Title

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# Pandemic Recovery: Persistent Disparities in Access to Elective Surgical Procedures

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## Structured Abstract

**Objective:** To examine potential disparities in patient access to elective procedures during the recovery phase of the COVID-19 pandemic.

**Summary Background Data:** Elective surgeries during the pandemic was limited acutely. Access to surgical care was restored in a recovery phase but backlogs and societal shifts are hypothesized to impact surgical access.

**Methods:** Adults with electronic health record orders for procedures ("procedure requests"), from March 16 to August 25, 2019 and March 16 to August 25, 2020, were included. Logistic regression was performed for requested procedures that were not scheduled. Linear regression was performed for wait time from request to scheduled or completed procedure.

**Results:** The number of patients with procedure requests decreased 20.8%, from 26,789 in 2019 to 21,162 in 2020. Patients aged 36–50 and >65 years, those speaking non-English languages, those with Medicare or no insurance, and those living >100 miles away had disproportionately larger decreases. Requested procedures had significantly increased adjusted odds ratios (aORs) of not being scheduled for patients with primary languages other than English, Spanish, or Cantonese (aOR 1.60, 95% confidence interval [CI] 1.12–2.28); unpartnered marital status (aOR 1.21, 95% CI 1.07–1.37); uninsured or self-pay (aOR 2.03, 95% CI 1.53–2.70). Significantly longer wait times were seen for patients aged 36–65 years; with Medi-Cal insurance; from ZIP codes with lower incomes; and from ZIP codes >100 miles away.

**Conclusions:** Patient access to elective surgeries decreased during the pandemic recovery phase with disparities based on patient age, language, marital status, insurance, socioeconomic status, and distance from care. Steps to address modifiable disparities have been taken.

## Mini abstract:

Surgical volume during the pandemic acute and recovery phases decreased 20% compared to 2019 generating a large backlog. As surgical volume was restored during the recovery phase, patient age, language, marital status, insurance, socioeconomic status, and distance from our institution disproportionately limited access to surgical care.

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## Introduction

The COVID-19 pandemic caused dramatic shifts in surgical and procedural care. Evidence and experience suggest that patients are avoiding healthcare settings, with the possibility that untreated disease burdens may worsen.[1] In response to the pandemic, many hospitals acutely limited elective surgeries and procedures to conserve resources and reduce potential exposures. After this acute phase of surgical volume restriction, most hospitals rapidly restored surgical volume to meet the backlog of cases, entering recovery phases.[2,3]
The impact of social determinants of health on access to care has been increasingly recognized across a range of surgeries and procedures.[4–15] The pandemic has accentuated social determinants of health, with Black and Latinx Americans in particular suffering disproportionate infection and mortality rates.[16–21] While surgical volume recovered, other contributors to access remained altered. The impact of pandemic-induced changes in access to surgical care during the recovery phase has not been well described.

This study aimed to examine access to elective surgeries and related procedures during the pandemic acute and recovery phases, with particular attention to the impact of social determinants of health. The analysis focused on two key points in the trajectory of care (Figure 1a). For patients who have consulted with a surgical or procedural specialist, received a recommendation for a procedure, and consented, the first administrative step is an electronic order for the procedure ("procedure request"). For the requested procedure to be scheduled and occur, additional systems and social hurdles must be overcome, including insurance authorization, administrative and logistic arrangements, deferral of patients' professional and personal commitments, and preoperative assessments (depending on the institution, this may now include SARS-CoV-2 screening).[22] Procedure requests represent the volume of patients who present for care, while procedure scheduling reflects the barriers between indication and intervention.[23]

This study hypothesized that social determinants of health are associated with reduced number of procedure requests, increased rate of requested procedures not being scheduled, and longer wait times. With the onset of the pandemic, healthcare resources are redirected, schools are closed, childcare is limited, public transportation is curtailed, jobs and insurance coverage have been lost, and economic uncertainty prevails. Studying procedure requests and scheduling can measure the impact of these changes in access and identify opportunities to improve equity.

## Methods

### Population

Patients with electronic health record orders for elective surgeries and procedures ("procedure requests") were identified using the electronic health record at a single tertiary/quaternary academic institution, where reserving time in any operating room or procedural suite required a procedure request. Emergent and urgent procedure requests, which have indications to be completed within 24–72 hours, were excluded. Patients aged <18 years were excluded. The following surgical and related procedural specialties were included: abdominal transplant surgery, breast surgery, cardiac surgery, cardiology, gastroenterology,

general surgery (including abdominal wall, bariatric/foregut, endocrine, hepatobiliary-pancreatic, and colorectal sections), gynecology (including benign gynecologic surgery, gynecologic oncology, and reproductive endocrinology & infertility), neurosurgery, otolaryngology/head & neck surgery, oral & maxillofacial surgery, ophthalmology, orthopedic surgery, plastic & reconstructive surgery, pulmonology, radiation oncology, radiology (including interventional and neurointerventional radiology), thoracic surgery, urology, and vascular surgery. Radiation oncology procedures included brachytherapy treatments but not external radiation treatments. Obstetric procedures were excluded from analysis because they were considered uniquely time-sensitive and less likely to have been disrupted by the pandemic.

