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Healthcare

The likely economic impact of fewer elective surgical procedures on US hospitals during the COVID-19 pandemic

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**Abstract**

**Background:** To help control the coronavirus disease 2019 pandemic, elective procedures have been cancelled in most US hospitals by government order. The purpose of this study is to estimate national hospital reimbursement and net income losses owing to elective surgical procedure cancellation during the coronavirus disease 2019 pandemic.

**Methods:** The National Inpatient Sample and the Nationwide Ambulatory Surgery Sample were used to identify all elective surgical procedures performed in the inpatient setting and in hospital-owned outpatient surgery departments throughout the United States. Total cost, reimbursement, and net income was determined for all elective surgical procedures.

**Results:** The estimated total annual cost of elective inpatient and outpatient surgical procedures in the United States was $147.2 billion, and estimated total hospital reimbursement was $195.4 to $212.2 billion. This resulted in a net income of $48.0 to $64.8 billion per year to the US hospital system. Cancellation of all elective procedures would result in estimated losses of $16.3 to $17.7 billion per month in revenue and $4 to $5.4 billion per month in net income to US hospitals.

**Conclusion:** Cancellation of elective procedures during the coronavirus disease 2019 pandemic has a substantial economic impact on the US hospital system.

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**Introduction**

On March 13, 2020, a state of emergency was declared in the United States owing to coronavirus disease 2019 (COVID-19), and the Centers for Medicare and Medicaid Services (CMS) made recommendations to curtail elective procedures to help limit viral exposure, control the spread of the pandemic, and conserve hospital resources in order to preserve them for a projected increase in patients with COVID-19.\textsuperscript{1,2} As of May 2020, some hospitals have begun to slowly resume some elective procedures in accordance with CMS recommendations.\textsuperscript{3}

Although cancellation of elective procedures leads to increased inpatient bed capacity and conservation of equipment, such as personal protective equipment and ventilators, it also results in substantial financial implications for the healthcare system.\textsuperscript{4,5} To help relieve financial strain on hospitals, Congress provided $175 billion in relief funding to the healthcare system through the Coronavirus Aid, Relief, and Economic Security Act and the Paycheck Protection Program and Health Care Enhancement Act.\textsuperscript{6,7}

Several reports evaluating the financial implications on hospitals during the pandemic use data from the Healthcare Cost and Utilization Project (HCUP) for economic predictions.\textsuperscript{4,7,8} However, these estimates do not include information on hospital revenue or profit, but rather only provide estimates of aggregate cost of inpatient procedures and admissions and are based on data that are 6 to 9 years old.\textsuperscript{9,10} Therefore, it is difficult to make accurate financial predictions involving hospital revenue from elective procedures using these reports.

The purpose of this study is to estimate the total cost, reimbursement, and net income of elective inpatient and outpatient surgical procedures in the United States and to determine the likely economic impact of elective procedure cancellation on the US hospital system during the COVID-19 pandemic using a nationally representative sample of both inpatient and outpatient surgical procedures.

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Methods

This study was exempt from institutional review board review because the data are de-identified and publicly available.

Data source

We used the National Inpatient Sample (NIS) and the Nationwide Ambulatory Surgery Sample (NASS), HCUP, data maintained by the Agency for Healthcare Research and Quality, for this study. The NIS, released from 1988 through 2017, is the largest all-payer database for inpatient hospital admissions in the United States. The database includes demographic and clinical information for each encounter such as diagnosis and procedure codes, length of hospital stay, source of payment, total hospital charges, and hospital characteristics such as teaching status. The NIS provides national estimates with data from over 35 million hospitalizations using a complex weighting method. Importantly, the NIS redesigned its hospital sampling method starting in 2012 to improve national estimates.

The NASS is the only nationally representative ambulatory surgery database in existence today. It is the largest all-payer database yielding national estimates of major ambulatory surgery encounters performed in hospital-owned facilities. The NASS contains clinical and resource-use related information including demographic information, diagnostic and procedure codes, total charges, source of payment, and facility characteristics. There are 2 years of data currently available for the NASS: 2016 and 2017. We utilized the most recent year available for both the NIS and the NASS.

