Adaptations of Breast Imaging Centers to the COVID-19 Pandemic: A Survey of California and Texas

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Abstract

Objectives: To determine the early impact of the COVID-19 pandemic on breast imaging centers in California and Texas and compare regional differences.

Methods: An 11-item survey was emailed to American College of Radiology accredited breast imaging facilities in California and Texas in August 2020. A question subset addressed March-April government restrictions on elective services ("during the shutdown" and "after reopening"). Comparisons were made between states with chi-square and Fisher's tests, and time frames with McNemar's and paired t-tests.

Results: There were 54 respondents (54/240, 23%, 26 California, 28 Texas). Imaging volumes fell during the shutdown and remained below pre-pandemic levels after reopening, with reduction in screening greatest (ultrasound 12% of baseline, mammography 13%, MRI 23%), followed by diagnostic MRI (43%), procedures (44%), and diagnostics (45%). California reported higher volumes during the shutdown (procedures, MRI) and after reopening (diagnostics, procedures, MRI) versus Texas ($P = 0.001 - 0.02$). Most screened patients (52/54, 96% symptoms and 42/54, 78% temperatures), and 100% (53/53) modified check-in and check-out. Reading rooms or physician work were altered for social distancing (31/54, 57%). Physician mask (45/48, 94%), gown (15/48, 31%), eye wear (22/48, 46%), and face shield (22/48, 46%) use during procedures increased after reopening versus pre-pandemic ($P < 0.001 - 0.03$). Physician (47/54, 87%) and staff (45/53, 85%) financial impacts were common, but none reported terminations.

Conclusion: Breast imaging volumes during the early pandemic fell more severely in Texas than in California. Safety measures and financial impacts on physicians and staff were similar in both states.

Keywords: COVID-19 ,Safety measures,Financial impact,Breast imaging

Introduction

The coronavirus disease 2019 (COVID-19) pandemic has had a profound impact on radiology practices in the United States. Breast imaging is no exception, and the nature of breast imaging poses several challenges during the pandemic. Breast imaging requires frequent intimate in-person contact for technologists and physicians, and social distancing cannot be maintained during mammographic and sonographic image acquisition or interventional procedures. Breast imaging centers are high traffic areas, and outpatient breast biopsy rooms do not usually have the same ventilation and infectious disease mitigation measures present in hospital-based procedural suites. These challenges are juxtaposed with limited personal protective equipment and other healthcare resources and the relatively non-emergent nature of breast imaging.

Medical societies released safety recommendations for breast imaging and breast cancer care early in the pandemic. On March 26, 2020, the Society of Breast Imaging recommended that "individual facilities delay screening breast imaging exams for several weeks or a few months. Furthermore, diagnostic studies on women without a clinically concerning symptom, such as patients with six month follow-up, should also be delayed" (1). Moreover, the COVID-19 Pandemic Breast Cancer Consortium, which included representatives from the American Society of Breast Surgeons, National Accreditation Program for Breast Centers, National Comprehensive Cancer Network, Commission on Cancer, and American College of Radiology, formulated an Expert Opinion regarding prioritization, treatment, and triage of breast cancer patients (2). In these recommendations, most breast cancer patients fell into categories where treatment could be safely deferred for part of the pandemic or until the pandemic was "over." At the same time, regions fell under state-wide government restrictions to reduce the spread of COVID-19 and conserve healthcare resources.

These factors contributed to a sharp decline in breast imaging volumes early in the pandemic (3-8). While publications have discussed the pandemic's impact on radiology in general and breast imaging in particular (9-16), none, to our knowledge, have surveyed state-wide breast imaging centers to determine how practices adapted to the pandemic.

Therefore, this study was performed to determine the early impact of the COVID-19 pandemic on breast imaging centers in California and Texas and to compare regional differences. As the two most populous states, and as states that both instituted state-wide government restrictions, California and Texas are useful case studies to assess regional variations in the impact of the pandemic and adaptations by breast imaging centers.

Methods

Survey Measure

This study was exempt from Institutional Review Board review. The California Breast Density Information Group, a working group of breast imaging radiologists representing academic and community-based practices, developed the survey. The survey addressed three major themes: imaging volumes, safety measures, and financial impact. The working group iteratively developed the initial survey questions, which were field tested by a pool of 12 radiologists. Based on this feedback, the group made changes to the survey design, language, and organization. The working group approved the final 11-item survey for distribution (see supplemental materials).

