



Cross-sectional Study

Retrospective analysis of trends in surgery volumes between 2016 and 2019 and impact of the insurance deductible: Cross-sectional study



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ABSTRACT

Background: Understanding trends in surgical volumes can help Ambulatory Surgery Centers (ASCs) prevent clinician burnout and provide adequate staffing while maintaining the quality of patient care throughout the year. Health insurance deductibles reset in January each year and may contribute to an annual rhythm where the levee of year-end deductibles is breached in the last few months of every year, resulting in a flood of cases and several accompanying challenges. This study aims to identify and analyze monthly and yearly surgical volume patterns in ASCs and explore a relationship with the deductible reset.

Methods: De-identified, aggregate visit data for 2016–2019 were obtained retrospectively from 14 ambulatory surgery centers within the same benchmarking consortium in the Southeast. The ASCs subspecialty types consisted of orthopedics, urology, otolaryngology, and multispecialty. Kaiser Family Foundation survey data from 2016 to 2019 was used to inform deductible trends. Augmented Dickey-Fuller tests, linear regressions, and two-sample T-tests were conducted to explore and establish patterns in surgical volume between 2016 and 2019.

Results: Overall, average orthopedic surgical volume increased 38.04% from January to December in 2016–2019 with an average difference of 64 cases (95% CI: 47–80), while that of all ASCs combined increased 19.24% within the same timeframe with an average difference of 37 cases (95% CI: 21–52). Average health insurance deductibles rose 12% from \$1476 to \$1655 within the same timeframe. Regression analysis showed a stronger association between year and volume for orthopedic ASCs (R (Claxton et al., 2019) [2] = 0.796) than for all ASCs combined (R (Claxton et al., 2019) [2] = 0.645). Regression analysis also showed a stronger association between month and volume for orthopedic ASCs (R (Claxton et al., 2019) [2] = 0.488–0.805) than for all ASCs combined (R (Claxton et al., 2019) [2] = 0.115–0.493).

Conclusion: This study is first to identify regular and predictable yearly and monthly increases in orthopedic ASCs surgical volume. The study also identifies yearly increases in surgical volume for all ASCs. The combination of increasing yearly demand for orthopedic surgery and growing association between month and volume leads to an unnecessary year-end rush. The study aims to inform future policy decisions as well as help ASCs better manage resources throughout the year.

1. Introduction

While the US population grew by 18% between 2000 and 2020, overall surgery volume increased by 31.5% [1]. Between 2009 and 2019, insurance deductibles across all covered workers rose by 162% [2]. The goal of deductibles is to require patients to share in the cost of

medical treatment up to a predetermined figure to prevent overuse or frivolous use of scarce medical resources [3]. Consumers with non-emergency or elective surgeries may delay costly procedures until their deductible has been met to then have insurance cover a larger percentage of the cost. Since many deductibles reset in January of each year, such trends may create an annual pattern where the levee of

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year-end deductibles is breached in the last few months of every year, resulting in a flood of cases and several accompanying challenges.

The average deductible increased every year from 2016 to 2019 [2–5]. This rise in deductibles delays the point in the calendar year when most consumers meet their deductible [6]. Consequently, Americans are currently paying a larger proportion of healthcare costs out of pocket than ever before, and these values are expected to continue rising as cost containment and catastrophic-only insurance policies become more common [7].

Within the past two decades, many surgical disciplines have shifted from the hospital to the ambulatory setting [8]. This shift results from advances in medical technology, changes in medical payment structures, and increases in the use of non-invasive and minimally invasive techniques which provided strong incentives for hospitals to shift less complex surgery cases to the outpatient setting [8]. Compared to the traditional hospital setting, ambulatory surgery centers (ASCs) typically provide similar services at a lower cost and with equal or better surgical outcomes when considering factors such as infection rates [9]. Surgical cases performed in the ASC setting may continue to increase as procedures such as total joint arthroplasties and spinal procedures become more common within ASCs. This study aims to explore the extent to which the drought-flood cycle described above has affected ASCs. Understanding trends in surgery volumes can help ASCs provide adequate staffing throughout the year, improve resource management, and maintain the quality of patient [10]. To this end, data from 14 ASCs was analyzed to test the following hypotheses:

1. Surgery caseloads are significantly more concentrated in the last few months (November and December) of each year.
2. Surgery caseloads are experiencing statistically significant increases on an annual basis (year to year).
3. Insurance deductibles rose each year during the study period (2016–2019).

