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Statewide Examination of Access to Cancer Surgery during the COVID-19 Pandemic

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Title: Statewide Examination of Access to Cancer Surgery during the COVID-19 Pandemic

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ABSTRACT

Introduction: The COVID-19 pandemic caused interruptions in the delivery of medical care across a wide range of conditions including cancer. Trends in surgical treatment for cancer during the pandemic have not been well described. We sought to characterize associations between the pandemic and access to surgical treatment for breast, colorectal, and lung cancer in Illinois.

Methods: We performed a retrospective cohort study evaluating inpatient admissions at Illinois hospitals providing surgical care for lung cancer (n=1913 cases, n=64 hospitals), breast cancer (n=910 cases, n=108 hospitals), and colorectal cancer (n=5339 cases, n=144 hospitals). Using discharge data from the Illinois Health and Hospital Association's Comparative Health Care and Hospital Data Reporting Services database, average monthly surgical case volumes were compared from 2019 to 2020. We also compared rates of cancer surgery for each cancer type, by patient characteristics, and hospital type across the three time periods using Pearson chi-squared and ANOVA testing as appropriate. Three discrete time periods were considered: pre-pandemic (7-12/2019), primary pandemic (4-6/2020), and pandemic recovery (7-12/2020). Hospital characteristics evaluated included hospital type (academic, community, safety net), COVID-19 burden, and baseline cancer surgery volume.

Results: There were 2096 fewer operations performed for breast, colorectal, and lung cancer in 2020 than 2019 in Illinois, with the greatest reductions in cancer surgery volume occurring at the onset of the pandemic in April (colorectal, -48.3%; lung, -13.1%) and May (breast, -45.2%) of 2020. During the pandemic, breast (-14.6%) and colorectal (-13.8%) cancer surgery experienced reductions in volume whereas lung cancer operations were more common (+26.4%) compared to 2019. There were no significant differences noted in gender, race,

ethnicity, or insurance status among patients receiving oncologic surgery during the primary pandemic or pandemic recovery periods. Academic hospitals, hospitals with larger numbers of COVID-19 admissions, and those with greater baseline cancer surgery volumes were associated with the greatest reduction in cancer surgery during the primary pandemic period (all cancer types, $p<0.01$). During the recovery period, hospitals with greater baseline breast and lung cancer surgery volumes remained at reduced surgery volumes compared to their counterparts ($p<0.01$).

Conclusions: The COVID-19 pandemic was associated with significant reductions in breast and colorectal cancer operations in Illinois, while lung cancer operations remained relatively consistent. Overall, there was a net reduction in cancer surgery that was not made up during the recovery period. Academic hospitals, those caring for more COVID-19 patients, and those with greater baseline surgery volumes were most vulnerable to reduced surgery rates during peaks of the pandemic and to delays in addressing the backlog of cases.

Keywords: COVID-19, pandemic, cancer surgery, oncology, breast cancer, colorectal cancer, lung cancer, surgery volumes

INTRODUCTION

Breast, colorectal, and lung cancer each rank among the ten most frequently diagnosed cancers, with an estimate of 287,850 new breast cancer diagnoses, 151,030 new colorectal cancer diagnoses, and 236,740 new lung cancer diagnoses to be made in 2022.¹ Surgical intervention is a mainstay for the treatment of each of these cancers, offering the greatest opportunity for curative therapy.²⁻⁴ Delays in surgical treatment in each of these conditions are associated with poorer outcomes, including reduced survival.⁵⁻⁷

The rapid development and spread of the coronavirus disease 2019 (COVID-19) overwhelmed the healthcare system, especially within the United States. In March of 2020, COVID-19 was declared a pandemic by the World Health Organization, and many states soon after adopted rules significantly limiting work and travel outside the home. In Illinois, a stay-at-home lockdown order was issued at the end of March 2020 and included the advisory for hospitals to suspend or limit elective surgery. This guidance remained in place through June 2020, with the majority of hospitals choosing to also delay a variety of oncologic procedures in the context of this operative rationing.