The first survey question related to practice type. The second question related to what exams were rescheduled or delayed. The next two questions asked respondents to provide the percent of daily pre-pandemic volume performed for 6 study and procedure types (screening mammography, screening ultrasound, screening MRI, diagnostic mammography and ultrasound, diagnostic MRI, and imaging guided procedures, if offered pre-pandemic) during the shutdown and in June 2020 after reopening (see survey time frame definitions below) using a 0% to 150% scale, with 100% equal to pre-pandemic daily volume. Patient safety measures were then assessed with two questions, focusing on the types of patient screening implemented and alterations made to patient check-in and check-out processes. The following three questions related to healthcare worker safety measures and assessed the types of healthcare worker screening implemented, the types of personal protective equipment required for physicians during a procedure, and how reading rooms and physician work were altered to allow for social distancing. The final two questions related to the financial impact of the pandemic on breast imaging physicians and staff and asked about changes to pay, benefits, and employment status. Questions could be skipped by the respondent.

Study Participants

An electronic link to the survey (Qualtrics, Provo, UT) was distributed via email to all American College of Radiology accredited breast imaging facilities in California on August 11, 2020 (n=459) and in Texas on August 20, 2020 (n=280). Only a single contact at each facility was emailed to avoid multiple responses from the same facility. The survey remained open for 60 days after email delivery. Of the delivered emails, 142/459 (30.9%) emails to California facilities were opened, and 98/280 (35%) emails to Texas facilities were opened. Of those who opened the email, the response rate was 23% overall (54/240); 18% (26/142) for California and 29% (28/98) for Texas.

Time Frames in the Survey

To assess changes over time, a subset of survey questions addressed three specific time frames related to the pandemic: baseline pre-pandemic, during the shutdown, and after reopening. Both California and Texas fell under state-wide restrictions, and some regions fell under additional local restrictions. The California state-wide shelter in place order, which included elective procedure restrictions, was issued March 19, 2020 (17) and was eased on April 22, 2020 (18). The Texas state-wide elective procedure restriction order began on March 22, 2020 and was eased on April 22, 2020 (19). In addition, the Texas state-wide stay-at-home order began on April 2, 2020 and was eased on May 1, 2020 (20). In both states, the elective procedure restriction applied to the entire healthcare system, including outpatient facilities. Other relevant state-wide restrictions included the required use of face masks in public, which went into effect June 18, 2020 in California (21) and July 3, 2020 in Texas (22).

"During the shutdown" was defined as the date the practice closed or began reducing services until the date the practice began ramping-up or restarting services. If the practice did not reduce services or close, "during the shutdown" was defined as the date the practice's regional stay-at-home order began until the date the order was eased.

"After reopening" was defined as after the date the practice began ramping-up or restarting services. If the practice did not reduce services or close, "after reopening" was defined as after the practice's regional stay-at-home order was eased.

Statistical Analysis

The paired t-test and McNemar's test were used to compare survey responses between different survey time frames. Pearson's chi-square test and Fisher's exact test were used to compare California and Texas responses, where appropriate. Statistical analyses were performed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY). The level of statistical significance was set at $P < 0.05$.

Results

Practice Setting

Of the 54 respondents, 31/54 (57%) facilities were private practices, 12/54 (22%) academic, 10/54 (19%) academic-private hybrid, and 1/54 (2%) military, Veteran Affairs, or government. There was no significant difference in the number of respondents in each practice type between California and Texas (P = 0.30 - 0.97). There was no significant difference in the response rate between California (26/142, 18%) and Texas (28/98, 29%) (P = 0.06).

Imaging Volumes

All but four practices (50/54, 93%) rescheduled or delayed at least some study or procedure types during the shutdown, most commonly screening mammography (49/53, 92%), followed by screening ultrasound (36/39, 92%) and screening MRI (28/39, 72%). Practices less frequently rescheduled diagnostic mammography and ultrasound (22/52, 42%), diagnostic MRI (14/40, 35%), breast biopsies (17/52, 33%), and breast localization procedures (16/52, 31%). The four practices (4/54, 7%) that did not reschedule or delay any study or procedure type were all from California (4/26, 15%) ($P = 0.047$). Texas respondents more frequently rescheduled or delayed screening MRI (18/19, 95%) compared with California (10/20, 50%) ($P = 0.002$).