2. Materials and methods

2.1. Participants

De-identified, aggregate visit data for 2016–2019 were obtained from 14 ASCs within the same benchmarking consortium in the Southeastern United States. These practices serve a diverse patient population and consist of orthopedics, urology, otolaryngology, and multispecialty surgery centers. Surgery volume distribution for these 14 ASCs is presented in Table 1.

3. Data collection

Data on subspecialty type and monthly volumes were gathered retrospectively from a centralized health information network (HIN) shared by all participating ASCs. The system was originally created as a quality improvement initiative for the benchmarking consortium and contained no patient identifiers, exempting it from institutional review board approval and patient consent. This also exempted the data from ethics review. No patients were involved in this study. Additionally, 2016–2019 data from the Kaiser Family Foundation's (KFF) yearly Benchmark Employer Survey were utilized to analyze trends in health insurance deductibles within the same time period [2,11–13].

Table 1

Ambulatory surgery center volume 2016–2019.

Average Surgery Cases Per Year	Ambulatory Surgery Center Count
<1000 cases	2
1001–3000 cases	7
3001–6000 cases	4
6001+	1

4. Statistical analysis

Initially, 51 centers were included in the report pulled from the HIN. As per the exclusion criteria, ASCs missing more than a quarter of their data were excluded from analysis, leaving 14 total sites. The inclusion criteria for clinics was set at having greater than a 75% response rate. Missing values were imputed using the linear interpolation process described by Moritz & Thomas [14]. An Augmented Dickey-Fuller (ADF) test was used to identify presence of monthly variations over the course of four years for average of the entire sample and for average of each ASC type. The ADF test assesses for a unit root (a signal for a systematic pattern in a time series) in the data sets, where the alternative hypothesis represents stationarity (or a constant trend throughout the years). These tests establish a baseline for the relationship of volume over time, but the ADF test alone does not indicate where seasonality exists or its role in volume. Therefore, graphic representations of yearly and monthly visits to complement the analysis were determined. Linear regressions were conducted to analyze the relationship between month and the month's average surgery volume. Two-sample t-tests were conducted to analyze differences between volume at the year's beginning (January–February) and at year's end (November–December). Finally, a separate linear regression was performed analyzing the relationship between average deductibles for covered workers and year to examine how the deductible varied between 2016 and 2019. Analyses were conducted with R software and tidyverse, tseries, and lubridate packages (version 3.6.3) [15–18]. This study has been registered with the Research Registry as [researchregistry6524](https://www.researchregistry.com/record/researchregistry6524). This study has been reported in line with the STROCCS Criteria [19].

5. Results

Of 51 ASCs initially pulled from the HIN report, 14 fit inclusion criteria for greater than 75% response rate. The average missing data per ASCs was 19% for these 14 ASCs. The 14 ASCs consisted of 3 orthopedic, 3 urology, 1 otolaryngology, and 7 multispecialty. The linear regressions conducted in this study yield R^2 values that represent the percent of change in the dependent variable that is explained by change in the independent variable. This value is used to characterize the association and relatedness of variables analyzed. Furthermore, within the context of this study, trend is defined as a relationship between two variables that is not necessarily causal in nature. A higher R^2 value indicates closer relationships and, therefore, a stronger trend. Finally, the slope of the line of best fit is used to comment on the general direction of these trends in the near future.

