

Industry Payment to Vascular Neurologists A 6-Year Analysis of the Open Payments Program From 2013 Through 2018

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Background and Purpose—Industry payments to physicians raise concerns regarding conflicts of interest that could impact patient care. We explored nonresearch and nonownership payments from industry to vascular neurologists to identify trends in compensation.

Methods—Using Centers for Medicare and Medicaid Services and American Board of Psychiatry and Neurology data, we explored financial relationships between industry and US vascular neurologists from 2013 to 2018. We analyzed payment characteristics, including payment categories, payment distribution among physicians, regional trends, and biomedical manufacturers. Furthermore, we analyzed the top 1% (by compensation) of vascular neurologists with detailed payment categories, their position, and their contribution to stroke guidelines.

Results—The number of board certified vascular neurologist increased from 1169 in 2013 to 1746 in 2018. The total payments to vascular neurologist increased from \$99 749 in 2013 to \$1 032 302 in 2018. During the study period, 16% to 17% of vascular neurologists received industry payments. Total payments from industry and mean physician payments increased yearly over this period, with consulting fee (31.1%) and compensation for services other than consulting (30.7%) being the highest paid categories. The top 10 manufacturers made the majority of the payments, and the top 10 products changed from drug or biological products to devices. Physicians from south region of the United States received the highest total payment (38.72%), which steadily increased. Payments to top 1% vascular neurologists increased from 64% to 79% over the period as payments became less evenly distributed. Among the top 1%, 42% specialized in neuro intervention, 11% contributed to American Heart Association/American Stroke Association guidelines, and around 75% were key leaders in the field.

Conclusions—A small proportion of US vascular neurologists consistently received the majority of industry payments, the value of which grew over the study period. Only 11% of the top 1% receiving industry payments have authored American Heart Association/American Stroke Association guidelines, but ~75% seem to be key leaders in the field. Whether this influences clinical practice and behavior requires further investigation.

Key Words: conflicts of interest ■ industry ■ medicaid ■ medicare ■ physician ■ stroke

Physicians and industry have long collaborated in scientific discoveries and patient care; however, financial transactions between industry and physicians still raise concerns regarding conflicts of interest that could potentially impact patient care.^{1,2} The Open Payments Program (OPP) supported by the Centers for Medicare and Medicaid Services was

initiated subsequent to the Physician Payments Sunshine Act of 2007. It mandates public reporting of financial relationships between the applicable manufacturers and group purchasing organizations and healthcare providers (physicians and teaching hospitals), with the goal of a transparent and accountable healthcare system, in response to legislative and public

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concerns regarding potential conflicts of interest and their impact on medical practice, education, and research.³

Vascular neurology is one of the most dynamic neurology subspecialties, driven by innovation and development of new devices and pharmacotherapies. In 2015, vascular neurology was the second highest paid neurology subspecialty category following multiple sclerosis.⁴ To the best of our knowledge, financial relationships between industry and vascular neurologists have not previously been reported. The aims of this study were to explore this relationship by analyzing the proportion, amounts, and categories of payments from industry to vascular neurologists and by identifying trends in payments among regions, sources, and forms of compensation from 2013 to 2018.

Methods

Data Sources

A retrospective analysis of 2 publicly available online databases, the Centers for Medicare and Medicaid Services OPP database and the American Board of Psychiatry and Neurology database, was performed on data collected from 2013 to 2018 and these 2 databases are completely independent with no risk of double counting. Both databases can be accessed by researchers online without registration and cost.

