



AOA Critical Issues in Education

A Review of Orthopaedic Resident Case Logs to Identify Fluctuations in Exposure to Adult Orthopaedic Procedures

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Introduction: Orthopaedic surgery resident case exposure is an important component of surgical training and is monitored by the Accreditation Council for Graduate Medical Education (ACGME) to ensure resident readiness for graduation. The purpose of this study was to investigate trends in exposure to adult orthopaedic surgical procedures and analyze the impact of the 2013 update in ACGME case logging expectations.

Methods: A retrospective review of ACGME case log data was conducted for adult orthopaedic procedures performed by graduating orthopaedic surgery residents from 2012 to 2020. Trends in the number of cases logged and the case share by anatomical location were investigated. Linear regression analysis was performed to analyze changes in case number over the 9-year period.

Results: For all surgical categories, there was stability in the average case number per resident from 2012 to 2013, followed by a precipitous decrease from 2013 to 2014. From 2014 to 2020, there has been a gradual increase in case number for all categories except “other musculoskeletal (MSK),” resulting in a total 46% recovery since the 2014 decline. Concomitant with the decline, there was a relative increase in pelvis/hip and femur/knee procedures and decrease in shoulder, other MSK, and spine procedures. From 2014 to 2020, shoulder, humerus/elbow, pelvis/hip, leg/ankle, foot/toes, and spine cases have gradually accounted for a larger proportion of total cases while femur/knee and “other MSK” cases have accounted for less.

Conclusions: The 2013 update in ACGME case logging expectations was associated with a significant decrease in case number. This is likely a reflection of residents correctly entering 1 primary Current Procedural Terminology code for each surgical case. Programs should be aware of a general increase in case number since 2014 and acknowledge the fact that some procedure types may be given priority from a logging standpoint when multiple Current Procedural Terminology codes apply.

Residency has long been recognized as a critical component of surgical training because it lays a foundation of experience on which surgeons can expand throughout their medical careers. The Accreditation Council for Graduate Medical Education (ACGME) has established a standard system for measuring the quality of resident education and evaluating

Disclosure: The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (<http://links.lww.com/JBJSOA/A307>).

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resident readiness for graduation. The ACGME provides a breakdown of case requirements, outlining the minimum number of procedures in which a resident must participate¹. The standardized minimum requirements ensure that residents are exposed to a variety of cases that will prepare them to either practice independently or further subspecialize after residency graduation.

Residents are responsible for logging their cases using Current Procedural Terminology (CPT) codes, and these are then reported to the ACGME. Starting with the 2013 to 2014 academic year, the ACGME changed their expectations for case logging such that residents were instructed to enter only 1 primary code into the Case Log System, despite the fact that there may be multiple CPT codes that apply¹. In light of recent concerns regarding the quality of orthopaedic surgery training at select centers^{2,3}, this study set out to investigate trends in exposure to adult orthopaedic surgical procedures and analyze the impact of the 2013 update in ACGME case logging expectations. Residency directors may find this information useful to identify gaps in trainee exposure and work to craft more well-rounded training programs.

Methods

A retrospective review of ACGME case logs was conducted to assess the cumulative number of adult orthopaedic cases performed by graduating orthopaedic surgery residents from academic year ending in 2012 to academic year ending in 2020 (a 9-year period)¹⁶. Cases included those in the following categories: shoulder, humerus/elbow, forearm/wrist, hand/fingers, pelvis/hip, femur/knee, leg/ankle, foot/toes, other musculoskeletal (MSK), and spine. Data were also collected regarding the number of residency programs and number of graduating residents each year. The average number of adult orthopaedic procedures was analyzed to determine trends in case exposure during the study period. All data were accessed directly from the ACGME website².

Descriptive data analyses were performed to characterize the cases reviewed and determine means for each case category. Linear regression analysis was used to investigate variations in caseload over time and changes in percent share over time (i.e., to investigate variations in the proportion of total cases represented by each category). Because of the decrease in case log numbers seen after the 2013 update in ACGME case logging guidelines (first affecting academic year ending 2014), peak recovery metrics were calculated to determine the percentage of cases regained after the 2014 decline. This was calculated by dividing the gain in cases from 2014 to 2020 by the reduction in cases from 2013 to 2014 and multiplying by 100. For all analyses, a p value of less than 0.05 was considered statistically significant.

