Estimated National and Regional Impact of COVID-19 on Elective Case Volume in Aesthetic Plastic Surgery

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Disclosures: The authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

Funding: The authors received no financial support for the research, authorship, and publication of this article.

Abstract

Background: In efforts to help alleviate the strain placed on healthcare during the COVID-19 pandemic, The American Society of Plastic Surgery (ASPS) recommended suspending elective procedures on March 19, 2020. When this suspension was enacted, it was unknown when cases would resume.

Objectives: This analysis aims to estimate the regional economic impact of the pandemic specifically with regards to elective, aesthetic surgical procedures. As knowledge regarding the effects of the pandemic has grown, the authors then evaluated the accuracy of our projected estimates when compared to actual events.

Methods: Using the ASPS 2018 Plastic Surgery Statistics Report, regional case volume and surgeons' fees were obtained for the top five aesthetic procedures. Models developed by the Institute for Health Metrics and Evaluation (IHME) were used to estimate the anticipated duration of suspension by using the date that no ventilators would be required to for COVID-19 patients. This duration was used to calculate the volume of cases that would not occur.

Results: These estimates predict up to 1.3 billion fewer dollars will be collected in surgeons' fees, representing a 20% loss compared to 2018. The South Atlantic region is predicted to have the greatest number of OR days lost; However, the Mountain and Pacific regions are estimated to have the greatest loss in case volume and surgeons' fees.

Conclusions: The cumulative impact of the pandemic on life, society, and the economy is tremendous. This analysis may help guide surgeons' responses during and after the crisis.

As the COVID-19 pandemic began to escalate in the United States, the authors sought to predict the economic impact of the crisis on elective, aesthetic surgical procedures. This study endeavors to both present estimations that were made prospectively using predictive models available as of March 2020 and assess the relevance and accuracy of these predictions with the benefit of hindsight in the months since that time.

The first 30 days of the pandemic in the United States were overwhelming and frightening for both the population in general and healthcare providers in particular. The most significant consequence of the pandemic has been loss of life. By the end of March 2020, more than 120,000 people worldwide and 24,000 people in the US had died of COVID-19.[i] As of June 27, 2020, almost 500,000 people worldwide and over 125,000 people in the US had died of COVID-19.[ii] In the early days of the pandemic in the US, the Institute for Health Metrics and Evaluation (IHME) at the University of Washington predicted that more than 80,000 Americans would die in the next 4 months.[iii] With the advantage of hindsight, we can appreciate that the scale of the pandemic exceeded our worst expectations.

Compounding the loss of life are the myriad ways in which society and the economy have been affected. Almost ten million Americans filed for unemployment in the last two weeks of March,[iv] and the US government took extraordinary steps to help staunch the economic hemorrhage.[v] In this context, any consideration of how this would affect the practice of Plastic Surgery may seem insensitive. The following analysis should not convey that the authors believe the economic impact to plastic surgery is as important as the morbidity and mortality caused by this disease.

This analysis sought to clarify the horizon beyond the storm in the early days of the pandemic. Initial estimations employed predictions made in the final days of March 2020. At that moment, it was unknown when practices would reopen and elective surgery would resume. While we have the advantage of hindsight to evaluate the accuracy of early predictions, we are facing renewed uncertainty. Assessing retrospectively the accuracy of our predictions made with incomplete information may be instructive as we try to imagine an uncertain future.

The impact of the pandemic has varied and will continue to vary between states, hospital systems, practitioners, and over time. The Centers for Medicare & Medicaid Services (CMS) released guidance on 3/18/2020 recommending that low and intermediate acuity surgeries be postponed (Table 1);[vi] within the next two days, Dr. Lynn Jeffers, current American Society of Plastic Surgeons (ASPS) president and Dr Charles Thorne, then president of the American Society for Aesthetic Plastic Surgery (ASAPS), issued similar guidance.[vii] The duration of this restriction was initially unknown. On April 19, CMS released recommendations[viii] in concordance with the White House's guidelines on reopening.[ix] Both phases I and II of reopening guidelines state that elective surgeries may resume provided certain criteria are met. In actuality, the resumption of surgery has occurred differently in each state and county. Despite the diversity of reopening plans nationwide, guidance on recommended changes to the informed consent process was released by ASPS[x] and ASAPS.[xi] These documents elaborate the additional risks of surgery imposed by COVID-19 as well as requirements for COVID-19 testing prior to surgery. It remains unknown when or whether elective surgeries will resume at a pace similar to that experienced prior to the pandemic. In many locales, hospitals began resuming elective cases with urgent and oncologic surgery, however this varied widely by region,[xii] and by operating room setting (eg, hospital-based versus private office).

Based on models accessed March 27, 2020 that predicted state-specific illness due to COVID-19, as well as annual cost data for cosmetic procedures, we generated predictions of the economic impact of these surgical restrictions nationally and by region on the five most frequently performed cosmetic procedures in each locale. A critique formulated with the knowledge gained in the three months since these estimates were developed informs the confidence one can place in models of dynamic phenomena.

METHODS

Data on surgical volume and surgeons' fees for elective, aesthetic cases were derived from the 2018 Plastic Surgery Statistics Report published by ASPS[xiii]; these data are based on survey responses from society members with estimates of regional and national volume extrapolated from these responses to the cohort of board certified plastic surgeons nationwide. Within this report, states are divided into five regions: (1) New England and Middle Atlantic (CT, ME, MA, NH, RI, VT, NJ, NY, PA); (2) East North Central and West North Central (IL, IN, MI, OH, WI, IA, KS, MN, NE, ND, SD); (3) South Atlantic (DE, DC, FL, GA, MD, NC, SC, VA, WV); (4) East South Central and West South Central (AL, KY, MS, TN, AR, LA, OK, TX); and (5) Mountain and Pacific (AZ, CO, ID, MT, NV, NM, UT, WV, AK, CA, HI, OR, WA) (Figure 1[xiv]). The population of each region varies and is enumerated in Table 2.[xv] Estimates of economic impact reflect the volume of the five most commonly performed cosmetic procedures within each region in 2018 using the national average physician fee (Table 3). Additional information on cost per procedure such as operating room fees vary regionally and by length of procedure and is not included in this analysis.