Inpatient analysis

In order to estimate cost and reimbursement for inpatient elective surgical procedures, we selected all elective encounters in the NIS using the HCUP elective variable designation. Cases were then selected based on procedure class using the HCUP procedure classification system, which divides procedures into 4 categories: minor diagnostic or minor therapeutic (not requiring operating room) and major diagnostic or major therapeutic (operating room procedure). We analyzed elective operating room procedures as well as those procedures not requiring an operating room.

Cost variable

The HCUP provides cost-to-charge ratio files that are calculated based on information from hospital accounting reports collected from the CMS and are specific to each encounter in the NIS. These files provide a cost that reflects the actual expenses from hospital services, such as wages, supplies, and utility costs for each case.

Reimbursement variable

Reimbursement was calculated for each case based on the CMS system of payment for acute care hospital inpatient stays with adjustments for different rates of payment by different insurers. The Medicare payment system is referred to as the inpatient prospective payment system and assigns payment based on the diagnosis-related group for each encounter. The CMS assigns each diagnosis-related group a payment weight, which is available in the CMS Final Rule tables. This weight is multiplied by the sum of standardized labor-related share (adjusted by wage index supplied by the NIS) and nonlabor share plus the capital amount, all of which are available in the Final Rule tables. This provided a base reimbursement for each case.

The CMS provides additional payments for each case to teaching hospitals referred to as the indirect medical education (IME) adjustment. The IME adjustment is calculated based on the number of residents and the number of beds in each hospital. The IME adjustment values of each teaching hospital are available in the CMS hospital cost report data. In order to estimate IME adjustments for cases in the NIS, we used the CMS hospital cost report data to calculate mean IME adjustment values stratified based on hospital census region, urban hospital setting, and hospital bed size. We then matched these adjustments to cases performed at teaching hospitals in the NIS based on the census region, urban hospital setting, and hospital bed size as listed in the NIS. The CMS also adjusts the payment for each case based on whether the hospital treats patients with low income. This is referred to as the disproportionate share hospital (DSH) adjustment and is available in the CMS hospital cost report. Using CMS data, we calculated mean DSH adjustments based on hospital census region and urban or rural hospital setting and matched these values to cases in the NIS based on hospital census region and hospital setting.

Outpatient analysis

Cost variable

We calculated cost for each outpatient case in the NASS using data from the hospital outpatient prospective payment system (HOPPS) designed by the CMS. The CMS determines mean cost values for each Current Procedural Terminology code, which is listed in the HOPPS Final Rule cost statistic tables. The CMS calculates these values to represent the average total cost for that type of case for all hospitals along with bundled services. Based on these published reports, we created 2 different sets of estimates for inpatient cases—a conservative and upper estimate: conservative estimate: 1.0 Medicare; 0.8 Medicaid; 1.8 private insurance; and 0.65 other, self-pay, missing, or no charge and upper estimate: 1.0 Medicare; 1.0 Medicaid; 2.0 private insurance; and 1.0 other, self-pay, missing, or no charge.

Reimbursement variable

Reimbursement was calculated for each outpatient case using the CMS payment system. As with cost, the CMS determines total payment amounts and minimum copayment amounts for each procedural code, which is listed in the HOPPS Final Rule cost statistical and addenda tables for each year. The CMS calculates these amounts based on ambulatory procedure classifications, and procedure codes are also classified under a status indicator. When more than 1 procedure is performed during a single surgery and more than 1 procedure code is listed, the status indicator is used to determine the method of payment. For example, if the status
Fig 1. Aggregate cost, reimbursement, and net income from inpatient and outpatient surgery and minor procedures not requiring an operating room, comparing elective to nonelective cases. (Color version of this figure is available online.) *Non-OR = minor procedures not requiring an operating room. OR, operating room.

Table I
Aggregate hospital charges, reimbursement, cost, and net income for elective surgery and all elective procedures in the United States

|                        | Annual    | Monthly   |
|------------------------|-----------|-----------|
|                        | Billion, USD | Billion, USD |
| Elective surgery       | 546.4     | 45.5      |
| Total charges          | 177.2–191.8 | 14.8–16.0 |
| Total reimbursement*   | 129.9     | 10.8      |
| Net income             | 47.1–61.6 | 3.9–5.1   |
| All elective procedures† | 615.3     | 51.3      |
| Total charges          | 195.4–212.2 | 16.3–17.7 |
| Total reimbursement*   | 147.2     | 12.3      |
| Net income             | 48.0–64.8 | 4.0–5.4   |

Net income = reimbursement – cost

* Ranges in hospital reimbursement are based on conservative (lower) to upper reimbursement estimates based on differences in payment rates based on payer type for each procedure.
† All elective procedures – includes surgeries requiring an operating room and minor procedures not requiring an operating room.