For the OPP database (<https://openpaymentsdata.cms.gov/query-builder>), data on industry payments to vascular neurologists are available under the physician specialty category "Allopathic & Osteopathic Physicians, Psychiatry & Neurology, Vascular Neurology". We excluded research and partnership payments and analyzed general payments (Over the 6 years analyzed, the total research payments made was \$312,163.23 or around 8% when compared with total general payments; there were no partnership payments made during this timeframe). General payments were aggregated into 9 subcategories: consulting fee, education, entertainment, gift, grant, honoraria, travel and lodging, food and beverage, and compensation for services other than consulting, including serving as faculty or as a speaker at a venue other than a continuing education program. Each payment carried a unique physician profile ID, recipient state, sponsor, and related product (drug or biological or device). In the OPP database, separate entries exist for each payment when a physician receives multiple payments. All individual payments were aggregated to obtain the total payment to each vascular neurologist using physician IDs and total payment by each sponsor using a sponsor's name.

American Board of Psychiatry and Neurology, a Member Board of American Board Medical Specialties, has a publicly available online database, published twice yearly, about the total number of practicing vascular neurologists in the United States (<https://www.abpn.com/wp-content/uploads/2016/08/ABPN-Certifications-by-Year-Subspecialties.pdf>).

Data Analysis

Using the total number of US vascular neurologists obtained from the American Board of Psychiatry and Neurology database as the denominator, we calculated the proportion of vascular neurologists who received industry payments at least every other year, since vascular neurology boards are held every other year by American Board of Psychiatry and Neurology. Mean, median, minimum, maximum as well as 90th percentile were calculated for these payments. To explore distribution of payments among the physicians, we calculated the Gini index (a statistical measure of dispersion) for those physicians who received any payment each year.⁵ The Gini index ranges from 0 indicating every physician received an equal number of payments to 1 indicating that one physician received all the payments and none of the others received any payment.

We identified the top 1% of vascular neurologists as those who received the highest amount of industry payment each year. The sum of all payments received by the top 1% of vascular neurologists was

calculated as a proportion of the total industry payment that year. We also investigated the position and division, scholarly activities, and participation in American Heart Association/American Stroke Association (AHA/ASA) guidelines for the top 1% of vascular neurologists using their specific profile ID. We also aggregated all payments made in each category (eg, food and beverage, consulting fee, etc) and calculated it as the proportion of the total payments for each year as well as over the 6 years combined.

Finally, we analyzed geographic patterns of payment by US census regions (<https://www.census.gov/programs-surveys/geography.html>): Northeast, Midwest, West, South, and Puerto Rico by combining the data for each US state/territory represented in these regions. To be a key leader in the field, the physician has to be Chief of Neurology, Chief of Stroke, Chief of Neuro-intervention, Director of Stroke Fellowship, or professor rank in an academic institution.

Results

Distribution of Payments

Between August 2013 and December 2018, a total of 17 468 payments worth \$3 782 222 were made to 304 vascular neurologists in the United States. The total board-certified vascular neurologist increases from 1169 to 1746 in 6 years. The total annual payment increased during the studied period (\$99 749 to \$1 032 302) while the proportion of recipient vascular neurologists remained the same ($\approx 16\%$ – 17%). The payment characteristics for vascular neurologists by year are summarized in Table 1. From 2013 through 2018, mean payments increased from \$627 to \$3396, which were much greater (5–6 fold) than respective median payments and their increase from \$115 to \$154. Amount paid to the top 1% of physicians steadily increased for the studied period from 64% to 79% of the total payment. The Gini index increased from 0.79 to 0.91 during the studied period, suggesting greater inequality among physicians for industry payments. (For details, see Tables I and II in the [online-only Data Supplement](#)).

Categories of Payment

The 2 categories with the highest payment were consulting fees and compensation for services other than consulting (defined as serving as a faculty member or speaker at a venue other than for continuing medical education [ie, industry-sponsored dinner talks]), representing 31.1% and 30.7% of the total payment value, respectively. Travel and lodging was the third highest payment amount, representing 18.4%. Food and beverage was the most frequent payment category; however, it only represented 12.4% of the total amount (Figure 1; Table 2). The most frequent payment categories for top 1% physicians were consulting fee and compensation for service (Figure 2).

