International Orthopaedics (2020) 44:2221–2228
https://doi.org/10.1007/s00264-020-04713-8

ORIGINAL PAPER

Economic implications of decreased elective orthopaedic and musculoskeletal surgery volume during the coronavirus disease 2019 pandemic

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Received: 7 June 2020 / Accepted: 6 July 2020 / Published online: 17 July 2020

Abstract

Purpose In order to reduce viral spread, elective surgery was cancelled in most US hospitals for an extended period during the COVID-19 pandemic. The purpose of this study was to estimate national hospital reimbursement and net income losses due to elective orthopaedic surgery cancellation during the COVID-19 pandemic.

Methods The National Inpatient Sample (NIS) and the Nationwide Ambulatory Surgery Sample (NASS) were used to identify all elective orthopaedic and musculoskeletal (MSK) surgery performed in the inpatient setting and in hospital owned outpatient surgery departments throughout the USA. Total cost, reimbursement, and net income were estimated for all elective orthopaedic surgery and were compared with elective operations from other specialties.

Results Elective MSK surgery accounted for $65.6–$71.1 billion in reimbursement and $15.6–$21.1 billion in net income per year to the US hospital system, equivalent to $5.5–$5.9 billion in reimbursement and $1.3–$1.8 billion in net income per month. When compared with elective surgery from all other specialties, elective MSK surgery accounted for 39% of hospital reimbursement and 35% of hospital net income. Compared with all hospital encounters for all specialties, elective MSK surgery accounted for 13% of reimbursement and 23% of net income. Estimated hospital losses from cancellation of elective MSK surgery during 8 weeks of the COVID-19 pandemic were $10.9–$11.9 billion in reimbursement and $2.6–3.5 billion in net income.

Conclusion Cancellation of elective MSK surgery for 8 weeks during the COVID-19 pandemic has substantial economic implications on the US hospital system.

Keywords COVID-19 · Orthopaedic surgery · Elective surgery cancellation · Economic impact

Introduction

To help limit viral exposure during the coronavirus disease 2019 (COVID-19) pandemic, the Centers for Medicare and Medicaid Services (CMS) recommended cancellation of elective surgery on March 13, 2020 [1]. New guidelines were released by the CMS on May 6, 2020, allowing for the gradual resumption of elective procedures based on hospital discretion [2]. This nearly eight week period with limited elective surgery volume has substantial financial implications which have caused reductions in hospital revenue and net income [3, 4]. To help offset these losses, Congress allocated $175 billion in funding to provide financial relief to the healthcare system, with roughly $207 million of this being allocated to orthopaedic practices [5].

Whether this amount is adequate to help cover losses from elective orthopaedic surgery is not known. Public financial reports often provide aggregate hospital costs but do not provide specific details on revenue or net income directly from elective orthopaedic surgery [6]. Several recent studies evaluating the financial implications on hospitals during the COVID-19 pandemic use data from the Healthcare Cost and Utilization Project (HCUP) for revenue predictions from decreased surgical volume [7–10]. However, the estimates referenced in these reports do not actually include any

Level of Evidence: III

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information on hospital revenue or profit, but rather only provide estimates of aggregate cost of inpatient procedures [9, 11]. This is because the HCUP does not collect information on revenue, only cost. Therefore, it is difficult to make accurate financial predictions of hospital revenue loss due to elective orthopaedic surgery cancellation using these reports.

The purpose of this study was to estimate the total cost, reimbursement, and net income of elective inpatient and outpatient orthopaedic and musculoskeletal surgery in the USA and to determine the likely economic impact of elective orthopaedic surgery cancellation on the US hospital system during the eight week period that was recommended by the CMS.

Materials and methods

Data source

The National Inpatient Sample (NIS), and the Nationwide Ambulatory Surgery Sample (NASS), Healthcare Cost and Utilization Project, data maintained by the Agency for Healthcare Research and Quality was used for this study. The NIS is the largest all-payer database for inpatient hospital admissions in the USA and includes diagnosis and procedure codes, length of hospital stay, source of payment, total hospital charges, and hospital characteristics such as teaching status for each hospital encounter [12]. The NIS redesigned its hospital sampling method starting in 2012 to improve the accuracy of national estimates using data from over 35 million hospitalizations [12].