Statistical analysis

The total cost and adjusted reimbursement variables for all surgical services in all hospitals were calculated. Net income was calculated by subtracting total cost from adjusted reimbursement for each case, and an aggregate sum was calculated. The most commonly performed inpatient and outpatient operating room surgical procedures were identified using the HCUP clinical classification software.12,13 There were 1.7% (175,119) of outpatient cases that had missing cost or reimbursement data so these were excluded from the analysis. We adhered to methodological standards for NIS use, including using discharge weights rather than hospital-level weights for analysis.31,32 Data were analyzed using SPSS, version 23, software (IBM Corporation, Armonk, NY).

Results

There were over 14.6 million elective inpatient and outpatient operating room surgical procedures in 2017, 4.6 million of which were inpatient and 10.0 million of which were outpatient. The total aggregate cost of elective inpatient and outpatient operating room surgical procedures was $129.9 billion, while the total aggregate reimbursement was $177.2 to $191.8 billion, resulting in an annual net income of $47.1 to $61.6 billion or a monthly net income of $3.9 to $5.1 billion (Table I). The total aggregate cost of all elective procedures (including surgeries requiring an operating room and minor procedures not requiring an operating room) was $147.2 billion, while total aggregate reimbursement was $195.4 to $212.2 billion, resulting in an annual net income of $48.0 to $64.8 billion or a monthly net income of $4.0 to $5.4 billion (Table I). When comparing elective procedures to nonelective procedures, elective procedures had lower cost and higher net income than nonelective procedures (Fig 1).

The most common elective inpatient operating room procedures were knee arthroplasty (n = 772,064), elective cesarean section (n = 673,394), hip arthroplasty (n = 434,195), spinal fusion (n = 379,575), and laminectomy/discectomy (n = 239,540) (Table II). The most common outpatient surgeries were cataract/lens surgery (n = 1,252,583), cholecystectomy (n = 580,424), arthroscopy with or without meniscectomy (n = 506,342), inguinal/femoral hernia repair (n = 452,353), and other hernia repair including ventral and umbilical (n = 423,480) (Table III).

Discussion

This study demonstrates that elective inpatient and outpatient surgical procedures account for approximately $195.4 to $212.2 billion in hospital reimbursement and approximately $48.0 to $64.8 billion in hospital net income per year in the United States. Cancellation of elective surgical procedures during the COVID-19 pandemic results in estimated losses of $16.3 to $17.7 billion per month in reimbursement and $4 to $5.4 billion per month in net income to the US hospital system.

There are substantial financial implications from cancellation of elective procedures and other services, which have caused reductions in hospital revenue and net income.33,34 Publicly available national healthcare cost and expenditure data often provide aggregate hospital financial data but do not provide specific details on revenue and net income directly from elective procedures.35 It is important to understand the reasons for the financial losses. This article shows the potential financial impact of stopping elective surgical procedures to the hospital, but it does not show the impact to surgeons.
Several reviews estimating hospital losses during the COVID-19 pandemic reference a report from the HCUP released in 2017, which estimated aggregate costs for inpatient US operating room procedures using data from 2014.5,6,8 However, the HCUP does not collect information on hospital revenue, so their statistical brief did not include revenue or profit in the analysis. Furthermore, the report did not contain information on ambulatory services.9 Therefore, it is difficult to make financial predictions on the financial performance of hospitals from elective procedure cancellation using this report. In this study, we estimate hospital reimbursement specifically for elective inpatient and outpatient surgical procedures, which can be used to aid in economic projections and decision-making. Aside from COVID-19 planning, it has information on the importance of elective surgeries and procedures for hospitals in the future.

On May 6, 2020, the CMS issued new recommendations on how hospitals may resume elective procedures at their own discretion.3 This decision places the responsibility to resume elective services on the leadership of specific hospitals and healthcare entities. Many hospitals may allow areas less affected by the virus, such as outside major metropolitan areas, to resume procedures before other areas with higher disease burden.