While a number of stakeholders advocated that cancer surgery continue amidst the COVID-19 pandemic,^{8,9} a comprehensive evaluation of cancer surgery during the pandemic has not been well described. In Illinois, as in many states, a number of hospitals chose to limit elective cancer operations, especially during the peak primary pandemic period in the spring of 2020. We utilized a state hospital association database to evaluate trends in inpatient breast, colorectal, and lung cancer surgery to 1) evaluate the status of surgical cancer treatment throughout phases of the pandemic; 2) examine healthcare disparities during the COVID-19 pandemic; and 3) determine whether access to cancer care during the pandemic was associated with particular hospital characteristics. We hypothesized that the number of oncologic surgeries significantly decreased during the COVID-19 pandemic and remained

significantly decreased after the lockdown order was lifted for all evaluated cancer types. Additionally, we hypothesized that known health disparities were exacerbated during the pandemic periods and that the greatest surgery reductions took place among community and safety net hospitals.

METHODS

This retrospective, population-based cohort study evaluated inpatient admissions between January 1, 2019, and December 31, 2020, using the Illinois Health and Hospital Association's Comparative Health Care and Hospital Data Reporting Services database. Data in the Illinois Health and Hospital Association's Comparative Health Care and Hospital Data Reporting Services database is de-identified and publicly available, thus our analysis was considered exempt by the institutional review board. Adult patients at least 18 years of age or older who underwent resection for breast, colorectal, or lung cancer and admitted postoperatively were identified using ICD-10 diagnosis and procedure codes (Supplemental Table 1).

Sociodemographic factors at the time of inpatient admission were evaluated and included sex, age, race, ethnicity, health insurance type, poverty, and state residence. The percentage of individuals living at or below the federal poverty line in the patient's zip code was used as a proxy for socioeconomic status. The 2019 5-year American Community Survey zip code tabulation area was used to determine the percentage of households living at or below the federal poverty line across each patient's zip code. We defined low, medium, high, and very high poverty by the following percentages of individuals living at or below the federal poverty line in the patient's given zip code: <5%, 5-9.99%, 10-20%, >20% respectively. The number of admissions to the intensive care unit (ICU) were also evaluated. Various hospital-level characteristics were assessed including hospital type, COVID-19 inpatient admissions, and

baseline cancer surgery volume. We evaluated the following hospital types: academic, safety net, and community hospitals. Academic hospitals were defined as those in the Council of Teaching Hospitals (COTH). Safety net hospitals were defined as those with 35% or more admissions whose primary insurance is Medicaid or do not have health insurance. Community hospitals were defined as hospitals which did not meet criteria for academic or safety net hospitals. COVID-19 inpatient admission burden was quantified by quartiles and baseline cancer surgery volume was calculated by tertiles. We defined three time periods based on the Illinois stay-at-home order: pre-pandemic from 7-12/2019, primary pandemic from 4-6/2020, and pandemic recovery from 7-12/2020.

Patient-level analysis was used to describe overall trends in surgery volume by cancer type and to evaluate for changes in sociodemographic factors across the periods using Pearson chi square. The average number of cancer surgeries taking place within a month per institution, or “mean monthly cancer surgery volume,” was evaluated by cancer type. Monthly percent change in cancer surgery volume from 2019 to 2020 was assessed for each cancer type. Hospital-level comparisons were made across the three periods using mean monthly cancer surgery volumes. Mean monthly cancer surgery volumes were calculated based on the average number of surgical oncology cases per month in each hospital type. Significance of hospital-level differences in mean monthly period volumes was assessed using analysis of variance. Differences in mean monthly period volumes were determined to be approximately normally distributed across cancer types based on data visualization (Supplemental Figure 1).

