

Research Article

Industry Payments to Teaching Hospitals for Orthopaedic Medical Devices: An Analysis from 2016 to 2021

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Background

The U.S. Centers for Medicaid & Medicare Services (CMS) reports payments from industry companies to physicians and teaching hospitals through the Open Payments

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As a fellow in sports medicine and shoulder surgery at Massachusetts General Hospital, Dr. Cohn served as an assistant team physician for the New England Patriots, Boston Red Sox, Boston Bruins, New England Revolution, and numerous colleges and high schools, gaining experience in treating athletes at all levels. Currently, Dr. Cohn is the team orthopaedic surgeon for Hofstra University and several Long Island high schools. He also serves as the director of Northwell Health's Dance Medicine and Performing Arts Program, Young Adult Hip Preservation Program, and as the medical director of the Hofstra University Athletic Training Program.

Dr. Cohn's academic titles include Associate Professor of Orthopaedic Surgery at the Zucker School of Medicine and the Program Director of the Northwell Health Huntington Hospital Orthopaedic Residency Program. Dr. Cohn's research interests include clinical outcomes of sports medicine procedures including arthroscopic surgery and ligament reconstruction. He has published in numerous peer-reviewed orthopaedic journals on topics including shoulder instability, shoulder injuries in throwing athletes, groin injuries, hip arthroscopy, patella (knee cap) dislocation, anterior cruciate ligament and meniscus tears, knee replacement surgery, and sideline management of athletic injuries.

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database. We explore the relationship between industry and teaching hospitals regarding industry payments for orthopaedic medical devices.

Objective

To explore changes in orthopaedic surgery research payments to teaching hospitals by analyzing CMS Open Payments data.

Methods

Orthopaedic surgery payments between 2016 and 2021 were analyzed using the CMS Open Payments database. Teaching hospitals were identified from the database as a covered payment recipient and the hospital name was recorded. Payment amount, industry company name, device category, and the name, state, and geographical region of the teaching hospital were recorded for each payment.

Results

There were 1,270 payments recorded to 90 teaching hospitals. The median payment value has no trend ($R=0.014$; $p=0.618$). The largest number of payments were made to UH Cleveland Medical Center (Cleveland, OH) (12.0%), followed by Charleston Area Medical Center (Charleston, WV) (6.6%) and Mary Hitchcock Memorial Hospital (Lebanon, NH) (6.3%). Vertos Medical (21.5%) and Medical Device Business Services (21.3%) made the most industry payments to teaching hospitals. Industry payments were primarily made towards devices utilized for the lower extremity (64.3%) and spine (29.3%). Lower extremity devices had a median payment value of \$1,393.75, while devices used for the spine had a median payment value of \$800.00 ($p<0.001$).

Conclusion

There is no apparent trend in the annual median payment to teaching hospitals from orthopaedic medical device companies.

INTRODUCTION

The Physician Payments Sunshine Act (PPSA) was included in the Affordable Care Act of 2010 to increase transparency between industry, physicians, and teaching hospitals (Agrawal, Brennan, and Budetti 2013). This legislation requires payments in excess of \$10 to be reported in the Centers for Medicare and Medicaid Services (CMS) Open Payments Database. This process requires reporting entities, such as manufacturers or group purchasing organizations, to report their payment data to the CMS. After submission, physicians and hospitals can dispute the presented data within forty-five days before integration into the database. Since this data is publicly available, the database allows for increased transparency between industry and physicians.

Industry-surgeon relationships are prevalent within orthopaedic surgery, as nearly half of orthopaedic surgeons identify as having an industry relationship (Cvetanovich, Chalmers, and Bach 2015). Often, the industry-surgeon relationship focuses on the use of medical devices. Orthopaedic surgeons frequently employ the use of medical devices in their practice and are essential in guiding the development of novel technologies for improved patient care. Orthopaedic surgeons hold the largest proportion of medical device patents and have the highest per-physician general payment values from industry companies among all medical specialties (Iyer, Derman, and Sandhu 2016; Tringale et al. 2017). This relationship has been further characterized within orthopaedic surgery subspecialties, with previous analyses demonstrating an increased annual payment value and number of payments to adult recon-

struction, sports medicine, and trauma physicians (White et al. 2021; Partan et al. 2021; Frane et al. 2021).