Estimates of duration of COVID-19 impact were based on state-specific figures and predictive models from IHME data as of March 27, 2020.[xvi] Data provided by this model include state-specific forecasts of mean and range of uncertainty for the daily number of patients with COVID-19 requiring hospital beds, ICU beds, and invasive ventilation. In additional, the model provides estimations of daily hospital and ICU admissions, mortality, and number of ICU and non-ICU beds required beyond the capacity of the state. The following values from the IHME model were collected and entered into a database: the mean, upper, and lower bounds of the 95% confidence interval that were used to estimate the mean, earliest, and latest dates for which the model predicts there will be fewer than 0.5 patients requiring hospitalization, invasive ventilation, and ICU beds. For states that had reported cases prior to 3/27/2020, the actual dates when the first patients required hospitalization, ICU beds, or ventilator support were known.

The duration of suspension of elective cases was estimated in several ways for each state: the number of days from 3/19/2020 (per ASPS guidance) to the respective predicted dates when a mean of <0.5 patients would require hospital beds, ICU beds, and invasive ventilation. Consequently, calculations of "OR days lost", are for all days including weekdays and weekends. The mean number of days affected for all states in a region was calculated and used for estimations of impact on surgical volume and economic loss on a regional basis. It was initially unknown which measure of predicted hospital burden (ie, hospital bed occupancy, ICU bed occupancy, or ventilator use) would most inform when the health system in a particular region would be ready to resume elective surgical procedures. However, the authors postulate that the period during which patients require invasive ventilation reflects the most acute degree of illness burden placed on the healthcare system and provides information on state-specific effects. Therefore, the predicted date by which the model as of 3/27/20 showed <0.5 patients would require invasive ventilation was used to project the date by which elective, cosmetic cases would resume to a pace similar to prior to the pandemic. Additional information on whether and when states have resumed elective cases was collected for each state (when available) and compared to the predictions made by the model.[xvii] Figures were developed using GraphPad Prism version 8.4.1 for Mac.[xviii]

RESULTS

COVID-19 Model

The IHME model incorporates data regarding regional hospital resources, state-wide information on infections and deaths from COVID-19, and observations on the spread of the disease to predict when and to what degree states would most likely have patients requiring hospitalization, critical care, and invasive ventilation. This model relies on several assumptions regarding most likely progression of the virus and death rates based on the data available from China, Italy, South Korea, and the US. The number of OR days lost, as estimated from 3/19/2020 to when invasive ventilators were estimated to no longer be required was determined for each state (Figure 2). The national average days

lost using this estimation is 94.38 (range, 43-119; SD, 21.24). For comparison, estimates of duration of COVID19 impact were also calculated for each state on the predicted duration when hospital beds and ICU beds would be required. Nationally, mean duration from 3/19/2020 to when the last hospital bed would be required is 105.3 (range, 53-126; SD, 20.77); the mean duration from 3/19/2020 to when the last ICU bed would be required is 96.18 (range, 44-119; SD, 21.15) (Figure 3). These values are also calculated per region, demonstrating that region three (South Atlantic) has the greatest number of estimated lost days using the duration from 3/19/20 to when invasive ventilators are estimated to no longer be required. Region 1 (New England and Middle Atlantic) has the fewest estimated OR days lost (Figure 4).

Several states have since announced when elective cases may resume following the initiation of restrictions. Data were available for 31 states; the mean duration from 3/19/2020 to when elective surgeries were stated to resume is 42.65 (range, 32-70; SD, 9.84).

Regional Case Volume and Surgeons' Fee Loss

Estimates of impact on regional case volume assume that the duration of restrictions on elective, cosmetic cases extends from 3/19/20 to the estimated date when patients no longer require invasive ventilation derived from the IHME model. When considering the five most commonly performed cosmetic procedures performed in each region in the year 2018, these figures predict an estimated 286,327 of these cases will not be performed (range, 173,299-304,324). This will result in an approximate loss of 1.2 billion dollars (range, 0.7-1.3 billion dollars) in surgeons' fees, based on national rates of reimbursement for 2018. The region expected to have the greatest loss in case volume and revenue is region 5 (Mountain and Pacific), reflecting the greater volume of cosmetic cases performed in this region relative to other regions (Figure 5). The contributions of individual procedures to the overall economic impact on a regional basis is displayed in Figure 6. In two regions, region 5 (Mountain and Pacific) and region 2 (East North Central and West North Central), the plurality of the total economic impact is due to loss

of breast augmentation procedures. The mean, minimum, and maximum estimates for anticipated OR days lost were used to predict the cumulative impact on case volume and surgeons' fees collected for the top five most common procedures in each region (Figure 7).

DISCUSSION

It is impossible to know what precisely lies ahead in this time of uncertainty. Of greatest concern is the enormous and ongoing loss of life due to the pandemic. This analysis makes no claims as to the relative importance of the concerns of cosmetic plastic surgery. Rather, these predictions are a dispassionate estimation of how surgical volume may be differentially affected based on regional variations in COVID-19 cases and surgical volume.