RESULTS

Admissions to non-federal Illinois hospitals performing oncologic surgery for breast (n=108 hospitals), colorectal (n=144), and/or lung (n=64) cancer were evaluated. Overall, there

were 2096 fewer operations performed for the 3 studied malignancies in 2020 than 2019. Inpatient breast cancer surgery decreased by 6.1% (n=78 fewer; 1287 vs 1209) in 2020 compared to 2019. Colorectal cancer surgery decreased by 11.6% (n=2648 fewer; 22806 vs 20158). Lung cancer surgery increased by 33.1% (n=630 more; 1904 vs 2534). The greatest percent change in cancer surgery volume between 2019 and 2020 occurred in April 2020 for colorectal (-48.3%) and lung cancer surgery (-13.1%) and in May 2020 for breast cancer surgery (-45.2%) (Figure 1). From the beginning of the pandemic in March 2020 to December 2020, breast and colorectal cancer surgery experienced greater percent reductions in surgery volume (-14.6% and -13.8% respectively) compared to lung cancer surgery, which experienced a 26.4% increase compared to the same period in 2019. While a return to pre-pandemic surgical volume was seen by the end of the study period, a commensurate 'make-up' of postponed operations was not observed at any point for breast or colorectal cancer.

There were no significant differences found in the sex, race, ethnicity, insurance type, or economic status of patients treated during any of the periods of the pandemic in any of the 3 examined malignancies (Table 1). Most patients who received oncologic surgery in our cohort were between the ages of 55 and 74 years old and self-identified as White. The majority of patients treated for breast cancer had private insurance (n=444, 48.9%), while most lung (n=2994, 56.1%) and colorectal (n=1273, 66.5%) cancer patients had Medicare as their primary insurance. Further, patients were less likely to undergo cancer surgery during the pandemic if they lived in areas with higher levels of poverty. Perioperative ICU utilization after cancer surgery was not significantly different during the peak, primary pandemic period for any of the three malignancies studied. However, ICU admission was less common for patients undergoing surgery for colorectal cancer during the 'pandemic recovery' period in late 2020 (22.8% in pre-pandemic 2019; 22.5% peak primary pandemic; 17.7% pandemic recovery; $p < 0.001$). ICU admission after breast and lung cancer surgery did not significantly vary throughout the pandemic.

There were significantly greater reductions in mean monthly cancer surgery volumes in academic hospitals, hospitals with greater COVID-19 admissions, and hospitals with greater baseline cancer surgery volume during the primary pandemic period (all cancer types, $p < 0.001$) (Table 2). During the recovery phase, hospitals with greater baseline cancer surgery volumes remained at significantly reduced monthly cancer surgery volumes compared to their pre-pandemic 2019 rates of surgery for both breast ($p = 0.021$) and lung cancer ($p < 0.001$). Mean monthly surgery volume in safety net and community hospitals remained relatively consistent throughout the pandemic and subsequent recovery periods. The majority of breast and colorectal cancer surgeries took place at community hospitals (62.0%, 67.3% respectively) while most operations for lung cancer took place at academic hospitals (50.4%) during the primary pandemic period.

DISCUSSION

The COVID-19 pandemic created unprecedented challenges for both patients and hospitals, with widespread reductions in access to surgical and medical care throughout the United States. These barriers were particularly challenging for patients with oncologic diagnoses where timely care is integral to achieve favorable outcomes. In this study, we examined access to cancer surgery during the COVID-19 pandemic using the Illinois State Hospital Association database with a hospital-level approach to assess whether the COVID-19 pandemic was associated with a reduction in surgical cancer care. We specifically examined surgical care for the three most common malignancies where surgical resection is typically associated with curative intent treatment: breast, colorectal, and lung cancer. The primary finding of this analysis was an absolute reduction of over 2000 surgically treated patients during the pandemic as compared to the prior year. We found that breast (-14.6%) and colorectal

cancer surgery (-13.8%) sustained volume reductions from the start of the pandemic through to the end of December 2020, while lung cancer surgery volumes surpassed their 2019 baseline by 26.4%. Importantly, inequities in access to surgical care for cancer did not appear to be exacerbated during the COVID-19 pandemic. Among hospitals, academic medical centers and those in the community caring for a larger number of patients with COVID-19 were more vulnerable to reductions in cancer surgery volumes during the primary pandemic period. Not surprisingly, hospitals with the largest baseline volume of cancer surgery also experienced the largest reduction in surgical volume during the pandemic, highlighting an important tradeoff made at many high-volume centers which duly serve critical roles in the high acuity healthcare infrastructure. Interestingly, we did not observe significant shifts of care between hospital types such as from academic centers to community or safety net hospitals per the average monthly surgical case load.

