge: A Population-Level Analysis of Patients Undergoing Pancreatectomy

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Abstract

Background—A minimum-volume policy restricting hospitals not meeting the threshold from performing complex surgery may increase travel burden and decrease spatial access to surgery. We aim to identify vulnerable populations that would be sensitive to an added travel burden.

Methods—We performed a retrospective analysis of the California Office of Statewide Health Planning and Development database for patients undergoing pancreatectomy from 2005 to 2014. Number of hospitals bypassed was used as a metric for travel. Patients bypassing fewer hospitals were deemed to be more sensitive to an added travel burden.

Results—There were 13,374 patients who underwent a pancreatectomy, of which 2,368 (17.7%) were non-bypassers. On unadjusted analysis, patients >80 year old travelled less than their younger counterparts, bypassing a mean of 10.9 ± 9.5 hospitals compared to 14.2 ± 21.3 hospitals bypassed by the 35–49 year old age group ($p < 0.001$). Racial minorities travelled less when compared to Non-Hispanic Whites ($p < 0.001$). Patients identifying their payer status as self-pay (8.9 ± 15.6 hospitals bypassed) and Medicaid (10.1 ± 17.2 hospitals bypassed) also travelled less when compared to patients with private insurance (13.8 ± 20.4 hospitals bypassed, $p < 0.001$). On multivariate analysis, advanced age, racial minority and patients with self-pay or Medicaid payer status were independently associated with increased sensitivity to an added travel burden.

Conclusion—In patients undergoing pancreatectomy, the elderly, racial minorities and patients with self-pay or Medicaid payer status were associated with an increased sensitivity to an added

travel burden. This vulnerable cohort may be disproportionately affected by a minimum-volume policy.

Keywords

Access to surgery; spatial barriers; travel burden; distance; volume pledge

INTRODUCTION

Hospital surgical volume has been repeatedly shown to be associated with perioperative mortality, with the most pronounced effect demonstrated in pancreatectomy.^{1–4} More recently, there has been a push towards implementing a mandate for volume-based regionalization, with three hospital systems publicly announcing a volume pledge.⁵ The “Take the Volume Pledge” is a campaign to restrict certain surgical procedures from being performed by surgeons or hospitals that perform relatively few of them, and challenges other health systems throughout the nation to join them in an effort to maximize patient outcomes. This Pledge is similar to other volume-based policies, such as Medicare’s selective reimbursement for solid organ transplant performed by high-volume facilities⁶ and lower co-pays for some insurance plans for consumers receiving services at high-volume centers.⁷ Proponents argue that the community is finally moving forward with an actionable concept to improve patient outcomes that was first described 36 years ago.¹

However, this policy could also reduce access to surgery.^{8–10} There are two major categories of barriers to access: spatial and non-spatial barriers.¹¹ Spatial barriers include a physical/geographic distance between patients and providers. Non-spatial barriers emphasize socioeconomic and cultural barriers such as age, race, education, social class as well as availability of and options within insurance.¹¹ While non-spatial barriers to access have been extensively studied, little is known regarding spatial barriers. Recently, investigators have identified spatial barrier as contributing factor to unequal delivery of surgical care.¹² Hence, our study will focus on the spatial aspect of barriers to access. By limiting complex operations to high volume centers, the travel burden of patients will undeniably increase due to the scarcity of high-volume centers (Figure 1). National data have already demonstrated an underutilization of pancreatectomy for potentially resectable pancreatic cancer.^{13–15} Such underutilization could be further exacerbated with increased travel burden associated with such volume-based regionalization. Therefore, this study aims to identify patients undergoing pancreatectomy whose access to surgery may be disproportionately affected by a volume mandate. We attempt to identify vulnerable cohorts by examining the travel patterns of different subpopulations. We hypothesize that racial/ethnic minorities, self-pay and Medicaid patients travel less and would be disproportionately affected by a low-volume threshold.

METHODS

We identified all patients who underwent a pancreatectomy in California from 2005 to 2014 from the California Office of Statewide Health Planning and Development (OSHPD) database. OSHPD maintains this database for all California-licensed facilities. Patients

undergoing pancreatectomy were identified by *International Classification of Diseases, Ninth Revision* (ICD-9) procedure codes of 52.51, 52.52, 52.53, 52.59, 52.6 and 52.7 as a primary or secondary procedure in the inpatient database. Patients were included irrespective of age and indication for surgery.