In the early days of the pandemic, it was unknown when elective cases would resume. States are now reopening, but some states that had resumed elective surgeries, such as Texas, have had to scale back due to increases in COVID-19 cases burdening the local healthcare system.[xix] In 2018, a total of 16.5 billion dollars was spent on cosmetic procedures, both surgical and minimally invasive, in the United States.[xx] Nationally, the top five most commonly performed surgical cosmetic procedures in 2018 were abdominoplasty, blepharoplasty, breast augmentation, liposuction, and rhinoplasty. The total surgeons' fees derived from these procedures in 2018 was approximately five billion dollars. This analysis demonstrates that the current pandemic will result in an approximately 20% decrease in collected fees. This does not approach the total economic impact. The cost involved in taking a patient to the operating room involves numerous factors with a wide degree of variation influenced by regional differences, type of care setting, devices utilized and patient mix. In 2018, authors Childers et al created the first standardized estimates of operating room cost.[xxi] It was estimated that for the state of California, the mean cost of an operating room was approximately $36 per minute. This estimate does not reflect the total cost charged to a surgical patient, as it does not include anesthesia, blood products, pathologic tests and fees for implants. However, we can utilize

this as a benchmark to attempt to estimate the effects of the surgical suspension has had in regards to operating room fees. Using these estimates, an hour of operating room costs is estimated to be $2,160. Assuming the majority of elective cases take anywhere from 1 to 4 hours, it is evident that the overall economic losses incurred by restrictions on surgeries are far greater than those due to lost surgeons' fees alone.

There are additional reasons why the aforementioned underestimates the overall economic impact: only the top five procedures in each region are included in this analysis; there is no discussion of minimally invasive procedures; office based surgery will likely resume prior to hospital based surgery for those same procedures; patients may be unwilling to undergo procedures in a hospital based setting for longer than the duration of OR closure; and patients may suffer economic losses during this time that preclude spending on non-essential costs such as elective surgeries. There are also factors that may result in surgeons recouping some of the anticipated lost income: surgeons may elect to perform procedures in private ORs at dates earlier than those employed in this analysis; surgeons may perform non-invasive or office-based procedures on a timeline that is wholly different from estimates based on ventilator need; and there may be a period after the restrictions are lifted when surgeons are performing procedures at a rate higher than that predicted from historical averages because of a "back log" of cases. In addition to variations in the data relating to surgeons' and patients' behavior, there are innumerable variables influencing the duration and severity of this pandemic.

Predictions from the IHME model on 3/27/20 undergird these estimates of the economic impact of the pandemic. There are significant limitations to this model including: limited foundational data based on publicly available information from Wuhan, China, the veracity of which cannot be assured; assumptions regarding social distancing and the impact thereof on the spread of the virus; the manner with which the virus will spread differently in the context of a metropolitan versus rural area, or a long term care facility versus an ambulatory population; and the manner with which different municipalities will enact mandatory or voluntary guidance on interventions to mitigate the spread of the virus (eg, requiring face covering) in the face of location-specific

epidemiology data. Additional variables including local politics, accuracy and availability of data, and population compliance to local mandates, complicate our ability to account for the limitations inherent to the model, or predict the direction in which these limitations may skew the model. However, the preceding analysis is anchored by the most robust predictive data available early in the pandemic regarding impact on hospital operations.

The authors do not believe that the appropriate response to such uncertainty is to avoid attempts to estimate the impact of the virus. Rather, it is valuable to assess the conclusions derived from these models as well as interrogate the accuracy of their predictions retrospectively. Understanding the reliability of these predictive models in a retrospective manner informs one's assessment of their future utility as the pandemic evolves. Comparing estimates of duration of restrictions on surgery based on anticipated duration of ventilator use to actual duration from 3/19/2020 to when some states announced the resumption of elective surgeries demonstrates a large discrepancy; the former predicts 94.38 days whereas the latter is 42.65 days. It is critical to recognize the following: the duration of restrictions based on states' announcing resumption of surgeries is calculated on incomplete information (31 of 50 states); although elective surgeries may resume, many hospital systems are resuming cases in a staggered manner that prioritizes tier 1b, 2a, and 2b cases; and individual hospital systems may resume cases in an idiosyncratic manner not accounted for in these estimates.

Of all surgical subspecialties, elective plastic surgery may be one of the most affected by the current crisis. All practitioners underwent dramatic, immediate changes to their practice. Those who operate for primarily reconstructive indications have generally been permitted to resume surgery prior to those performing cosmetic cases. One may also consider whether there are distinct levels of risk to each procedure given nasopharyngeal carriage of the virus. It is reasonable to hypothesize that rhinoplasty may have greater inherent risk compared to abdominoplasty (given that all other variables are equal) due to the anatomic site of surgery. However, patients undergoing elective surgery are required to undergo COVID-19 testing prior to their procedure, which may mitigate

potential increased risk based on surgical site. The authors further anticipate that all cosmetic, elective cases will be deferred until the risk of surgery is perceived to be minimal regardless of anatomic location. Finally, procedures requiring general anesthesia require intubation, a process that generates potentially infectious aerosolized material and occurs regardless of surgical site.

Prior scholarship on the impact of economic downturns on aesthetic plastic surgery has shown that since consumers directly pay for procedures, the application of market economic analysis is appropriate, in contrast to other surgical procedures financed by health insurance. In 2010, Gordon et al investigated this premise by comparing the volume of four common cosmetic procedures to trends of the three major US stock market indices; the Dow Jones, NASDAQ and S&P 500 funds. As anticipated, the study confirmed a direct correlation between the majority of their cosmetic procedures and the three major market indices. Procedures such as total joint replacements and elective lumbar and cervical spine surgery were not influenced by the economic downturns in the 2000s.[xxii,xxiii,xxiv,xxv] The recent restriction of elective surgeries was entirely unique, and the relevance of these historical findings to the current situation is yet unknown. However, given this and other works by Krieger et al in regards to cosmetic surgery during times of recession,[xxvi] it may be prudent to maintain a broad-based practice including reconstructive surgery, aesthetic surgery, and minimally invasive procedures in order to maintain control over one's practice during this time of uncertainty.