Compared to baseline pre-pandemic, the volume of all breast imaging study and procedure types fell dramatically during the shutdown (Figure 1). Screening studies demonstrated the largest drop during the shutdown, with the average daily screening mammography volume falling to 13% of pre-pandemic levels ($P < 0.001$), 12% for screening ultrasound ($P < 0.001$), and 23% for screening MRI ($P < 0.001$). Diagnostic mammography and ultrasound (45%) ($P < 0.001$), diagnostic MRI (43%) ($P < 0.001$) and imaging guided breast procedure (44%) ($P < 0.001$) volumes were all less than half that of pre-pandemic levels. The 3 screening modalities had significantly lower volumes than the diagnostic modalities and procedures ($P < 0.001$ - 0.001). California respondents reported significantly less reduction in volumes during the shutdown compared to Texas respondents for screening MRI (39% California versus 6% Texas) ($P = 0.005$), diagnostic MRI (60% California versus 27% Texas) ($P = 0.008$), and imaging guided breast procedures (57% California versus 32% Texas) ($P = 0.02$).

Average daily volumes as a percentage of baseline pre-pandemic volumes rose for all study and procedure types in the month of June after reopening (screening mammography 58%, screening ultrasound 50%, screening MRI 65%, diagnostic mammography and ultrasound 73%, diagnostic MRI 72%, imaging guided procedures 71%) compared to during the shutdown ($P < 0.001$ for all 6 study and procedure types) but remained below pre-pandemic levels ($P < 0.001$ for all 6 study and procedure types) (Figure 1). As seen during the shutdown, the 3 screening modalities continued to have significantly lower volumes than the diagnostic modalities and procedures in June after reopening ($P < 0.001$ - 0.01). California respondents reported significantly higher volumes in June compared to Texas respondents for screening MRI (81% California versus 49% Texas) ($P = 0.004$), diagnostic mammography and ultrasound (84% California versus 63% Texas) ($P = 0.009$), diagnostic MRI (90% California versus 53% Texas) ($P = 0.001$), and imaging guided breast procedures (85% California versus 59% Texas) ($P = 0.004$).

Safety Measures

Nearly all (52/54, 96%) reported verbal or written COVID-19 symptom screening of patients at the facility entrance, with 42/54 (78%) also performing temperature screening. Most practices (43/54, 80%) reported symptom screening at the time of scheduling (via telephone or online). Only 3/54 (6%) reported implementing severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2, the virus that causes COVID-19) swab testing for patients at their practice, and none (0/54, 0%) reported implementing SARS-CoV-2 serological antibody testing. Texas respondents (25/28, 89%) more frequently reported temperature screening compared to California respondents (17/26, 65%) (P = 0.04).

Breast centers implemented similar screening for healthcare workers. Most reported symptom (44/54, 81%) and temperature screening (42/54, 78%) at the facility during the shutdown, which did not significantly change after reopening (38/54, 70% and 34/54, 63%, respectively) (P = 0.07 and 0.06, respectively). A minority reported symptom screening online during the shutdown (9/54, 17%), which was unchanged after reopening (9/54, 17%) ($P > 0.99$). A minority implemented SARS-CoV-2 swab testing during the shutdown (7/54, 13%) and after reopening (7/54, 13%) ($P >$ 0.99), and only a few reported SARS-CoV-2 serological antibody testing during the shutdown (3/54, 6%) and after reopening (2/54, 4%) ($P > 0.99$). There was no significant difference between the California and Texas responses with respect to healthcare worker screening (P = 0.11 - 0.73).

All respondents (53/53, 100%, one did not answer) modified patient check-in and check-out processes (Table 1). Most (47/53, 89%) limited visitors or no longer allowed visitors with patients. Nearly all (52/53, 98%) altered the check-in area with increased seat spacing, and 46/53 (87%) implemented social distancing markings in the facility. A majority of practices (31/53, 58%) protected check-in personnel with plastic shields. These modifications were similar for California and Texas (P = 0.42 - 0.99). California respondents more frequently reported having patients wait in their car and phoned or texted the patient when ready (5/26, 19% California versus 0/27, 0% Texas) (P = 0.02). California respondents also more frequently reduced the exchange of physical items such as insurance cards, biopsy information, and after-visit summaries (5/26, 19% California versus 0/27, 0% Texas) (P = 0.02). Texas respondents more frequently reported having history questionnaires filled out by technologists to avoid exchange of paper questionnaires and electronic devices (11/27, 41% Texas versus 3/26, 11% California) (P = 0.02).

A majority of respondents (31/54, 57%) reported altering reading rooms or physician work to allow for social distancing (Table 2). Physician density was reduced by relocating workstations to offices or other rooms (15/54, 28%), by utilizing workstations in physician homes (10/54, 19%), with staggered shifts (9/54, 17%), and by reducing the number of physicians working clinically each day (6/54, 11%). There was no significant difference between the California and Texas responses with respect to alterations to reading rooms or physician work (P = 0.15 - 0.99). Table 3 details the cost and logistics of deploying a Mammography Quality Standards Act (MQSA)-compliant mammography home workstation during the pandemic.

