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Profile of the Oncology Physician Workforce and the Characteristics of Attrition

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ABSTRACT

PURPOSE To determine the prevalence of attrition and the frequency of transition from a primarily clinical role to an industry-related role among oncology physicians.

METHODS We tracked yearly Centers for Medicare & Medicaid Services (CMS) billing between 2015 and 2022 to estimate attrition of oncology physicians. A subanalysis of a random sample of 300 oncologists with fewer than 30 years of experience and who had stopped billing were used to conduct a more thorough assessment of current employment. Employment was primarily found through LinkedIn; otherwise a secondary search was done through a Google search. Type of employer was categorized as industry (pharmaceutical or biotechnology), nonindustry (academic/clinical/government), others, or no information found. The results are provided separately by sex.

RESULTS Of the 16,870 oncologists who billed to CMS in 2015, 3,558 (21%) had stopped billing by 2022. Among a randomly selected 300 oncologists, we found current employment information for 223 (74%); 78 of the 223 (35%) were most recently employed within industry. Among all CMS-billing oncologists, 30% (5,126 of 16,870) identified as female. Women stopped billing at the rate of 18% (929 of 5,126) by 2022. Surgical oncologists had the lowest overall attrition (17%, 149 of 855). Radiation oncologists had 21% (881 of 4,244) overall attrition and 7% (5 of 71) sampled attrition to industry.

CONCLUSION By 2022, 21% of oncology physicians billing to CMS in 2015 had stopped. 78 of the 300 sampled physicians were found to be working in industry. In total, 1 in 17 oncologists (5%) moved to industry over a 5-year period.

ACCOMPANYING CONTENT

Appendix

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INTRODUCTION

Recent literature and public discourse have documented changes in the job market. Often dubbed the great resignation, experts are noticing a shift in the ways in which employees are navigating the job market. Across sectors, workers are reportedly shuffling jobs, employers, and even occupations at a higher rate than ever seen before.[1,2]

Medicine seems to be following a similar trajectory, but with an added factor of the supposed divide between clinic and industry. The literature has detailed a change in the average career trajectory available to physicians.[3,4] With the introduction of pharmaceutical and biotechnology as pillars in the economy of medicine, the academy is no longer the dominating force in the medical community for research.[5] However, speculation persists on the prevalence of how physicians are trending overall. How many physicians, who start in patient-facing services, make the turn to industry? Most evidence relies on self-reported surveys of future behavior or expected physician shortages across the United States and do not detail attrition to industry.[6-8]

This study sought to measure patterns of oncologists moving from a primarily patient-facing role in practice to the private sector industry of pharmaceuticals and biotechnology (colloquially referred to as industry) between 2015 and 2022.

METHODS

Identification of Oncologists and Characteristics

We measured attrition of oncologists with a cohort analysis of Medicare Fee-for-Service billing claims. Data were sourced from the quarterly files of clinicians in the Centers for Medicare & Medicaid Services (CMS) national provider database.[9] Inclusion in each quarterly files required billing to Medicare Fee-for-Service within the previous 6 months.

As the claims data were only available for the previous 7 years, we limited our analysis to years 2015 through 2022. We

CONTEXT

Key Objective
What is the prevalence of oncology physicians leaving a primarily clinical position and moving to employment within the private sector industries of pharmaceuticals and biotechnology?

Knowledge Generated
One in five Medicare-serving oncology physicians left over a 5-year period. This study estimates that a portion moved to roles in industry and highlights patterns in this migration by physician characteristics.

Relevance
Overall attrition from Centers for Medicare & Medicaid Services-billing practice and attrition to industry show patterns among the oncology physician workforce. Strategies to retain talented individuals in clinical medicine should be considered.

extracted the data sets for each quarter coinciding with the middle and end of year (Appendix Fig A1, online only). Only observations of physicians with a specialty of oncology were included. Using the National Provider Identifier (NPI) as a unique identifier per clinician, the two quarterly files for each year were merged and cleaned to provide a wholistic data set of all oncologists who billed CMS within that year.

For every oncologist listed in the 2015 Medicare Fee-for-Service billing claim file, each yearly data set between 2016 and 2022 was then compared to provide an annual timeline of each oncologists billing to CMS. Clinicians who billed consecutive years but stopped were coded to have left patient-facing services. The last year of billing was used as proxy for the timing of attrition. Those with continuous billing to Medicare were coded as remained in patient-facing services. Clinicians with inconsistent yearly billing appearances were excluded.