These data suggest that there will be significant regional variation in economic impact due to COVID-19. Many variables contribute to these regional discrepancies, only some of which are considered in the figures provided herein. The total population in each region varies between 51,557,675 and 77,993,663.[17] There are likely also regional differences in average annual income, interest in cosmetic surgery, and proximity to a plastic surgeon; these differences exist apart from the differential impact the pandemic has on each state. On January 20, 2020, the first confirmed case of SARS-CoV2 was reported in Washington State.[xxvii] Within two weeks, cases were identified in six states (WA, CA, IL, AZ, MA, WI). By March 18, cases were present in all 50 states. New York

emerged as an early epicenter and struggled to care for the thousands who had fallen ill and required hospitalization. Case incidences were predicted to peak and wane at different times, with the mean predicted date on which patients no longer require ventilators ranging from 5/31 - 7/3.

Areas of the country in which the predicted date of peak case volume is closer to the date when surgeries were restricted nationally per CMS guidance (3/19/2020) are predicted to have a shorter duration of case restriction, as the national prohibition on surgeries aligns with their predicted time course. States that experienced peak case incidence later than 3/19/2020 were estimated to have a longer duration of impact as their time to case volume decrease lagged behind the respectively later date of peak cases. Region 1 (New England and Middle Atlantic), which saw the majority of cases early in the pandemic, was predicted to have the earliest resolution of ventilator requirement. Region 3 (South Atlantic) was predicted to have patients requiring ventilators until 7/3. Although states on the East and West coasts were the first to be significantly affected by the pandemic, restrictions on cosmetic surgery reflect the national guidance that recommended suspending procedures beginning 3/19/2020.

Data are also provided with respect to estimated OR days lost based on the duration for which ventilator, ICU beds, and hospital beds are required by state. It is possible that these estimations do not accurately reflect the period during which elective surgeries are suspended. Additional limitations on availability of Personal Protective Equipment (PPE) may inspire hospitals to have a staged reinstatement of elective surgical cases with priority placed on semi-elective procedures that were delayed due to the pandemic. States may officially reinstate elective cases earlier than the duration during which ICU beds and ventilators are required; however, the authors believe that full reinstatement of elective, cosmetic cases will lag behind as surgical priority is given to cases such as oncologic extirpations. The authors therefore elect to rely on estimations that are more conservative. It is likely that elective cases will resume while some number of patients are predicted to still require critical care and ventilation. However, the delayed fashion with which cosmetic cases are permitted by individual hospitals relative

to the stated date when elective surgeries resume; as well as the limited OR time available given the backlog of cases that need to be performed, will likely result in full reinstatement of cosmetic cases being delayed longer than suggested by states' published date of elective case resumption.

Although some states have resumed elective surgeries at dates earlier than those provided by the aforementioned estimations, it is possible that early resumption of elective cases will be followed by reimposed restrictions, as seen in Texas. Recent findings suggest that when Hong Kong relaxed restrictions on social interaction after having apparently controlled the virus, the number of new cases rapidly increased.[xxviii] However, as testing becomes more widely available, it is possible that social distancing restrictions could be limited to regions with continued viral transmission. Furthermore, testing for antibodies against the virus could identify patients and healthcare providers who have recovered from the virus and are at a theoretically reduced risk of illness. It is important to note that knowledge of the risk of reinfection and the prevalence of asymptomatic viral carriers remains limited.[xxix]

CONCLUSION

The IHME models of the impact of the pandemic by state were a valuable resource for estimating the trajectory of the pandemic in its early days. Despite this, the actual course of the virus throughout the US deviated from these predictions in several states. Overall, elective surgical cases have resumed prior to the date estimated by the predicted requirement for invasive ventilation in each state. The resumption of cases has not meant that operating rooms are functioning at full pre-pandemic capacity. Furthermore, the reopening of some states has been met with increasing numbers of COVID patients and consequently some states have had to reverse course. The financial impact with respect to anticipated loss of surgeons' fees does not capture the total economic impact of the pandemic or of the loss in elective cases as it does not include operating room fees or hospital costs.

Despite the limitations of the above analysis, it is instructive to interrogate a predictive model and hypothesize how the new reality brought on by the pandemic affects the practice of aesthetic plastic surgery. Retrospection affords comparison of the predicted duration of restrictions to the lived reality we now appreciate. Although the prospective estimates yielded a relatively longer duration of anticipated restrictions on elective surgery, the staged manner with which hospitals are resuming surgeries may result in the prospective estimations being closer to the true experience of surgeons performing elective aesthetic cases. While surgeons eagerly await the time when case volumes return to pre-pandemic levels, there are behaviors we can all enact to help mitigate the impact of the virus on our patients and practices. All individuals are encouraged to follow state and federal recommendations for hand hygiene, social distancing, and travel restrictions. Surgeons can continue to help protect patients and decrease the burden on hospital emergency rooms by offering to repair lacerations and manage acute hand injuries within their office. Doing so prevents otherwise healthy patients from having to enter a high-risk area and frees up emergency department staff to care for patients with critical needs. Although it is helpful to provide office-based care in these scenarios, such care must be provided while ensuring patient and staff safety by limiting patient density in waiting areas, using and providing PPE, and requiring preoperative COVID19 testing. Plastic surgeons have a substantial presence on social media. This too can be parlayed into an opportunity for surgeons to broadcast best practices regarding social distancing, face coverings, and hand hygiene. Plastic surgeons are respected as medical professionals and the caché this affords can be used to influence others into taking the steps necessary to slow the spread of the pandemic.

REFERENCES

Figure Legend

Figure 1. Regions as defined by ASPS[13] (created with mapchart.net[14]).

Figure 2. Duration from 3/19/20 to predicted date on which invasive ventilation would be required for <0.5 patients. The range depicts the duration from 3/19/20 to the earliest and latest dates based on the model's upper and lower limits of uncertainty.

Figure 3. Duration from 3/19/20 to when patients no longer require invasive ventilation, hospitalization, and ICU beds (national mean and range).