In order to obtain distances from patients' residence to hospitals in California, hospital street addresses and patients' residential ZIP codes were first converted to geographic coordinates (geocoded) using previously described geocoding methodologies.¹⁶ Distance from each patient's residential ZIP code to any possible hospital was then determined via a straight-line distance calculated in miles between the geographic centers of patients' five-digit residential ZIP codes and geocoded hospital locations.¹⁷

The primary outcome was to determine sensitivity to an added travel burden. Patients were classified as "bypassers" if they travelled past hospitals closer to their residential ZIP code to undergo pancreatectomy. This is in contrast to patients who received their pancreatectomy at the hospital closest to their residential ZIP code, which will be termed "non-bypassers". In order for a hospital to qualify as an option to be bypassed, the hospital has to have performed at least one pancreatectomy for that specific year to indicate availability of pancreatectomy services. Patient bypass of hospital was used as a travel metric over straight line distance in miles, given that it better accounts for geographic density which may confound the distance required to be travelled by the patient. For example, a patient may travel 80 miles but does not bypass any hospitals because the patient lives in a rural region with no hospitals in close proximity (underestimates travel burden in rural settings). The number of hospitals bypassed was then used as a metric to quantify the patient's travel to get to their destination hospital, and patients who bypass less hospitals were deemed to be more sensitive to an added travel burden. In review of the data, there is considerable overlap of distance travelled amongst bypassers and non-bypassers (Figure 2), suggesting that it is a more accurate travel metric. Straight-line distance in miles is then used as a sensitivity analysis to account for the possibility that number of hospitals bypassed could underestimate travel burden in patients in less dense settings, and the concordance/discordance between the metrics is then assessed.

All models controlled for patient demographics and comorbidities including age, sex, race/ethnicity, primary payer and Charlson comorbidity index.¹⁸ Malignant indication for pancreatectomy was defined as ICD-9 diagnoses code of 152.0, 152.8, 152.9, 155.0–155.2, 156.0–156.2, 156.8–157.4, 157.8, 157.9, 230.8 and 230.9. Hospital level characteristics such as teaching status, volume and mortality rates were also recorded. Hospital teaching status was defined by the affiliation of the hospital with a general surgery residency program. Hospital pancreatectomy volume was recalculated for each year individually, accounting for the possibility that volume at a given hospital could change over time.

Maps were created using ArcMap™ and ArcGIS® software (Esri, Redlands, CA). Statistical analyses were performed using Intercooled Stata software, version 12.0 (StataCorp, College Station, TX). Categorical variables and continuous variables were analyzed using Pearson chi-square tests and Wilcoxon rank sum tests respectively. Certain continuous variables, such as age and Charlson comorbidity index scores, were stratified into categories and

analyzed as ordinal variables to avoid assumption of linearity. The multivariable analysis was performed via a linear regression model. Statistical significance was accepted at the p -value 0.05 level.

RESULTS

Patient demographics

We identified 13,374 patients who underwent a pancreatectomy in the state of California throughout the study period, with 11,006 (82.3%) patients bypassing the hospital closest to their ZIP centroid to receive pancreatectomy. Bypassers circumvented a median of 7 hospitals (IQR 3–20), and travelled a median of 15.9 miles (IQR 7.5–36.7 miles), vs 3.2 miles (IQR 1.8–5.9 miles, $p<0.001$) in the non-bypasser group. Figure 2 depicts the distribution of distance travelled by bypassers and non-bypassers.

Our travel metric, the number of hospitals bypassed, were then analyzed based on patient characteristics. There were no differences in the number of hospitals bypassed between patients of different sex and Charlson comorbidity index scores. However, patients >80 year old travelled less than their younger counterparts, bypassing a mean of 10.9 ± 9.5 hospitals compared to 14.2 ± 21.3 and 14.3 ± 21.3 hospitals bypassed by the 35–49 years and <20 year old age groups respectively ($p<0.001$). Hispanics (8.9 ± 13.5 hospitals bypassed) and African Americans (11.7 ± 19.4 hospitals bypassed) also travelled less when compared to Non-Hispanic Whites (13.3 ± 20.4 hospitals bypassed, $p<0.001$). Patients identifying their payer status as self-pay (8.9 ± 15.6 hospitals bypassed) and Medicaid (10.1 ± 17.2 hospitals bypassed) also travelled less when compared to patients with private insurance (13.8 ± 20.4 hospitals bypassed, $p<0.001$).