While industry payments received by teaching hospitals have been described, previous reviews of these payments did not evaluate them in relation to orthopaedic surgery (Pope and Sehgal 2023; Anderson, Gellad, and Good 2020). In 2018, 27,613 non-research payments for medical devices were made to teaching hospitals, while the total value of these transactions was nearly \$143 million (Anderson, Gellad, and Good 2020). Royalty and license payments made up a large portion (46%) of these medical device payments. The strongest predictors of receiving industry payments for teaching hospitals include being listed in the *U.S. News & World Report* Best Hospitals Honor Roll, having greater than five hundred hospital beds, and having an affiliation with a major medical school (Anderson, Gellad, and Good 2020; Anderson et al. 2014; Lalani et al. 2018; “U.S. News Best Hospitals” 2023). Numerous hospitals in the CMS database are listed in the *U.S. News & World Report*, including Hospital for Special Surgery (“U.S. News Best Hospitals” 2023).

This study attempts to answer the following questions regarding payments for orthopaedic medical devices at teaching hospitals: (1) How has the annual payment value and the number of payments made to teaching hospitals changed in recent years?; (2) Has there been consistency in the teaching hospitals receiving the largest number of payments and the greatest median payment value annually?; (3) Which orthopaedic device companies report the most payments?; (4) What are the orthopaedic devices with the largest number of payments? This study was performed to assess the role of teaching hospitals in the physician-industry relationship for orthopaedic surgeons.

METHODS

A cross-sectional review was performed using the CMS Open Payments Database to identify research payments from industry companies to teaching hospitals between 2016 and 2021 (Centers for Medicare & Medicaid Services 2014). Research payments in the CMS database are reported monetary payments (\$USD) by industry companies for medical devices used in orthopaedic research. Payment values for devices vary and are dependent on market value, predetermined rates, or company policies. The CMS research payment database was searched and stratified to identify payments to teaching hospitals. Teaching hospitals were identified in the database as covered recipients of payments. According to CMS hospitals are considered a “teaching hospital” if they submitted an open payment for Medicare direct graduate medical education, IPPS indirect medical education (IME), or psychiatric hospital IME programs (“Open Payments Program Participants | CMS” 2023). The teaching hospital name, payment amount, industry company name, and device name were recorded for each payment. Each teaching hospital is an academic medical center. A payment was excluded ($n=7,973$) if all of the above variables were not provided for a particular payment. Each teaching hospital’s regional and state information was collected and categorized according to the U.S. census guidelines into Northeast, South, Midwest, and West regions (U.S. Census Bureau 2015). The authors categorized the devices into lower extremity, upper extremity, spine, biological, and miscellaneous. Devices with biological modifications were categorized as biological, and devices that fit into more than one category (i.e. upper extremity and lower extremity), or did not fit into any category, were placed into a miscellaneous category. Two authors independently searched the product names utilizing the Google search engine (Alphabet, Menlo Park, CA) to identify the product before categorization. A third author was queried to resolve any disputes in categorization. There was a total of 1,270 individual payments to academic medical centers included in our analysis.

Statistical analysis was performed with SPSS 28 (IBM, Armonk, NY). The analysis of payment data (\$USD) with the Shapiro-Wilk test showed a non-normal distribution ($p<0.001$). Therefore, non-parametric analysis was performed with the Mann-Whitney U test to compare median payment values between years. A Kruskal-Wallis H Test was used to compare differences in medians between teaching hospitals, industry companies, regions, and device categories. Descriptive statistics are provided as median payment values with the 25th and 75th percentiles. A Pearson correlation was used to determine the R value between payment value and year. A p-value less than 0.05 was utilized to demonstrate statistical significance. This investigation is exempt from IRB approval.

RESULTS

ANNUAL PAYMENTS

Between 2016 and 2021, 1,270 payments for a total of \$7,791,084.64 was paid to teaching hospitals. In 2019, 315 payments were made to 42 teaching hospitals. The lowest median payment value (\$900.00) was seen in 2019 ($p<0.001$) and 2020 ($p=0.004$). No trend was observed with the annual median payment value ($R=0.014$; $p=0.618$) (Table 1). In regard to the states the teaching hospitals are located in, Ohio received the greatest number of payments (300), while Wisconsin and Arkansas each only received a single payment.