Fig. 1 characterizes the year-to-year change in surgical volume from 2016 to 2019. A linear regression analysis of average total surgical volume for all 14 ASCs shows an increase in annual surgery volume each year from 2016 to 2019. The R^2 value of 0.645 indicates that 64.5% of the change in average number of cases can be explained by the change in years for all ASCs considered together. When orthopedic ASCs are isolated, the R^2 value rises to 0.769 indicating that 76.9% of change in average number of cases can be explained by the change in years. Both orthopedics and all specialties combined saw an increase in volume from 2016 to 2019. However, the percent of this increase explained by the change in year is greater for orthopedic ASCs (76.9%) than for all ASCs combined (64.5%). A positive slope in the line of best fit for both orthopedic ASCs individually and all ASCs combined suggests the average surgical volume within the ASC setting should continue to rise each year.

Fig. 2 characterizes the month-to-month change in surgical volume for all ASCs combined from 2016 to 2019. On average, surgical volume was lowest during January–February and highest during November–December (Fig. 2). The R^2 value is less than 0.5 each year with a range of 0.115–0.493, indicating that no more than 50% of variation in surgical volume is explained by change in months for all ASCs combined. The R^2 value also fluctuates yearly, indicating that the variation in volume explained by change in month is inconsistent year-to-year when

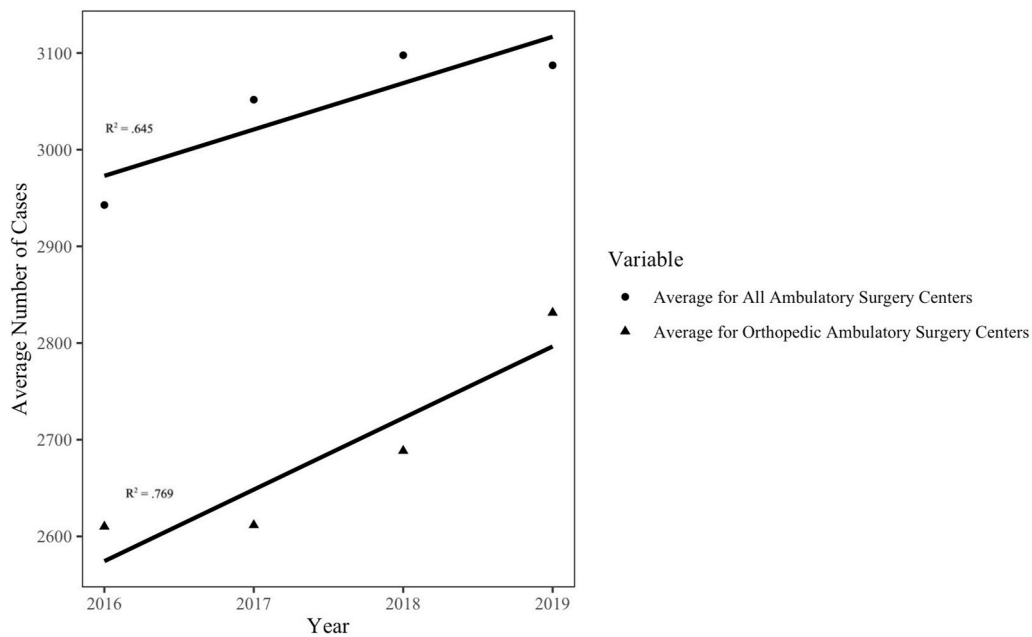


Fig. 1. Fig. 1: Linear regression of annual change in surgical volume between 2016 and 2019.