Compared to pre-pandemic, there was an increase in the required use of personal protective equipment by physicians during procedures, both during the shutdown and after reopening (Table 4). Most required the use of a surgical mask (45/48, 94%) and gloves (41/48, 85%) during procedures after reopening, while nearly half required the use of protective eye wear (22/48, 46%) and face shields (22/48, 46%). The required use of an N95 mask (9/48, 19%) and gown (15/48, 31%) during procedures also increased after reopening. There was no significant difference between the

California and Texas responses with respect to the types of required personal protective equipment used during procedures (*P* = 0.17 - 0.99).

Financial Impact

Most respondents (47/54, 87%) reported a negative financial impact on breast imaging physicians in their practice. A decrease or elimination of bonuses (20/54, 37%) and a decrease in productivity-based pay (20/54, 37%) were the most common financial impacts for breast imaging physicians. A decrease in salary or hourly pay rate (11/54, 20%) and a decrease in hours resulting in a pay reduction (10/54, 19%) were also reported. Two respondents (2/54, 4%) reported furlough of breast imaging physicians. A few (3/54, 6%) also reported that breast imaging physician job security was in jeopardy, but none (0/54, 0%) reported termination of breast imaging positions. There was no significant difference between the California and Texas responses with respect to financial impacts on physicians (*P* = 0.23 - 0.99).

Most (45/53, 85%) also reported a negative financial impact on breast imaging staff (non-physicians). The most common financial impact for staff was a decrease in hours resulting in pay reduction (23/53, 43%). Staff was furloughed at 13/53 (25%) practices. Two respondents (2/53, 4%) reported breast imaging staff job security was in jeopardy, but none (0/53, 0%) reported termination of positions. Some respondents (13/53, 25%) also reported the required use of vacation or paid time off, with Texas respondents (10/27, 37%) more frequently reporting this financial impact compared with California respondents (3/26, 12%) (*P* = 0.03).

Discussion

Our study demonstrates how breast imaging centers adapted to the COVID-19 pandemic, which has had a profound impact on radiology practices. Our data reveals that the pandemic resulted in a severe decline in breast imaging volumes in both California and Texas, but the decline was more severe among the Texas survey respondents. Screening volumes were particularly affected, demonstrating a greater decline than diagnostic studies and procedures. Despite the difference in imaging volume between the two states, the safety measures implemented in California and Texas breast imaging centers were similar, as were the financial impacts on physicians and staff. Although nearly all reported financial impacts such as pay reduction, furlough, and required use of vacation, these cost saving measures appeared to be sufficient to avoid layoffs of breast imaging physicians and staff in this short term analysis, with no reported terminations.

The severity of the pandemic is one probable culprit for the decline in imaging volumes, and the volumes in the current study during the March-April shutdown are similar to those reported in several prior studies demonstrating a greater than 70% decline in overall breast imaging volume early in the pandemic (4-7). However, our results suggest that the state-wide severity of the pandemic alone does not explain the changes in breast imaging volumes, nor does it explain the differences between California and Texas. Both states had a greater number of daily hospitalized patients (a surrogate marker of pandemic severity) in June than during the March-April shutdown, despite increased imaging volumes. In addition, compared to Texas, California had a greater number of daily hospitalized patients per 100,000 residents during the shutdown but maintained significantly higher imaging volumes. Texas did experience an increase in hospitalizations in the second half of June and ended the month with 71% more confirmed COVID-19 hospitalized patients per 100,000 residents than did California (23-25). While this may have impacted June imaging volumes in Texas, our results suggest overall the volume declines reported are multifactorial.

Government restrictions in both states likely played a role in the decline in imaging volumes. Collado-Mesa et al previously reported reduced breast imaging volumes in two South Florida counties early in the pandemic in April 2020 during a period of government restrictions on elective medical services (3). As in our survey, volumes severely declined across all study and procedure types during this shutdown period. Among five facilities rescheduling studies in April 2020, Collado-Mesa et al reported a 98.1% decrease in screening mammography and 90.2% decrease in diagnostic mammography; this decline was even more severe than in the current study, which demonstrated an 87% decrease in screening mammography overall (82% in California and 91% in Texas) and 55% decrease in diagnostic mammography and ultrasound overall (46% in California and 64% in Texas). These differences may in part be related to differences in the timing and implementation or interpretation of government restrictions in these regions, as well as differences in pandemic severity. The greater geographic diversity in the current study may also play a role (two entire states versus two counties), and these results from South Florida are in line with our findings that the pandemic had varying impacts on imaging volumes in different regions.