Figure 4. Regional duration from 3/19/20 to predicted date on which invasive ventilation required for <0.5 patients (regional mean with individual mean state values).

Figure 5. Regional estimates for lost case volume for the top five most common procedures if restrictions on cases extend from 3/19/20 to predicted date when invasive ventilation required for <0.5 patients.

Figure 6. Regional estimates for surgeons' fees not collected for the top five most common procedures if restrictions on cases extend from 3/19/20 to predicted date when invasive ventilation required for <0.5 patients.

Figure 7. Regional estimates for mean, minimum, and maximum cumulative lost case volume and surgeons' fees for top five most common procedures if restrictions on cases extend from 3/19/20 to predicted date when invasive ventilation required for <0.5 patients.

Table 1. CMS Elective Surgery Recommendations

Tiers	Action	Definition	Locations	Examples
Tier 1a	Postpone surgery/ procedure	Low acuity surgery/healthy patient Outpatient surgery, not life-threatening illness	• HOPD • ASC • Hospital with low/no COVID-19 census	• Carpal tunnel release • EGD • Colonoscopy • Cataracts
Tier 1b	Postpone surgery/ procedure	Low acuity surgery/unhealthy patient	• HOPD • ASC • Hospital with low/no COVID-19 census	• Endoscopies
Tier 2a	Consider postponing surgery/procedure	Intermediate acuity surgery/healthy patient Not life-threatening but potential for future morbidity and mortality. Requires in-hospital stay	• HOPD ASC Hospital with low/no COVID-19 census	• Low risk cancer • Non-urgent spine and ortho: Including hip, knee replacement and elective spine surgery • Stable ureteral colic • Elective angioplasty
Tier 2b	Postpone surgery/ procedure if possible	Intermediate acuity surgery/unhealthy patient	• HOPD • ASC • Hospital with low/no	

			COVID-19 census	
Tier 3a	Do not postpone	High acuity surgery/healthy patient	Hospital	• Most cancers • Neurosurgery • Highly symptomatic patients
Tier 3b	Do not postpone	High acuity surgery/healthy patient	Hospital	• Transplants • Trauma • Cardiac w/ symptoms • Limb-threatening vascular surgery

HOPD, hospital outpatient department; ASC, ambulatory surgery center. Adapted from CMS Adult Elective Surgery and Procedures Recommendations.[6]

Table 2. Population of Regions as Defined by ASPS

Region	Regional population per 2018 US census
Region 1 (CT, ME, NH, RI, VT, NJ, NY, PA)	51,557,675
Region 2 (IL, IN, MI, OH, WI, IA, KS, MN, NE, ND, SD)	62,182,292
Region 3 (DE, DC, FL, GA, MD, NC, SC, VA, WV)	58,577,235
Region 4 (AL, KY, MS, TN, AR, LA, OK, TX)	59,431,540
Region 5 (AZ, CO, ID, MT, NV, NM, UT, WV, AK, CA, HI, OR, WA)	77,993,663

Table 3. Case Volume and Total Surgeons' Fees Collected for Five Most Frequent Aesthetic Procedures by Region and Nationally

	2018 number of procedures by region (surgeons' fee)#							
	Rhinoplasty ($5350)	Liposuction ($3518)	Breast augmentation ($3824)	Blepharoplasty ($3156)	Abdominoplasty ($6253)	Dermabrasion ($1249)	Facelift ($7655)	Mastopexy ($4816)
Region 1	62,045 ($331,940,750)**	44,581 ($156,835,958)**	46,738 ($178,726,112)**	37,988 ($119,890,128)**	25,476 ($159,301,428)**	9,797 ($12,236,453)	24,302 ($186,031,810)	14,185 ($68,314,960)
Region 2	29,187 ($156,150,450)**	33,276 ($117,064,968)**	53,522 ($204,668,128)**	28,169 ($88,901,364)**	24,038 ($150,309,614)	24,324 ($30,380,676)**	14,224 ($108,884,720)	16,153 ($77,792,848)
Region 3	26,649 ($142,572,150)**	58,312 ($205,141,616)**	50,623 ($193,582,352)**	45,663 ($144,112,428)**	21,810 ($136,377,930)	17,555 ($21,926,195)	27,904 ($213,605,120)**	22,412 ($107,936,192)
Region 4	39,024 ($208,778,400)**	40,077 ($140,990,886)**	50,900 ($194,641,600)**	24,597 ($77,628,132)**	21,462 ($134,201,886)	9,124 ($11,395,876)	17,278 ($132,263,090)	22,686 ($109,255,776)**
Region 5	56,975 ($304,816,250)**	82,312 ($289,573,616)**	111,952 ($428,104,448)**	70,112 ($221,273,472)**	37,295 ($233,205,635)	19,897 ($24,851,353)	37,823 ($289,535,065)**	34,202 $164,716,832)
United States	130,081 ($695,933,350)**	206,529 ($726,569,022)**	258,558 ($817,494,720)**	258,558 ($816,009,048)**	313,735 ($1,961,784,955)**	80,697 ($100,790,553)	121,531 ($930,319,805)	109,638 ($528,016,608)

#Data from 2018 Plastic Surgery Statistics Report by ASPS National Clearinghouse of Plastic Surgery Procedural Statistics.
**Denotes top five most common procedures in a given region, used in subsequent analysis.