## Time period

On March 2, 2020, our institution's perioperative leadership team moved to limit elective surgeries and procedures, and on March 13, 2020, a new priority system for elective procedure requests was implemented.[24] Initially scheduling was restricted to high priority cases, with access for normal priority cases being restored in April. Access for procedures of all priority levels was restored May 1, 2020, shifting from the acute to recovery phase, with operative volume subsequently approaching pre-pandemic levels (Figure 2). To account for a delay in uptake from Friday, March 13, procedure requests from Monday, March 16 to August 25, 2020 (the date of data extraction) were defined as the 2020 cohort. Procedure requests from March 16 to August 25, 2019 were defined as the 2019 cohort. Routine SARS-CoV-2 screening prior to high priority procedures was implemented on April 2, 2020 and expanded to all elective procedures on April 22, 2020.[22]

## Procedure prioritization

Departmental and divisional leaders established a procedure priority scale of high, normal, and low. Procedures were classified as high priority if a delay >1–2 weeks would likely lead to adverse outcomes; normal priority if a delay >2–4 weeks would lead to adverse outcomes; and low priority if delay would not lead to adverse outcomes. Each specialty set guidelines and designated service leaders to review and adjudicate issues.[24] Given the evolving nature of the pandemic and the complexity of tertiary/quaternary surgical care, overall policies and specific cases were subject to discussion between health system and departmental leadership and individual surgeons.

## Data and outcomes

The following demographic, socioeconomic, and clinical variables were collected: patient age, gender, race/ethnicity, primary language, marital status (categorized as partnered [with a spouse, registered domestic partner, or significant other] or unpartnered), insurance type (categorized as commercial, Medi-Cal [California's Medicaid], Medicare, other, or uninsured/self-pay), ZIP code of residence >100 miles from our institution, quartile of geographic income distribution based on median income for their ZIP code, surgical or procedural specialty, specialist-indicated priority level, pre-procedural SARS-CoV-2 test result (detected or not detected), whether the procedure request had single or multiple panels (panels indicate the number of planned procedures and/or surgeons; multi-panel requests are likely to have increased complexity and multi-specialty involvement), whether the procedure

was associated with a cancer diagnosis (defined below), and result of procedure request (completed, scheduled for a future date, canceled, or not scheduled). Patients self-identified their gender, race/ethnicity, language, and marital status. “Other” race/ethnicity is an option for patients to select and was analyzed as a discrete category. Languages besides the three most common at our center (English, Spanish, and Cantonese) were categorized as “Other.”

While procedure requests represented patients evaluated by specialists, procedure scheduling reflected barriers to care after specialist evaluation (Figure 1a). Two outcomes of procedure scheduling were analyzed: requested procedures that were not scheduled; and wait time for completed or scheduled procedures. Requested procedures were considered not scheduled if after two weeks they had not been scheduled or completed, and had also not been canceled. This status was primarily found in the 2020 cohort (Figure 1b). Procedure requests that are not scheduled remain anticipated (that is, not canceled), but are in limbo without a set date. Wait time was considered only among completed or scheduled procedures and was defined as the number of days between the date of procedure request and the date of the completed or scheduled procedure.

Numerous barriers exist to scheduling procedures, including insurance authorization, availability of procedural rooms and hospital beds, alignment of patient and provider schedules, and completion of pre-procedural evaluations (Figure 1a). When analyzing results of procedure requests, those requested in the first week of the 2020 cohort were excluded to account for rapid policy changes with the evolving pandemic, and those requested less than two weeks before the date of data extraction were excluded to account for the time required for the scheduling process (essentially an adjustment for immortal time).

Procedure requests were determined to be cancer-associated if either the ICD-10-CM code matched the 2020 ICD-10-CM Casefinding List of the National Cancer Institute Surveillance, Epidemiology, and End Results Program, or if the free text pre-operative or post-operative diagnosis contained any of the following case-insensitive terms/strings: cancer, neoplasm, tumor, carcinoma, sarcoma, melanoma, chondroma, lymphoma, leukemia, myeloma, blastoma, glioma, craniopharyngioma, meningioma, cytoma, GIST, MALT, DCIS, LCIS. This definition was designed to be maximally sensitive for cases in which cancer was confirmed or suspected.

## Statistical analysis

Patient and procedure characteristics were compared between the 2019 and 2020 cohorts using the Chi-squared test. Logistic regression for requested procedures not being scheduled and linear regression for wait times were performed for the 2020 cohort. Unselected regression followed by backward stepwise-selected regression was performed using pre-specified covariates, including patient age, gender, language, race/ethnicity, marital status, insurance type, quartile of ZIP code median income, ZIP code distance >100 miles away from this institution, priority level, multiple procedure panels, whether the procedure was associated with cancer, and surgical or procedural specialty. Specialty was included as a covariate to account for service-specific practice patterns.

Multicollinearity in all models was assessed using generalized variance inflation factors (GVIFs); none were greater than 5, and after correction for degrees of freedom (DF), no covariate had a $GVIF^{1/(2*DF)}$ greater than 2, indicating no significant multicollinearity.[25] Because this study aimed to describe a single center's entire population with confounders that may not be generalizable, training and validation subsets were not used for modeling. Sensitivity analyses excluding non-surgical services did not find significant differences in proportions or regression modeling.

Data analysis was performed in R version 4.0.2 (The R Foundation for Statistical Computing). The United States Census Bureau 2014–2018 American Community Survey 5-Year Estimates were used to determine ZIP code median income. Census Bureau ZIP code tabulation areas (ZCTAs) were linked to conventional ZIP codes using the ZIP Code to ZCTA Crosswalk Table by John Snow, Inc.

### Missing data

Patient race/ethnicity was unknown/declined for 961 patients (2.0%), and marital status was unknown/declined for 1,794 (3.8%); each of these was assigned a separate category. Insurance status was missing for 1,418 (3.0%) and was considered uninsured/self-pay. ZIP codes were missing for 49 patients; for an additional 113 patients, ZIP code median income could not be determined with Census Bureau data. This total of 162 missing ZIP code median incomes were imputed to be equal to the median of all ZIP code median incomes in our sample. Sensitivity analysis excluding imputed incomes did not result in meaningfully different proportions or regression results, so the imputed incomes were used to minimize bias from missing data.[26] Priority level was not available for Cardiology, Gastroenterology, and Interventional Radiology procedure requests, so those were excluded from analysis of procedure request results. Priority level was missing for 645 (5.7%) of the remaining procedure requests across all specialties; exploratory analysis showed these were likely emergent/urgent requests so they were excluded (Figure 1b).