Top 1% Payment Receivers

The small group constituting 1% of all vascular neurologists (n=45) received more than two thirds of the total industry-to-physicians payments each year included. Of those, 19 (42%) had neuro-interventional practice, 18 (40%) were in the field of vascular neurology, and the remaining 8 (18%) were general neurologists. Nearly half (n=22; 48%) worked in academic institutions and about three quarters (n=34; 75%) carried designations of division chief, professor, or director of stroke fellowship program. The top 1% group generated a

Table 1. Characteristic of Industry Payments to Vascular Neurologists From 2013 to 2018

	2013	2014	2015	2016	2017	2018
Mean payment	\$627	\$2189	\$2650	\$2818	\$3071	\$3396
Median payment	\$115	\$241	\$203	\$201	\$228	\$154
Payment SD	\$1770	\$8589	\$10379	\$10578	\$13786	\$15004
Maximum payment	\$17469	\$93706	\$114556	\$115254	\$190551	\$168898
90th percentile single payment	\$1766	\$2839	\$4988	\$4816	\$4775	\$4102
Top 1% total payment*	\$63723	\$366323	\$465695	\$512455	\$585967	\$815992
Top 1%/total payment	64%	74%	72%	72%	74%	79%
Total value of payment	\$99749	\$492617	\$649617	\$712893	\$795442	\$1032302
Gini index†	0.79	0.86	0.89	0.87	0.88	0.91
No. physicians‡	159	225	245	253	259	304
Board-certified physicians§	1169	1362	1362	1573	1573	1746
Percentage of recipients	13.6%	17%	18.0%	16%	16.4%	17%

*Top 1% total payment: amount of total payment for each vascular neurologist who is in the top 1% among all vascular neurologists of that year.

†Gini index ranges from 0 (every physician received an equal number of payments) to 1 (one physician received all the payments and none of the others received any payment).

‡No. physicians means number of physicians who received payment.

§American Board of Psychiatry and Neurology updates numbers of board certificated vascular neurologists every other year.

total of 522 publications (11 publications per person) in the AHA/ASA Stroke journal and 2266 publications (50 publications per person) listed in PubMed. Only 5 out of the 45 (11%) vascular neurologists in the top 1% group authored AHA/ASA guideline papers.

Sponsors and Regions

A total of 263 companies provided compensation to neurologists; among these, the top 10 biomedical manufacturers accounted for 74% to 79% of the total payment over the 6-year studied period. During this time, top payments displayed a trend from those related to pharmacological products to those related to medical devices. Payments related to neuro-interventional devices increased sharply since 2017 (for details see Tables III and IV in the [online-only Data Supplement](#)). Physicians based in the South region received ≈38% of the total payments over the 6 years, which was the highest among regions. Payment to physicians in the South region steadily increased every year (Table 3).

Drugs and Devices

In 2018, the highest paid drug/device was Trevo stent retriever, providing 18.04% of the total payments to vascular neurologists followed by Activase (5.92%) and Penumbra (5.80%). In 2017, the top 3 drug/devices were Pipeline (9.95%, an embolization device used in endovascular treatment of intracranial aneurysms), Xarelto (Rivaroxaban) (8.76%), and Stent Retrievers (6.41%). Similarly, in 2016, Xarelto (Rivaroxaban; 20.12%), Activase (Alteplase; 9.27%), and Pipeline (6.90%) made up the top 3 drugs/devices for that year. Since the OPP database was started in 2013, during initial years (2013–2015), some data on name of the drug/device were missing or unavailable.