The NASS is the largest all-payer outpatient database and the only national ambulatory surgery database in use today. It provides national estimates for major ambulatory surgery encounters performed in hospital-owned facilities [13]. The NASS includes demographic information, diagnosis and procedure codes, hospital charges, source of payment, and facility characteristics. We utilized the 2017 data year which is the most recent year available for the NIS and for the NASS.

Inpatient analysis

We selected all elective encounters in the NIS using the HCUP elective variable designation. Orthopaedic and MSK cases were selected based on International Classification of Diseases, Tenth Revision (ICD-10) procedure codes involving bones, joints, extremities, muscles, tendons, ligaments, peripheral nerves, and the spine. Further selection of specific orthopaedic and MSK surgeries was performed using specific ICD-10 procedure codes. We excluded cases of infection, tumour, fracture, and revision surgery based on Medicare Severity-Diagnosis Related Group (MS-DRG) codes.

Cost variable

We used cost-to-charge ratio files provided by HCUP which are collected from the Centers for Medicare & Medicaid Services (CMS) and are specific to each encounter in the NIS [14]. This provides a total cost amount for each case that indicates the actual expenses from hospital services, such as wages, supplies, and utility costs [14].

Reimbursement variable

We used the CMS system of payment for acute care hospital inpatient stays with adjustments for different rates of payment by different insurers. The CMS payment system is known as the inpatient prospective payment system (IPPS) and assigns payment based on the DRG code for each encounter [15]. CMS designated DRG payment weights were obtained from the CMS Final Rule tables [16]. In order to obtain a base reimbursement rate for each case, the DRG weights were multiplied by the sum of standardized labour-related share, which was adjusted by wage index, and non-labor share plus the capital amount. These values were all obtained from the CMS Final Rule tables [16, 17].

Additional payments for each case, known as the indirect medical education (IME) adjustment, are made to teaching hospitals and are based on the number of residents and beds in each hospital [18]. We obtained IME adjustment values of each teaching hospital from the CMS hospital cost report data [19]. We then calculated mean IME adjustment values stratified based on hospital census region, hospital setting, and bed size and matched these adjustments to cases performed at teaching hospitals in the NIS based on census region, hospital setting, and bed size as listed in the NIS. The CMS also adjusts payment for each case based on whether the hospital treats patients with low income, referred to as the disproportionate share hospital (DSH) adjustment [20]. We obtained DSH adjustment values from the CMS hospital cost report and calculated mean DSH adjustments stratified by hospital census region and hospital setting and matched these values to cases in the NIS based on hospital census region and hospital setting.

Finally, the CMS provides an outlier payment for cases with exceptionally high cost. Cases are eligible for outlier payments if the costs are greater than the sum of the adjusted payment plus a constant value set by CMS each year known as the fixed-loss cost threshold. The outlier payment is equal to 80% of the difference between the cost and the sum of the adjusted payment and the fixed-loss cost threshold [21].

Prior studies have shown that private insurance pays more and Medicaid pays less than Medicare [22–28]. We utilized data from these reports to adjust payment rates by insurer type to account for differences in payment rates by payer [22–28]. Based on these published reports, we created a conservative and upper estimate of payment for inpatient cases:

Conservative estimate: 1.0 Medicare; 0.8 Medicaid; 1.8 private insurance; 0.65 other, self-pay, missing, or no charge.
Upper estimate: 1.0 Medicare; 1.0 Medicaid; 2.0 private insurance; 1.0 other, self-pay, missing, or no charge.

Outpatient analysis

Cost variable

Cost for each outpatient case in the NASS was calculated based on the hospital outpatient prospective payment system (HOPPS) designed by the CMS. Mean cost values for each Current Procedural Terminology (CPT) code were obtained from the HOPPS Final Rule cost statistic tables [29]. The CMS calculates these values to represent the average total cost for that type of case for all hospitals along with bundled services [29]. When more than one CPT code is entered for a single surgery, then the code with the highest cost is used to determine the total cost for the case. In the Medicare payment system, subsequent codes do not add to the total case cost.