TEACHING HOSPITALS

The hospitals most commonly receiving annual payments for orthopaedic devices included Emory University Hospital (Atlanta, GA) (2016–2018), Mary Hitchcock Memorial Hospital (Lebanon, NH) (2019–2021), Medical University of South Carolina (Charleston, SC) (2018, 2020–2021), and Lutheran Hospital (Cleveland, OH) (2016–2017) (Table 2). Mary Hitchcock Memorial Hospital (Lebanon, NH) received 80 (6.3%) payments, while Emory University Hospital (Atlanta, GA), Medical University of South Carolina (Charleston, SC), and Lutheran Hospital (Cleveland, OH) received 64 (5.0%), 57 (4.5%), and 44 (3.5%) payments, respectively. Between 2016 and 2021, UH Cleveland Medical Center (Cleveland, OH) had the greatest number of payments (152; 12.0%) with a median payment value of \$900.00. The Medical University of South Carolina (Charleston, SC) had the largest median payment value of \$17,114.50 ($p<0.001$) (Table 3).

INDUSTRY COMPANIES AND ORTHOPAEDIC DEVICES

Vertos Medical reported the largest number of payments (273; 21.5%) between 2016 and 2021, with a median payment value of \$700.00. Exactech had the greatest median payment value, \$16,204.80 ($p<0.001$), but only 107 (8.4%) separate payments. Medical Device Business Services, a subsidiary of DePuy Synthes, had 270 (21.3%) payments with a median payment of \$1,308.00. (Table 4). Devices for the lower extremity had the most payments compared to other categories (817; 64.3%). There were 372 (29.3%) separate payments for devices used in spine. The greatest median payment value was \$13,550.00 for miscellaneous devices, followed by \$11,425.00 for upper extremity devices. Spine devices had the lowest median payment value, \$800.00 ($p<0.001$) (Table 5).

DISCUSSION

This study examined the relationship between teaching hospitals and industry payments for orthopaedic medical devices. There was a no discernable trend in the annual median payment value, however annual payments appeared to vary from 2016 to 2021. The lowest number of annual pay-

Table 1. Annual median payment value to teaching hospitals

Year	Hospitals, n	Payments, n (%)	Median Payment	Percentile (25 th)	Percentile (75 th)	P-value ^{a,b}	R ^c
2016	37	173 (13.6)	2,093.00	459.00	20,100.00	-	0.014
2017	40	232 (18.3)	1,315.63	459.00	25,000.00	0.039	
2018	41	206 (16.2)	1,917.08	918.00	39,917.00	0.878	
2019	42	315 (24.8)	900.00	560.00	19,913.00	<0.001	
2020	42	236 (18.6)	900.00	540.00	33,968.00	0.004	
2021	28	108 (8.5)	2,322.00	1,102.50	47,753.00	0.314	

^a Mann-Whitney U compared with 2016^b 2016 is used as the reference year^c Pearson Correlation P-value is equal to 0.618

ments (108; 8.5%) were made in 2021. Due to the COVID-19 pandemic, elective surgeries were canceled beginning in March 2020 and resumed mid-year with limitations of surgical scheduling due to hospital policies and infection control (Krauss et al. 2022). As many orthopaedic procedures are elective, fewer industry payments may have been a result of these cancellations (Piuzzi et al. 2019; White et al. 2020).

The most frequent teaching hospitals receiving payments were Emory University Hospital (Atlanta, GA), Mary Hitchcock Memorial Hospital (Lebanon, NH), Medical University of South Carolina (Charleston, SC), and Lutheran Hospital (Cleveland, OH). The Hospital for Special Surgery (New York, NY) was among the top 10 hospitals receiving payments. UH Cleveland Medical Center (Cleveland, OH) had the largest number of payments. These hospitals are considered high performing and are regionally ranked by *U.S. News Hospital Rankings and Ratings* (Clement et al. 2022). A study by Sehgal indicated that reputable hospitals are more likely to have a higher rank in the *U.S. News & World Report* (Sehgal 2010). This dilutes the objective measure of the rankings by emphasizing reputation. Cua et al. reported similar findings of reputation having a greater influence than objective measures in these hospital rankings (Cua, Moffatt-Bruce, and White 2017). Therefore, there is a possibility that hospital reputation may have an impact on the number of industry payments and the median payment value to teaching hospitals.