It is unclear what other factors contributed to the more severe decline in breast imaging volumes at Texas practices during the shutdown and after reopening compared to California practices. It is possible that earlier preparation and mobilization of resources blunted the impact on the healthcare systems in California, as California was among the first states to respond to the pandemic (third state to declare a state of emergency on March 4, 2020 and first state with a stay-at-home order on March 19, 2020, while Texas was the 46th state to declare a state of emergency on March 13, 2020 and 36th state with a stay-at-home order on April 2, 2020) (26-27). Other factors that may have influenced imaging volumes include differences in local pandemic severity, local government restrictions including travel restrictions, individual practice policies and community outreach efforts, population density and geography, patient financial difficulties (income reduction or job and insurance loss), disruptions to childcare preventing patients seeking medical care, and local public perception of the pandemic, the safety of healthcare facilities, and the importance of routine breast cancer screening during the pandemic. Further studies are needed to assess which factors significantly impacted breast imaging volumes so practices can be better prepared for any future disruptions to their workflow.

Our study also adds to the literature by demonstrating that breast imaging volumes improved after easing of government restrictions but remained below pre-pandemic volumes. Both internal and external factors likely explain this continued suppression of imaging volumes. Some practices may have reduced the number of examinations performed per day to allow for social distancing of patients and additional room and equipment cleaning time. Staffing may have been limited due to staffing needs in other radiology areas, illness or quarantine, or disruptions to usual childcare. In addition, the public's perception of the safety of healthcare facilities likely affected volumes given that less was known about SARS-CoV-2 transmission early in the pandemic. Patient financial difficulties due to the pandemic unfortunately also may have caused some to not seek medical care.

While this survey identified some of the near term impacts of this imaging volume decline on breast imaging centers, the long term impact on patient care is less clear but, nonetheless, troublesome. In particular, screening studies showed a greater decline in volume than diagnostic studies and procedures. The decrease in screening volumes likely will result in the delayed diagnosis of breast cancer for some women, resulting in later stage presentations and an increase in breast cancer deaths. Several models have projected an increase in breast cancer deaths as a result of the pandemic (28-30), and the director of the U.S. National Cancer Institute Dr. Norman Sharpless conservatively estimated in June 2020 that there would be greater than 5000 excess deaths from breast cancer in the U.S. between 2020 and 2030 (31). In addition, 44% of U.S. breast cancer survivors (defined as any individual from the time of breast cancer diagnosis until the end of life) surveyed by Papautsky et al in April 2020 reported a delay or interruption in care due to the pandemic, with delays in all aspects of care including surgery (26%) and any type of imaging (60%) (32). These numbers are similar to our findings, with 31% of practices rescheduling or delaying breast localization procedures, and many rescheduling or delaying screening and diagnostic studies (ranging from 35% for diagnostic MRI to 92% for screening mammography). A recent meta-analysis by Hanna et al demonstrated an association between a 4 week delay in breast cancer treatment and increased mortality (33), making these delays potentially worrisome. These potential impacts on patient outcomes emphasize the importance of maintaining the safe operation of breast imaging centers for the duration of the pandemic.

Seely et al outlined safety guidelines for resuming breast imaging during the pandemic, providing recommendations regarding prescreening patients, physical distancing, personal protective equipment, cleaning, and communication (34). Many of the recommendations include common changes reported by the surveyed practices, including screening patients at the time of scheduling, screening patients at the facility, reduced waiting room seating, physical barriers to protect check-in personnel, use of personal protective equipment, and reading room social distancing. There was no significant difference between California and Texas in these practices, perhaps because both used some of the guidelines available early in the pandemic (9, 34-35). While specific changes implemented at an individual breast imaging center may vary based on facility layout and workflow, the same safety principles can be applied with guidance.

However, our study did show that a few less frequently utilized safety measures differed between California and Texas. In the case of having patients wait in their car and phoning or texting the patient when the clinic was ready to receive them, this practice may have varied due to differences in geography, transportation arrangements, parking, the safety of waiting in a parked car given weather and outside temperature, and availability of or familiarity with texting platforms. Other state differences in safety measures may be in part due to a lack of specific guidelines on these measures, e.g. no specific guidelines on limiting the exchange of physical items, and these measures were instead developed locally in response to the individual facility's physical plant and practice set-up.