The variables for analysis and identification in the attrition analysis and sample search were derived from the 2015 data set and included NPI, first name, middle name/initial, last name, sex, year of medical school graduation, medical school, medical school credentials, and CMS Open Payments database.[10] Further methodology of variables is provided in Appendix 1 (Methods S1).

Sampling Current Employment

Using R Project for Statistical Computing, we created a random sample of oncologists who had stopped billing to CMS between 2015 and 2022. A total of 100 oncologists in each of the younger age groups (<10 years of experience, 10-11 years, and 21-30 years) were selected at random to conduct a further in-depth search on current whereabouts. LinkedIn was used as the primary source of employment information and was searched using the term: "[First Name] [Last Name] Oncology." Middle initial, medical school graduation year, and institution were used to confirm the identities for individuals from the CMS data set.

If an individual was not found through a LinkedIn search, we used business association from the NPI registry if it had been updated since the year of attrition on record for the oncologist. Finally, we searched Google Scholar, PubMed, and a general Google search to identify journal articles, business announcements, or news posts noting their affiliations. Sources where the documentation was unclear or dated before a clinician's attrition year were excluded.

For those found within LinkedIn, all positions which were noted as present with no end date were recorded as the current position. In this case, people could hold multiple positions at the same time. We used the most recent record of employment since their year of attrition.

Jobs were coded into four larger categories: academic/clinician/government, industry, others, and not found. Included in the others category was work in a health care business that did not have a patient-facing role (such as insurance, health care management/executive consulting, advocacy groups, professional association, lobbying group, nonmedical fields, fitness, real estate office, and life coach), or life events (such as retirement, death, or prison). The searches were performed between July 1, 2022, and August 31, 2022.

Information on education beyond medical degrees (MD, DO) was gathered with identical methodology as employment. This was categorized into MPH, MBA, masters in other field, PhD, none, or not found. The search was performed on January 11-17, 2023.

Analysis

We calculated descriptive characteristics for all included oncologists in the CMS 2015 data set, overall and by attrition

status (remained in clinical practice *v* left). We used the Wilcoxon rank sum test to determine differences in attrition and used the Kruskal-Wallis rank sum test for differences in employment in industry, employment in nonindustry, and employment information not found. For categorical independent variables, we used Pearson's chi-squared test. Appendix 1 (Methods S2) details our adjusted logistic regression models to determine factors associated with attrition status and attrition to industry. All inferential statistics were two-tailed tests with an $\alpha = 0.05$. Analyses were conducted in R version 4.1 (R Project for Statistical Computing). Because we used publicly available data and this is not human subjects research in accordance with Title 45 of the Code of Federal Regulations §46.102(f), we did not submit this study to an institutional review board or require informed consent procedures.

RESULTS

Profile of Oncology Physicians

Of the 17,855 oncologists found in the CMS data set, we excluded 985 because of inconsistent data. In total 16,870 oncologists were analyzed using Medicare data. Overall, oncologists had a median of 23 years of experience as a physician (Table 1, IQR, 14-33). 13% had less than 10 years of experience, 31% had 11-20 years, 27% for 21-30 years, and 30% had more than 30 years.

30% of all oncologists in the data set were female. Broken down by years of experience, 44% of physicians with fewer than 10 years were female. Comparatively, females made up 40%, 30%, and 17% of those with 11-20, 20-30, and >30 years of experience, respectively. A total of 1,500 (8.9%) graduated from top 10 medical schools. Hematology/oncology was the largest oncology specialty, with 7,953 physicians, representing almost half (47%) of all oncologists in the cohort. Radiation oncology was the second largest with 4,244 specialists (25%), followed by medical oncology (n = 2,886, 17%), gynecological (n = 932, 6%) oncology, and surgical oncology (n = 855, 5%). 25% (n = 4,223) received research funding in 2015 from industry and a median value of $42,703 (IQR, $8,868-$175,811). A total of 12,712 (75%) received general payments with a median value of $449 (IQR, $114-$2,174).