The top orthopaedic industry companies reporting payments include Vertos Medical (21.5%), Medical Device Business Services (21.5%), and OrthoSensor (19.3%). However, Exactech reported the greatest median payment value of \$16,204.80, followed by 4WEB with a median payment value of \$10,000. Vertos Medical develops medical devices for minimally invasive treatments for lumbar spine surgery (Deer 2010). Medical Device Business Services, formerly known as DePuy Orthopaedics, provides various orthopaedic medical devices (Piuzzi et al. 2019). Exactech focuses on orthopaedic implants for joint replacement while OrthoSensor provides sensor-based technology for joint replacement surgery (Clement et al. 2022). 4WEB provides truss implant systems (Corr et al. 2020). As these companies produce many devices for lower extremity and spine, it

is likely they play a role in the large number of payments made for these two categories

Tanenbaum et al. observed a staggering 232% increase in 510(k) clearances (FDA approval for device marketing) for devices used in spine surgery from 2000 to 2019. Increases in 510(k) clearances were also noted for foot and ankle, knee, and shoulder arthroplasty devices. However, there was a 36% in clearances for hip arthroplasty devices (Tanenbaum et al. 2022). This is consistent with the expanding spine surgery market and the arthroplasty market's downward price pressure (Sheikh et al. 2020). This review reported 817 payments made for lower extremity devices, compared to 372 payments for spine devices. While spine devices had the second largest number of payments, it had the lowest median payment value (\$800.00). The large number of payments for spine and lower limb devices reflects an increase in the number of spinal fusions and lower extremity arthroplasty over the past two decades. Previous research has reported a 118% increase in spinal fusions from 1998 to 2014, while there was an 81% increase in hip and knee procedures within the same timeframe (Sheikh et al. 2020; Rajaei et al. 2012). Despite the increase in hip and knee procedures, Medicare reimbursements for these procedures have decreased since 2000 (Eltorai et al. 2018).

McDermott and Liang detailed the major ambulatory surgeries performed in 2019 at hospital-owned facilities. The authors reported that 22% of all major surgeries were related to musculoskeletal interventions. Additionally, nearly 90% of ambulatory surgeries were conducted in urban areas (McDermott and Liang, n.d.). According to Anderson et al., hospitals in the Midwest were less likely to receive industry payments compared to other regions (Anderson, Gellad, and Good 2020). Interestingly, in this review, three of the top 10 hospitals receiving payments are in the Midwest compared to four hospitals in the South.

Inadequate reporting by industry companies and associated payment confirmation by physicians places the quality of Open Payments records within question. A prior review by the Department of Health and Human Services identified 11,463 (0.1%) records missing at least one data element, with subsequent incorrect records of at least 100,000 in the Open Payments database out of 11,901,001 records (Murrin and Deputy Inspector General 2018). This can lead to in-

Table 2. Median payments made to the top five teaching hospitals from 2016 to 2021