Results

The number of orthopaedic surgery residency programs and graduating resident physicians increased from 149 to 154 and 675 to 724, respectively, from 2012 to 2020 (Table I). The cumulative number of adult orthopaedic procedures per

graduating resident was stable from 2012 to 2013, but demonstrated a precipitous decrease from 2013 to 2014. After this decrease (from 2014 to 2020), there has been a steady increase (Fig. 1) at a rate of 44 cases per year ($r^2 = 0.99$, $p < 0.001$). When stratifying by anatomical location of the procedure, a 2014 reduction followed by year-over-year growth remains apparent (Fig. 2, Table II). From 2014 onward, the number of shoulder procedures increased by 6 cases per year ($r^2 = 0.98$, $p < 0.001$), humerus/elbow by 2 cases per year ($r^2 = 0.98$, $p < 0.001$), forearm/wrist by 3 cases per year ($r^2 = 0.95$, $p < 0.001$), hand/fingers by 3 cases per year ($r^2 = 0.97$, $p < 0.001$), pelvis/hip by 8 cases per year ($r^2 = 0.99$, $p < 0.001$), femur/knee by 8 cases per year ($r^2 = 0.95$, $p < 0.001$), leg/ankle by 7 cases per year ($r^2 = 0.99$, $p < 0.001$), foot/toes by 3 cases per year ($r^2 = 0.98$, $p < 0.001$), and spine by 4 cases per year ($r^2 = 0.98$, $p < 0.001$). Regression analysis revealed a decrease in cases listed in the “other MSK” category at a rate of 0.4 cases per year, but this was not statistically significant ($r^2 = 0.04$, $p = 0.676$). Peak recovery metrics show that, across all categories, 46% of the 2014 decrease has been regained as of 2020¹⁴. However, stratification by anatomical location shows considerable variability in the percent recovered (Table III).

When comparing case share from 2013 to 2014, there was a notable increase in case share for pelvis/hip (11.8% of total cases to 15.9%) and femur/knee (23.7% to 26.1%) procedures with a concomitant decrease in shoulder (12.5% to 10.4%), other MSK (10.9% to 9.4%), and spine (8.8% to 4.7%) procedures (Table IV). After 2014, there were gradual, yet statistically significant, increases in case share for shoulder (0.08% per year, $r^2 = 0.7$, $p = 0.024$), humerus/elbow (0.03% per year, $r^2 = 0.84$, $p = 0.007$), pelvis/hip (0.1% per year, $r^2 = 0.85$, $p = 0.003$), leg/ankle (0.17% per year, $r^2 = 0.98$, $p < 0.001$), foot/toes (0.08% per year, $r^2 = 0.84$, $p = 0.004$), and spine cases (0.16% per year, $r^2 = 0.95$, $p < 0.001$). The femur/knee and “other MSK” categories showed significant decreases in case share (0.28% per year, $r^2 = 0.95$, $p < 0.001$ and 0.32% per year, $r^2 = 0.77$, $p = 0.010$, respectively). There were no significant changes in the other categories (i.e., forearm/wrist and hand/fingers).

TABLE I Number of Orthopaedic Surgery Residency Programs and Graduating Resident Physicians From 2012 to 2020

Year	Residency Programs	Graduating Residents
2012	149	675
2013	150	678
2014	151	684
2015	151	699
2016	153	705
2017	156	709
2018	154	729
2019	154	725
2020	154	724