Reimbursement variable

Reimbursement was calculated for each outpatient case using the CMS payment system. Total payment amounts and minimum copayment amounts for each CPT code were obtained from the HOPPS Final Rule cost statistical and addenda tables for each year. The CMS also provides a status indicator for each CPT code, which is used to determine total payment calculation [30]. When more than one CPT code is entered for a single procedure, the status indicator dictates the exact payment algorithm. If the status indicator of any CPT code is J1, then the case receives a bundled payment and additional CPT codes to do not affect payment. Payments for over 92% of cases in the NASS were bundled based on the CMS method. Non-bundled cases receive full payment for the primary procedural code, followed by 50% payment for subsequent codes in accordance with CMS rates.

Payments were adjusted by payer status based on published reports comparing outpatient payments from Medicare, Medicaid, and private insurance [22–28]. Using a conservative and upper estimate, the final reimbursement adjustment values for outpatient cases were:

Conservative estimate: 1.0 Medicare; 0.8 Medicaid; 2.5 private insurance; 0.65 other, self-pay, missing, or no charge.
Upper estimate: 1.0 Medicare; 1.0 Medicaid; 2.65 private insurance; 1.0 other, self-pay, missing, or no charge.

Statistical analysis

Aggregate sum was calculated for cost, reimbursement, and net income. The most commonly performed inpatient and outpatient elective orthopaedic surgery was determined by ICD-10 procedure codes and CPT codes respectively. 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 Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.).

This study was exempt from institutional board review.

Results

There were over 4.8 million elective orthopaedic MSK surgical procedures analyzed from the year of 2017; 2.3 million of which were inpatient and 2.5 million of which were outpatient. The total aggregate cost of annual elective inpatient and outpatient orthopaedic and MSK surgery was $49.9 billion while the total aggregate reimbursement was

Table 1 Annual and monthly hospital total charges, reimbursement, cost, and net income for all elective orthopedic and musculoskeletal surgery in the USA in billions, US dollars ($). Inpatient $N = 2.3$ million surgeries; outpatient $N = 2.5$ million surgeries; inpatient and outpatient $N = 4.8$ million procedures

	Per year Billion ($)	Per month Billion ($)
Inpatient		
Total charges	152.7	12.7
Total reimbursement*	44.8–48.8	3.7–4.1
Total cost	39.2	3.3
Net income*	5.5–9.4	0.5–0.8
Outpatient		
Total charges	53.1	4.4
Total reimbursement*	20.7–22.4	1.7–1.9
Total cost	10.7	0.9
Net income*	10.1–11.7	0.8–1.0
Inpatient and outpatient		
Total charges	205.7	17.1
Total reimbursement*	65.6–71.1	5.5–5.9
Total cost	49.9	4.2
Net income*	15.6–21.1	1.3–1.8

Net income = total reimbursement – total cost; outpatient = hospital-owned outpatient surgery centers

*Ranges provided for total reimbursement and net income are calculated using hospital payments adjusted by payer status using a conservative estimate and an upper estimate

$65.6–$71.1 billion, resulting in a net income of $15.6–$21.1 billion. This was equivalent to $5.5–$5.9 billion in monthly reimbursement and $1.3–$1.8 billion in monthly net income to the US hospital system (Table 1). Approximately 45% of inpatient elective orthopaedic and MSK procedures were paid for by Medicare while 40% were paid for through private insurance (Table 2). Overall, 36.9% of elective inpatient and outpatient orthopaedic and MSK operations were paid for by Medicare while 49.3% were paid for by private insurance (Table 2).

Compared with elective surgery in specialties other than orthopaedic MSK, elective orthopedic and MSK surgery accounted for 39% of hospital reimbursement and 35% of hospital net income (Fig. 1). When compared with all hospital encounters (inpatient and outpatient, elective and non-elective, surgical and non-operative), elective orthopaedic and MSK surgery accounted for 13% of total hospital reimbursement and 23% of total hospital net income (Fig. 2).