Attrition

Of the 16,870 physicians studied, 3,558 (Fig 1, 21%) were determined to have left CMS-billing practice and 13,312 (79%) remained. Oncologists who left had a median of 35 years of experience (IQR, 25-42). In comparison, those who remained had a median of 20 years (IQR, 13-29). Attrition, between 2016 and 2022, was 11% for younger oncologists with fewer than 30 years of experience and 45% for those with more than 30 years ($P < .01$). Physicians with fewer than 10 years of experience had the lowest attrition at 8%. This trend persisted across all specialties, except for medical oncology in which 14% of the youngest group left, compared with medical oncologists with 11-20 years of experience, of whom 11% left.

Overall, 22% of the 11,744 male oncologists and 18% of the 5,126 female oncologists had left by 2022.

16% of oncologists who received research funding from industry left CMS billing. The 2015 median annual research payment for those who left was $39,668 (IQR, $5,930-$171,374). Comparatively, the median industry funds received among those who remained was $43,328 (IQR, $9,369-$177,813). Of the oncologists who received general payments from industry, 19% left. Those who left had a median value payment of $304 (IQR, $77-$1,404). Oncologists who remained had a median general payment of $497 (IQR, $123-$2,393). There were significant differences for research funding ($P < .01$) and general payments ($P < .01$) between those who left and those who remained. In the adjusted logistic regression model (Appendix Table A1), lower research (odds ratio [OR], 0.98; 95% CI, 0.97 to 0.99) and general payments in 2015 (OR, 0.91; 95% CI, 0.89 to 0.92) were associated with lower odds of attrition.

Sampling Current Employment

We found information for 223 (74%) of the randomly selected 300 oncologists with fewer than 30 years of experience.

78 (Table 2, 26%) of the 300 oncologists who stopped billing to CMS 2015-2022 worked in industry at follow-up. Of the 223 found in the search, oncologists working in industry made-up 35% and were employed by 67 different companies in the pharmaceutical and biotechnology sector. The most common companies were Janssen Pharmaceutical (n = 6), Bristol Myers Squibb (n = 4), Merck (n = 4), and Novartis (n = 4). Of the 78 industry-employed physicians, the median years of experience was 14 (IQR, 9-18). 32 (41%) had fewer than 10 years of experience, 31 (40%) had 11-20 years, and 15 (19%) had 21-20 years. 50 (64%) were men.

36 (46%) and 49 (63%) of those in industry received research funding or general payment, respectively, from industry in 2015. The median research funding was $91,990 ($15,565-$654,166), and the median general payment was $1,769 (IQR, $224-$11,972). Of the 145 physicians found to be not working for industry, 16% received research payments, at a median of $34,745 (IQR, $9,795-$83,731), and 67% received general payments, at a median of $251 (IQR, $61-$848). There was a significant difference for research funding ($P < .05$) between those reported as working in industry and those who were not. In the adjusted logistic regression models (Appendix Table A2), research payments in 2015 (OR, 1.21; 95% CI, 1.12 to 1.33) were associated with greater odds of working in industry by 2022.

Top specialties moving to industry include medical, hematology, and gynecological, which saw 38%, 33%, and 23% attrition toward industry, respectively. No one from surgical oncology moved to industry.

TABLE 1. Characteristics of Oncologists in the CMS National Provider Database (2015), by Attrition Status