Independent predictors of travel effort

In an attempt to determine independent patient subgroups that would be more sensitive to an increased travel burden, number of hospitals bypassed was used as an end-point in a linear regression model. Advanced age was independently associated with less travel, with patients age 65–79 years old (5.32 fewer hospitals bypassed, $p=0.001$) and 80 years old (6.83 fewer hospitals bypassed, $p<0.001$) associated with the least travel when compared to younger patients. These two age categories comprised 47% of the study population. African American, Hispanic and Asian/Pacific islander race/ethnicity were also associated with less travel, travelling by 4.20 ($p<0.001$), 1.44 ($p=0.002$) and 1.69 ($p=0.002$) fewer hospitals respectively, compared to non-Hispanic White patients. These racial minority groups comprised 38% of the study population. Patients who identified their payer status as self-pay (4.64 fewer hospitals bypassed, $p<0.001$) and Medicaid (3.38 fewer hospitals bypassed, $p<0.001$) were associated with less travel when compared to patients with Health Maintenance Organization (HMO) private insurances. Self-pay or Medicaid payer status accounted for 13% of the study population. The complete linear regression analysis and corresponding percentage of the study population for each subpopulation is depicted in Figure 3.

Sensitivity analysis

Straight-line distance in miles is then used as the outcome in a linear regression similar to the model above, accounting for the possibility that number of hospitals bypassed may conversely minimize travel burden in patients in less dense settings. Similarly, there were no differences in miles travelled between patients of different sex and Charlson comorbidity index scores. Patients >80 years old travelled 15.1 miles (95% C.I. -6.6 to -23.5 miles, $p<0.001$) less than their younger counterparts. Hispanics (-17.1 miles, 95% C.I. -13.7 to -20.6 miles, $p<0.001$) and African Americans (-5.4 miles, 95% -3.2 to -7.6 miles, $p<0.001$) also travelled miles less when compared to non-Hispanic Whites. Patients identifying their payer status as self-pay (-6.9 miles, 95% C.I. -2.6 to -11.2 miles, $p=0.002$) and Medicaid (-14.2 miles, 95% C.I. -11.6 to 16.7 miles, $p<0.001$) also travelled less when compared to patients with private insurance.

Travel patterns

Of the 11,006 patients who travelled beyond the hospital closest to their ZIP centroid, 9.8% bypassed a low-volume hospital (<20 cases/year) to receive their pancreatectomy at a high-volume hospital (≥ 20 cases/year). Conversely, 25.3% of patients bypassed a high-volume hospital to receive their pancreatectomy at a low-volume hospital.

DISCUSSION

The conversation surrounding volume-based regionalization was revisited once again when The Volume Pledge was put forth by three major health systems.⁵ The Pledge is a campaign that will restrict complex procedures to be performed only by hospitals that meet minimum volume standards. However, our study raises important considerations regarding its potential impact on access to surgery for specific, already vulnerable populations. In this study, we found that of all the patients undergoing a pancreatectomy in California, patients' advanced age, minority race/ethnicity, and presence of Medicaid or uninsured payer status were associated with less travel, and would be more sensitive to an increased travel burden as a result of a low-volume threshold.

Previous studies have demonstrated the potentially detrimental impact of volume-based regionalization on access to surgery in other disease processes. Livingston and colleagues showed that requirements that bariatric procedures be performed at accredited centers increased the median distance Medicare patients were required to travel from 25 miles to 44 miles.¹⁹ Similarly, Stitzenberg et al. demonstrated that regionalization of cancer care increased the median travel distance for pancreatic cancer care by 40%, and was as high as 72% for patients with esophageal cancer.²⁰ While recent studies have cited superior outcomes for patients who travel to high-volume centers for complex cancer care,^{21, 22} it neglects sub-populations that may not be able to travel for surgery and exacerbate disparity. In fact, these analyses demonstrated that the similar vulnerable cohorts identified in our study were also associated with lower probabilities of receiving surgery for operable cancers. Additionally, the degree of regionalization in bariatric surgery and cancer care are different from the proposed minimum volume standards of The Pledge, which has not been previously described. For example, there are 50 bariatric Accredited Centers in the state of

California, but only 21 centers meeting the minimum volume requirement of performing 20 pancreatectomies/year (Figure 1). The present study goes beyond quantifying travel burden by identifying vulnerable cohorts that historically do not/are not able to travel far for their surgery. Furthermore, the study utilizes number of hospitals bypassed as a novel travel metric, which adjusts for geographic density as a potential confounder of distance travelled (Figure 2). This latter adjustment may explain the incongruent findings of studies that utilize distance travelled as a metric of travel burden.^{19, 23, 24} It should be noted that in our study, sensitivity analysis demonstrates that the subpopulation most likely to be affected by a low-volume threshold were similar, whether number of hospitals bypassed or distance travelled in miles were used as endpoints.