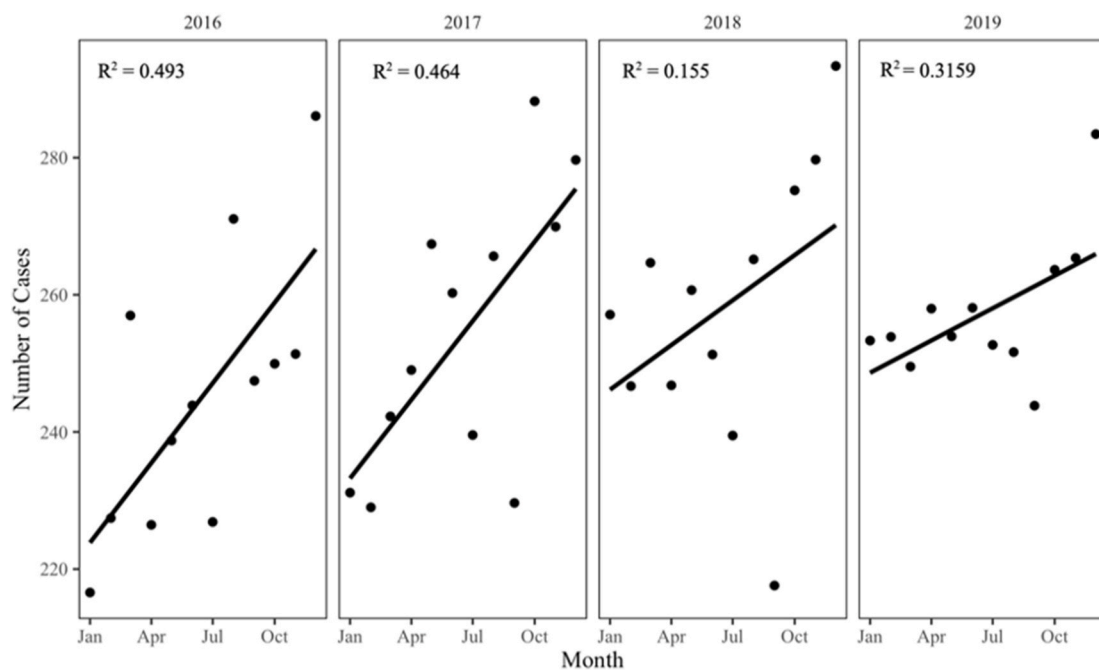


Fig. 2. Linear Regression of Total Surgical Volume for all Surgical Subtype Categories within years 2016–2019.

all ASCs are combined.

Fig. 3 characterizes the month-to-month change in surgical volume when orthopedic ASCs are isolated. Orthopedic ASCs individually also have the lowest volume during January–February and the highest volume during November–December. Except for 2016, the R^2 values for orthopedic ASCs were considerably higher than R^2 values for all ASCs together indicating a range of 48.8–80.5% of variation in surgical volume is explained by change in months depending on the year. The R^2 values for orthopedic ASCs also increased consistently each year from 0.488 to 0.805, indicating that the association between months and volume is progressively getting stronger each year.

Table 2 characterizes month-to-month seasonality of the data. The ADF test indicated that while all subspecialty ASCs averaged together

show significant seasonality ($p = 0.016$), this finding does not hold true when each subspecialty type is treated separately (Table 2). Individually, only orthopedics ASCs showed a statistically significant relationship between month and surgery volume ($p = 0.035$). This finding indicates that orthopedic ASCs have high seasonality in workflow, with a regular and predictable rise and fall in surgery volume that recurs yearly.

A similar finding is observed in Table 3, which evaluates the magnitude of change in volume from beginning to end of year. From January to December, the total average difference in volume for all surgical subspecialties was 37 cases (95% CI: 21–52). The ASCs with the highest average increases in surgery volume were otolaryngology (77, 95% CI: 1–153) and orthopedics (64, 95% CI: 47–80). The 95%