This study was approved by the Institutional Review Board of our institution (IRB #20–32014).

## Results

Overall, the number of patients presenting to our institution in need of elective procedures decreased in 2020 compared to 2019. Elective procedure requests decreased 20.8% from March-August 2019 (n = 26,789) to March-August 2020 (n = 21,162). Changes in overall and specialty-specific procedure requests are summarized in Table 1; Obstetrics was included for description but excluded from subsequent analysis. Abdominal transplant surgery (−29.9%), neurosurgery (−27.1%), ophthalmology (−28.8%), pulmonology (−28.6%), and thoracic surgery (−26.8%) had the largest relative decreases in procedure requests. The only specialties with persistently robust procedure requests were Obstetrics (+27.9%) and Radiation Oncology (+10.9%), likely reflecting high priority levels and expanding practices resistant to the impact of the pandemic.

Decreases were seen in nearly all patient categories from 2019 to 2020 (Table 2). Disproportionately larger decreases occurred among patients aged 36–50 years and >65 years; patients of Asian, White/Caucasian, or multiple race/ethnicity; patients with non-English primary language; partnered patients; patients with Medicare, who are frequently >65 years; those without insurance; and those living in ZIP codes >100 miles away from our institution. Patient gender and income distribution were not significantly different from 2019 to 2020. The proportions of patients with multi-panel procedure requests (multiple procedures or specialists involved) and cancer-associated procedure requests both increased, but not significantly. The proportion of completed or scheduled procedure requests decreased slightly from 76.4% in the 2019 cohort to 74.9% in the 2020 cohort, with a significant increase in the proportion of requests not scheduled (from 0.3% to 12.5%) and a commensurate decrease in canceled requests (from 23.3% to 12.6%).

Rate of requested procedures not being scheduled was stable month to month from March to August 2020. Backward stepwise selection excluded patient age, gender, and ZIP code data from the most parsimonious model (Table 3). When adjusted for selected covariates, priority levels normal and low had the largest effect on requested procedures not being scheduled, with adjusted odds ratios (aOR) 2.43 and 2.46, respectively. Other notable predictors of requested procedures not being scheduled included patient's primary language other than English, Spanish, or Cantonese (the three most common languages at our institution) (aOR 1.60, 95% confidence interval [CI] 1.12–2.28); marital status of unpartnered (aOR 1.21, 95% CI 1.07–1.37); and uninsured or self-pay (aOR 2.03, 95% CI 1.53–2.70). Multi-panel and cancer-associated procedure requests had significantly lower risks of not being scheduled, likely reflecting prioritization of complex multi-procedure and cancer-related cases. In fact, these procedures may have been easier to schedule than normal because specialists were not traveling and many non-clinical obligations had decreased.

In the 2020 cohort, median wait time from request to scheduled or completed procedure was 24 days (24 days for surgical and 21 days for non-surgical procedures), compared to 32 days in the 2019 cohort. Backward stepwise selection excluded gender, primary language, race/ethnicity, and multiple panels from the most parsimonious model (Table 4). Priority levels normal and low had the greatest effect on wait times, adding 16.6 and 21.5 days, respectively. Significantly longer wait times were found for patients with Medi-Cal insurance (2.0 days, 95% CI 0.06–3.90 days); those from ZIP codes with income below the top quartile (point estimates 2.6–5.0 days); and those from ZIP codes >100 miles from our institution (2.6 days, 95% CI 0.56–4.61 days). Uninsured/self-pay patients had significantly shorter wait times (−5.5 days, 95% CI −9.73 to −1.30 days), likely reflecting fewer insurance-related delays.

SARS-CoV-2 was rarely detected among screened patients undergoing elective procedures, with 35 out of 11,351 (0.3%) testing positive; 7 cases were completed or rescheduled, 21 were canceled, and 7 were not scheduled. Local prevalence of SARS-CoV-2 during this time period by rate of overall test positivity remained consistently low (Figure 3).

## Discussion

This study represents a first report of disruptions in access to elective procedures during the pandemic recovery phase at a tertiary/quaternary academic center. As operating room volume was restored, the demographics of patients presenting for and receiving surgical care shifted disparately. Direct and indirect effects of the pandemic likely occurred. Patients >65 years are at greater risk of mortality from COVID-19, while partnered patients and those aged 36–50 years are most likely to have school-aged children, potentially explaining the hesistancy of these populations to present for care compared to younger patients. Procedure requests declined disproportionately for patients who speak non-English languages, those without insurance, and those who live farthest from care, highlighting concerning early signals of vulnerable populations seeking less care than before. The pandemic underscored inequities in healthcare in the United States, and identifying these disparities is an important first step toward equitable surgical care.

Predictors of wait times and requested procedures not being scheduled during the acute and recovery phases may be generalizable, as resource limitation may persist with shifts in the healthcare system or future unanticipated disruptions.[27,28] Social determinants of longer wait times in this cohort were associated with delays on the order of 2–7 days. While unlikely to be clinically significant for individual patients, these delays and disparities may compound as demand increases. Our institution during this study period was still operating below 100% capacity.[22,24] Among patients who received procedure requests during the acute and recovery phases, scheduling and wait times were largely determined by physician-designated priority, but disparities were found based on language, race/ethnicity, marital status, insurance, local socioeconomic status, and distance from care that were unexplained by clinical prioritization – suggesting that social determinants correlate with barriers to receiving interventions. Rapid recognition and a systemic response are essential to mitigate the pandemic's accentuation of disparities in access to care.