Characteristic	Overall (N = 16,870)	Left (n = 3,558)	Remained (n = 13,312)	*P*[a]
Years since medical school graduation, median (IQR)	23 (14-33)	35 (26-42)	20 (13-29)	<.001
Years of experience, No. (%)				<.001
<10	2,171 (13)	164 (4.6)	2,007 (15)	
11-20	5,205 (31)	454 (13)	4,751 (36)	
21-30	4,484 (27)	669 (19)	3,815 (29)	
>30	5,010 (30)	2,271 (64)	2,739 (21)	
Decade of graduation year, No. (%)				<.001
1940	4 (<0.1)	4 (0.1)	0 (0)	
1950	57 (0.3)	51 (1.4)	6 (<0.1)	
1960	578 (3.4)	417 (12)	161 (1.2)	
1970	2,380 (14)	1,204 (34)	1,176 (8.8)	
1980	4,301 (26)	1,020 (29)	3,281 (25)	
1990	4,602 (27)	468 (13)	4,134 (31)	
2000	4,777 (28)	387 (11)	4,390 (33)	
2010	165 (1.0)	4 (0.1)	161 (1.2)	
Sex, No. (%)				<.001
Male	11,744 (70)	2,629 (74)	9,115 (68)	
Female	5,126 (30)	929 (26)	4,197 (32)	
Credential, No. (%)				<.001
Unknown	9,264 (55)	1,815 (51)	7,449 (56)	
MD	7,432 (44)	1,702 (48)	5,730 (43)	
DO	174 (1.0)	41 (1.2)	133 (1.0)	
Year of last CMS billing, No. (%)				<.001
2015	405 (2.4)	405 (11)	0 (0)	
2016	460 (2.7)	460 (13)	0 (0)	
2017	580 (3.4)	580 (16)	0 (0)	
2018	420 (2.5)	420 (12)	0 (0)	
2019	561 (3.3)	561 (16)	0 (0)	
2020	660 (3.9)	660 (19)	0 (0)	
2021	472 (2.8)	472 (13)	0 (0)	
Specialty, No. (%)				.003
Hematology/oncology	7,953 (47)	1,650 (46)	6,303 (47)	
Radiation oncology	4,244 (25)	881 (25)	3,363 (25)	
Medical oncology	2,886 (17)	670 (19)	2,216 (17)	
Gynecological oncology	932 (5.5)	208 (5.8)	724 (5.4)	
Surgical oncology	855 (5.1)	149 (4.2)	706 (5.3)	
Received research funding from industry, No. (%)	4,223 (25)	676 (19)	3,547 (27)	<.001
Received general payment from industry, No. (%)	12,712 (75)	2,386 (67)	10,326 (78)	<.001
2015 annual research funding received, median (IQR)	$42,703 ($8,868-$175,811)	$39,668 ($5,930-$171,374)	$43,328 ($9,369-$177,813)	.091
2015 total industry general payments received, median (IQR)	$449 ($114-$2,174)	$304 ($77-$1,404)	$497 ($123-$2,393)	<.001
Graduated from top 10 medical schools, No. (%)	1,500 (8.9)	360 (10)	1,140 (8.6)	.004

Abbreviation: CMS, Centers for Medicare & Medicaid Services.
[a]Wilcoxon Rank Sum test; Pearson's Chi-squared test.

DISCUSSION

There has been widespread interest in the physician workforce, its direction, and the impacts of industry on physician migration. Our findings attempt to assess such patterns. With a focus on the oncology specialties, this analysis shows the prevalence of attrition and provides a preliminary estimate on the flow of the physician workforce between patient-facing clinical work and industry.

About 1 in 10 (11%) younger oncologists with fewer than 30 years of experience—and who are thus assumed to still be in

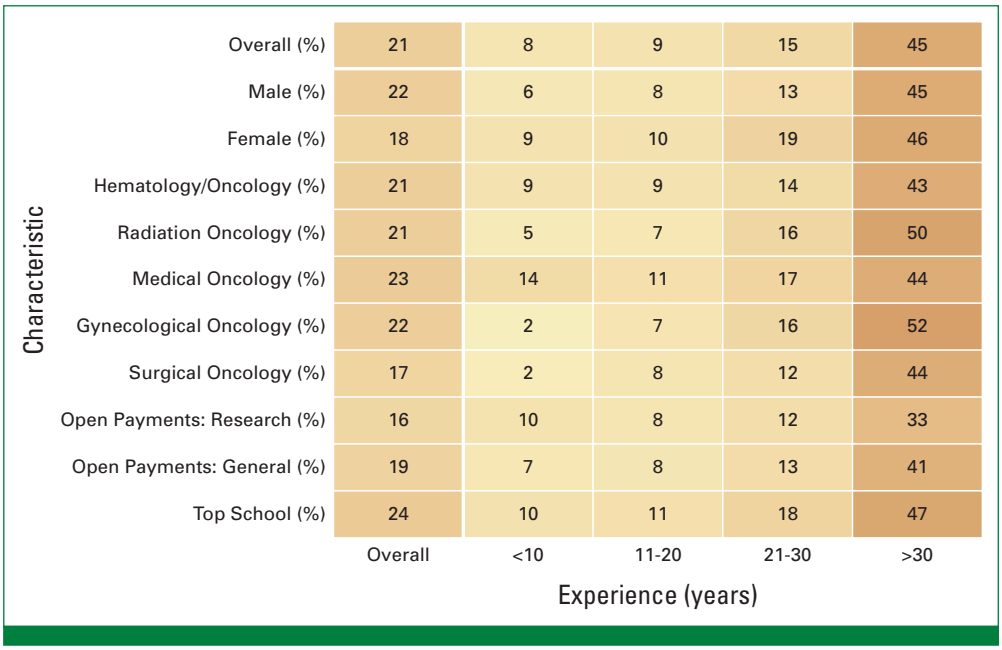

FIG 1. Characteristic-specific 5-year attrition rate (2016-2022), overall and per years of experience.

the workforce—are shown to have stopped billing to CMS between 2015 and 2022. However, we cannot discount the possibility of ending CMS billing while remaining in clinical practice or moving to jobs that do not bill CMS (eg, US Department of Veterans Affairs).