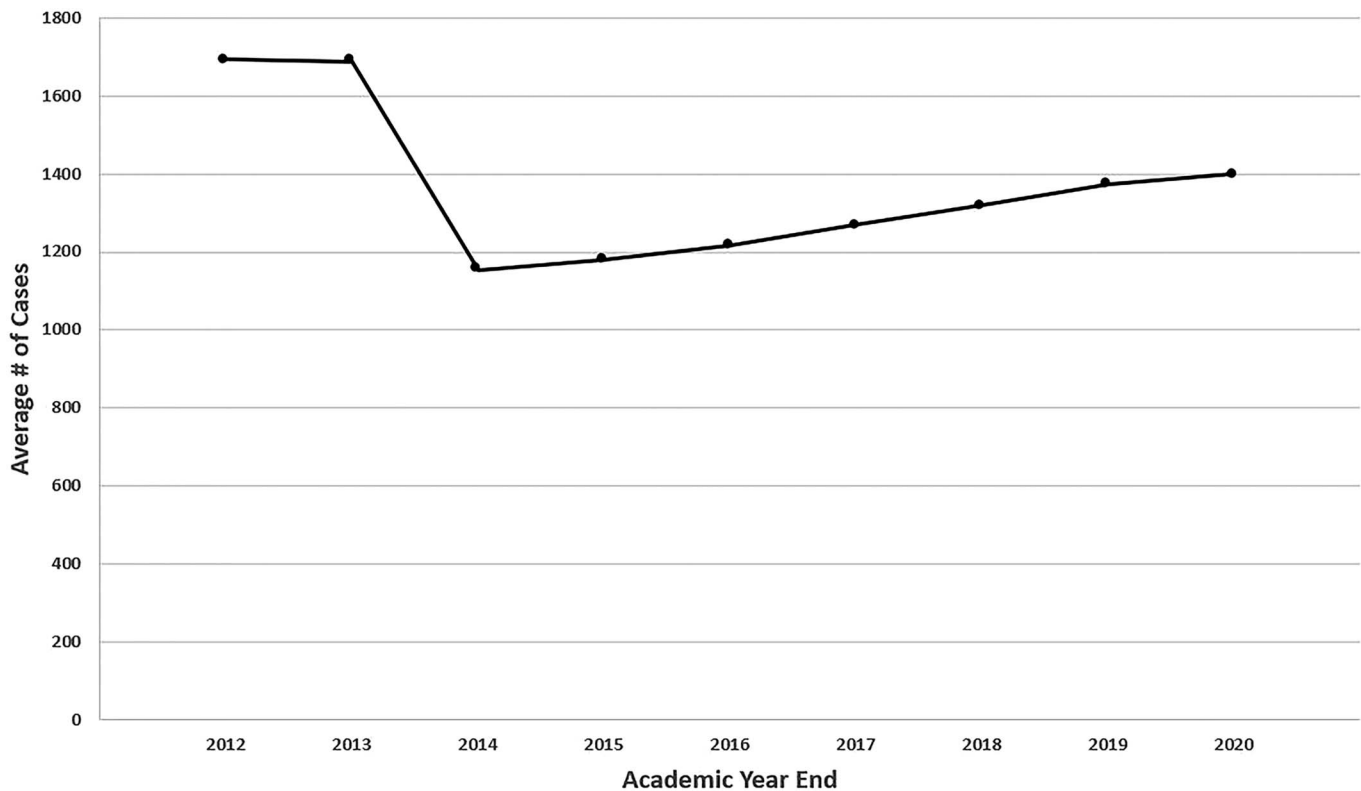


Fig. 1
Average total number of cases logged from 2012 to 2020.

Discussion

Case composition of resident training programs is a key factor in the preparation of competent orthopaedic surgeons. Previous studies have characterized orthopaedic residency exposures using ACGME data, notably those by Gil et al. and Pierce et al.^{4,5}. However, the date ranges explored in each of these studies only encompass a short period after the 2013 enactment of the case log reporting limitation by the ACGME. This is the first study to investigate case exposures for a considerable period after the reporting limitation was instituted, allowing for investigation of its effects.

Our results demonstrate a precipitous decrease in cases reported in 2014, which is associated with the 2013 update in ACGME case logging expectations. Gil et al. report an increase in the average total adult cases logged from 2007 to 2013⁴. The data in this study pick up where Gil's leave off, showing that 2013 was the peak of a 2007 to 2013 growth trend in overall caseload, followed by a marked decrease in 2014. This drop likely came in response to the ACGME statement, whereby residents were instructed to enter only 1 primary code into the Case Log System, despite the fact that there may be multiple CPT codes that apply¹. Thereafter, our data show that overall caseloads increased gradually through 2020 in all anatomical categories except for "other MSK." In a 2010 to 2016 analysis, Pierce et al. reported a decrease in total adult cases, with increases only in pelvis/hip procedures⁵. This study period straddles the 2013 peak and subsequent trough in caseloads, understandably showing an