### Table II

| Elective surgery | Teaching hospitals (n = 10,034,858) | Nonteaching hospitals (n = 4,703,939) |
|------------------|-------------------------------------|-------------------------------------|
|                  | Billion, USD                        | Billion, USD                        |
| Total charges    | 400.8                              | 145.5                               |
| Total reimbursement\(^\d\) | 130.8—141.7                       | 46.4—50.0                          |
| Total cost       | 94.8                               | 35.0                                |
| Net income       | 35.7—46.7                          | 11.3—15.0                          |
| **All elective procedures**\(^\d\) | (n = 11,343,748)                 | (n = 5,338,817)                     |
| Total charges    | 452.6                              | 162.7                               |
| Total reimbursement\(^\d\) | 144.6—157.3                     | 50.8—54.9                          |
| Total cost       | 107.6                              | 39.5                                |
| Net income       | 36.8—49.4                          | 11.2—15.4                          |

Net income = reimbursement − cost
\(^\d\) Ranges in hospital reimbursement are based on conservative (lower) to upper reimbursement estimates based on differences in payment rates based on payer type for each procedure.
\(^\d\) All elective procedures includes surgeries requiring an operating room and minor procedures not requiring an operating room.

### Table III

Most common elective inpatient and outpatient operating room procedures performed in the United States based on surgery setting

#### Inpatient

| Description                  | n (Thousand) | Cost (Billion, $) | Reimbursement\(^\d\) (Billion, $) | Net income (Billion, $) |
|------------------------------|--------------|-------------------|-----------------------------------|-------------------------|
| 1 Knee arthroplasty          | 772.1        | 12.7              | 14.1—15.2                        | 1.4—2.4                 |
| 2 Cesarean section           | 673.4        | 4.5               | 5.7—6.6                           | 1.1—2.0                 |
| 3 Hip arthroplasty           | 434.2        | 7.3               | 8.2—8.8                           | 0.9—1.5                 |
| 4 Spinal fusion              | 379.6        | 11.7              | 14.4—15.8                         | 2.6—4.1                 |
| 5 Laminectomy/discectomy     | 239.5        | 6.7               | 8.4—9.2                           | 1.7—2.6                 |
| 6 Hysterectomy               | 148.4        | 1.9               | 2.0—2.2                           | 0.1—0.3                 |
| 7 Gastrectomy                | 145.3        | 2.1               | 2.7—3.0                           | 0.6—0.9                 |
| 8 Heart valve procedures     | 124.8        | 6.3               | 7.2—7.7                           | 0.9—1.3                 |
| 9 Arthroplasty other than hip/knee | 123.0      | 2.3               | 2.4—2.5                           | 0.002—0.2               |
| 10 Colorectal resection      | 120.3        | 2.6               | 2.8—3.1                           | 0.2—0.5                 |

Net income = reimbursement − cost

#### Outpatient

| Description                  | n (Thousand) | Cost (Billion, $) | Reimbursement\(^\d\) (Billion, $) | Net income (Billion, $) |
|------------------------------|--------------|-------------------|-----------------------------------|-------------------------|
| 1 Cataract/lens surgery      | 1,252.6      | 2.3               | 3.5—3.7                           | 1.2—1.4                 |
| 2 Cholecystectomy/duct exploration | 580.4     | 2.3               | 5.2—5.7                           | 2.9—3.3                 |
| 3 Arthroscopy/periappendectomy | 506.3     | 1.7               | 3.5—3.8                           | 1.8—2.1                 |
| 4 Inguinal/femoral hernia repair | 452.4     | 1.7               | 3.1—3.3                           | 1.4—1.7                 |
| 5 Other hernia repair/ventral/umbilical | 423.5  | 1.7               | 3.5—3.7                           | 1.7—2.0                 |
| 6 Removal of tonsils and/or adenoids | 417.9   | 1.5               | 2.7—2.9                           | 1.2—1.5                 |
| 7 Peripheral nerve decompression | 354.5   | 0.7               | 1.2—1.3                           | 0.5—0.6                 |
| 8 Myringotomy/tympanostomy   | 319.7        | 0.6               | 1.0—1.1                           | 0.4—0.5                 |
| 9 Lumpectomy                 | 315.8        | 0.9               | 1.7—1.8                           | 0.8—1.0                 |
| 10 Laminectomy/discectomy    | 234.3        | 1.4               | 3.1—3.3                           | 1.7—1.9                 |
based on hospital discretion may allow departments to slowly resume procedures in a tiered fashion, with the more time-sensitive elective surgeries being performed first. A concern about placing the decision under the responsibility of hospital leadership who may be experiencing firsthand the financial ramifications of the pandemic is that they may place financial concerns over safety concerns. It is important to remember that the federal funds were designed to help hospitals respond to the financial concerns of fewer elective surgeries. Hospital leaders must remember to keep the safety of patients as their top priority as they weigh the risks and benefits of resuming elective procedures while ensuring the safety of patients.