Discussion

In this study, we used publicly available databases to explore and report the financial relationships between industry and vascular neurologists over a 6-year period. We noted that while the total sum of industry-to-physicians payments

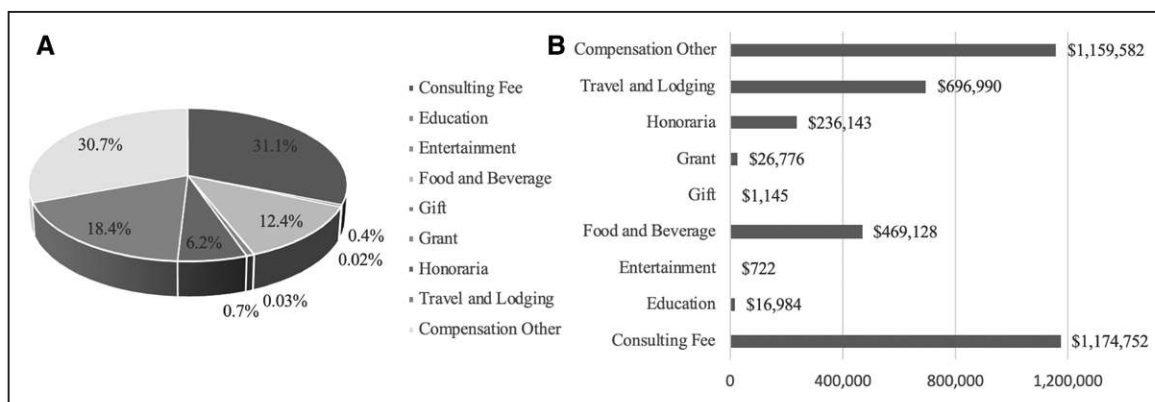


Figure 1. Categories and proportion of total payment from 2013 through 2018. When the payments over the 6-y studied period are combined, both consulting fee and compensating other represented two-thirds of the total amount; Although, Food and Beverage was the most common payment category, it only represented one-tenth of the total amount.

Table 2. Industry Payment Categories From 2013 to 2018

Category	2013	2014	2015	2016	2017	2018	Total
Consulting fee	\$26 969	\$113 528	\$141 298	\$161 221	\$239 339	\$492 398	\$1 174 752
Education	\$6589	\$4855	\$1156	\$1339	\$1162	\$1882	\$16 984
Entertainment	\$0	\$0	\$596	\$126	\$0	\$0	\$722
Food and beverage	\$26 132	\$81 206	\$88 663	\$84 554	\$85 241	\$103 333	\$469 128
Gift	\$23	\$166	\$896	\$7	\$52	\$0	\$1145
Grant	\$0	\$2500	\$19 300	\$1540	\$1221	\$2215	\$26 776
Honoraria	\$5600	\$81 074	\$102 785	\$11 299	\$8685	\$26 700	\$236 143
Travel and lodging	\$20 301	\$109 101	\$132 689	\$149 460	\$164 543	\$120 897	\$696 990
Compensation*	\$14 136	\$100 187	\$161 834	\$303 348	\$295 199	\$284 878	\$1 159 582
Total	\$99 749	\$492 617	\$649 218	\$712 893	\$795 442	\$1 032 302	\$3 782 222
No. physicians†	159	225	245	253	259	304	304

*Compensation means compensation for services other than consulting, including serving as faculty or as a speaker at a venue other than a continuing education program.

steadily increased every year, a stable proportion (16% to 17%) of vascular neurologists received those payments. For these payments, a high degree of inequality exists among physicians, with a steady increase in this inequality (Gini index increased from 0.79 to 0.91) over the 6 years, with the top 1% of all vascular neurologists receiving >60% of total payments.

Our study indicates that in this small group of physicians receiving a large share of payments, most (~75%) were key leaders in the field. Similar studies for other specialties have previously demonstrated that industry targets physicians who are perceived as opinion leaders and who can potentially influence practice patterns of other physicians.⁶⁻⁸ Financial relationships between industry and physicians, and their potential influence on research and patient care, remains controversial. Payments from industry have been noted to influence physician prescribing patterns.⁹ In our study, <20% of the vascular neurologists practicing in the United States were paid by industry every year, with a relatively stable pattern of payment

through 6 years since the enactment of Sunshine Act in 2010. This indicates that majority of vascular neurologists may not be prone to the biases introduced by industry payments. It is also encouraging to note that only a small percentage (11%) of the top 1% have authored AHA/ASA guideline papers, which potentially further limits the conflicts of interest percolating into practice guideline statements.