Prior studies also noted disparities in wait times due to socioeconomic factors.[29] However, this study is the first to our knowledge that addresses the outcome of requested procedures that are not scheduled. This state of limbo may be unique to the pandemic as patients with lower acuity postpone requested procedures, and given that the proportion of requested procedures not scheduled was commensurate with the reduction in cancellations, some of these requests may ultimately be canceled. However, we believe this is a different outcome from cancellation. Surgical care became increasingly selective and restrictive during the pandemic, suggesting that requested procedures had cleared a higher bar of necessity and priority than pre-pandemic.

The magnitude of shifts in elective procedural care during the pandemic has only been sporadically reported, primarily for acute phases and exclusively from European centers. Four non-academic centers in hard-hit Northern Italy reported an 82% decline in elective surgeries (1,903 to 350) comparing March-May 2019 to March-May 2020.[30] Another Italian group described a COVID-19-free cancer center's experience maintaining baseline surgical volume (79 breast cancer surgeries from March 15 to April 30, 2020) by performing only biopsy-proven cancer cases.[31] A breast cancer group representing five centers in the

Netherlands reported fewer referrals and lower surgical volume (217 surgeries, no baseline provided) from March-May 2020 with a shift toward more advanced cancers and fewer early-stage cancers. Even as prioritization has limited access to surgical care, demand and need are likely unchanged for both malignant and non-malignant diseases. An Italian plastic surgery group recently surveyed 124 patients awaiting abdominoplasty and found stable patient desire for this purely cosmetic procedure despite the ongoing pandemic.[32] This underscores the potential magnitude of the demand for surgical care today.

The ongoing pandemic has exacerbated existing disparities by its increased incidence and mortality in disadvantaged groups. Increased rates of SARS-CoV-2 infection and mortality have been found among Black, Latinx, Native American, Alaska Native, and Pacific Islander populations.[16–21] Lower socioeconomic status, particularly service-sector employment and unemployment, has been linked to increased community transmission of SARS-CoV-2.[19] Our analysis identified significant disparities in access based on patient age, language, marital status, insurance type, local socioeconomic status, and distance from care, many of which have not previously been described regarding the pandemic but align with known social determinants of health.[33,34] Understanding these disparities in access is the first step toward mitigating them.[23] Whether physician-designated prioritization contributed to disparities was unclear, as known social determinants of high priority indications such as cancer were associated with decreased access. Evidence of these disparities in the context of resource limitation and surgeon prioritization suggests compounded disadvantages. Care likely remained high-value as patients undergoing procedures mid-pandemic had presented despite infection risks, and surgeons triaged time-sensitive indications. Further study is needed to understand if prioritization during the pandemic impacted value.

The observed trends are not confounded by major surges in COVID-19 cases in local or referral areas during the study period (Figure 3). The largest regional outbreak during the study period was among incarcerated persons, a vulnerable population making up a very small proportion of this sample (16 patients total). This study had several limitations. The data come from a single tertiary/quaternary academic center and may not be generalizable. Granular determinants of health not recorded in electronic health records were not captured, including discrete financial and employment status, social support, dependents, transportation, and housing or food instability. Only patients with procedure requests were assessed – the denominator of all patients in the population with surgical or procedural indications, including those who never presented for care, was unknown. Missing data were rare but, in some cases, may have been non-random, as unknown/declined marital status and race/ethnicity were associated with outcomes of interest.

In light of these disparities in access after presentation and before procedural care, our center has instituted several changes. To promote awareness among providers, scheduling staff, and leadership, we have developed a dashboard to monitor patients whose scheduling may be slow to progress. Multiple changes have been made to support patients preparing for surgery. The requirement for SARS-CoV-2 screening within four days pre-op has prompted patients to travel to our center days in advance of surgery; to ease the financial burden, hotel vouchers are provided. Telehealth has become the norm for most clinics including for preoperative anesthesia evaluation. Clinics screen patients for potential social needs.

Inpatient social workers were redeployed to support increased outpatient needs. Electronic documentation was modified to better record interpreter deployment. A quality improvement initiative has begun to monitor and increase rates of interpreter usage for patients with limited English proficiency, improving coordination of care. Recognition of barriers to equitable care in the pandemic has been an impetus for our health system and providers to implement change.

In summary, this study represents a first report of shifting access to elective surgeries and procedures during the pandemic acute and recovery phases at a large U.S. academic center. Access to care, as determined by procedure requests, scheduling, and wait time, significantly decreased for elderly patients, those with non-English primary languages, the unpartnered, those with no insurance or Medi-Cal, those living in less wealthy areas, and those living farther from care. These populations that were already vulnerable before the pandemic now have disproportionately less access to surgeries and procedures. Initial steps to addressing some of these disparities have been taken at our center. Further study is needed to understand the impact and to continue working towards equitable surgical care.