Yet, our subsequent random sample of 300 younger oncologists, who are presumably beneath the age of retirement, attempts to provide a preliminary estimate of career movements. Of those who leave CMS-billing practice, about one in four (26%) head toward careers in pharmaceutical or biotechnological industries.

The first question is why are people leaving a primary role in clinical practice? What tradeoffs are physicians considering in their departure?

The overarching theme of attrition in academic and clinical practice has been heavily studied.[11] In academia specifically, the lack of institutional support and a de-emphasis on building the skills, opportunity, and motivation in the job are seen as driving factors of attrition.[8,12] Similarly, clinicians find administrative work and an overwrought health care system burdensome.[4,13-16] With physicians experiencing stress and burnout at higher rate than the general population, burnout is shown as a predictor of attrition in the clinical setting.[17,18]

Type of clinical practice setting could also play a role—as larger, more consolidated practices are showed to have higher rates of attrition.[19] Our current analysis does not distinguish between varying levels of attrition by type of institution. We can suspect that the 56% of the sample who were reported as remaining in nonindustry services since attrition were dependent on more granular factors, specific to the type of service or the institution that they are moving to/from.

Although private practice and academia can feel vastly different at times, they share a common goal of providing care to patients. In contrast, pharmaceutical and biotechnology companies are a product-driven environment, more reliant on business mechanics than their patient-serving counterparts. If 21% of oncologists are leaving patient-facing service, why are one in four departing physicians rerouting their careers toward this alternative career?

There is less understanding about the overall experiences of physicians in industry sectors, but first-hand accounts often point to stark differences in culture, product, and incentives. Overall directionality of physicians' day-to-day life is the most analyzed in the literature. Several studies have found intrinsic and psychosocial factors, such as patient-relationships, work-life balance, goodwill, and autonomy, are more influential on physician satisfaction.[11,20] As previously mentioned, deteriorating conditions in the health care delivery system have left physicians grasping for reform. Industry can repackage some of these characteristics into a new profession outside the clinic. Industry physicians report opportunity for greater influence, as they replace one-on-one patient relationships with the ability to create lasting impact at the societal level through the development of innovative medical products.[21,22] Administrative weight is replaced with streamlined corporate culture.[21]

For those in academia, research becomes less about publishing and more about marketability (and presumably more about applicability).[21,23] In our findings, higher research

TABLE 2. Characteristic of a Random Sample of Oncologists in the CMS National Provider Database (2015), Overall and by Employment Status (2016-2022)