overall decrease. A year-by-year analysis shows trends in line with those of this study. Pierce's observed increase in pelvis/hip procedures is also corroborated by the present findings, which demonstrate pelvis/hip procedures well overtaking the 2013 peak by the year 2020. In a spine-specific study, Pham et al. report a 2013 peak followed by a 2014 trough and subsequent rise in orthopaedic spine procedures, again in line with the our most recent findings⁶. These data indicate that, in the wake of the ACGME case reporting limitation, residents are still reporting an increase in their total caseload. Although the reduced number of cases after 2014 was anticipated, given the change in reporting expectations, the subsequent increase may be less expected. On one hand, residents may be overemphasizing time spent in the operating room in lieu of hospital floor work. This would be concerning, given the importance of postoperative care and its effect on outcomes. On the other hand, it is possible that there is fatigue with regards to accurate case logging, as is seen in many quality improvement initiatives⁷. For example, in the setting of a single case consisting of multiple procedures, the 2013 guidelines intended to discourage logging multiple cases. Residents may be reverting back to this practice in the absence of clear and frequent instruction. Residency directors should be aware that despite an overall hours limitation, case numbers have still risen since 2014. This trend may be caused by residents working longer hours to increase case log volume while reporting only the 80-hour work week maximum. Such a phenomenon may be a manifestation of the competitive