Although Congress has already allocated $175 billion in relief funding to the healthcare system to help reduce net income losses, the exact impact this funding has on hospitals is not well elucidated because the funding has not been completely allocated. The findings of this study may be useful for federal and state agencies in further considerations to provide hospitals with additional measures to help offset these financial losses. Also, not all of the allocated dollars have been spent, and it is possible to change which hospitals receive the funding.

Some centers have needed to furlough employees and faculty, reduce salaries, decrease retirement funding, and limit benefits for workers, which may reduce financial losses. Alternatively, hospitals may incur greater costs in the future (owing to increased COVID testing, greater use of personal protective equipment, and decreased operating room efficiency during tiered procedure resumption) in order to return to normal business operations and may have decreased efficiency in the next few years owing to distancing measures and limited personal protective equipment. Other long-term costs which may arise include enhanced testing measures to keep patients safe for elective visits, improved cleaning and sterilization processes, and enhanced infection control standards.

There are several limitations of this study. Most important, the study does not examine the impact on surgeons. Second, we do not know how many elective surgeries were actually cancelled, and how long the cancellations will continue. Third, the NASS only includes data for outpatient surgery that takes place in hospital-owned facilities (including those within the hospital, attached to the hospital, or in a different geographic location than the hospital) and represents a true national estimate of this but does not include physician-owned facilities. However, our objective was to study the economic impact on the US hospital system and not on private practice; a separate study would be needed to examine privately owned outpatient surgery centers. Additionally, some hospitals are exempt from the CMS inpatient prospective payment system, but these tend to be smaller, rural hospitals, and our payer adjustment would take this into account. Using the NIS and NASS, we cannot determine losses incurred by hospitals owing to employees and infrastructure in the absence of surgery. Finally, this study estimates potential losses in the case that all elective procedures were cancelled, but the true number is likely lower than this.

The cost and revenue calculations are based on estimates. Cost estimates are reflective of the expenses for each case and represent hospital services such as wages, supplies, and utility costs. However, these costs do not include professional fees. Owing to variation across the United States based on physician-hospital contracts and other variables, we felt that estimates of professional fees would be difficult to assess and did not include these in the analysis. Our study utilizes CMS methodology for calculating reimbursement, but several estimations were necessary, including IME and DSH estimates. Mean IME and DSH estimates were stratified according to census region, hospital bed size, urban versus rural setting, and teaching status, because we cannot link data from CMS to specific hospitals in the NIS. Larger teaching hospitals have the highest IME and DSH adjustments, so calculating stratified mean estimates will decrease the adjustments for these larger and busier hospitals; however, we calculated national estimates, not estimates for specific hospitals, so this would not affect the results. Although the HCUP provides cost estimates, we cannot determine exactly how the costs are allocated within the hospital. The hospitals may be allocating fixed and indirect costs to elective surgeries or away from elective surgeries depending on how payment rates are set. This is known as cost allocation by accountants. It is critical to note that the data presented in this study are a summary of financial implications to the entire hospital system in the United States and do not provide information on specific hospital losses. Different hospitals may have variable income losses based on volume and type of elective procedures performed, hospital staffing, hospital financial reserves, and other factors specific to each hospital. Finally, we made adjustments based on the source of payment; these were determined based on published literature estimating the differences in Medicare and private insurance payments.

In conclusion, the COVID-19 pandemic and the subsequent cancellation of elective surgical procedures has led to substantial strain on hospitals. Elective procedures account for approximately $195.4 to $212.2 billion in revenue and $48.0 to $64.8 billion in net income per year to hospitals in the United States. Cancellation of elective procedures results in deficits of $163.3 to $178.8 billion per month in revenue and $4 to $5.4 billion per month in net income to the US hospital system. These findings may aid state and federal agencies in financial planning during and after the COVID-19 pandemic, and officials should consider these results when deciding how to allocate funds and resources to sustain hospital operations.

Conflict of interest/Disclosure

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