Characteristic	Overall (N = 300)	Industry (n = 78)	Not Industry (n = 145)	Not Found (n = 77)	P[a]
Years of experience/since medical school graduation, median (IQR)	16 (10-24)	14 (9-18)	16 (10-23)	21 (10-27)	<.001
Years of experience, No. (%)					<.001
<10	100 (33)	32 (41)	48 (33)	20 (26)	
11-20	100 (33)	31 (40)	52 (36)	17 (22)	
21-30	100 (33)	15 (19)	45 (31)	40 (52)	
Most recent employer type[b], No. (%)					
Industry	78 (26)	78 (100)	0 (0)	0 (0)	<.001
Academia/clinic/government	133 (44)	14 (18)	119 (82)	0 (0)	<.001
Others	37 (12)	5 (6.4)	32 (22)	0 (0)	<.001
No current employment found	77 (26)	0 (0)	0 (0)	77 (100)	<.001
Decade of graduation year, No. (%)					.003
1980	61 (20)	8 (10)	28 (19)	25 (32)	
1990	97 (32)	23 (29)	47 (32)	27 (35)	
2000	141 (47)	47 (60)	70 (48)	24 (31)	
2010	1 (0.3)	0 (0)	0 (0)	1 (1.3)	
Sex, No. (%)					.10
Male	162 (54)	50 (64)	75 (52)	37 (48)	
Female	138 (46)	28 (36)	70 (48)	40 (52)	
Credential, No. (%)					.2
Unknown	193 (64)	55 (71)	96 (66)	42 (55)	
MD	105 (35)	23 (29)	48 (33)	34 (44)	
DO	2 (0.7)	0 (0)	1 (0.7)	1 (1.3)	
Year of last CMS billing, No. (%)					.2
2015	29 (9.7)	9 (12)	17 (12)	3 (3.9)	
2016	36 (12)	16 (21)	13 (9.0)	7 (9.1)	
2017	56 (19)	14 (18)	26 (18)	16 (21)	
2018	21 (7.0)	8 (10)	10 (6.9)	3 (3.9)	
2019	40 (13)	9 (12)	19 (13)	12 (16)	
2020	73 (24)	15 (19)	36 (25)	22 (29)	
2021	45 (15)	7 (9.0)	24 (17)	14 (18)	
Specialty, No. (%)					<.001
Hematology/oncology	144 (48)	47 (60)	63 (43)	34 (44)	
Radiation oncology	71 (24)	5 (6.4)	43 (30)	23 (30)	
Medical oncology	61 (20)	23 (29)	27 (19)	11 (14)	
Gynecological oncology	13 (4.3)	3 (3.8)	6 (4.1)	4 (5.2)	
Surgical oncology	11 (3.7)	0 (0)	6 (4.1)	5 (6.5)	
Received research funding from industry, No. (%)	65 (22)	36 (46)	23 (16)	6 (7.8)	<.001
Received general payment from industry, No. (%)	197 (66)	49 (63)	97 (67)	51 (66)	.8
2015 annual research funding received, median (IQR)	$50,931 ($10,000-$225,334)	$91,990 ($15,565-$654,166)	$34,745 ($9,795-$83,731)	$3,888 ($2,754-$16,784)	.005
2015 total industry general payments received, median (IQR)	$333 ($80-$1,683)	$1,769 ($224-$11,972)	$251 ($61-$848)	$136 ($45-$694)	<.001
2015 no. of general payments received, median (IQR)	5 (2-25)	8 (3-39)	5 (1-29)	4 (1-14)	.075
Graduated from top 10 medical schools, No. (%)	39 (13)	14 (18)	19 (13)	6 (7.8)	.2
Degree outside of medical diploma[b], No. (%)					
No other degree	111 (37)	42 (54)	69 (48)	0 (0)	<.001
MBA	11 (3.7)	6 (7.7)	5 (3.4)	0 (0)	.038
MPH	5 (1.7)	3 (3.8)	2 (1.4)	0 (0)	.2
Masters, others	20 (6.7)	9 (12)	11 (7.6)	0 (0)	.013
PhD	22 (7.3)	15 (19)	7 (4.8)	0 (0)	<.001
No information found	134 (45)	5 (6.4)	52 (36)	77 (100)	<.001

Abbreviation: CMS, Centers for Medicare & Medicaid Services.
[a]Kruskal-Wallis rank sum test; Pearson's Chi-squared test.
[b]Multivalues allowed; percentages may not add up to 100%.

funding from industry was associated with remaining in CMS-billing practice. However, looking exclusively at those who left, higher industry research funding was associated with moving to industry. This suggests that industry's influence is not driving any exodus of physicians but that it may play a nontrivial role in migration of trialists further on. As funding from National Institutes of Health is dwindling, trialists are becoming increasingly funded by industry which may affect these dynamics further.[24]

Financial incentives could play a role in the movement toward industry. As mentioned, much of the current literature focuses on everyday happenings of physicians, but compensation has long been seen as a pivotal factor in employee retention across all professions.[25] Among physicians, potential earnings has been described to influence trainee specialty selection.[26] There is research connecting financial incentives to changes in clinical practice.[27] However, for mid-career physicians, less is known about how earnings effect overall employment decisions. Thus, there is little literature specific to a pay gap between clinicians and industry employees, although generally it is believed that those in industry receive greater pay.

The disparity in pay between specialties could also explain the varying levels of attrition. Our findings show that radiation oncology had one of the lowest attritions to industry, with only 5 of the 71 radiation oncologists documented as moved to industry. Overall attrition within radiation oncology is on par with other specialties (21% *v* overall median 21%). In comparison, none of the 11 surgical oncologists in our sample were shown to work in industry at the time of analysis; however, the group only had 17% overall attrition, the lowest of all specialties. There is no evidence on why these discrepancies would occur. Higher earnings among these specialties could contribute to greater retention to CMS-billing practice. Coupling this with possible differences in specialty opportunity outside clinic could explain this trend.