An interesting finding of this study was the shift in payment pattern from predominantly pharmacological companies in 2013 to 2015 to device companies after 2017. This was associated with a surge in the number of neuroendovascular specialists receiving payments, who now accounted for ~42% of the top 1% payment receivers. This trend is largely explained by the recent advances in neuroendovascular treatment of acute stroke. These large payments are usually categorized into consulting fee or compensation for services other than consulting or even for royalties and licensing. Large payments, which naturally attract attention, may represent appropriate compensation for time and intellectual property spent in

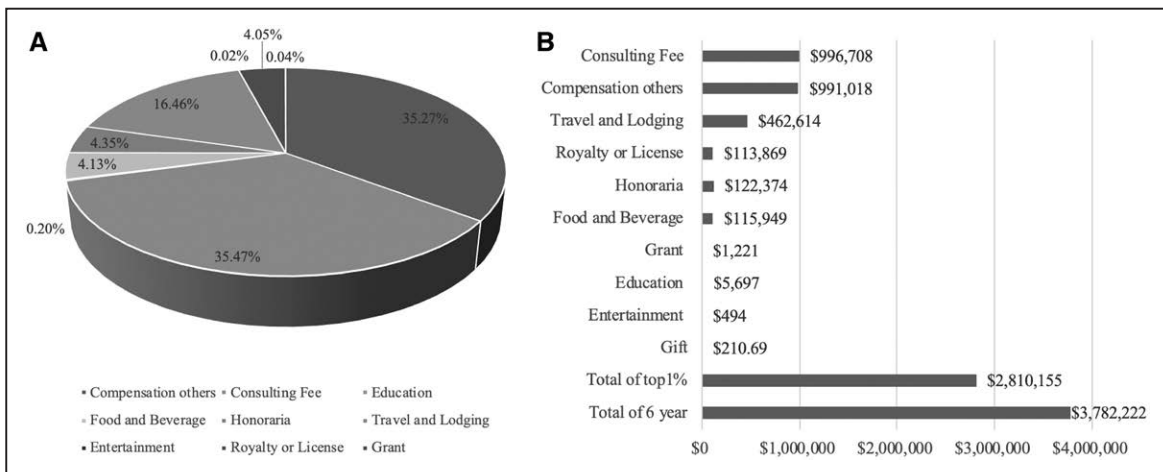


Figure 2. Payments to top 1% vascular neurologists by category from 2013 through 2018. **A**, Indicates proportions of top 1% payment categories. Compensation others and consulting fee are the major payment per category, which represent about two thirds of the total payment. **B**, Shows amount of payment of each category paid to top 1% vascular neurologists. The ratio of top 1% vascular neurologists payment of the 6-y total payment is 74.3% (\$2 810 155/\$3 782 222).

Table 3. Industry Payments to Vascular Neurologists From 2013 Through 2018: Regional Data

Region	2013	2014	2015	2016	2017	2018	Total	Proportion of Total Payment
Midwest	\$32 473	\$166 573	\$128 116	\$304 637	\$163 081	\$209 867	\$1 004 747	26.56%
Northeast	\$12 926	\$39 773	\$176 132	\$131 045	\$130 656	\$272 649	\$763 180	20.18%
Puerto Rico	\$497	\$253	\$493	\$137	\$277	\$169	\$1826	0.05%
South	\$36 823	\$146 819	\$189 633	\$213 260	\$407 443	\$470 551	\$1 464 529	38.72%
West	\$17 031	\$139 198	\$154 845	\$63 814	\$93 986	\$79 065	\$547 940	14.49%

these endeavors; however, further examination of these payments and their impact on patient care is warranted.