The most common inpatient elective orthopaedic surgeries were total knee arthroplasty ($N = 718,344$), total hip arthroplasty ($N = 401,905$), posterior lumbar fusion ($N = 197,740$), total shoulder arthroplasty ($N = 96,355$), and anterior cervical discectomy and fusion (ACDF, $N = 83,540$) Table 3. The most common outpatient elective orthopaedic procedures were knee arthroscopy ($N = 493,273$), shoulder arthroscopy ($N = 276,754$), carpal tunnel release ($N = 248,478$), rotator cuff repair ($N = 219,074$), and hardware/implant removal ($N = 169,379$) Table 3.

Discussion

Elective orthopaedic and MSK surgery accounts for approximately $65.6–$71.1 billion in hospital reimbursement and approximately $15.6–$21.1 billion in hospital net income per year in the USA, equivalent to $5.5–$5.9 billion in monthly reimbursement and $1.3–$1.8 billion in monthly net income to the US hospital system. Compared with elective surgery in specialties other than orthopaedic MSK, elective orthopaedic and MSK surgery accounted for 39% of hospital reimbursement and 35% of hospital net income. Compared with all hospital encounters, elective MSK surgery accounted for 13% of all hospital reimbursement and 23% of all hospital net income.

To our knowledge, this is the first study to show a national estimate of cost, reimbursement, and net income specifically from elective orthopaedic surgery in the USA. The results of this study show that during the eight weeks of elective surgery cancellation as recommended by the CMS, estimated losses to the US hospital system from cancellation of elective orthopaedic and MSK surgery alone were $10.9–$11.9 billion in reimbursement and $2.6–3.5 billion in net income. These findings suggest that decreased volume of elective orthopaedic and MSK surgery during the COVID-19 pandemic is a main contributor leading to loss of hospital revenue and net income [33, 34].

The results of this study expand on prior national estimates in several ways. Compared with prior data [8, 9, 35] which only estimated inpatient hospital costs, we utilized the most recent national data to show reimbursement and net income for elective orthopaedic surgery, which is critical for the current economic crisis. In contrast to prior reports, we performed these estimates for both inpatient and outpatient surgery [9–11]. Additionally, we extrapolated these results over the course of the time period of elective surgery cancellation. The results of this study are important since we demonstrate that revenue and net income from elective orthopaedic surgery are a large contributor not only compared with elective surgery from other specialties but also compared with all hospital encounters.

The findings of this study can be used for financial planning and decision-making during and following the COVID-19 pandemic. Through the Coronavirus Aid, Relief, and Economic Security (CARES) Act, and the Paycheck Protection Program and Health Care Enhancement Act, Congress allocated $175 billion in funding to provide financial relief to the healthcare system, with over $207 million of this provided to orthopaedic practices across the USA [5]. However, all of this funding has not yet been spent and there are still options to adjust the specific amounts and change which hospitals receive it. It may be reasonable to allocate available funding based on the amount of elective surgery hospitals perform since this is the main reason for the loss in revenue. Given the results of this study, it also may be reasonable to consider orthopaedic surgery volume when allocating funding, as we have shown that these procedures provide over one-third of hospital revenue and net income from all elective

Table 2 Percentage of annual elective orthopedic and musculoskeletal surgery volume by most common payer type and surgery setting

	Medicare	Private insurance	Medicaid
Inpatient surgery (%)	45.0	40.0	9.7
Outpatient surgery (%)	29.5	57.9	15.0
Inpatient and outpatient surgery (%)	36.9	49.3	12.5

Percentages may not add to 100% as cases with self-pay, other insurance, or no-charge payment status comprise less than 5% of all cases and are not listed here