Figure 1

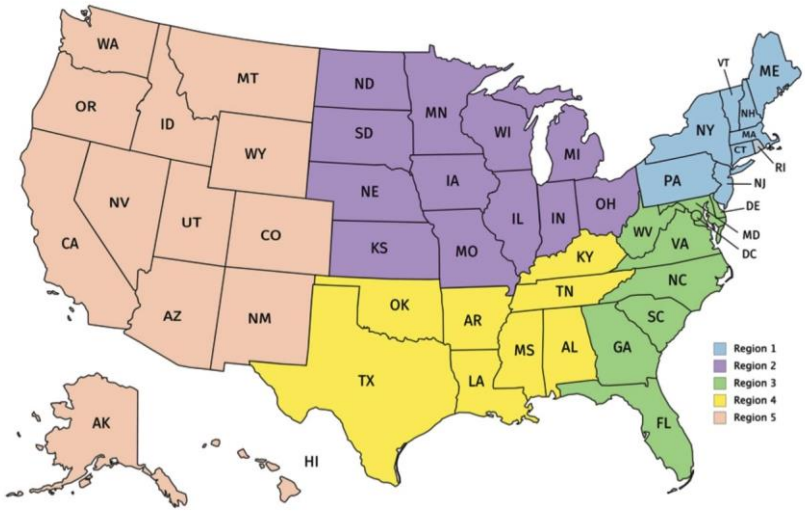


Figure 2

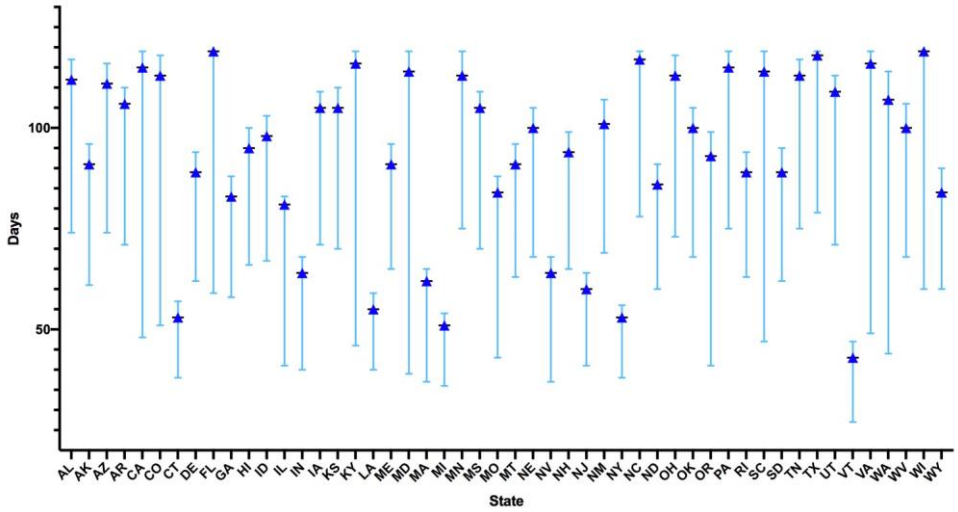


Figure 3

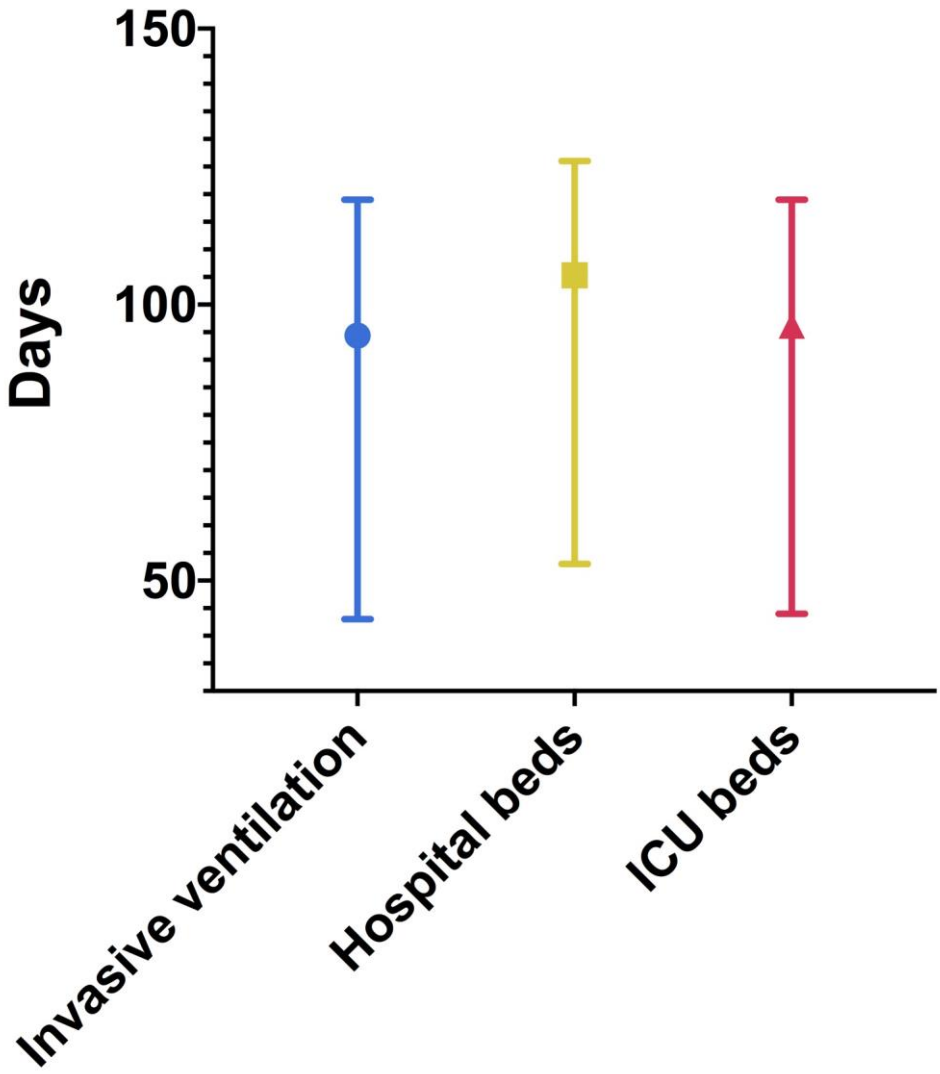


Figure 4

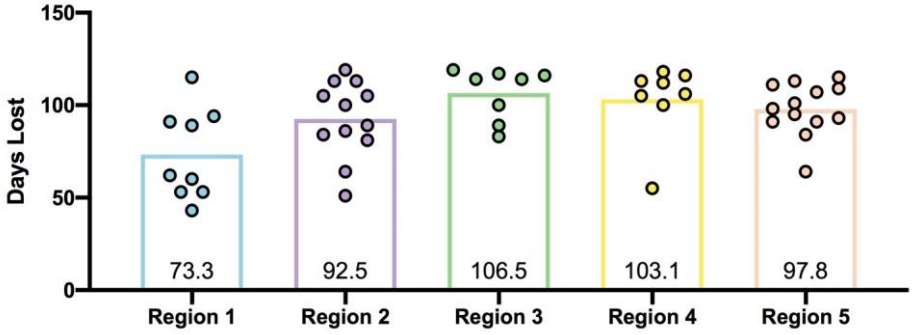


Figure 5

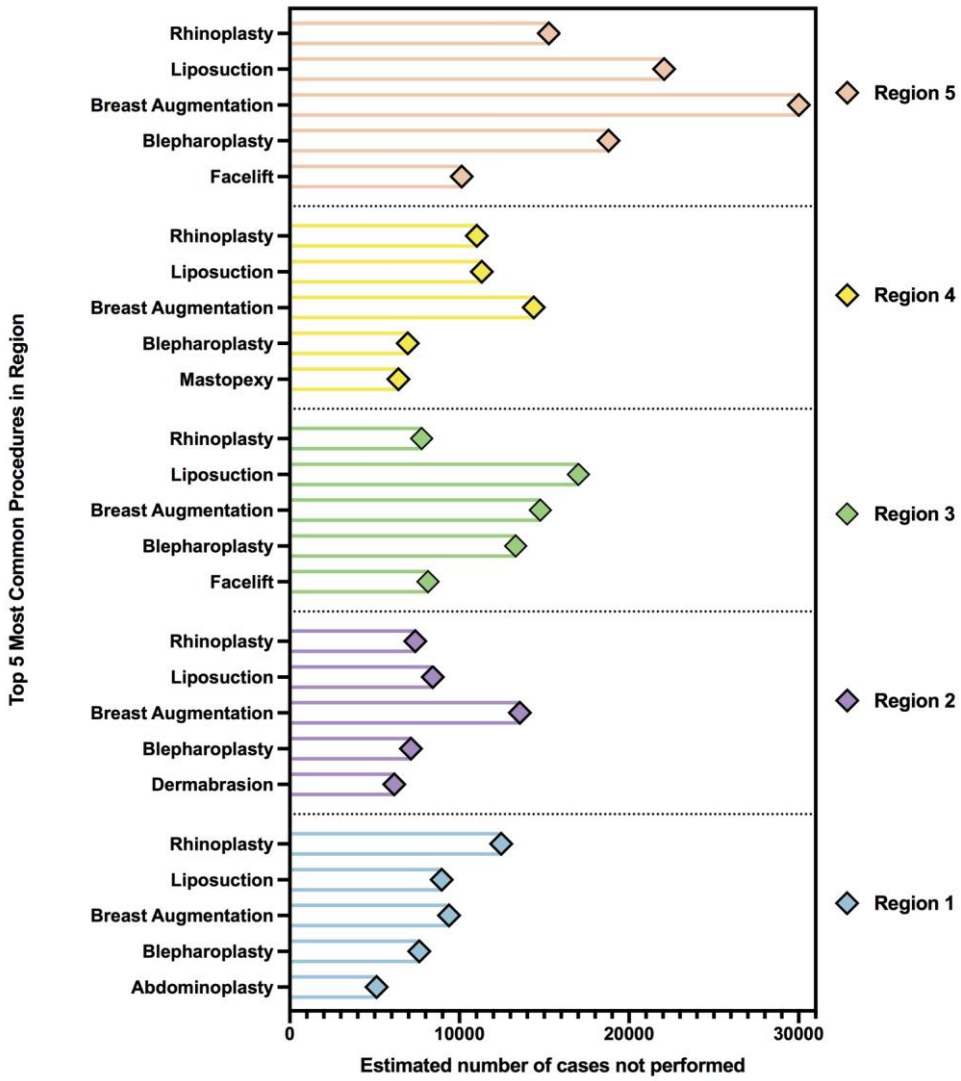


Figure 6