Year	Teaching Hospital	Region	State	Payments, n (%)	Median Payment	Percentile (25 th)	Percentile (75 th)	P-value ^a
2016	Emory University Hospital	South	Georgia	20 (11.6)	459.00	459.00	2,273.50	<0.001
	Lutheran Hospital	Midwest	Ohio	16 (9.2)	459.00	459.00	13,770.00	
	The Rehab. Institute of Chicago	Midwest	Illinois	15 (8.7)	8,333.00	8,333.00	8,3334.00	
	UCSD Medical Center	West	California	13 (7.5)	10,000.00	10,000.00	45,000.00	
	Mayo Clinic Hospital Rochester	Midwest	Minnesota	13 (7.5)	610.00	250.00	23,495.00	
2017	Lutheran Hospital	Midwest	Ohio	25 (10.8)	459.00	459.00	1,836.00	.566
	Emory University Hospital	South	Georgia	25 (10.8)	780.00	459.00	2,639.00	
	Cleveland Clinic Hospital	Midwest	Ohio	21 (9.1)	459.00	459.00	9,308.00	
	CCF Hospital-Weston	South	Florida	21 (9.1)	459.00	459.00	6,600.00	
	Sinai Hospital of Baltimore Inc.	South	Maryland	17 (7.3)	459.00	459.00	6,600.00	
2018	St. Vincent Charity Medical Center	Midwest	Ohio	19 (9.2)	247.34	25.00	17,027.93	<0.001
	Medical University of South Carolina	South	South Carolina	14 (6.8)	25,987.50	3,375.00	128,250.00	
	Emory University Hospital	South	Georgia	14 (6.8)	905.88	459.00	6,600.00	
	Cleveland Clinic Hospital	Midwest	Ohio	13 (6.3)	1,901.90	1,300.00	55,460.10	
	Hospital for Special Surgery	Northeast	New York	12 (5.8)	5,989.00	125.00	22,623.00	
2019	UH Cleveland Medical Center	Midwest	Ohio	103 (32.7)	900.00	700.00	6,359.00	<0.001
	Charleston Area Medical Center Inc.	South	West Virginia	49 (15.6)	400.00	50.00	5,051.00	
	Hospital of the University of Pennsylvania	Northeast	Pennsylvania	19 (6.0)	2,150.00	1,000.00	39,015.00	

	Mary Hitchcock Memorial Hospital	Northeast	New Hampshire	16 (5.1)	1,180.09	723.00	4,172.00	
	Boston Medical Center	Northeast	Massachusetts	13 (4.1)	1,911.00	877.50	16,465.00	
2020	UH Cleveland Medical Center	Midwest	Ohio	49 (20.8)	900.00	700.00	6,359.00	<0.001
	Charleston Area Medical Center Inc.	South	West Virginia	35 (14.8)	500.00	400.00	5,051.00	
	Mary Hitchcock Memorial Hospital	Northeast	New Hampshire	26 (11.0)	502.50	100.00	4,275.00	
	University of Kansas Hospital	Midwest	Kansas	12 (5.1)	500.00	450.00	8,789.41	
	Medical University of South Carolina	South	South Carolina	9 (3.8)	6,526.00	4,264.00	65,325.00	
2021	Mary Hitchcock Memorial Hospital	Northeast	New Hampshire	22 (20.4)	1,220.00	50.00	5,200.00	<0.001
	Medical University of South Carolina	South	South Carolina	18 (16.7)	13,969.75	5,175.00	51,575.00	
	Hospital for Special Surgery	Northeast	New York	5 (4.6)	1,388.00	1,125.00	3,250.00	
	Hospital of the University of Pennsylvania	Northeast	Pennsylvania	5 (4.6)	1,388.00	1,125.00	3,250.00	
	New England Baptist Hospital	Northeast	Massachusetts	5 (4.6)	537.50	750.00	1,500.00	

^a Kruskal-Wallis H Test

accurate results due to incorrect data entry. Another factor with incorrect data entry is that physicians are not required to review payments before submission, leading to possible discrepancies in the industry payment value (Cvetanovich, Chalmers, and Bach 2015; Murrin and Deputy Inspector General 2018; Buerba et al. 2018). As such, incorrect data entry leads to an inaccurate illusion of transparency. This can potentially lead to inaccurate analysis and misrepresentation of payments from hospitals and physicians. Additionally, CMS reporting for devices is lenient as manufacturers may report the device's therapeutic area rather than function. Approximately 6% of devices in the Open Payments database included only the anatomical location for which the device was utilized. Interestingly, "hip", "knees", and "spine", totaled \$153 million in payments in the Open Payments database. However, in this study, spine and lower

extremity devices were found to have the greatest number of payments. Discrepancies in reported payments may influence the results of this study as missing, unverified, or incorrect payments can influence trends. Additionally, conflicts of interest may arise in the database due to unrestricted grants provided by several companies to teaching hospitals for fellowship or residency activities.