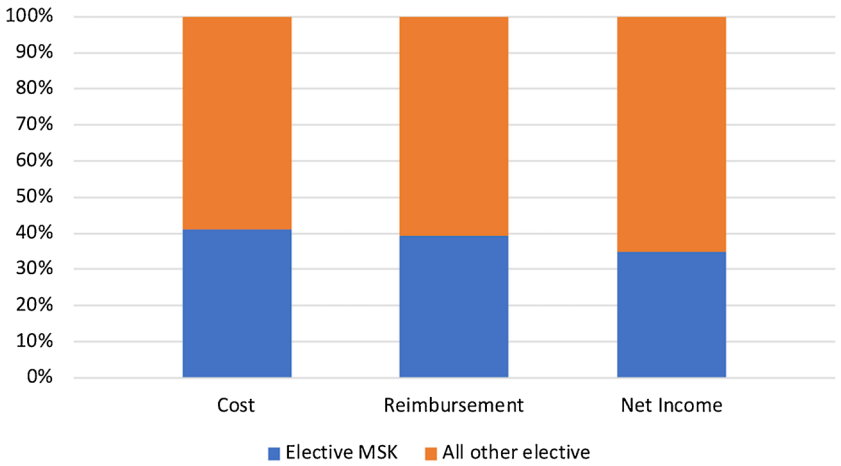

Fig. 1 Percentages of national hospital aggregate cost, reimbursement, and net income per year comparing elective orthopedic and musculoskeletal surgery to elective surgery in all other specialties in the USA. Elective MSK, elective orthopaedic and musculoskeletal surgery

surgery. Government officials should consider these results when deciding how to allocate current available funding and if any additional funding is necessary.

Following the COVID-19 pandemic, knowledge of the financial data for various orthopaedic procedures presented in this analysis can aid in future economic and decision-making models. Hospitals may continue to accumulate financial losses while attempting to return to normal business operations and may not achieve pre-pandemic surgical volume for months after resuming elective surgery and the results of our study can aid in these predictions as well. Hospitals have already implemented methods to reduce spending through employee layoffs, reduced salaries, and limited benefits for workers to decrease financial losses [36]. During the period of recovery, how hospitals allocate resources such as supplies or operating room availability to various specialties can be arranged in order to optimize productivity in cases of equal acuity disease or injury. The results of this study can aid in this kind of hospital planning and resource allocation.

Our study has several limitations including that we examined the financial implications on hospitals but not on individual surgeons or physicians. Furthermore, the NASS only includes data for outpatient surgery that takes place in hospital-owned facilities. However, the goal of this study was to analyze the impact on the US hospital system, and therefore, data from privately owned surgery centres would not change our results. Our study assumes that all elective surgery was cancelled. However, some centres may have continued some elective procedures in a more limited capacity. To calculate reimbursement, we used the CMS method of hospital payment but still required estimates for IME and DSH adjustments which were stratified according census region, hospital teaching status, bed size, and setting. However, we calculated national estimates, not estimates for specific hospitals so this would not affect our findings. Also, we cannot determine how hospitals are allocating costs but that is not the purpose of this study. Finally, we made adjustments for payment source but these were based on published literature estimating the differences in Medicare and private insurance payments [22–28].

This study demonstrates that elective orthopaedic and MSK surgery accounts for approximately $65.6–$71.1 billion in reimbursement and $15.6–$21.1 billion in annual net income to the US hospital system. Elective orthopaedic and MSK surgery makes up a large portion of hospital

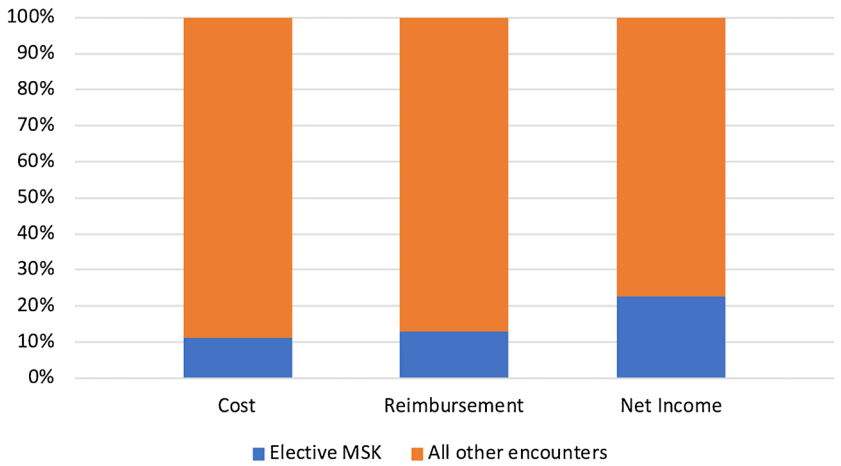

Fig. 2 Percentages of national hospital aggregate cost, reimbursement, and net income per year comparing elective orthopaedic and musculoskeletal surgery to all other encounters (elective and non-elective, inpatient and outpatient, surgical and non-operative) in the USA. Elective MSK, elective orthopaedic and musculoskeletal surgery