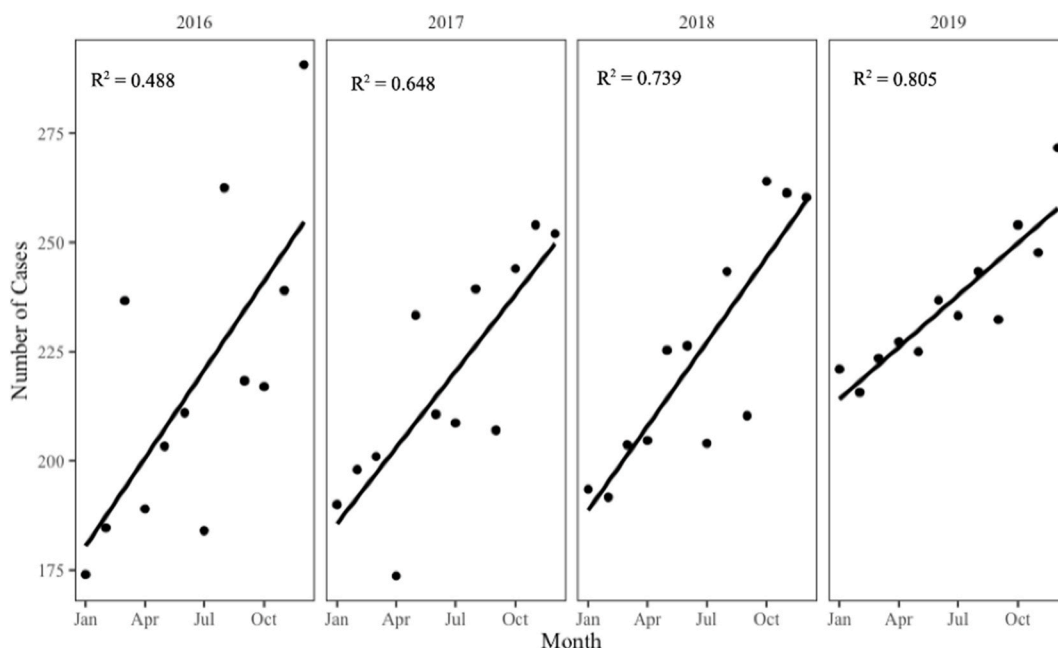


Fig. 3. Linear Regression of Orthopedic Surgical Volume from years 2016–2019.

Table 2

Augmented Dickey Fuller stationarity test.

Ambulatory Surgery Center Type	Dickey-Fuller Test Statistic	p-value
All	-4.0292	0.01619*
Otolaryngology	-2.9854	0.1806
Orthopedics	-3.701	0.03456*
Urology	-2.8007	0.2544
Multispecialty	-2.2533	0.473

Table 3

T-test of surgical subspecialties to establish the magnitude of change from January–February to November–December.

Ambulatory Surgery Center Type	Average Difference (95% CI)	t-test statistic	p-value
All	37 (21–52)	5.1456	0.0001567*
Otolaryngology	77 (1–153)	1904	0.04695*
Orthopedics	64 (47–80)	8.0818	1.221e-06*
Urology	14 (-5–34)	1.5777	0.1402
Multispecialty	27 (8–45)	3.1177	0.009061*

confidence interval for otolaryngology showed a level of uncertainty that included between 1 and 153 additional cases, which while statistically relevant ($p = 0.04695$), may not be clinically relevant. Orthopedics shows the highest statistically significant and clinically relevant change in surgery volume.

Fig. 4 characterizes yearly change in the average health insurance deductibles for covered workers from 2016 to 2019 as reported by KFF yearly Benchmark Employer Survey [2,10–12]. The deductibles increased 12% from 2016 to 2019. Regression yielded R^2 value of 0.937 indicating that 93.7% of the increase in deductibles is explained by change in year (Fig. 4). Furthermore, the positive slope of line of best fit indicates that deductibles will continue to rise yearly. This figure serves to establish that health insurance deductibles have consistently increased each year from 2016 to 2019 and that there is a strong relationship between the increase in deductibles and change in year.

6. Discussion

The purpose of this study was to identify and examine month-to-month and year-to-year surgical volume patterns in the ASC setting using data from 2016 to 2019. When all subspecialties were considered together, the study found regular and predictable yearly and monthly increases in surgery volume; however, when subspecialties were considered individually, orthopedic ASCs were the only category that still demonstrated that pattern. This study is first to identify regular and predictable yearly and monthly changes in orthopedic ASCs surgical volume. It also provides some context to patterns in surgery volume by analyzing changes in deductible costs during the study period.

All ASCs combined showed increased yearly surgical volume between 2016 and 2019 ($R^2 = 0.645$) (Fig. 1). The yearly increase in surgical volume reaffirms previous studies, which have predicted dramatic increases in overall surgery workload in coming years [1]. Explanations for this finding are multifaceted, but studies cite the aging US population as a large contributing factor [1]. Other factors such as advances in surgical procedures, post-operative pain management, and reduced costs associated with ASCs procedures have also helped migrate cases toward the outpatient setting.