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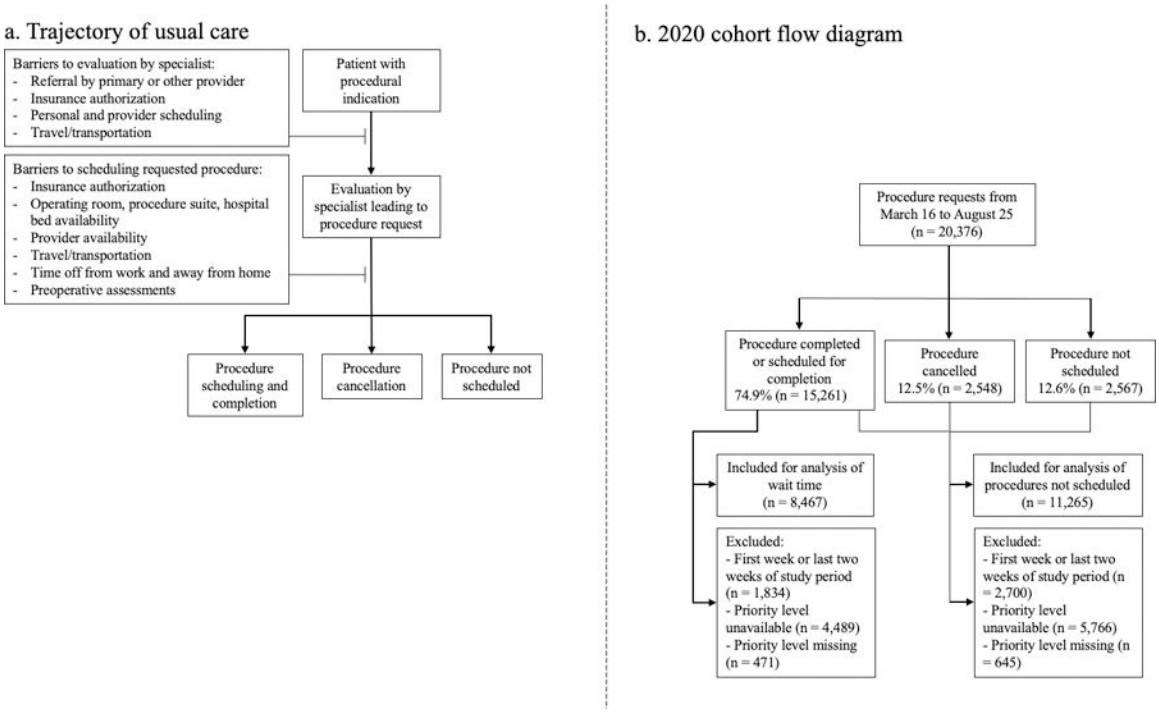


**Figure 1:**

Trajectory of care and cohort flow diagram

a. Trajectory of care and barriers from indication to evaluation by specialist, procedure request, and procedure scheduling. b. Cohort flow diagram of patients with procedure requests from March 16 to August 25, 2020.

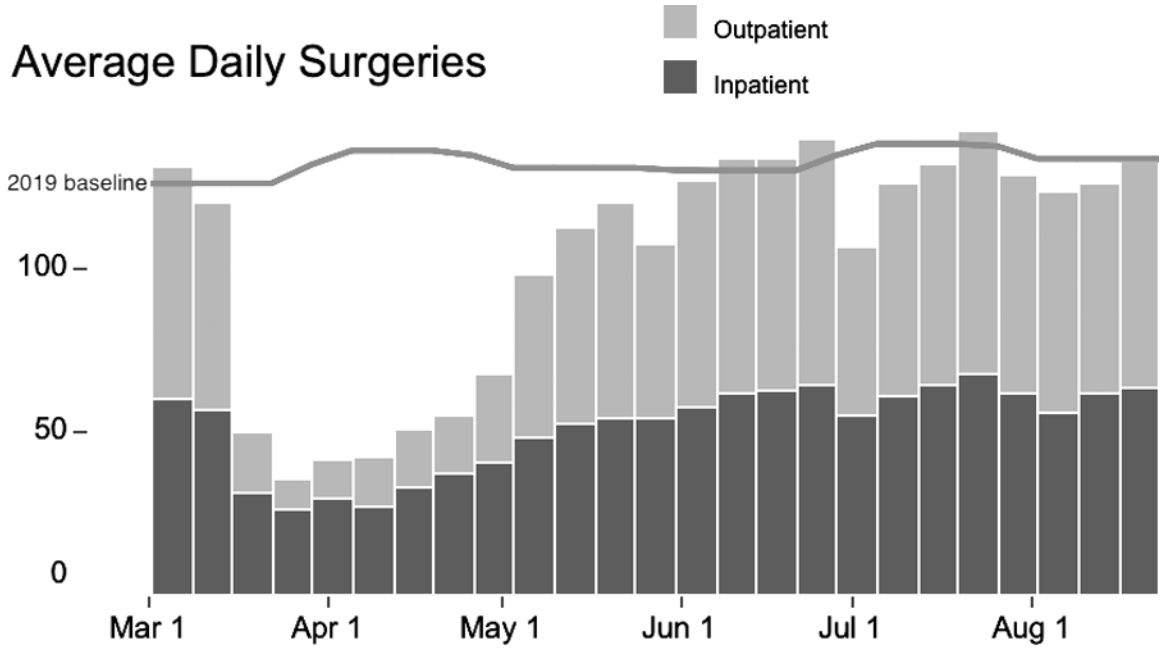


**Figure 2:**
Average daily surgeries March-August 2020, with 2019 baseline

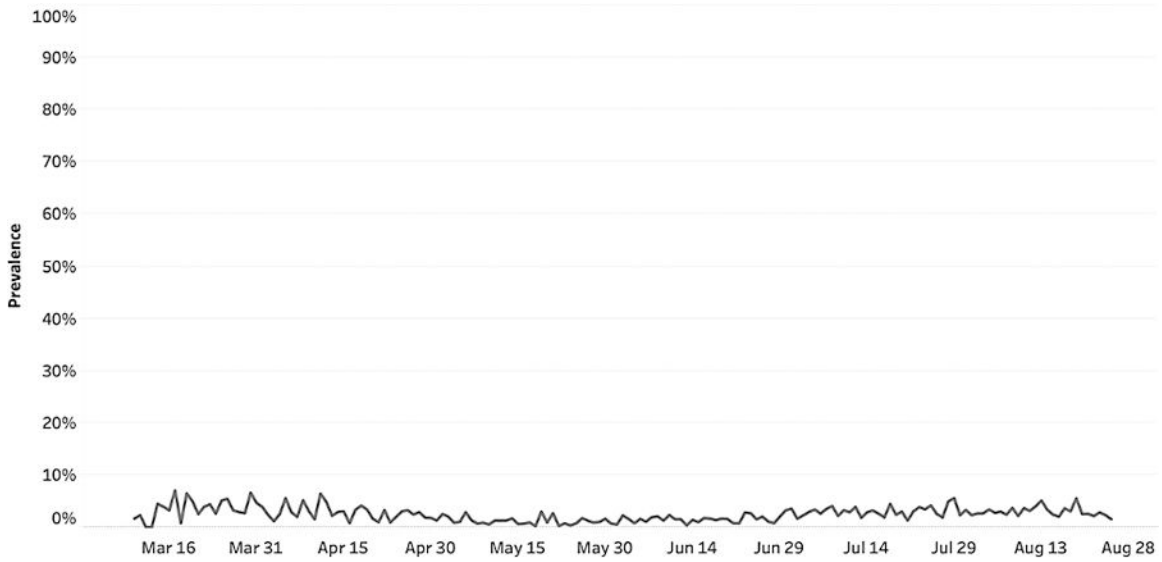


**Figure 3:**
Institutional SARS-CoV-2 test positivity rate during the study period

**Table 1:**

Changes in total procedure requests from 2019 to 2020

| | 2019 | 2020 | Difference |
|---|---|---|---|
| Overall | 26,353 | 20,876 | −20.8% |
| By specialty: | | | |
| Abdominal Transplant Surgery | 294 | 206 | −29.9% |
| Breast Surgery | 429 | 332 | −22.6% |
| Cardiac Surgery | 234 | 191 | −18.4% |
| Cardiology | 1,797 | 1,356 | −24.5% |
| Gastroenterology | 5,681 | 4,639 | −18.3% |
| General Surgery | 1,857 | 1,456 | −21.6% |
| Gynecology | 2,095 | 1,612 | −23.1% |
| Interventional Radiology | 754 | 628 | −16.7% |
| Neurosurgery | 1,897 | 1,383 | −27.1% |
| Obstetrics | 391 | 500 | 27.9% |
| Otolaryngology/Head & Neck Surgery | 1,474 | 1,177 | −20.1% |
| Oral & Maxillofacial Surgery | 185 | 161 | −13.0% |
| Ophthalmology | 1,545 | 1,100 | −28.8% |
| Orthopedic Surgery | 4,384 | 3,271 | −25.4% |
| Plastic & Reconstructive Surgery | 853 | 731 | −14.3% |
| Pulmonology | 213 | 152 | −28.6% |
| Radiation Oncology | 175 | 194 | 10.9% |
| Thoracic Surgery | 209 | 153 | −26.8% |
| Urology | 1,425 | 1,251 | −12.2% |
| Vascular Surgery | 461 | 383 | −16.9% |

2019 cohort is patients with procedure requests from March 16 – August 25, 2019. 2020 cohort is patients with procedure requests from March 16 – August 25, 2020.

**Table 2:**

Changes in patients with procedure requests from 2019 to 2020

| | 2019 N (%) | 2020 N (%) | p-value |
|---|---|---|---|
| Age category (years) | | | <0.001 |
| 18–35 | 4,009 (15.4) | 3,459 (17.0) | |
| 36–50 | 5,521 (21.3) | 4,217 (20.7) | |
| 51–65 | 7,932 (30.6) | 6,350 (31.2) | |
| >65 | 8,500 (32.7) | 6,350 (31.2) | |
| Gender | | | 0.5 |
| Male | 11,842 (45.6) | 9,403 (46.1) | |
| Female | 14,093 (54.3) | 10,953 (53.8) | |
| Other | 27 (0.1) | 20 (0.1) | |
| Primary language | | | <0.001 |
| English | 23,738 (91.4) | 18,856 (92.5) | |
| Spanish | 890 (3.4) | 690 (3.4) | |
| Cantonese | 361 (1.4) | 244 (1.2) | |
| Other | 973 (3.7) | 586 (2.9) | |
| Race/ethnicity | | | <0.001 |
| American Indian or Alaska Native | 129 (0.5) | 101 (0.5) | |
| Asian | 3,761 (14.5) | 2,725 (13.4) | |
| Black or African American | 1,496 (5.8) | 1,289 (6.3) | |
| Latinx | 3,442 (13.3) | 2,754 (13.5) | |
| Multi-race/ethnicity | 640 (2.5) | 412 (2.0) | |
| Native Hawaiian or other Pacific Islander | 149 (0.6) | 123 (0.6) | |
| Other | 956 (3.7) | 790 (3.9) | |
| Unknown/declined | 417 (1.6) | 544 (2.7) | |
| White or Caucasian | 14,972 (57.7) | 11,638 (57.1) | |
| Marital status | | | <0.001 |
| Partnered | 14,472 (55.7) | 11,145 (54.7) | |
| Unpartnered | 10,587 (40.8) | 8,352 (41.0) | |
| Unknown/declined | 903 (3.5) | 879 (4.3) | |
| Insurance type | | | <0.001 |
| Commercial | 9,729 (37.5) | 8,025 (39.4) | |
| Medi-Cal | 4,687 (18.1) | 4,014 (19.7) | |
| Medicare | 9,884 (38.1) | 7,155 (35.1) | |
| Other | 845 (3.3) | 707 (3.5) | |
| Uninsured/Self-Pay | 817 (3.1) | 475 (2.3) | |
| Quartile of ZIP code median income in overall cohort | | | 0.5 |

| | 2019 N (%) | 2020 N (%) | p-value |
|---|---|---|---|
| Top quartile | 6,409 (24.7) | 5,159 (25.3) | |
| 3rd quartile | 6,370 (24.5) | 4,948 (24.3) | |
| 2nd quartile | 6,663 (25.7) | 5,182 (25.4) | |
| Bottom quartile | 6,520 (25.1) | 5,087 (25.0) | |
| ZIP code >100 mi from our center | 4,266 (16.4) | 3,124 (15.3) | 0.001 |
| Multi-panel procedure | 1,268 (4.9) | 1,061 (5.2) | 0.12 |
| Cancer-associated procedure | 4,896 (18.9) | 3,918 (19.2) | 0.3 |
| Procedure request result | | | <0.001 |
| Completed or Scheduled | 19,840 (76.4) | 15,261 (74.9) | |
| Canceled | 6,055 (23.3) | 2,548 (12.5) | |
| Not Scheduled | 67 (0.3) | 2,567 (12.6) | |