Table 3 Aggregate national hospital reimbursement, cost, and net income of the most common elective inpatient and outpatient orthopaedic and musculoskeletal surgery performed annually in the USA based on surgery setting

	Description	*N* (thousand)	Reimbursement* (billion, $)	Cost (billion, $)	Net income* (billion, $)
Inpatient					
1	Primary total knee arthroplasty	718.4	12.8–13.7	11.4	1.4–2.3
2	Primary total hip arthroplasty	402.0	7.4–7.9	6.6	0.8–1.3
3	Posterior lumbar fusion	197.8	8.2–9.0	6.6	1.7–2.4
4	Total shoulder arthroplasty	96.4	1.8–1.9	1.8	0–0.1
5	ACDF	83.5	2.1–2.4	1.7	0.5–0.7
6	Lumbar decompression (no fusion)	57.6	1.0–1.1	0.9	0.1–0.2
7	Lumbar discectomy (no fusion)	26.7	0.6–0.7	0.5	0.1–0.2
Outpatient					
1	Knee arthroscopy (without ACLR)	493.3	3.2–3.4	1.5	1.7–1.9
2	Shoulder arthroscopy (without RCR)	276.8	2.5–2.7	1.4	1.1–1.3
3	Carpal tunnel release	248.5	0.81–0.88	0.43	0.39–0.45
4	Rotator cuff repair (RCR)	219.1	2.2–2.4	1.3	0.97–1.15
5	Removal of implant/hardware	169.4	0.89–0.97	0.46	0.43–0.51
6	Lumbar discectomy (no fusion)	121.8	1.4–1.5	0.57	0.83–0.93
7	Trigger finger release	106.0	0.28–0.29	0.15	0.13–0.14
8	ACL reconstruction (ACLR)	87.6	1.1–1.2	0.6	0.49–0.59
9	Lumbar decompression (no fusion)	76.7	0.75–0.79	0.39	0.36–0.40
10	ACDF	59.1	1.24–1.33	0.66	0.58–0.67

N, number of procedures performed annually in thousands; net income = reimbursement – cost; outpatient, hospital-owned outpatient surgery centers; *ACDF*, anterior cervical discectomy and fusion; *ACL*, anterior cruciate ligament; *ACLR*, anterior cruciate ligament reconstruction; *RCR*, rotator cuff repair

*Ranges provided for total reimbursement and net income are calculated using hospital payments adjusted by payer status using a conservative estimate and an upper estimate

reimbursement and net income when compared with elective surgery in other specialties and compared with all hospital encounters. Cancellation of elective orthopaedic and MSK surgery during the time period recommended by the CMS resulted in losses $10.9–$11.9 billion in reimbursement and $2.6–3.5 billion in net income to the US hospital system. These findings are important for financial planning and decision-making during and after the COVID-19 pandemic.

Authors' contributions Initial manuscript draft: MB
Manuscript composition and editing: MB, KA, EM, GA, US
Critical review of data: MB, KA, EM, GA, US
Manuscript revision and final approval: MB, KA, EM, GA, US
Supervision: EM, GA, US
Data acquisition: MB, US

Data availability HCUP National Inpatient Sample (www.hcup-us.ahrq.gov/nisoverview.jsp) and Nationwide Ambulatory Surgery Sample (https://hcup-us.ahrq.gov/nassoverview.jsp)

Compliance with ethical standards

This study was exempt from institutional review board approval.

Conflict of interest The authors declare that they have no conflicts of interest.

Code availability NIS and NASS clinical classification software

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