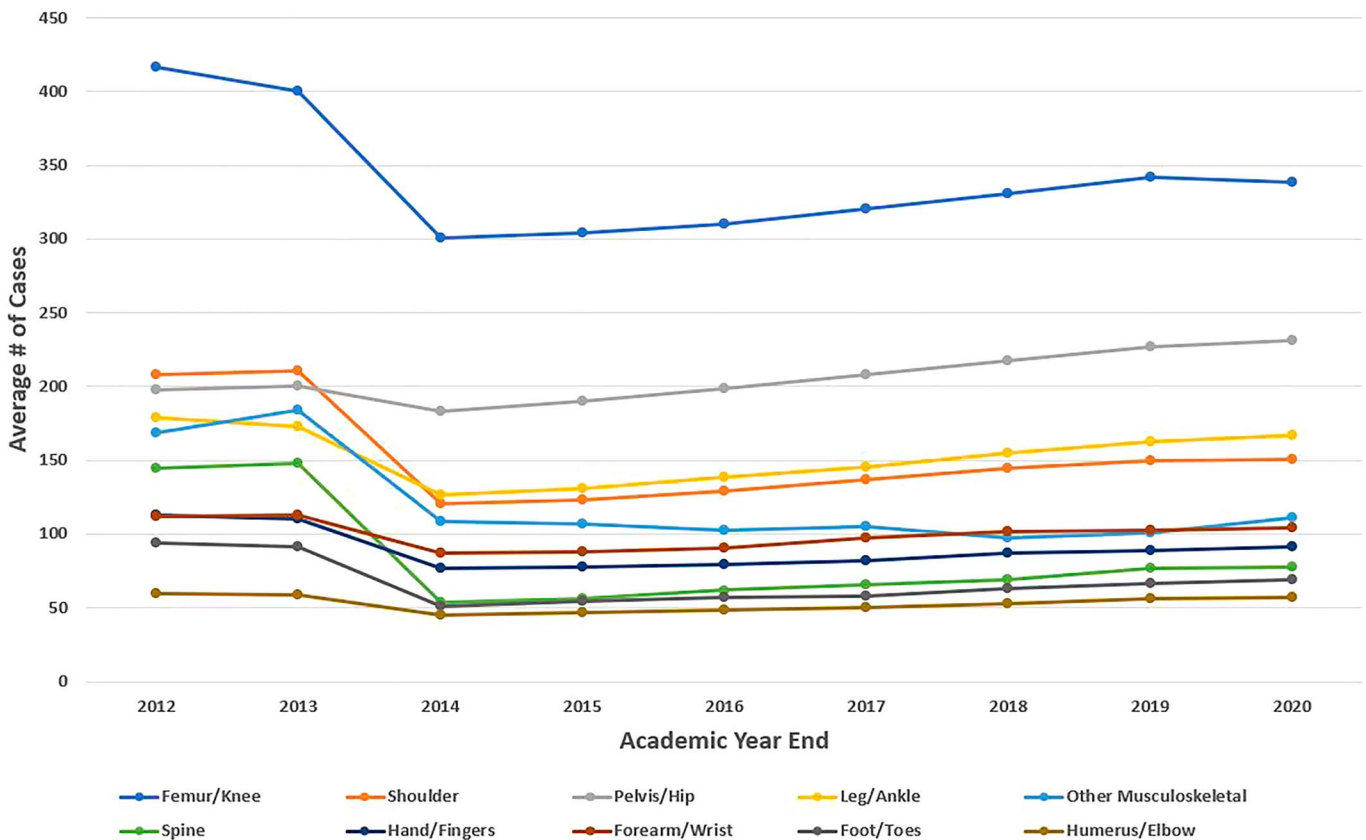


Fig. 2 Average number of cases from 2012 to 2022 stratified by anatomical location.

nature of orthopaedic surgery residency, where new doctors are subject to social pressures to experience success. Although additional caseload does not directly imply an impact on resident well-being, the trend should be followed closely to ensure such an effect does not manifest. Regardless of impact, the orthopaedic community would benefit from investigation into the cause of the rise in case numbers.

The case share analysis provides potential insight into the priorities of both residents and residency directors. In the face of the case reporting limitation, certain types of surgery have seemingly been prioritized (at least in terms of logging; at most in terms of actual exposure and participation), while others have been de-emphasized. The proportion of cases logged into the pelvis/hip and femur/knee categories increased from 2013

Year	Shoulder	Humerus/Elbow	Forearm/Wrist	Hand/Fingers	Pelvis/Hip	Femur/Knee	Leg/Ankle	Foot/Toes	Other MSK	Spine	Total
2012	208	60	112	113	198	417	179	94	169	144	1,693
2013	211	59	113	111	200	401	173	91	184	148	1,689
2014	120	45	87	76	183	301	126	51	109	54	1,154
2015	123	47	88	78	190	304	131	55	107	56	1,179
2016	130	48	91	80	199	310	139	57	103	62	1,217
2017	137	50	98	82	208	320	145	58	105	65	1,269
2018	145	53	102	88	218	331	155	63	97	69	1,319
2019	150	57	102	89	227	342	163	67	101	77	1,373
2020	151	57	105	92	231	339	167	70	111	78	1,399

*MSK = musculoskeletal. †Bold values indicates the years before and after the ACGME case logging guideline update.

TABLE III Peak Recovery Percentage After the 2014 Decrease Stratified by Anatomical Location*

Procedure Category	Peak Recovery Percentage
Shoulder	34%
Humerus/elbow	91%
Forearm/wrist	69%
Hand/fingers	44%
Pelvis/hip	289%
Femur/knee	38%
Leg/ankle	87%
Foot/toes	46%
Other MSK	3%
Spine	25%
Total	46%

*MSK = musculoskeletal.

to 2014, while there were decreases in the shoulder, other MSK, and spine categories. This suggests that exposure and/or reporting of pelvis/hip and femur/knee cases may be favored when directed to report only 1 primary CPT code. The decrease in shoulder, other MSK, and spine categories may speak to the potential deprioritization of these types of surgeries when put in a position to choose.

Previous studies investigating surgeon preparedness help underline the importance of a varied residency case experience. Kohring et al. found that highly varied and complex residency case exposures better prepare trainees for clinical settings and possible subspecializations, when compared with a mere high volume of cases⁸. There seems to be consensus that inadequate

training could be negatively impacting performance and quality of care delivered during fellowship and onwards. Mattar et al. reported on the sentiment of program directors of general surgery subspecialties, namely that incoming residency graduates were unable to operate independently during an unsupervised major procedure⁹. Perhaps more concerning are the opinions of residents themselves. According to Kohring, many 2018 residency graduates believed additional case exposure beyond the ACGME's baseline was needed, and these ideas were shared by a greater proportion than a cohort surveyed in 2012¹⁰. The reality is that there are variations in the number of cases required for each resident to become proficient. This highlights the need for a more individualized approach to determining competency. Perhaps, a competency-based, as opposed to a numbers-based, assessment would be more beneficial for resident education.