Decreases in cancer surgery were well-described in the media, but this is the first population-based study to describe the trends of oncologic surgery overall, by patient-level factors, and across hospital types at a statewide level. In an analysis of 20 hospitals, London and colleagues described the impact of the COVID-19 pandemic on oncologic care, including a statistically significant reduction in cancer screening and oncologic treatment encounters including initial diagnosis, second opinion, and medical treatment initiation.¹⁰ Patt and colleagues also found significant reductions in cancer screening and treatment during the pandemic among a cohort of Medicare beneficiaries.¹¹ These authors examined the percent change of select breast cancer and colon cancer operations from 2019 to 2020 and found there were marked reductions in mastectomies from April-July 2020 and marked reductions in colectomies from April-May. We found similar trends in our study, with the greatest disruptions in care occurring in April and May 2020. While Tsai and colleagues did not find that cancer surgery was able to recover to pre-pandemic baseline volumes, we were able to show that there

was variation in recovery by cancer type, with lung cancer surgery surpassing 2019 case volume by the end of the pandemic period.¹²

It has been well-established that the COVID-19 pandemic has exacerbated existing racial, ethnic, and socioeconomic health inequities in the United States.¹³⁻¹⁵ Importantly, in our study we did not find significant changes in existing disparities in cancer surgery access during the COVID-19 pandemic; with minimal sociodemographic changes noted among patients receiving surgery across the phases of the pandemic evaluated. Our findings were similar to those reported by Tsai and colleagues who found that existing racial and ethnic disparities in access to oncologic care were not exacerbated during the COVID-19 pandemic.¹² Similarly, others have reported that there were no significant changes in breast, colorectal, or lung cancer screening by race or ethnicity during the pandemic.¹⁶

As waves of the COVID-19 pandemic continue well into 2022, it is important to understand the potential unintended consequences of strategies to both mitigate infectious spread and create hospital capacity to care for patients infected with COVID-19. Our study provides evidence that some patients who have surgery for cancer delayed may never ultimately progress to resection. Since resection is the mainstay of treatment in early-stage disease, those patients who have surgical care withheld due to resource constraints are more likely to risk compromised treatment outcomes and, potentially, even decreased survival. Indeed, a number of prior studies have demonstrated the importance of minimizing time to surgery for the primary cancers evaluated in the present study,^{5,17,18} with a greater than 30-day delay significantly decreasing overall survival. Identification of hospital systems which are more vulnerable to such delays, or more broadly subject to resource limitations, may allow for improved preparation for future COVID-19 surges or other similar events. In addition, identifying hospital structures and cancer types which are less vulnerable to surgical delays offers the opportunity to explore the protections they have. Further exploration of factors, such as those

promoting the recovery of lung cancer surgeries, may promote the development of similar protections for additional cancer types.

This analysis, in conjunction with the established literature, has significant implications for the trajectory of cancer surgery amidst the COVID-19 pandemic. The reductions and delays in oncologic surgeries, as seen especially in academic medical centers, those caring for more COVID-19 patients, and those with greater baseline cancer surgery volumes, have created a backlog of patients in need of resection. Hospitals must not only return to their pre-pandemic surgical volumes but must surpass them in order to account for all the patients in need of surgical resection. Though notably, we anticipate that a number of patients who originally had resectable cancers have now progressed amidst delays and are no longer surgical candidates. While lung cancer surgery recovered the most, it did not surpass its pre-pandemic volumes. This highlights the remaining demand for cancer surgery without accounting for the future influx of newly diagnosed patients as many patients were unable to seek screening.¹⁰ While we hypothesize that the majority of patients waited for their surgeries, we postulate that a greater number of patients may have sought systemic therapies or ambulatory procedures than they otherwise would have.