All ASCs combined also showed increased monthly surgical volume between 2016 and 2019 ($R^2 = 0.115-0.493$) (Fig. 2). The t-test of surgical subspecialties also showed a 19.24% average increase in monthly volume with an average difference of 47 cases (95% CI: 21–52, $p = 0.01619$) (Table 3). The ADF test denoted that all ASCs combined exhibited significant regular and predictable monthly patterns in surgical volume ($p = 0.016$) (Table 3). While all ASCs together showed strong positive association between month and surgery volume, this finding did not hold true for all ASC types when considered individually.

Compared to all ASCs considered together, orthopedics ASCs individually showed substantially stronger association between surgical volume and month ($R [2] = 0.488-0.805$) (Fig. 3) as well as year ($R [2] = 0.769$) (Fig. 2). This existence of a drought-flood pattern in orthopedic ASC surgeries was further implicated in orthopedic ASCs consistently having the fewest cases during the beginning of year and the most cases at end of year with an average difference of 64 cases (95% CI: 47–80, $P = 1.221e-06$) (Table 3). The Augmented Dickey Fuller Stationarity test confirmed that these volume patterns in orthopedics are regular and predictable changes that recur every calendar year between 2016 and

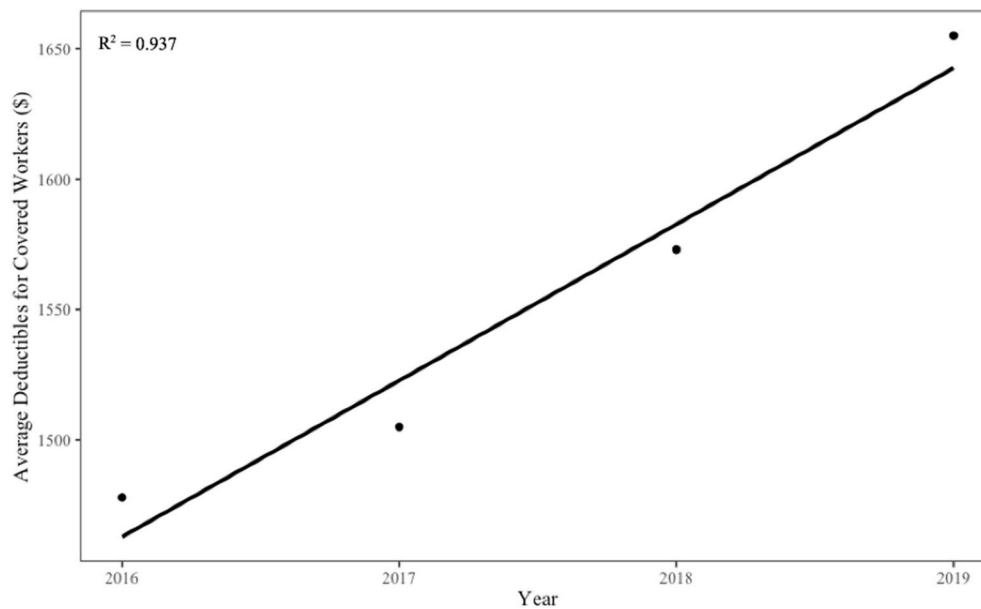


Fig. 4. Linear regression of average deductibles for covered workers from 2016 to 2019.

2019 (Table 2). The other specialties' ASCs considered individually did not show statistically significant seasonal changes.

In a 2016 study, surgeons reported dramatic increases in surgery workload near the end of the year, leading to the need to hire temporary help, book operating rooms from early morning until evening, and restrict time off for surgical teams [20]. They also reported subsequent disruptions to their work-life balance. Surgeons have less time to spend with patients as workload increases [1]. This could disrupt preoperative and intraoperative surgery consultation, which is crucial to surgical risk assessment, and result in miscommunications between surgeons and patients [21]. Wait times for urgent/emergent cases may also increase when elective cases accumulate at year-end. Previous studies show that time to surgery for urgent orthopedic cases like hip fractures impacts outcomes [22]. Further research is necessary to determine impact on complications, quality of patient care, and surgeon burnout at year-end.