2019 cohort is patients with procedure requests from March 16 – August 25, 2019. 2020 cohort is patients with procedure requests from March 16 – August 25, 2020.

**Table 3:**

Multivariate logistic regression models of requested procedures not being scheduled during the pandemic

| | Unselected model | | | Selected model | | |
|---|---|---|---|---|---|---|
| **Predictors** | **Odds Ratios** | **95% CI** | **p-value** | **Odds Ratios** | **95% CI** | **p-value** |
| Age category (years) | | | | | | |
| 18–35 | *Reference* | | | | | |
| 36–50 | 1.15 | 0.96 – 1.38 | 0.14 | | | |
| 51–65 | 1.10 | 0.91 – 1.31 | 0.3 | | | |
| >65 | 1.12 | 0.87 – 1.43 | 0.4 | | | |
| Gender | | | | | | |
| Male | *Reference* | | | | | |
| Female | 1.01 | 0.89 – 1.14 | 0.9 | | | |
| Other | 0.35 | 0.04 – 2.82 | 0.3 | | | |
| Primary language | | | | | | |
| English | *Reference* | | | *Reference* | | |
| Spanish | 1.11 | 0.77 – 1.61 | 0.6 | 1.12 | 0.78 – 1.62 | 0.5 |
| Cantonese | 1.18 | 0.66 – 2.10 | 0.6 | 1.18 | 0.66 – 2.09 | 0.6 |
| Other | **1.59** | **1.12 – 2.27** | **0.01** | **1.60** | **1.12 – 2.28** | **0.009** |
| Race/ethnicity | | | | | | |
| White or Caucasian | *Reference* | | | *Reference* | | |
| American Indian or Alaska Native | 0.92 | 0.40 – 2.08 | 0.8 | 0.93 | 0.41 – 2.11 | 0.9 |
| Asian | 1.12 | 0.92 – 1.37 | 0.3 | 1.11 | 0.92 – 1.35 | 0.3 |
| Black or African American | 1.07 | 0.83 – 1.37 | 0.6 | 1.06 | 0.83 – 1.36 | 0.6 |
| Latinx | 1.01 | 0.83 – 1.24 | 0.9 | 1.00 | 0.82 – 1.23 | 1.0 |
| Multi-Race/Ethnicity | 0.84 | 0.53 – 1.34 | 0.5 | 0.83 | 0.52 – 1.32 | 0.4 |
| Native Hawaiian or other Pacific Islander | 0.82 | 0.32 – 2.10 | 0.7 | 0.81 | 0.32 – 2.08 | 0.7 |
| Other | **1.67** | **1.29 – 2.16** | **<0.001** | **1.66** | **1.29 – 2.15** | **<0.001** |
| Unknown/declined | **2.39** | **1.79 – 3.18** | **<0.001** | **2.37** | **1.78 – 3.16** | **<0.001** |
| Marital status | | | | | | |
| Partnered | *Reference* | | | *Reference* | | |
| Unpartnered | **1.24** | **1.09 – 1.41** | **0.001** | **1.21** | **1.07 – 1.37** | **0.003** |
| Unknown/declined | **1.84** | **1.42 – 2.39** | **<0.001** | **1.82** | **1.40 – 2.37** | **<0.001** |
| Insurance type | | | | | | |
| Commercial | *Reference* | | | *Reference* | | |
| Medi-Cal | 0.96 | 0.81 – 1.13 | 0.6 | 0.97 | 0.82 – 1.14 | 0.7 |
| Medicare | 0.91 | 0.74 – 1.11 | 0.3 | 0.93 | 0.81 – 1.07 | 0.3 |
| Other | 0.77 | 0.53 – 1.10 | 0.15 | 0.77 | 0.54 – 1.10 | 0.15 |
| Uninsured/Self-Pay | **2.03** | **1.53 – 2.70** | **<0.001** | **2.03** | **1.53 – 2.70** | **<0.001** |
| ZIP code median income | | | | | | |

| | Unselected model | | | Selected model | | |
|---|---|---|---|---|---|---|
| **Predictors** | **Odds Ratios** | **95% CI** | **p-value** | **Odds Ratios** | **95% CI** | **p-value** |
| Top Quartile | *Reference* | | | | | |
| 3rd Quartile | 1.06 | 0.90 – 1.25 | 0.5 | | | |
| 2nd Quartile | 0.97 | 0.82 – 1.15 | 0.7 | | | |
| Bottom Quartile | 1.04 | 0.86 – 1.26 | 0.7 | | | |
| ZIP code >100 mi away | 1.04 | 0.88 – 1.25 | 0.6 | | | |
| Priority level | | | | | | |
| High | *Reference* | | | *Reference* | | |
| Normal | **2.42** | **2.02 – 2.90** | **<0.001** | **2.43** | **2.03 – 2.90** | **<0.001** |
| Low | **2.46** | **1.96 – 3.10** | **<0.001** | **2.46** | **1.95 – 3.09** | **<0.001** |
| Multi-panel procedure request | **0.62** | **0.47 – 0.81** | **<0.001** | **0.62** | **0.47 – 0.81** | **<0.001** |
| Cancer-associated procedure request | **0.72** | **0.60 – 0.87** | **0.001** | **0.73** | **0.61 – 0.88** | **0.001** |

Outcome was requested procedures not being scheduled (vs completed, scheduled, or canceled). Model selection used backward stepwise methodology. Surgical/procedural specialty was included as a covariate and preserved in model selection, but odds ratios are not displayed. Observations: 11,265. CI: confidence interval.