This study has several limitations. As our primary endpoint was the differences in orthopaedic device payments to teaching hospitals, the payments made to orthopaedic surgeons were not stratified by subspecialty. Previous work had detailed industry payments to general orthopedists and subspecialists in pediatrics, spine, foot and ankle, sports medicine, and adult reconstruction (White et al. 2021; Partan et al. 2021; Chen et al. 2021; Pathak et al. 2019, 2021, 2020). While teaching hospitals were stratified by geo-

Table 3. Top 10 teaching hospitals from 2016 to 2021

Teaching Hospital	Region	State	Payments, n (%)	Median Payment	Percentile (25 th)	Percentile (75 th)	P-value ^{a,b}
UH Cleveland Medical Center	Midwest	Ohio	152 (12.0)	900.00	700.00	6,359.00	<0.001
Charleston Area Medical Center Inc.	South	West Virginia	84 (6.6)	500.00	250.00	5,051.00	
Mary Hitchcock Memorial Hospital	New England	New Hampshire	80 (6.3)	1,349.00	260.00	10,600.00	
Emory University Hospital	South	Georgia	64 (5.0)	712.50	459.00	2,639.00	
Medical University of South Carolina	South	South Carolina	57 (4.5)	17,114.50	5,775.00	86,125.00	
Cleveland Clinic Hospital	Midwest	Ohio	52 (4.1)	1,099.50	459.00	25,494.50	
Hospital of the University of Pennsylvania	Middle Atlantic	Pennsylvania	50 (3.9)	2,387.50	1,000.00	13,700.00	
Lutheran Hospital	Midwest	Ohio	44 (3.5)	459.00	459.00	6,600.00	
CCF Hospital-Weston	South	Florida	41 (3.2)	459.00	459.00	6,600.00	
Hospital for Special Surgery	Middle Atlantic	New York	35 (2.8)	17,808.00	1,800.00	22,623.00	

^a Kruskal-Wallis H Test**Table 4. Top 10 industry companies reporting payments**

Company	Payments, n (%)	Median Payment	Percentile (25 th)	Percentile (75 th)	P-value ^a
Vertos Medical	273 (21.5)	700.00	500.00	6,359.00	<0.001
Medical Device Business Services	270 (21.3)	1,308.00	500.00	10,447.25	
OrthoSensor	245 (19.3)	755.00	459.00	8,978.00	
ConforMIS	126 (9.9)	1,562.50	877.50	20,257.00	
Exactech	107 (8.4)	16,204.80	5,175.00	61,500.00	
Spineology	67 (5.3)	5,891.00	2,000.00	60,312.20	
Think Surgical	39 (3.1)	251.40	62.70	55,098.00	
Ottobock SE & Co. KGaA	22 (1.7)	8,333.00	8,333.00	28,804.00	
4WEB	13 (1.0)	10,000.00	10,000.00	45,000.00	
OMNIlife Science	11 (0.9)	2,500.00	825.00	19,396.00	

^a Kruskal-Wallis H Test

graphical region, hospital county and zip code were not evaluated which may lead to misleading results between rural and urban areas within these regions. Finally, while a thorough review of the devices was performed by the au-

Table 5. Top 10 industry companies reporting payments

Company	Payments, n (%)	Median Payment	Percentile (25 th)	Percentile (75 th)	P-value ^a
Lower Extremity	817 (64.3)	1,393.75	459.00	25,000.00	<0.001
Spine	372 (29.3)	800.00	558.50	18,483.00	
Upper Extremity	51 (4.0)	11,425.00	2,500.00	86,125.00	
Biological	24 (1.9)	5,702.50	1,818.00	33,968.00	
Miscellaneous	6 (0.5)	13,550.00	6,550.00	131,666.00	

^a Kruskal-Wallis H Test

thors, subjectivity in their categorization exists as some devices only listed the anatomical location for which the device was utilized.

CONCLUSION

This study demonstrates no difference in trends for annual median payment values but a decreasing number of payments to teaching hospitals from 2016-2021. The most

common device payments were utilized for the lower extremity and spine. This study highlights the increased transparency that was made possible since implementation of the Sunshine Act.

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