There are some limitations to our study. The Illinois Health and Hospital Association's Comparative Health Care and Hospital Data Reporting Services database only includes inpatient admissions. Therefore, outpatient operations, such as those commonly performed for breast cancer are not captured, as evidenced by the low number of breast cancer surgeries evaluated. With over three quarters of lumpectomies and approximately half of unilateral mastectomies taking place in outpatient ambulatory surgical centers, we accept that this analysis does not begin to account for the entirety of breast cancers within the state of Illinois.^{19,20} However, this limitation was not specific to the pandemic period, allowing for a reasonable comparison to be made across time points and to still have a meaningful analysis of breast cancer surgeries taking place in the inpatient setting. We also acknowledge that there

are notably fewer lung cancer surgeries evaluated in this analysis than the incidence of lung cancer in Illinois, however, we accept this because a minority of lung cancers are operable and thus a minority would be captured in our analysis.²¹ We are reassured by our analytical technique and integrity of the dataset as the number of colorectal cancer resections evaluated approaches that of the colorectal cancer incidence in Illinois, a cancer type whose incidence more directly correlates with inpatient resections. We are not able to report granular information regarding cancer stage as this information is not available in the dataset. For all three studied conditions, surgical resection is typically performed in patients at early disease stage and thus the study is not likely to accurately reflect patterns of care for patients with advanced stage or metastatic disease during the pandemic. Finally, the database does not include federally funded hospital networks, such as the Veterans Affairs system, and the findings of this study may not be generalizable to that setting.

CONCLUSION

There was a significant reduction in the surgical treatment of cancer during the COVID-19 pandemic. Operations for colorectal cancer and breast cancer across Illinois experienced a significant and persistent decline, while lung cancer operations were initially reduced but rebounded during the pandemic recovery period in late 2020. We found that academic hospitals, those caring for more COVID-19 patients, and those with greater baseline cancer surgery volumes were most vulnerable to disruptions in oncologic surgery during peaks of the pandemic. The identification of hospital systems which are more vulnerable to such delays, or more broadly subject to resource limitations, may allow for improved preparation for future COVID-19 surges and similar events.

Study Type: Population-based retrospective cohort study

Supplemental Table 1: ICD-10 diagnosis and procedure codes.

Supplemental Figure 1: Distribution of differences in mean monthly period volumes

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Table 1: Admission sociodemographic and hospital-level characteristics during the pre-pandemic, primary pandemic, and pandemic recovery periods for all cancer types.