Disparities in receipt of pancreatectomy have also been well described. Bilimoria and colleagues described an astonishing 38.2% of patients with stage I pancreatic cancer without any identifiable contraindications who were not offered surgery.¹³ An updated analysis of the National Cancer Database in 2013 shows a similarly high rate of non-surgical treatment of stage I pancreatic cancer (43.5% in teaching hospitals, 63.3% in community hospitals).¹⁴ The patient characteristics that were associated with an increased risk of not undergoing surgery were also similar to our described population of patients that do not generally travel for surgery (Table 2). In California, Medicaid patients are not allowed to receive care outside their county of residence, which may explain their propensity to travel less. Such external constraint on access will only be exacerbated by a Volume Pledge, given that Medicaid patients will not be able to travel further for care. As such, the Volume Pledge may very well widen the disparity in surgery access and compound on the underutilization of pancreatectomy in specific populations.

There are other interesting findings noted in this study. We found that 25.3% of bypassers (20.8% of entire study population) travelled past a high-volume hospital to receive surgery at a low-volume hospital. Such travel patterns may be related to limited insurance networks that have contracts with specific hospitals, leading to an unintended and non-beneficial consequence. Under a low-volume policy mandate, these patients would be redirected to high-volume hospitals and actually reduce travel. While this may be true for some patients, the overall impact for the entire population is unclear. However, considering the scarcity of high-volume centers (Figure 1), it is likely that the net impact on travel burden of the population will be negative. While important for future research, exploring the impact of limited insurance network on access is beyond the scope of this paper.

This study should be interpreted in the context of the study design. The analysis only includes patients receiving pancreatectomy in the state of California, thus the generalizability of our findings at the national level is unknown. Geographically, access to surgery is dictated by the proportion of patients within proximity of a service-providing hospital, which differs in every state.²⁵ However, California represents the nation's most racially/ethnically diverse state, providing us with sufficient patients in racial/ethnic and payers subgroups for analysis. This 100% capture state database allows for complete evaluation of travel effort in all patients receiving surgery at California-licensed facilities. In contrast, use of the Medicare database would limit analysis to patients >65 years old. Unfortunately, we do not know why certain patients travelled less for surgery. Possible

reasons for travelling less could include personal preferences, level of education, financial constraints for both medical and non-medical expenses, or referral practices of diagnosing providers. Nevertheless, studies have demonstrated that patients who live in rural regions and travel less often end up in low-volume hospitals.^{26, 27} It is more likely that this finding can be explained by inequality with respect to hospital choice rather than personal preferences or referral practices. Finally, this analysis only identifies patients who underwent resection, as the California state database lack cancer staging information to appropriately delineate patients with resectable disease that did not undergo resection, and their proximity to high-volume centers.

This study has many important implications. The subpopulations that are associated with less travel effort represent the same subpopulation affected by ongoing policy discussions surrounding Medicaid's non-emergency medical transportation (NEMT) coverage. Medicaid provides NEMT services in the form of direct delivery or public transit voucher programs to facilitate access to care for low-income beneficiaries who otherwise may not have a reliable and affordable means of getting to health care appointments, including patients with both Medicare and Medicaid coverage.^{28, 29} A review of computerized records from a large NEMT broker covering 40 states demonstrated that the majority of NEMT users were elderly patients residing in ZIP codes predominantly populated by African Americans, and from rural regions plagued by poverty.³⁰ These populations are very similar to the ones demonstrated to be associated with less travel effort, and may explain the disparities in the utilization of high-volume hospitals for complex surgery.^{27, 31} As states adapt to increasing Medicaid enrollment, multiple states including Iowa and Indiana have received waivers from Medicaid to restrict coverage of NEMT for beneficiaries. Given the overlap between the vulnerable cohort in our study and those who traditionally utilize NEMT, ongoing evaluation of converging policies is essential as to not exacerbate disparities in access to surgery.

The potential pitfalls of a low-volume mandate identified by the present study should also provide impetus to develop alternative solutions, such as improving quality of surgery provided by low-volume hospitals. Quality improvement initiatives identify variations in patient outcomes and aim to close the gap between high- and low-performing hospitals. Redirecting patients from low-volume hospitals to high-volume hospitals exploits this variation, and may further widen this gap in quality. However, such redirection should be expected to do little to directly improve processes of care in low-volume hospitals. Instead, participation of low-volume centers in Statewide or Regional Quality Collaboratives can help drive improvements through sharing expertise and conducting joint multidisciplinary evaluation of patients.^{32, 33} Additionally, identifying care processes beyond volume may help inform and focus quality improvement initiatives at hospitals of any volume.^{34, 35}

CONCLUSION

In patients undergoing pancreatectomy, the elderly, racial minorities and patients identifying their payer status as self-pay or Medicaid were associated with less travel effort. This vulnerable population may be disproportionately affected by the increased travel burden as a result of minimum volume standards. Expansion of the Volume Pledge should strongly

consider the vulnerable populations impacted most by increased travel requirements as well as the broader policy context currently affecting patient access to surgery.

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Figure 1.

A, Density map of patients who required pancreatotomy based on patient ZIP code and B, the distribution of low- (<20 cases/year) and high-volume (≥20 cases/year) hospitals for pancreatotomy in California in 2014.

Figure 2.

Histogram depicting the distribution of distance travelled by patients who bypassed and did not bypass hospitals closest to their ZIP centroid to receive pancreatotomy.

Figure 3.

Linear regression of patient subpopulations for number of hospitals bypassed to receive pancreatectomy, and the corresponding percentage of study population specific to each subpopulation.

*, indicates statistical significance.

Table 1

Patient demographics and travel effort, represented by the number of hospitals patients bypassed before arriving at their destination hospitals.

	Number of hospitals bypassed Mean $\pm$ SD	p-value
Sex		0.862
Male	12.6 $\pm$ 19.5	
Female	12.6 $\pm$ 19.9	
Age (years)		<0.001
<20	14.3 $\pm$ 21.3	
20–34	12.2 $\pm$ 18.5	
35–49	14.2 $\pm$ 20.8	
50–64	12.6 $\pm$ 19.4	
65–80	12.3 $\pm$ 19.7	
>80	10.9 $\pm$ 19.5	
Charlson comorbidity index		0.861
0	12.3 $\pm$ 19.0	
1–3	12.3 $\pm$ 18.7	
4–5	12.8 $\pm$ 19.3	
6–8	12.8 $\pm$ 21.4	
>8	12.8 $\pm$ 20.7	
Race		<0.001
Non-Hispanic White	13.3 $\pm$ 20.4	
Hispanic	8.9 $\pm$ 13.5	
African-American	11.7 $\pm$ 19.4	
Asian/Pacific Islander	11.4 $\pm$ 17.5	
Other	16.0 $\pm$ 25.8	
Insurance		<0.001
Self-pay	8.9 $\pm$ 15.6	
Medicare	12.2 $\pm$ 19.9	
Private	13.8 $\pm$ 20.4	
Medicaid	10.1 $\pm$ 17.2	
Other	13.4 $\pm$ 20.7	
Setting		<0.001
Elective	13.3 $\pm$ 19.9	
Non-elective	9.9 $\pm$ 18.9	
Indication for resection		0.036
Malignant	12.5 $\pm$ 19.5	
Benign	12.6 $\pm$ 20.1	

Table 2

Comparison of patient-level characteristics and travel effort as well as odds of undergoing surgery in two separate studies.

Fong et al.			Blimoria et al.		
Patient characteristics	Travel effort* Number of hospitals bypassed (95% CI)	Patient characteristics (not offered surgery)	Odds of undergoing surgery (95% CI)	Patient characteristics (refused surgery)	Odds of undergoing surgery (95% CI)
Age (years)		Age (years)		Age (years)	
<20	Reference	<55	Reference	<55	Reference
65–79	–5.3 (–8.5–2.1)	66–75	0.5 (0.4–0.6)	66–75	0.4 (0.2–0.9)
80	–6.8 (–10.2–3.4)	>75	0.2 (0.2–0.3)	>75	0.08 (0.04–0.2)
Race		Race		Race	
Non-Hispanic White	Reference	Non-Hispanic White	Reference	Non-Hispanic White	Reference
African American	–4.2 (–5.6–2.8)	African American	0.7 (0.6–0.9)	African American	0.3 (0.2–0.6)
Hispanic	–1.4 (–2.4–0.5)	Hispanic	0.8 (0.6–1.2)	Hispanic	0.6 (0.3–1.2)
Asian/Pacific islander	–1.7 (–2.7–0.6)	Asian/Pacific islander	1.0 (0.6–1.6)	Asian/Pacific islander	1.2 (0.4–4.4)
Insurance status		Insurance status		Insurance status	
Private	Reference	Private	Reference	Private	Reference
Self-pay	–4.6 (–6.4–2.9)	Self-pay	1.0 (0.7–1.1)	Self-pay	†
Medicaid	–3.4 (–4.7–2.1)	Medicaid	0.6 (0.4–0.9)	Medicaid	0.4 (0.2–0.9)

* , travel effort as measured by number of hospitals bypassed as a surrogate.

† , inadequate sample size for odds ratio calculation.