Overall, the employment patterns of physicians are unclear, but we theorize that a confluence of work cultural factors contribute to a migration to industry. Further research is needed to explore the phenomenon.

Our analysis also highlights interesting trends and insights to the oncology workforce. Oncologists billing to CMS were predominantly male, accounting for 70% of the entire cohort. However, broken down by age group, gender representation equalizes among the more recent medical school graduates. Females made up 44% of oncologists with fewer than 10 years of experience compared with only 17% of those with more than 30 years of experience. This suggests a positive trend of increased gender representation over time.

LIMITATIONS

There are several limitations to our work. First, attrition was estimated from the CMS data set, excluding physicians who practice but do not bill to CMS. This may limit our results since the findings cannot be extrapolated to all oncologists, but this methodology allows us to focus on oncologists who work with vulnerable populations in the United States. Data availability limits the scope of analysis as we do not know the trends of employment before 2015 nor do we know the amount of clinical care physicians are providing in their CMS-billing practice, which can vary. Similarly, we are limited to data from CMS database and public information, thus more granular insights such as nononcologist specialties who practice in cancer care are unavailable. Furthermore, using publicly available sources for determining current job status may lead to bias since not all professional and social media sites have current information. We also acknowledge that the term industry is heterogeneous as it could mean anything from a small startup company to working for a large Fortune 100 pharmaceutical company. Our intent was to focus on trends in physicians leaving clinical care and thus constrained our ability to examine more specific follow-up characteristics of physicians. In addition, our analysis only captures a specific segment of the outward flow of oncology physicians and does not account for incoming physicians, so findings are not reflective of the overall net labor flow of the workforce.

In conclusion, our analysis shows a gradual closing of the gender representation gap in the oncology physician workforce. Overall, 21% of all oncology physicians studied left CMS billing between 2015 and 2022. In a subsequent sample of those who left, our results suggest that approximately one in 17 oncologists will move to industry over a 5-year period. Among doctors who move to biopharmaceuticals, receiving industry payments is modestly associated with the transition, suggesting that trialists may be disproportionately moving to industry. Strategies to retain talented individuals in a primary role in clinical medicine should be considered.

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AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

Profile of the Oncology Physician Workforce and the Characteristics of Attrition

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Open Payments is a public database containing information reported by companies about payments made to US-licensed physicians (Open Payments).

Vinay Prasad
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APPENDIX 1. SUPPLEMENT METHODS

Methods S1

Years of experience were calculated by years since medical school graduation, as of 2015. Younger oncologists are referred to as those who had fewer than 30 years of experience as a physician. This does not account for any time before 2015, which is to say that it assumes continual clinical service since medical school graduation. Years of experience were also broken down into categorical variables of fewer than 10 years of experience, 10-11, 21-30, and more than 30 years of experience.

National Provider Identifier was matched to profiles in the Centers for Medicare & Medicaid Services (CMS) Open Payments database for extracting 2015 research funding and general payments from industry.[10] According to CMS, research payments are recorded as transactions "in connection with a research agreement or research protocol," and general payments are "not in connection with a research agreement or research protocol". For each type, we summed all payments within the year to provide two distinct variables: total annual funding received from industry and general payment received from industry.

Methods S2

In our logistic regressions, attrition status was a binary outcome of left patient-facing services or remained in patient-facing services. The variables included in the model were sex (male *v* female), primary specialty (hematology oncology *v* gynecological oncology, medical oncology, radiation oncology, and surgical oncology), graduate of a top medical school (yes *v* no, on the basis of the top 10 US News & World Report ranking for 2015),[28] years of experience (continuous), 2015 total research funding received from industry (log-transformed continuous), and 2015 total general payments received from industry (log-transformed dollar amount). A similar model was used for the subset sample data set, but works in industry or does not work in industry was used as the binary outcome for the logistic regression and excludes physicians with no employment information found. A variable of other advanced nonmedical degrees (no other degree *v* master's *v* PhD *v* not found) was included.