Interestingly, 10/54 (19%) respondents reported reducing reading room density by utilizing workstations in physician homes. In addition to being effective for social distancing, home workstations are a useful option for those in isolation due to personal or family underlying medical conditions or while under quarantine. They may also help mitigate work schedule difficulties related to family care needs, such as children learning remotely for school. However, there are substantial costs and logistical hurdles to deploying MQSA-compliant mammography home workstations. The approximate first year cost is $40000 per workstation, and the ongoing annual operating cost is

$5000 per workstation, with additional institutional data center costs of $39000 for the first year and $13000 annually thereafter. There are also workflow-related barriers to physicians working from home. Interventional procedures still require a breast imaging physician on site. While screening mammography and breast MRI can be interpreted remotely as usual, remote diagnostic workflow would require changes. Communication with technologists would no longer be in-person, and communication with patients would need to be performed remotely via video or telecommunication, by another team member, or not at all. Ultrasound scanning and physical examination by the physician are also not possible.

Our study has several limitations. The survey response rate was modest, and there is a risk for response bias. Survey fatigue may have affected the response rate, as there have been several COVID-19 surveys distributed since the onset of the pandemic. However, the email open rate for both states was above average for surveys distributed with the assistance of the American College of Radiology, so this impact may be minimal. Our results may not be generalizable to other United States regions, as case rates and government restrictions varied across the United States as well as within the states surveyed. Finally, our survey reflects only the early months of the pandemic, and practices likely have changed as guidelines change and more information is known about SARS-CoV-2 transmission.

Conclusion

The early portions of the COVID-19 pandemic resulted in a severe decline in breast imaging volumes in both California and Texas, but the decline was more severe in Texas. Screening studies showed a greater decline in volume than diagnostic studies and procedures, and this may result in the delayed diagnosis of breast cancer for some women. Despite this difference in imaging volume, breast imaging center safety adaptations in California and Texas were similar, as were the financial impacts on physicians and staff. Future studies would be needed to determine how breast imaging centers continue to adapt to the ongoing pandemic and how, while using best safety practices, current and future government restrictions impact breast imaging facilities and imaging volumes.

Key Messages

The pandemic resulted in a severe decline in breast imaging volumes in both California and Texas, but the decline was more severe in Texas; screening studies showed a greater decline in volume than diagnostic studies and procedures, and this may result in the delayed diagnosis of breast cancer for some women.

Despite this difference in imaging volume, breast imaging center safety adaptations to the early portions of the COVID-19 pandemic were similar between California and Texas.

Although nearly all respondents reported financial impacts on breast imaging physicians and staff such as pay reduction, furlough, and required use of vacation, these cost saving measures appeared to be sufficient to avoid layoffs in this short term analysis, with no reported terminations.

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Figure Legend

Figure 1. Percentage of daily baseline pre-pandemic volume by study and procedure type performed at California and Texas breast imaging facilities during the COVID-19 shutdown and in June 2020 after reopening.

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Conflict-of-interest Declarations

Debra M. Ikeda, MD: Consultant for Hologic, Inc.

Jessica W.T. Leung, MD: Speaker for GE Healthcare, speaker for Fujifilm, advisory board member for Subtle Medical, advisory member for CureMetrix.

The other authors have no conflict-of-interest to declare.

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Table 1. California and Texas breast imaging facility modifications to patient check-in and check-out processes during the COVID-19 pandemic.

	All	California	Texas	*P* value (California versus Texas)
No change	0/53 (0%)	0/26 (0%)	0/27 (0%)	NA
Remote check-in prior to facility entry	8/53 (15%)	2/26 (8%)	6/27 (22%)	0.25
COVID-19 symptom screening, temperature screening, and/or masking	47/53 (89%)	23/26 (88%)	24/27 (89%)	>0.99
No visitors or limited visitors with patients	47/53 (89%)	24/26 (92%)	23/27 (85%)	0.67
Patient waits in car, phone or text when ready	5/53 (9%)	5/26 (19%)	0/27 (0%)	**0.02**
6-foot distancing labeling in facility	46/53 (87%)	24/26 (92%)	22/27 (81%)	0.42
Limited check-in area with seat spacing	52/53 (98%)	26/26 (100%)	26/27 (96%)	>0.99
Plastic shields for check-in personnel	31/53 (58%)	15/26 (58%)	16/27 (59%)	0.91
Eliminated in-person payments (billed after visit)	3/53 (6%)	3/26 (12%)	0/27 (0%)	0.11
History questionnaires filled out by technologist	14/53 (26%)	3/26 (12%)	11/27 (41%)	**0.02**
Reduced exchange of physical items (insurance card, biopsy information, after-visit summary)	5/53 (9%)	5/26 (19%)	0/27 (0%)	**0.02**
Other	0/53 (0%)	0/26 (0%)	0/27 (0%)	NA

Table 2. California and Texas breast imaging facility alterations to reading room or physician work to allow for social distancing during the COVID-19 pandemic.

	All	California	Texas	*P* value (California versus Texas)
No change	23/54 (43%)	9/26 (35%)	14/28 (50%)	0.25
Reduced physician density by relocating workstations (moved workstations to offices or other rooms)	15/54 (28%)	8/26 (31%)	7/28 (25%)	0.64
Reduced physician density with home workstations	10/54 (19%)	3/26 (12%)	7/28 (25%)	0.30
Reduced physician density with fewer physicians working clinically per day	6/54 (11%)	3/26 (12%)	3/28 (11%)	>0.99
Staggered shifts	9/54 (17%)	4/26 (15%)	5/28 (18%)	>0.99
Lengthened imaging center hours or added weekends	8/54 (15%)	4/26 (15%)	4/28 (14%)	>0.99
Assigned physician to specific reading room or workstation (no rotating)	12/54 (22%)	8/26 (31%)	4/28 (14%)	0.15
Physician cohorts (same group always works together)	4/54 (7%)	3/26 (12%)	1/28 (4%)	0.34
Added or increased video or telecommunication with patients	4/54 (7%)	3/26 (12%)	1/28 (4%)	0.34
Added or increased video or telecommunication with technologists	9/54 (17%)	6/26 (23%)	3/28 (11%)	0.29
Other	2/54 (4%)	1/26 (4%)	1/28 (4%)	>0.99

Table 3. Equipment and cost example for deploying a single Mammography Quality Standards Act-compliant mammography workstation at a physician's home (actual costs from an academic center during the COVID-19 pandemic).

<u>Hardware</u>	<u>Approximate cost</u>	<u>Comments</u>
PC Tower (HP Z4 or Z440 tower) HP 27" navigation screen Two Barco 5MP mammography-rated monitors Nuance Powermic, Logitech M500 mouse, standard keyboard Display, network, power cables	$33000	Hardware costs can be mitigated by redeployment of unused reading room workstations
<u>Network</u>		
Cisco Meraki MX600 security appliance (data center hardware)	$26000 hardware $13000 annual license	Realtime VPN, access can be restricted to only the workstation that has been assigned for use with a specific router
Cisco Meraki MX67 or MX67w router (in home hardware)	$1200 hardware $400 annual license	
Business class internet connection (150 Mbps)	$250 per installation $3600 per year	Wired connections preferred between workstation, router, and modem, as wireless connections are less secure
<u>Logistics</u>		
Coordination of physician, IT staff, and third party vendors for internet installation and workstation equipment preparation, pickup, installation, and testing (salary costs of IT and administrative support not included in estimates)		Many organizations do not allow IT staff to make home visits due to liability concerns, complicating installation and ongoing technical support and requiring use of a third party vendor for this task
Pickup and installation of workstations by third party vendor	$1500 per installation (includes liability insurance)	Risk of SARS-CoV-2 transmission serves as an additional barrier to IT staff or third party vendors entering personal residences, beyond usual liability concerns
<u>Quality control and quality assurance</u>		
Calibration of mammography monitors (annually, performed by a physicist)	$500 plus travel ($31.25 per hour and $0.58 per mile)	
Barco QAWeb monitor quality		

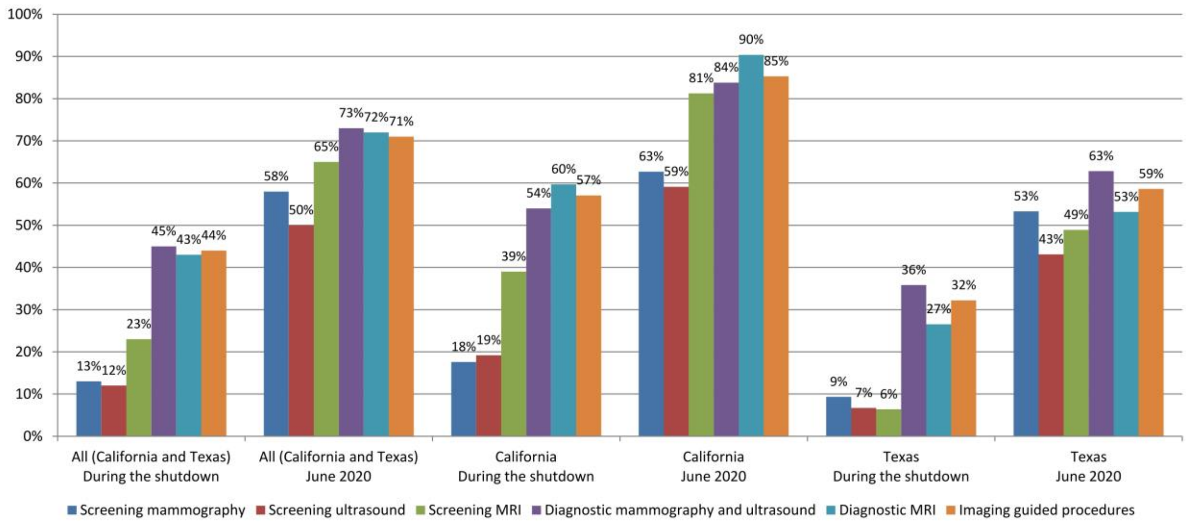
assurance (weekly, performed by physician)		
Total first year cost		
Workstation	$40000 per workstation	
Data center	$39000	Total first year cost rounded to nearest $1000
Annual ongoing cost		
Workstation	$5000 per workstation	
Data center	$13000	Annual ongoing cost rounded to nearest $1000