A possible cause of this year-end accumulation is the increase in health insurance deductibles. Insurance open enrollment periods have customarily been held in Fall of each year, leading both private and government insurance plans to function on calendar-year schedules and reset on January 1. Data from the KFF survey showed increases in health insurance deductibles for covered workers each year from 2016 to 2019 ($R^2 = 0.937$) (Fig. 4). Previous studies have demonstrated that having high-deductible health plans influence patients to delay elective otolaryngology surgeries until deductibles are met [23]. Patients take advantage of insurance coverage after meeting deductibles and schedule elective surgeries near year-end. An analysis by Athena Health of 3.5 million visits in 2015 found that average out-of-pocket obligation for an orthopedic visit dropped from \$63.23 in January to \$39.60 in December as visit volumes rose 13% [24]. Understanding these trends may elucidate a relationship between the yearly deductible increases and year-end increase in surgical volume.

If the increase in deductibles is contributing to the concentration of surgical volume at year-end, demand for surgery at year-end will continue to rise as deductibles rise. The ASCs examined in this study have their highest volume during the common holiday season. Typically, holiday closure days minimize available operating room hours and coincide with many clinicians and healthcare workers requesting time off. In 2016–2019, the fourth fiscal quarter had a cumulative total of 16 federally mandated holidays, the most in any fiscal quarter [25]. Increased demand for surgery during this time, combined with an expected decrease in healthcare providers' availability due to time off,

serves to compound the problem. Practical alternatives to the January 1 deductible resets include resetting policies based on the primary policy holder's birth date or utilizing arbitrary dates such as initiation of the fiscal year instead of calendar year. Distributing deductible reset dates may result in a more even distribution of surgery caseload throughout the year. Implementation of such measures could help improve management and efficacy of ASC resources, leading to safer healthcare delivery, less clinician burnout, higher personal and occupational satisfaction, and lower healthcare costs by reducing overtime and part time staffing needs.

This study is subject to several limitations., with the relatively small number of included ASCs being the most prominent. With small sample sizes for specialty specific ASCs, trends between subspecialties are difficult to determine. This study also focuses on outpatient surgeries and does not include in-patient or hospital-based surgical volume. While missing data is limited based on inclusion/exclusion criteria, missing values were estimated using validated statistical imputation. Lastly, the timing for surgical intervention is a result of many personal and financial considerations. The insurance deductible reset is one of many factors that may play into that decision process. Other factors were not examined in this study.

7. Conclusion

This study is first to identify regular and predictable yearly and monthly increases in orthopedic ASCs surgical volume. The study also identifies yearly increases in surgical volume for all ASCs. The combination of increasing yearly demand for orthopedic surgery and growing association between month and volume leads to an unnecessary year-end rush. This research serves to inform future healthcare policy and help surgery centers think proactively about the accompanying challenges, including surgeon burnout, adequate staffing, and the potential for associated increases in complications.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Consent

There were no patients involved in the study from whom consent

needed to be taken.

Declaration of competing interest

The Authors report no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.amsu.2021.02.022>.

Ethical approval

This study was exempt from ethics approval as it had no human or animal participants in the study. The study was analysis of data in surgery.

Source of funding

There is no source of funding for this research.

Author contribution

Dhairya Shukla: Study concept, data analysis, writing the paper.
Sharvil Patel: data analysis, writing the paper.
Tyler Smith: study concept. Data collection.
Dr. Lesley Clack: Study concept.
Dr. Michael Shuler: Study concept, study design, data collection.

Registration of research studies

1. Name of the registry: Research Registry.
2. Unique Identifying number or registration ID: researchregistry6524.
3. Hyperlink to your specific registration (must be publicly accessible and will be checked): <https://www.researchregistry.com/browse-the-registry#home/>

Guarantor

Dr. Michael Shuler, Dhairya Shukla.

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