TABLE A1. Logistic Regression Analysis for Attrition Among Oncologists in the Centers for Medicare & Medicaid Services National Provider Database (2015)

Term	Estimate	Std. Error	Statistic	*P*	OR	2.5%	97.5%
Intercept	−3.258	0.075	−43.175	.000	0.038	0.033	0.045
Male*	−0.261	0.049	−5.311	.000	0.770	0.699	0.848
Specialty							
Hematology oncology	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Gynecological oncology	−0.052	0.094	−0.555	.579	0.949	0.788	1.139
Medical oncology**	0.131	0.059	2.241	.025	1.140	1.016	1.279
Radiation oncology*	−0.181	0.055	−3.265	.001	0.835	0.748	0.930
Surgical oncology*	−0.338	0.106	−3.192	.001	0.714	0.578	0.876
Years of experience*	0.098	0.002	46.760	.000	1.102	1.098	1.107
Open payments: research*	−0.022	0.005	−4.172	.000	0.979	0.969	0.989
Open payments: general*	−0.100	0.007	−14.328	.000	0.905	0.893	0.918
Attended top medical school							
Yes	0.139	0.073	1.905	.057	1.149	0.995	1.324
No	Ref	Ref	Ref	Ref	Ref	Ref	Ref

Abbreviation: OR, odds ratio.
*$P < .01$; **$P < .05$.

TABLE A2. Logistic Regression Analysis for Employment in Industry Among a Random Sample of Oncologists (n = 223, excludes those not found) in the Centers for Medicare & Medicaid Services National Provider Database (2015)

Term	Estimate	Std. Error	Statistic	*P*	OR	2.5%	97.5%
Intercept	0.383	0.549	0.698	.485	1.467	0.500	4.346
Male	0.521	0.376	1.385	.166	1.684	0.807	3.550
Specialty[a]							
Hematology oncology	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Gynecological oncology	0.921	0.858	1.074	.283	2.513	0.425	13.534
Medical oncology	−0.377	0.442	−0.853	.393	0.686	0.282	1.616
Radiation oncology*	−1.559	0.562	−2.773	.006	0.210	0.063	0.591
Years of experience*	−0.079	0.030	−2.593	.010	0.924	0.868	0.979
Open payments: research*	0.192	0.044	4.331	.000	1.211	1.115	1.327
Open payments: general	−0.046	0.056	−0.806	.420	0.956	0.854	1.066
Attended top medical school							
Yes	0.066	0.501	0.132	.895	1.068	0.393	2.838
No	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Degree outside of MD, DO, or MBBA							
No other degree	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Masters (MPH, MBA, master—others)	0.600	0.491	1.222	.222	1.822	0.696	4.833
PhD**	1.219	0.574	2.124	.034	3.385	1.131	10.985
Not found*	−2.359	0.602	−3.916	.000	0.095	0.026	0.280

Abbreviation: OR, odds ratio.
[a]Surgical oncology is excluded since 0 moved to industry.
*$P < .01$; **$P < .05$.

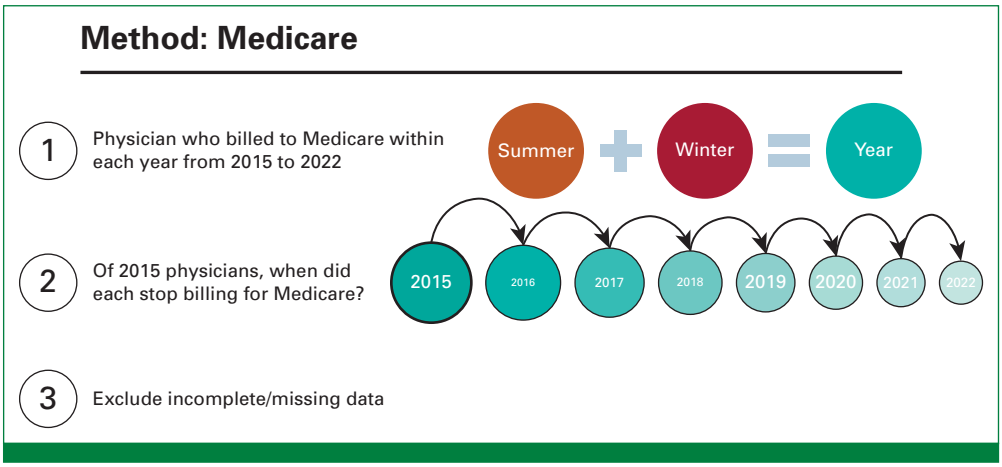

FIG A1. Visual methods.