Abbreviations: MP, megapixel; Mbps, megabits per second; IT, information technology

Table 4. California and Texas breast imaging facility required use of personal protective equipment by physicians during breast imaging procedures during the COVID-19 pandemic.

All	Pre-pandemic	During the shutdown	*P* value (pre-pandemic versus during the shutdown)	After reopening	*P* value (pre-pandemic versus after reopening)
Surgical mask	15/49 (31%)	15/49 (82%)	**<0.001**	45/48 (94%)	**<0.001**
N95 mask	2/49 (4%)	9/49 (18%)	**0.02**	9/48 (19%)	**0.03**
Gown	8/49 (16%)	19/49 (39%)	**<0.001**	15/48 (31%)	**0.004**
Gloves	40/49 (82%)	39/49 (80%)	>0.99	41/48 (85%)	0.38
Hair covering	7/49 (14%)	11/49 (22%)	0.06	5/48 (10%)	>0.99
Protective eye	9/49 (18%)	13/49 (27%)	0.11	22/48 (46%)	**0.001**
wear	4/49 (8%)	18/49 (37%)	**<0.001**	22/48 (46%)	**<0.001**
Face shield	2/49 (4%)	2/49 (4%)	>0.99	1/48 (2%)	>0.99
Shoe covering	8/49 (16%)	2/49 (4%)	0.11	0/48 (0%)	**0.008**
None					
California	6/23 (26%)	19/23 (83%)	**0.001**	20/22 (91%)	**0.001**
Surgical mask	0/23 (0%)	5/23 (22%)	0.06	5/22 (23%)	0.06
N95 mask	5/23 (22%)	10/23 (43%)	**0.03**	9/22 (41%)	0.06
Gown	19/23 (83%)	19/23 (83%)	>0.99	20/22 (91%)	0.50
Gloves	2/23 (9%)	6/23 (26%)	0.13	3/22 (14%)	>0.99
Hair covering	5/23 (22%)	4/23 (17%)	>0.99	10/22 (45%)	0.18
Protective eye	1/23 (4%)	7/23 (30%)	**0.03**	11/22 (50%)	**0.002**
wear	1/23 (4%)	1/23 (4%)	>0.99	1/22 (5%)	>0.99
Face shield	5/23 (22%)	1/23 (4%)	0.22	0/22 (0%)	0.06
Shoe covering					
None					
	9/26 (35%)	21/26 (81%)	**0.002**	25/26 (96%)	**<0.001**
Texas	2/26 (8%)	4/26 (15%)	0.50	4/26 (15%)	>0.99
Surgical mask	3/26 (12%)	9/26 (35%)	**0.03**	6/26 (23%)	0.13
N95 mask	21/26 (81%)	20/26 (77%)	>0.99	21/26 (81%)	>0.99
Gown	5/26 (19%)	5/26 (19%)	>0.99	2/26 (8%)	>0.99
Gloves	4/26 (15%)	9/26 (35%)	**0.03**	12/26 (46%)	**0.004**
Hair covering	3/26 (12%)	11/26 (42%)	**0.004**	11/26 (42%)	**0.02**
Protective eye	1/26 (4%)	1/26 (4%)	>0.99	0/26 (0%)	>0.99
wear	2/26 (12%)	1/26 (4%)	0.63	0/26 (0%)	0.25
Face shield					
Shoe covering					
None					

Figure 1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All (California and Texas) June 2020
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Texas During the shutdown
Texas June 2020
Screening mammography
Screening ultrasound
Screening MRI
Diagnostic mammography and ultrasound
Diagnostic MRI
Imaging guided procedures