	Pre-Pandemic Period			Primary Pandemic Period			Pandemic Recovery Period		
Cancer Type	Breast	Colorectal	Lung	Breast	Colorectal	Lung	Breast	Colorectal	Lung
Admission-Level Variable									
Cancer Surgery Admissions	391	2341	809	137	828	278	382	2170	826
Sex									
Male	0.0%	47.3%	43.9%	0.7%	43.6%	43.5%	1.0%	47.3%	43.3%
Female	100%	52.7%	56.1%	99.3%	56.4%	56.5%	99.0%	52.7%	56.7%
Age in Years									
≤45	15.8%	6.1%	0.8%	21.9%	4.7%	0.4%	16.9%	6.3%	1.4%
46-54	18.9%	11.7%	3.8%	19.0%	13.4%	2.9%	16.3%	12.4%	4.4%
55-64	26.3%	21.8%	25.3%	24.8%	23.3%	27.3%	24.4%	21.7%	23.6%
65-74	22.8%	27.2%	41.9%	18.2%	28.0%	45.0%	24.9%	26.5%	42.6%
75+	16.1%	33.3%	28.1%	16.1%	30.8%	24.5%	17.6%	33.1%	28.0%
Race, Ethnicity									
White, NH	62.7%	68.4%	73.9%	54.7%	67.1%	73.4%	62.2%	66.1%	74.9%
Black, NH	20.2%	14.4%	11.7%	22.6%	13.5%	10.4%	18.1%	13.4%	11.7%
Hispanic	7.4%	5.9%	2.3%	8.8%	5.7%	2.2%	7.5%	6.8%	1.7%
Asian	4.3%	2.3%	2.1%	6.6%	3.0%	1.8%	3.1%	2.3%	2.9%
Other, Multiple	5.4%	9.1%	9.9%	7.3%	10.6%	12.2%	9.1%	11.4%	8.7%
Insurance									
Private	49.9%	31.8%	27.1%	49.6%	33.9%	31.3%	46.9%	32.2%	26.2%
Medicaid	12.3%	8.0%	5.3%	8.0%	8.7%	3.2%	8.0%	8.9%	5.0%
Medicare	34.5%	57.1%	65.9%	33.6%	54.0%	65.1%	40.9%	55.8%	67.7%
Uninsured	3.3%	3.1%	1.7%	8.8%	3.4%	0.4%	4.1%	3.0%	1.2%
Poverty									
Low	40.9%	33.4%	36.2%	32.1%	33.3%	32.4%	35.5%	33.5%	38.3%
Medium	27.4%	28.2%	28.1%	28.5%	28.3%	27.0%	28.2%	28.7%	25.7%
High	17.9%	28.7%	25.1%	23.4%	27.8%	27.7%	26.2%	28.8%	23.7%
Very High	9.0%	6.2%	5.4%	10.9%	7.5%	6.8%	7.5%	5.5%	6.8%
Unknown	4.9%	3.5%	5.2%	5.1%	3.1%	6.1%	2.6%	3.5%	5.6%
Residence									
Cook County	43.5%	38.0%	36.8%	43.1%	36.6%	31.7%	45.9%	38.1%	35.0%
Other IL County	36.1%	23.2%	26.3%	26.3%	20.3%	21.6%	29.3%	22.0%	25.4%
Non-IL	20.5%	38.9%	36.8%	30.7%	43.1%	46.8%	24.9%	39.9%	39.6%
ICU Admission*									
ICU	12.5%	22.8%	45.6%	13.9%	22.5%	41.4%	11.4%	17.7%	41.9%
Non-ICU	87.5%	77.2%	54.4%	86.1%	77.5%	58.6%	88.6%	82.3%	58.1%
Hospital-Level Variables									
Hospital Type									
COTH/Public	38.4%	31.3%	57.1%	37.2%	30.4%	50.4%	38.1%	32.4%	56.9%
Safety Net	1.5%	2.1%	0.6%	0.7%	2.3%	0.0%	2.1%	2.5%	0.5%
Community	60.1%	66.6%	42.3%	62.0%	67.3%	49.6%	59.8%	65.1%	42.6%
COVID-19 Admissions									
<500	13.0%	18.5%	11.4%	18.2%	21.3%	11.9%	20.7%	20.7%	11.1%
500-999	29.2%	27.6%	19.7%	24.1%	26.1%	24.8%	22.3%	26.6%	20.7%
1000-1499	25.6%	32.2%	30.0%	31.4%	33.5%	28.1%	27.7%	31.4%	30.3%
1500+	32.2%	21.6%	38.9%	26.3%	19.2%	35.3%	29.3%	21.2%	37.9%
Baseline Cancer Surgery Volume									
Low	12.5%	17.4%	4.3%	23.4%	16.3%	3.2%	15.3%	18.3%	3.3%
Medium	49.1%	51.9%	39.7%	50.4%	53.4%	43.2%	50.8%	50.6%	40.6%
High	38.4%	30.8%	56.0%	26.3%	30.3%	53.6%	33.9%	31.2%	56.2%

*p=0.001, colorectal cancer surgery only

Table 2: Average number of surgical cases per month per hospital by hospital type and cancer type.