In our study, food and beverage was the most common payment type, a trend similar to other specialties⁹; however, large variation exists among specialties with regard to the highest amount of payments. For example, royalties and licensing accounted for the largest percentage of payments among plastic surgeons and neurosurgeons, whereas speaker fees were more common in medical specialties.^{10,11} Our study showed consulting fee and compensation for services other than consulting accounted for the major payment categories for vascular neurologists.

Limitations

Our study has few limitations. First, the OPP database is an industry self-reporting system, the accuracy and completeness of which is unknown. This self-reported data often carries ambiguities; for example, we noticed several large payments explained by device or drug or biological product, without much of the necessary details provided. Second, the number of practicing vascular neurologists is reported on biennial basis, which may influence the annual mean payment values. Third, it is important to understand the potential implications of industry to physician payments on the delivery of patient care; however, it was beyond the scope of this study. Further studies may help to overcome these limitations and increase our understanding of the biases introduced by industry through physician payments and their impact on patient care.

Conclusions

Payments from industry to vascular neurologists is highly skewed with 1% of physicians receiving around two thirds of all payments. Only 11% of these vascular neurologists in the top 1% receiving payments from industry have authored AHA/ASA guidelines, but the majority of them ($\approx 75\%$) seem to be thought leaders in the field. Industry is known to target key leaders in the field whether this is translating to changes in clinical practice and such influence on clinical behavior requires further investigation.

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Disclosures

Dr Li is a paid consultant to eMax Health Systems on statistical issues of unrelated projects. The other authors report no conflicts.

References

- Ross JS, Keyhani S, Korenstein D. Appropriateness of collaborations between industry and the medical profession: physicians' perceptions. *Am J Med*. 2009;122:955–960. doi: 10.1016/j.amjmed.2009.04.013
- Bailey CS, Fehlings MG, Rampersaud YR, Hall H, Wai EK, Fisher CG. Industry and evidence-based medicine: believable or conflicted? A systematic review of the surgical literature. *Can J Surg*. 2011;54:321–326. doi: 10.1503/cjs.008610
- Glass HE. Open payments and the us clinical landscape. *Ther Innov Regul Sci*. 2019;13:2168479019837526
- Ahlatw A, Narayanaswami P. Financial relationships between neurologists and industry: the 2015 open payments database. *Neurology*. 2019;92:1006–1013. doi: 10.1212/WNL.0000000000007640
- Bellù LG, Librati P. Inequality Analysis: The Gini Index. EASYPol; Available at: <http://www.fao.org/3/a-am352e.pdf%20>. Dec 2006. Accessed September 1, 2019.
- Annapureddy A, Murugiah K, Minges KE, Chui PW, Desai N, Curtis JP. Industry payments to cardiologists. *Circ Cardiovasc Qual Outcomes*. 2018;11:e005016. doi: 10.1161/CIRCOUTCOMES.118.005016
- Moynihan R. Key opinion leaders: independent experts or drug representatives in disguise? *BMJ*. 2008;336:1402–1403. doi: 10.1136/bmj.39575.675787.651
- Annapureddy A, Sengodan P, Mahajan S, Annapureddy T, Murugiah K, Desai NR, et al. Distribution of industry payments among medical directors of catheterization and electrophysiology laboratories from the top 100 us hospitals. *JAMA Intern Med*. 2019;179:1282–1284. doi: 10.1001/jamainternmed.2018.8775
- Fleischman W, Agrawal S, King M, Venkatesh AK, Krumholz HM, McKee D, et al. Association between payments from manufacturers of pharmaceuticals to physicians and regional prescribing: cross sectional ecological study. *BMJ*. 2016;354:i4189. doi: 10.1136/bmj.i4189
- Chao AH, Gangopadhyay N. Industry financial relationships in plastic surgery: analysis of the sunshine act open payments database. *Plast Reconstr Surg*. 2016;138:341e–348e. doi: 10.1097/PRS.0000000000002404
- Wong VSS, Avalos LN, Callahan ML. Industry payments to physician journal editors. *PLoS One*. 2019;14:e0211495. doi: 10.1371/journal.pone.0211495