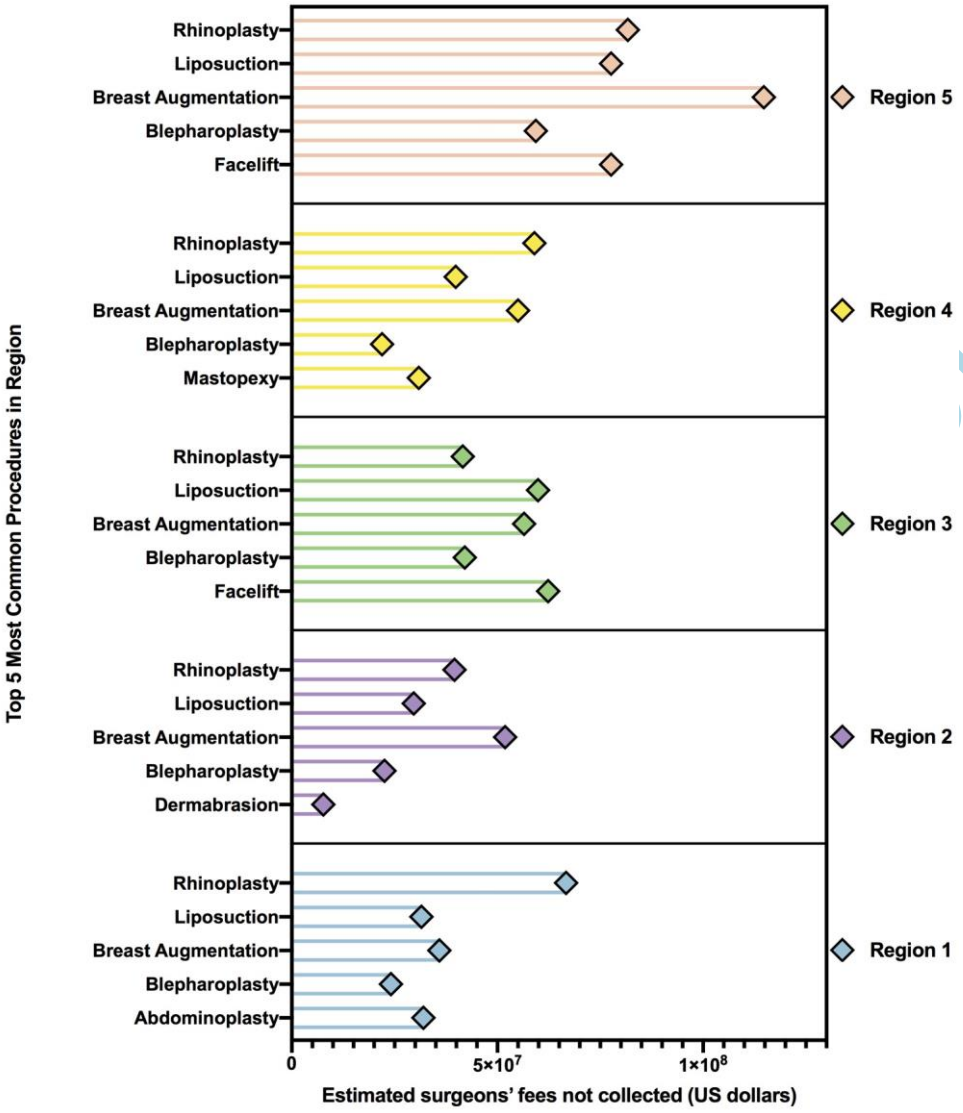
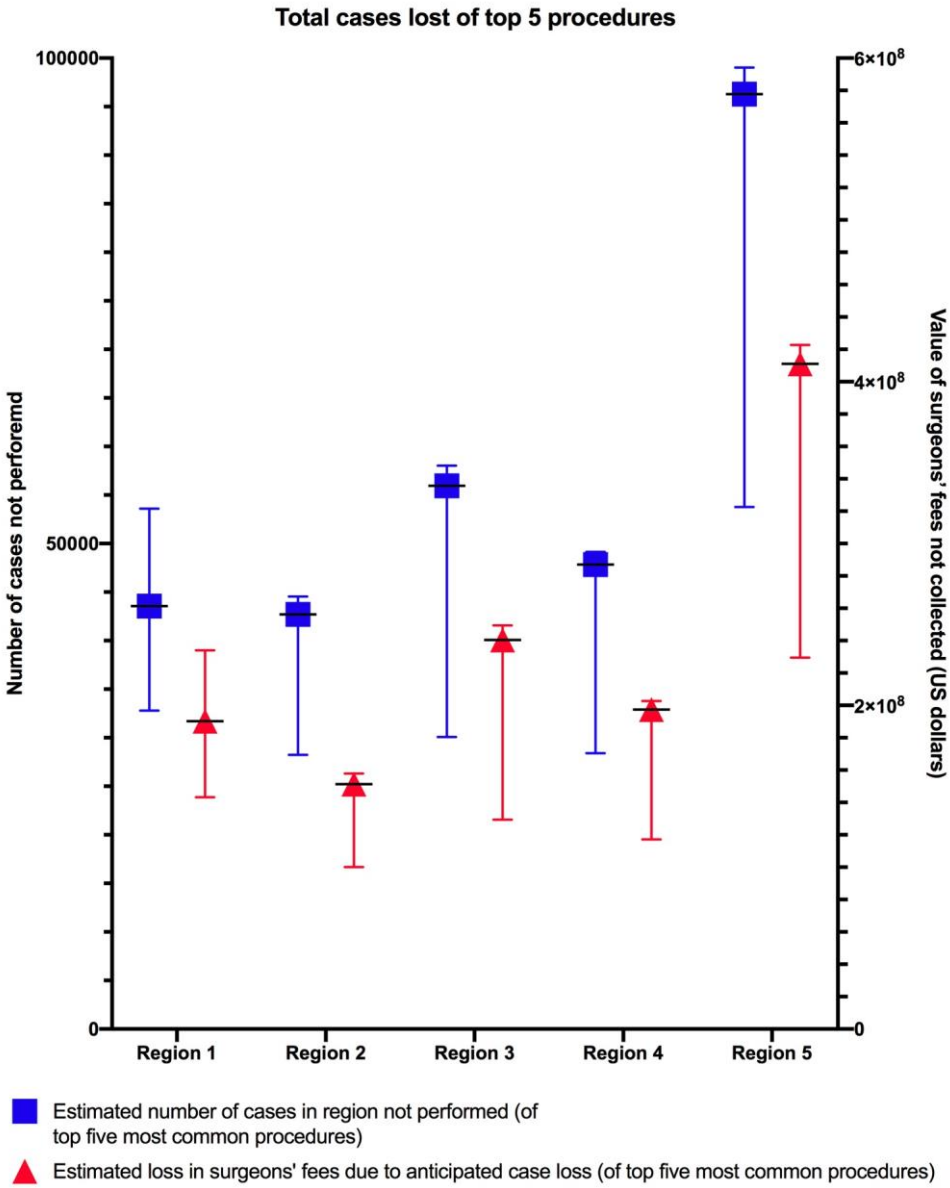


Figure 7



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