Cancer Type	Breast			Colorectal			Lung		
Phase	Pre-Pandemic	Primary Pandemic	Pandemic Recovery	Pre-Pandemic	Primary Pandemic	Pandemic Recovery	Pre-Pandemic	Primary Pandemic	Pandemic Recovery
Overall									
N Hospitals	108	118	118	144	144	144	64	64	64
Overall	0.6 (0.9)	0.4 (0.6)	0.5 (0.8)	2.7 (3.3)	1.9 (2.5)	2.5 (3.2)	2.1 (3.3)	1.4 (2.1)	2.2 (3.2)
Hospital Type	**PP: p<0.001 PR: p=0.934			**PP: p<0.001 PR: p=0.671			**PP: p<0.001 PR: p=0.969		
COH/Public	1.8 (1.7)	1.2 (1.0)	1.8 (1.4)	8.7 (4.2)	6.0 (2.9)	8.4 (4.0)	5.9 (5.2)	3.6 (3.1)	6.0 (4.8)
Safety Net	0.2 (0.2)	0.1 (0.1)	0.2 (0.2)	1.0 (1.7)	0.8 (1.2)	1.1 (1.7)	0.4 (0.35)	0.0 (0.0)	0.3 (0.2)
Community	0.4 (0.6)	0.3 (0.4)	0.4 (0.5)	2.7 (3.3)	1.5 (2.1)	1.9 (2.4)	1.2 (1.6)	0.9 (1.4)	1.2 (3.2)
COVID-19 Volume	**PP: p<0.001 PR: p=0.510			**PP: p<0.001 PR: p=0.620			**PP: p<0.001 PR: p=0.992		
<500	0.2 (0.4)	0.2 (0.2)	0.3 (0.4)	0.9 (1.2)	0.7 (1.1)	0.9 (1.3)	1.3 (1.7)	0.9 (1.0)	1.3 (2.1)
500-999	0.6 (0.7)	0.3 (0.4)	0.4 (0.7)	3.3 (2.4)	2.2 (2.1)	2.9 (2.1)	1.2 (2.1)	1.0 (1.9)	1.2 (2.4)
1000-1499	0.9 (0.5)	0.6 (0.5)	0.8 (0.5)	5.5 (3.6)	4.0 (3.4)	4.9 (3.9)	1.9 (2.4)	1.2 (1.7)	2.0 (2.2)
1500+	2.8 (1.8)	1.5 (1.0)	2.4 (1.6)	10.5 (3.0)	6.6 (2.2)	9.6 (3.7)	6.6 (6.0)	4.1 (3.1)	6.5 (5.0)
Baseline Volume	**PP: p<0.001 *PR: p=0.021			**PP: p<0.001 PR: p=0.230			**PP: p<0.001 **PR: p<0.001		
Low	0.3 (0.1)	0.4 (0.2)	0.2 (0.2)	1.3 (1.2)	0.8 (0.9)	1.1(1.0)	1.2 (1.3)	0.9 (1.2)	1.2 (1.4)
Medium	0.9 (0.4)	0.6 (0.5)	0.8 (0.5)	6.7 (3.0)	5.0 (2.2)	6.2 (2.7)	7.9 (2.1)	5.1 (2.3)	8.9 (3.0)
High	3.6 (1.1)	1.7 (1.0)	3.1 (1.0)	16.3 (3.3)	11.5(3.5)	17.1 (0.8)	20.0 (0.0)	10.3 (0.0)	14.5 (0.0)

Standard deviation noted in parenthesis.

Significance testing for change in average monthly cases per hospital evaluated for the following periods:

PP: Pre-Pandemic to Primary Pandemic

PR: Pre-Pandemic to Recovery Period

Significant findings are bolded with ** noting p<0.001 and * noting p <0.05

Figure 1: Percent change in cancer surgery volume from 2019 to 2020 for breast, colorectal, and lung cancer surgery.