**Table 4:**

Multivariate linear regression models of wait time (in days) for procedures during the pandemic

| | Unselected model | | | Selected model | | |
|---|---|---|---|---|---|---|
| **Predictors** | **Days delayed** | **95% CI** | **p-value** | **Days delayed** | **95% CI** | **p-value** |
| Intercept | 16.3 | 10.78 – 21.82 | **<0.001** | 16.0 | 10.54 – 21.41 | **<0.001** |
| Age category (years) | | | | | | |
| 18–35 | *Reference* | | | *Reference* | | |
| 36–50 | **2.7** | **0.58 – 4.81** | **0.013** | **2.7** | **0.58 – 4.80** | **0.012** |
| 51–65 | 2.1 | −0.04 – 4.16 | 0.055 | **2.1** | **0.04 – 4.20** | **0.046** |
| >65 | 0.9 | −1.97 – 3.74 | 0.5 | 0.8 | −2.04 – 3.59 | 0.6 |
| Gender | | | | | | |
| Male | *Reference* | | | | | |
| Female | 1.1 | −0.38 – 2.48 | 0.2 | | | |
| Other | 1.0 | −17.90 – 19.87 | 0.9 | | | |
| Primary language | | | | | | |
| English | *Reference* | | | | | |
| Spanish | −3.0 | −7.10 – 1.18 | 0.16 | | | |
| Cantonese | −2.0 | −8.36 – 4.36 | 0.5 | | | |
| Other | 0.3 | −4.06 – 4.67 | 0.9 | | | |
| Race/ethnicity | | | | | | |
| White or Caucasian | *Reference* | | | | | |
| American Indian or Alaska Native | 1.1 | −7.68 – 9.79 | 0.8 | | | |
| Asian | **−2.3** | **−4.47 – −0.17** | **0.034** | | | |
| Black or African American | 1.8 | −1.14 – 4.66 | 0.2 | | | |
| Latinx | −0.1 | −2.40 – 2.15 | 0.9 | | | |
| Multi-Race/Ethnicity | −1.4 | −6.02 – 3.17 | 0.5 | | | |
| Native Hawaiian or other Pacific Islander | −5.3 | −14.12 – 3.55 | 0.2 | | | |
| Other | 1.3 | −2.40 – 5.08 | 0.5 | | | |
| Unknown/declined | **4.9** | **0.40 – 9.43** | **0.033** | | | |
| Marital status | | | | | | |
| Partnered | *Reference* | | | *Reference* | | |
| Unpartnered | 0.4 | −1.08 – 1.79 | 0.6 | 0.7 | −0.74 – 2.10 | 0.3 |
| Unknown/declined | **5.3** | **1.34 – 9.26** | **0.009** | **6.9** | **3.11 – 10.59** | **<0.001** |
| Insurance type | | | | | | |
| Commercial | *Reference* | | | *Reference* | | |
| Medi-Cal | **2.3** | **0.31 – 4.27** | **0.024** | **2.0** | **0.06 – 3.90** | **0.043** |
| Medicare | 1.3 | −1.00 – 3.56 | 0.3 | 1.3 | −1.01 – 3.54 | 0.3 |
| Other | −0.8 | −4.46 – 2.97 | 0.7 | −1.0 | −4.73 – 2.69 | 0.6 |
| Uninsured/Self-Pay | **−5.4** | **−9.67 – −1.22** | **0.012** | **−5.5** | **−9.73 – −1.30** | **0.01** |

| | Unselected model | | | Selected model | | |
|---|---|---|---|---|---|---|
| **Predictors** | **Days delayed** | **95% CI** | **p-value** | **Days delayed** | **95% CI** | **p-value** |
| ZIP code median income | | | | | | |
| Top Quartile | *Reference* | | | *Reference* | | |
| 3rd Quartile | **2.7** | **0.82 – 4.57** | **0.005** | **2.6** | **0.76 – 4.49** | **0.006** |
| 2nd Quartile | **4.5** | **2.62 – 6.36** | **<0.001** | **4.5** | **2.65 – 6.36** | **<0.001** |
| Bottom Quartile | **4.9** | **2.71 – 6.98** | **<0.001** | **5.0** | **2.91 – 7.11** | **<0.001** |
| ZIP code >100 mi away | **2.4** | **0.39 – 4.50** | **0.019** | **2.6** | **0.56 – 4.61** | **0.012** |
| Priority level | | | | | | |
| High | *Reference* | | | *Reference* | | |
| Normal | **16.5** | **14.87 – 18.21** | **<0.001** | **16.6** | **14.95 – 18.28** | **<0.001** |
| Low | **21.3** | **18.83 – 23.85** | **<0.001** | **21.5** | **18.96 – 23.96** | **<0.001** |
| Multi-panel procedure request | 0.9 | −1.65 – 3.43 | 0.5 | | | |
| Cancer-associated procedure request | −1.6 | −3.59 – 0.36 | 0.11 | −1.6 | −3.61 – 0.33 | 0.10 |

Outcome was wait time (in days) between date of procedure request and date of scheduled or completed surgery/procedure. Model selection used backward stepwise methodology. Surgical/procedural specialty was included as a covariate and preserved in model selection, but coefficients are not displayed. Observations: 8,467. CI: confidence interval.