It is unclear from these data whether the COVID-19 virus has had an impact on overall resident caseloads—caseloads in 2020 once again increased, but the magnitude of that increase was diminished from increases seen in previous years. When taken alongside a documented global decrease in orthopaedic cases and concerns about surgeon training, it seems likely that COVID-19 was indeed implicated in the slowed growth in orthopaedic cases seen in the ACGME data. Studies from Pakistan, the United Kingdom, Europe, and the United States all showed a significant drop in orthopaedic cases as a result of the COVID-19 pandemic¹¹⁻¹⁴. It is likely that the values reflected in the ACGME data are a result of the same factors highlighted in these reports: pauses on elective procedures and reassignment of orthopaedic providers to help with COVID-19 patients.

Program directors should be aware that the effect seen in the ACGME data for 2020 may become more apparent in subsequent classes, who will be subjected to COVID-19 protocols for a proportionally greater period of residency. To identify which skills are most at risk, recent surveys of program

TABLE IV Proportion of Total Cases Attributable to Each Anatomical Location*

Year	Shoulder	Humerus/Elbow	Forearm/Wrist	Hand/Fingers	Pelvis/Hip	Femur/Knee	Leg/Ankle	Foot/Toes	Other MSK	Spine	Total
2012	12.3%	3.5%	6.6%	6.7%	11.7%	24.6%	10.6%	5.5%	10.0%	8.5%	100%
2013	12.5%	3.5%	6.7%	6.5%	11.8%	23.7%	10.2%	5.4%	10.9%	8.8%	100%
2014	10.4%	3.9%	7.6%	6.6%	15.9%	26.1%	11.0%	4.4%	9.4%	4.7%	100%
2015	10.5%	4.0%	7.5%	6.6%	16.1%	25.8%	11.1%	4.7%	9.1%	4.8%	100%
2016	10.6%	4.0%	7.5%	6.6%	16.3%	25.5%	11.4%	4.7%	8.4%	5.1%	100%
2017	10.8%	4.0%	7.7%	6.5%	16.4%	25.2%	11.5%	4.6%	8.3%	5.2%	100%
2018	11.0%	4.0%	7.7%	6.6%	16.5%	25.1%	11.7%	4.8%	7.4%	5.2%	100%
2019	10.9%	4.1%	7.5%	6.5%	16.5%	24.9%	11.8%	4.9%	7.3%	5.6%	100%
2020	10.8%	4.1%	7.5%	6.5%	16.5%	24.2%	11.9%	5.0%	7.9%	5.6%	100%
Slope 2014-2020	0.08	0.03	0.00	-0.01	0.10	-0.28	0.17	0.08	-0.32	0.16	
p value	0.024	0.007	0.940	0.314	0.003	<0.001	<0.001	0.004	0.010	<0.001	

*MSK = musculoskeletal.

directors may be useful. For example, as many as 73.6% of orthopaedic surgery residency directors believe COVID-19 has had a “somewhat negative” or “very negative” impact on the clinical and surgical training of fellows. Alternatively, similar levels of concern were not seen in other areas, such as didactic learning¹⁵. Similar surveys conducted among trainees found that as many as 25% believed an additional year of training was necessary as a result of COVID-related impairment in education¹³. With this in mind, residency directors should consider alternative, COVID-compatible educational materials, especially in the realm of clinical and surgical skills.

Limitations

This study is limited primarily by its data source, the ACGME case log reports, which would suffer from any inaccurate reporting from individual residents or programs. We did not conduct a sampling audit to document reporting accuracy. In addition, we were unable to stratify data by geographic location, type of hospital, etc., which may also have an impact on case exposure. For example, there exist differences in quality, quantity, and variability of case exposure across different institutions. Previous studies have found considerable variability in surgical case exposure across several subspecialty rotations^{4,16,17}. Moreover, a number of studies have found significant variation in exposure to specific subspecialty procedures, including those related to oncology, pediatric surgery, spine surgery, microsurgery, arthroscopy, carpal tunnel release, foot and ankle, and peripheral nerve surgeries^{6,18-23}. