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CLINICAL RESEARCH

How Much Tumor Surgery Do Early-career Orthopaedic Oncologists Perform?

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Abstract

Background There are few data on the types of procedures orthopaedic oncologists perform in their first years of practice. Because fellowships are graduating fellows each year and the number of tumor patients is limited, defining the practice patterns of early-career orthopaedic oncologists may help diminish early employment discontent and enhance workforce discussions.

Questions/purposes The aim of the study was to use the objective case log volumes of a cross-section of early career orthopaedic oncologists to describe (1) the number of operations performed annually; (2) the proportion of tumor, trauma, adult reconstruction, and other operations for individual participants, (3) individual practice characteristics that were associated with the number of tumor procedures; and (4) the sources of satisfaction and challenges in each individual's career and surgical practice.

Methods Fifteen fellowship-trained orthopaedic oncologists out of a potential pool of 33 (45%) in their first 4 years of practice responded to a survey by submitting complete operative case lists for a 2-year period. We recorded the type of procedure and determined associations between the annual number of tumor operations and total operative caseload, years in practice, and some details of individual

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Each author certifies that his or her institution approved or waived approval for the reporting of this investigation and that all investigations were conducted in conformity with ethical principles of research.

This work was performed at the University of Iowa, Iowa City, IA, USA.

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practice patterns. Each participant completed a survey regarding practice-related sources of stress and satisfaction. A total of 5611 surgical cases were available for review. For the entire cohort, there were 3303 (59%) tumor procedures, 973 (17%) trauma, 890 (16%) adult reconstruction, and 445 (8%) other.

Results The median annual number of total operations was 214 (range, 63–356) and median annual number of tumor operations was 135 (range, 47–216). The median proportion of tumor operations in an individual practice was 56% (range, 43%–94%). The annual number of tumor operations correlated with the total annual number of operations ($r = 0.73$, $p < 0.001$). Sources of stress and satisfaction were similar to the general membership of the Musculoskeletal Tumor Society (MSTS), apart from more early-career surgeons regarding case volume as important (29 of 104 [28%] of MSTS versus 11 of 15 [73%] of early-career, $p < 0.001$).

Conclusions The typical early-career orthopaedic tumor surgeon had fewer than 60% of his or her operative procedures directly related to the subject of his or her fellowship training in orthopaedic oncology. Overall, the challenges and rewards of clinical practice are similar to oncologic surgeons later in their career. This study is a first step in assessing early practice characteristics and may be of value to the prospective orthopaedic oncologist, fellowship educators, and the society in workforce discussions. Early-career practice patterns have not been previously presented, to our knowledge, for any subspecialty of orthopaedic surgery, and we hope that this study will stimulate similar efforts throughout the field.

Level of Evidence Level IV, economic and decision analyses. See Guidelines for Authors for a complete description of levels of evidence.

Introduction

An estimated 50% of orthopaedic surgeons will change practices within the first 2 years after the completion of training [6]. The inability to accurately evaluate an employment opportunity may increase the likelihood of a change in practice setting. Topics such as call responsibility, reimbursement, and clinical expectations often are complex but generally are quantifiable. An accurate prediction of the types and number of operative cases an individual can expect to perform in the first few years is less clear but may add to a realistic assessment of the opportunity. Therefore, specific details regarding the practice patterns of early-career surgeons may be of use to residents considering specialty training, current fellows in contract negotiations, fellowship directors, and senior physicians contemplating the addition of a partner [8]; however, to our knowledge, there are no such data available to guide these choices in orthopaedic oncology.

In a survey of the Musculoskeletal Tumor Society (MSTS) membership, White et al. [15] reported that established orthopaedic oncologists spent an average of 71% of their clinical time practicing within the specialty, treating an average of 58 total bone and soft tissue sarcomas annually. Although this assessment can help define what an average tumor practice may look like, the survey reflected primarily established surgeons several years or decades into their career and it was based on surgeons' recall estimations of cases they performed, not actual case logs. To our knowledge, the degree to which these estimates hold true for early-career orthopaedic oncologists is not known.

Tumor surgery fellowships in the United States and Canada typically produce no more than 12 to 15 new tumor surgeons each year. However, the relative proportion of younger and prospective orthopaedic oncologists is growing [5, 7, 9]. In 2012, candidate members (fellows and board-eligible orthopaedic surgeons) accounted for 25% of the North American orthopaedic surgeon membership of the MSTS (55 candidate members, 166 full members). The continuing (and perhaps expanding) interest in a field known for its rarity and need for a large population base makes an accurate assessment of early-career practice patterns all the more relevant.

The aim of the study was to use the objective case log volumes of a cross-section of early career orthopaedic oncologists to determine (1) the number of subspecialty operations performed annually; (2) the proportion of subspecialty operations for individual participants; (3) individual practice characteristics that were associated with the number of tumor cases; and (4) the sources of satisfaction and challenges in each individual's career and surgical practice.

Materials and Methods

Fifteen fellowship-trained musculoskeletal oncologists in the first years of independent clinical practice (range, 1–4 years) agreed to participate in this email survey study. Investigators were targeted with an email inviting participation if they were between 1 and 4 years into independent practice in North America and a candidate member of the MSTS. Of the 33 individuals eligible to participate, 15 agreed to submit case logs (45%). We do not know the reasons that some declined to participate but can speculate that the labor associated with reporting 2 years of operative cases seemed arduous to some. We do not know how many nonparticipants completed ACGME-accredited fellowships or non-ACGME-accredited apprenticeships. Nine participants had been in practice for 2 years, and two participants

Table 1. Number of surgical procedures for the entire cohort

Category	Number	Percent of total
All procedures	5611	
Tumor	3303	59
Trauma	973	17
Adult reconstruction	890	16
Other	445	8
Tumor only		
Benign	1407	42
Sarcoma	748	23
Metastatic	591	18
Nonneoplastic	557	17

each had been in practice for 1, 3, and 4 years. One participant had also completed an adult reconstruction fellowship; all others had ACGME-approved fellowship training in orthopaedic oncology only. Each surgeon contributed deidentified individual case logs from all cases performed from September 1, 2010, to August 31, 2012. The two participants with less than 2 years of practice submitted only 1 year of case logs. Each unique operation was recorded only once, and Current Procedural Terminology (CPT) codes were not used for categorization or counting. This project was approved by the institutional review board at all participating institutions.

A total of 5611 operative cases were available for review (Table 1). Our primary outcome was the number and type of subspecialty cases performed. These were categorized as "tumor," "adult reconstruction," "trauma," "spine," and "other." This was determined by the description of the operation by the treating surgeon with only one operation recorded per patient and not based on CPT codes. We did include multiple procedures on the same patient (such as a biopsy followed by a resection) if performed in two distinct operative settings. Tumor cases were further broken down into nonneoplastic, benign, sarcoma, and metastatic (metastatic carcinoma, melanoma, myeloma, and lymphoma) based on the operative histology. Nonneoplastic conditions include entities such as avascular necrosis, osteomyelitis, and stress fractures. The total number of cases for each surgeon was transformed into an estimated annual number of cases for comparison. We recorded additional independent variables unique to each surgeon and practice location. These included years in practice, estimated time dedicated to research, estimated time dedicated to clinical activity, estimated time dedicated to medical education, number of orthopaedic oncologists in the practice, number of orthopaedic oncologists in the metropolitan area, number of orthopaedic oncologists in the state, orthopaedic practice size, and metropolitan population. This information, including practice size and number of orthopaedic oncologists in the area, was obtained by asking the individual participants to estimate the preceding information in the survey. We did not confirm the accuracy of these estimations.

Table 2. Variation in average annual number of procedures of individual surgeons

Category	Number	
	Median	Range
All procedures	214	63–356
Tumor	135	47–216
Trauma	36	0–91
Adult reconstruction	21	1–114
Other	13	1–59
Tumor only		
Benign	56	20–77
Sarcoma	23	6–60
Metastatic	24	5–32
Nonneoplastic	24	0–52

A previously published survey of the general membership of the MSTS [15] was completed by the 15 study participants who submitted cases. The survey has not been formally validated but was designed by several orthopaedic oncologists to include questions most relevant to the clinical practice of orthopaedic oncology. This survey was used to establish and compare sources of satisfaction and challenges for early-career orthopaedic oncologists and more senior surgeons.

Statistical Analysis

We used bivariate methods (chi-square and Fisher's exact testing for categorical variables, t-tests for continuous variables) to determine associations between the annual number of tumor operations performed and the individual practice characteristics. We created a linear regression model to determine if the amount of tumor surgery correlated with any of our independent variables.

Results

The median annual number of total operations was 214 (range, 63–356) and median annual number of tumor operations was 135 (range, 47–216) (Table 2). Notably, there was a fivefold difference in the number of annual operations between high- and low-volume surgeons (Fig. 1).

The percent of subspecialty cases in each individual's practice also demonstrated a wide range (Fig. 2). Tumor

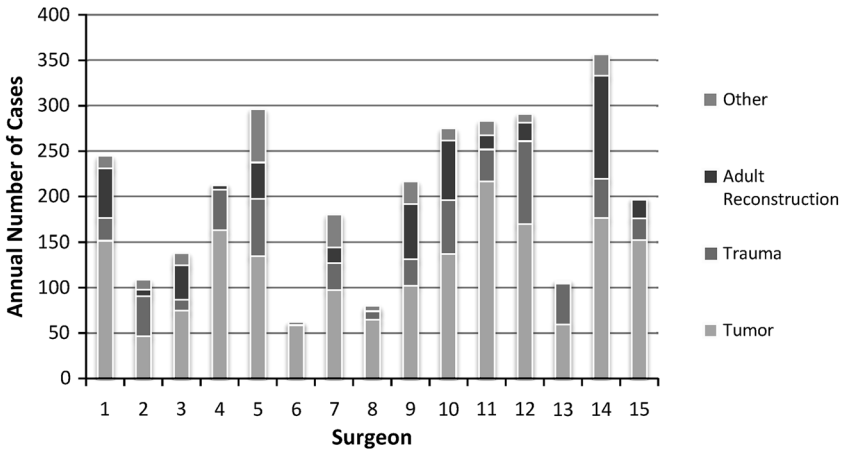

Fig. 1 This is a bar graph of the average annual number of surgical procedures by individual.

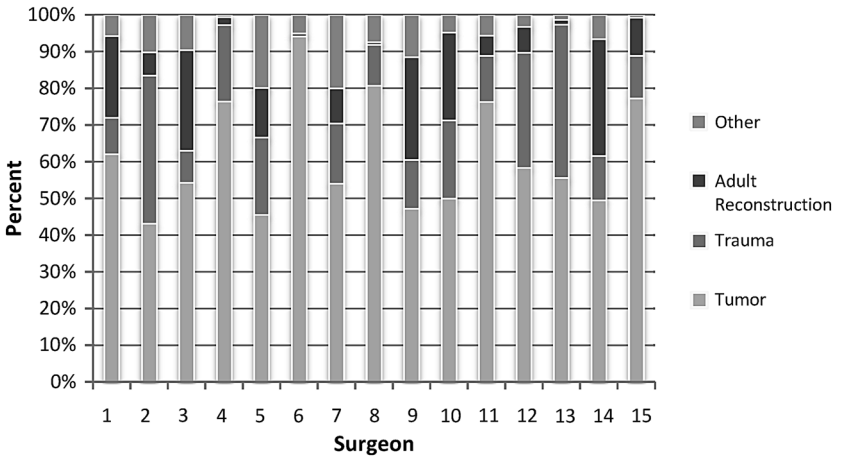

Fig. 2 This is a bar graph of the percent of surgical procedures by individual.

Table 3. Variation in the percentage of specialty procedures in the practices of individual surgeons

Category	Percent of practice	
	Median	Range
Tumor	56	43–94
Trauma	13	0–42
Adult reconstruction	10	1–32
Other	6	1–20

operations ranged from 43% to 94% of operative loads, trauma from 0% to 42%, and adult reconstruction from 1% to 32% (Table 3). None of the participants reported any spine procedures.

Surgeons in practice for 3 or more years reported a higher annual number of tumor procedures than those in practice for 1 or 2 years ($p = 0.026$). We did not find any significant differences in caseload between surgeons reporting their first and second years of practice ($n = 9$). The annual number of tumor operations performed correlated with the total number of annual operations ($r = 0.73$, $p < 0.001$) and did not have any apparent relationship with time spent in research, number of orthopaedic oncologists in the referral base, department size, or population of the metropolitan area.

The results of the practice contentment survey demonstrated that early-career orthopaedic oncologists place more importance on case volume than surgeons later in their career ($p < 0.001$) (Fig. 3). Within our cohort, we found that the stress of insufficient case volume was more important to those who performed less than 280 total cases annually ($p = 0.033$) or less than 160 tumor operations annually ($p = 0.033$). There was no apparent association

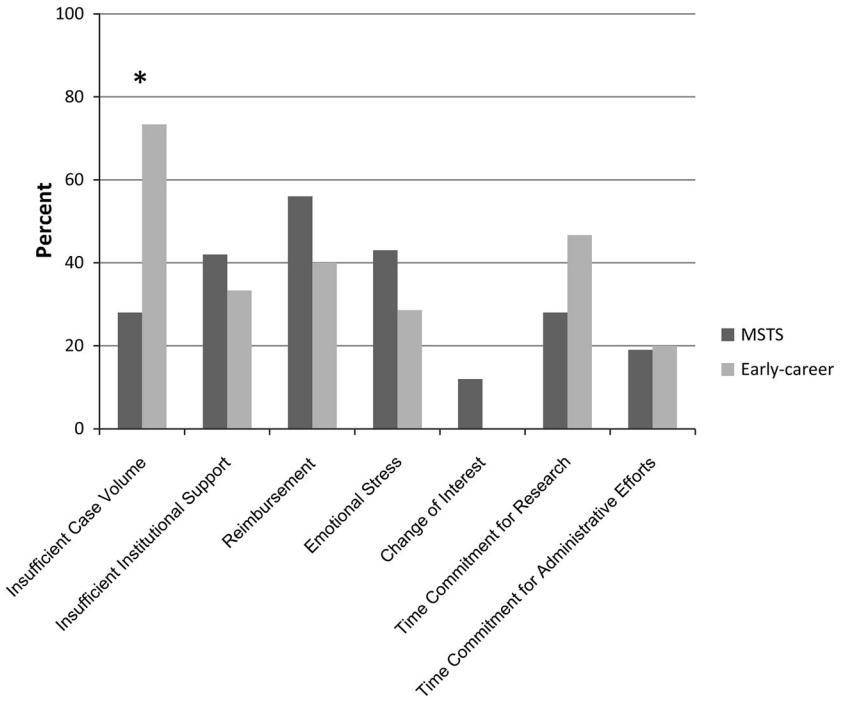

Fig. 3 This is a comparison of the sources of challenges between members of the MSTS and early-career surgeons. The bars represent the percentage of participants responding "important" or "very important" (*$p < 0.05$).

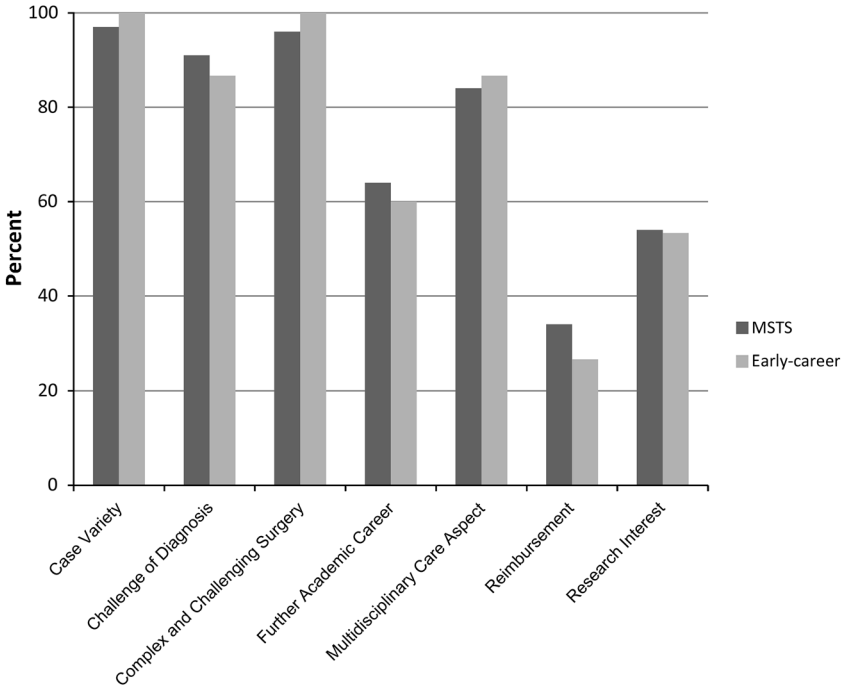

Fig. 4 This is a comparison of the sources of satisfaction between members of the MSTS and early-career surgeons. The bars represent the percentage of participants responding "important" or "very important" (*$p < 0.05$).

between the stress of insufficient case volume and a practice made up of more or less than 55% tumor operations ($p = 0.282$). The participants' perception of other career challenges and sources of satisfaction were nearly identical to those previously reported for the general membership of the MSTS (Fig. 4).

Discussion

There is currently a paucity of data describing the practice patterns of early-career orthopaedic oncologists. Defining surgical volume is important for workforce discussions and may be helpful for future fellows, graduating trainees, and expanding practices to set realistic expectations of operative caseload. In a review of more than 5000 cases collected by 15 early-career orthopaedic oncologists, there was substantial variation in individual operative practices. We found a wide range in the number of total annual operations (63–356) and tumor operations (47–216). The number of tumor operations correlated with the total number of operations ($r = 0.73$, $p < 0.001$). Early-career orthopaedic oncologists placed more importance on case volume than those later in their career.

There are limitations to this investigation that warrant discussion. First, although this is a substantial representation of a very specific cohort of physicians, fewer than half of those eligible for the survey elected to participate in it, and the overall sample size was small (15 participants). It is possible that there are other individuals in a similar state of practice whose clinical careers appear different than the participants; in particular, it seems possible that busier surgeons would have chosen not to participate, because participation was somewhat demanding on the participants in terms of time (they were asked to provide 2 years of case logs). It is also possible that participants did not respond as a result of an outdated email address, a clinical practice that does not include orthopaedic oncology, or an institution with an onerous internal review process for human subjects research. Furthermore, there are many factors that are likely important but difficult to quantify such as the strength and presence of the referral base. However, we do believe that the current sampling, although not exhaustive, emphasizes that there is a substantial amount of individual variability and establishes a starting benchmark. The lack of complete participation unquestionably weakens the generalizability of our conclusions; however, this cohort contains the most comprehensive information to date from individuals with substantial geographic and practice variability. Our findings may not be reflective of every early-career orthopaedic oncologist, but the fact that the case log data we present are novel and different than prior estimates indicates that our findings remain notable. Next, the case logs were submitted by individual surgeons and were not validated by any external source. It would be preferable to have validated case logs such as those compiled by the American Board of Orthopaedic Surgery for Part 2 of the certification examinations. It would then be possible to compare these findings with those surgeons who are completing case lists for maintenance of certification [10].

Our satisfaction survey was not a validated instrument but has some utility in general workforce analysis. Although the data derived from this are not definitive, they serve well as a simple measure of comparison to encourage further discussion. We also did not record other details about the practice environment such as competing services for the treatment of neoplastic conditions, which would certainly influence operative numbers. However, because we recorded actual case logs, any tumors cared for by other physicians would not falsely elevate the reported findings. The amount of detail we recorded was only for comparison and was not sufficient or intended to draw any conclusions regarding the treatment or outcomes of individual patients and we did not look at specific types of operations such as biopsies, curettage, or limb salvage procedures. Finally, our analysis investigated a unique time in the career of a surgeon, and the numbers reported cannot be extrapolated past the very beginning of an individual's career.

We found that the total number of procedures performed annually varied dramatically among participants with a median of 241 (range, 63–356). The 2012 Orthopaedic Surgeon Census reported that the average annual case load for an orthopaedic surgeon younger than 40 years old was 352 [2], which is 46% greater than the median surgeon in our cohort; however, this may not a valid comparison as a result of differences in how the data were collected (the Census asks surgeons to estimate monthly caseloads rather than submit actual case logs). Because orthopaedic oncologists were not stratified as a group in that census, it is possible that all tumor surgeons are below the national average as a result of the rarity and complexity of problems encountered. For example, many limb salvage procedures are lengthier than arthroscopies or even most arthroplastys, which may skew the numbers. However, a direct comparison to established orthopaedic oncologists showed that early-career surgeons performed a median of 23 annual procedure on sarcomas, which is less than half of the 58 average annual sarcomas reported by the MSTS membership [15]. There are a number of possible explanations for the relatively low productivity in the group we surveyed. First, the early years of a career are used to build a referral base, gain surgical expertise, and improve clinical efficiency, and so it is not surprising that the total number of cases is smaller than those even just a few years later. An additional explanation may be that patients with sarcoma are preferentially choosing more seasoned practitioners and the number of patients with sarcoma who were treated will increase as a surgeon ages. The previous MSTS survey [15] was based on surgeon recall and not derived from actual case logs, so it is also plausible that there were overestimations regarding the number of sarcomas treated, and in reality, the gap is not so wide. Finally, it is possible that many of the current employment opportunities are in orthopaedic groups or geographic areas where there is an established oncology service, and the total number of sarcomas any one surgeon may treat is diminishing, which is

potentially concerning because high volume has been linked to improved outcomes in some orthopaedic procedures [4, 13]. This would impact the practice of orthopaedic oncology in the future and is an area in need of further study.

Furthermore, our investigation found that the surgical treatment of benign diagnoses, metastatic disease, and nonneoplastic issues that required the skills of an orthopedic oncologist constituted 77% of the surgeon's tumor-related practice. In our experience, much of the emphasis in the orthopaedic oncology workforce and educational issues is focused on sarcoma treatment [1, 15]. The results of this study emphasize that there is a significant need for the skills of an orthopaedic oncologist outside of sarcoma treatment and this must factor into these discussions. The median orthopaedic oncologist in this cohort performed 56% (range, 43%–94%) of procedures directly related to their fellowship training in oncology. This is not dramatically different than the general membership of the MSTS, who reported a mean of 71% of time practicing within the specialty [15]. Trauma and adult reconstruction were the most popular additional subspecialties, which is also consistent with the previous survey [15]. From this, it seems that early-career surgeons and established orthopaedic oncologists alike routinely supplement their oncology practice with additional orthopaedic subspecialty cases.

We did not find that the number of tumor procedures performed correlated with anything other than the total annual number of procedures. This was a bit surprising, because the proportion of time dedicated to research, number of other orthopaedic oncologists in the referral area, and size of the metropolitan area did not appear to be associated with the annual number of tumor procedures. It is possible that these factors do have some influence on an individual level that we were not able to ascertain in the analysis of this group. Although we did have participants from several large cities (Phoenix, San Antonio, and Seattle), we did not have any participants from the three largest American cities (New York, Los Angeles, or Chicago). The referral patterns may be different and not reflected in our data. The observation that the surgeons in their third year of practice or later performed more tumor operations than surgeons with 2 or less years of experience suggests that as an individual becomes established in a community, his or her operative practice increases. Maintaining a high individual surgical volume is important to optimize operative results. Prior studies have found that surgeon volume is associated with improved outcomes in a number of surgical procedures [12] as varied as hip replacements [11] and colon cancer resections [14]. Birkmeyer et al. [3] further asserted that surgeon volume is the driving factor behind the association of hospital volume and operative mortality. These works suggest that individual surgeon volume is clearly linked to quality of care and postoperative outcomes. Because surgical care in orthopaedic oncology is varied, complex, and rare, the need for continuing investigation on the role and determinants of surgeon volume is apparent.

Although early-career orthopaedic oncologists typically perform substantially fewer procedures than the average orthopaedic surgeon younger than 40 years of age and care for a smaller number of sarcomas than established orthopaedic oncologists, the sources of satisfaction and stresses were not generally different than the membership of the MSTS. The area with an obvious discrepancy was the stress of "insufficient case volume," which was important to 73% of our cohort but only 28% of the MSTS [15]. This implies that concerns about the size of one's operative practice are most apparent at the beginning of a career. This is a predictable difference and underscores the importance of attempting to define as clearly as possible the expected operative workload in a potential employment opportunity. Of note, nearly half of the participants in this project considered leaving, and three of the 15 we surveyed did leave their first job in the first 3 years of practice. The most common cause of discontent was a low case volume. Although our attrition rate (three of 15 [20%]) may seem acceptable (and is perhaps normal for this subspecialty) because it is less than the previously reported 50% rate of change in practice setting [6], any effort to increase employment satisfaction has the potential to be beneficial.

In conclusion, there are two primary observations from these data. The first is that early-career orthopaedic oncologists perform fewer procedures than the average orthopaedic surgeon. A low case volume may be a source of stress and potential dissatisfaction with a practice. Second, this small group of early-career surgeons performed a substantial number of procedures not directly related to orthopaedic oncology fellowship training, primarily in total joint arthroplasty and trauma. Interestingly, this trend mimics what is seen in more established orthopaedic oncologists. Therefore, physicians contemplating training in orthopaedic oncology should be prepared to supplement a tumor practice with other subspecialty procedures both initially and throughout their career. Our summary case log data can serve as a quantifiable benchmark to help facilitate employment discussions for residents, fellows, fellowship directors, and hiring partners to minimize early-career stress and maximize the likelihood of sustained employment.

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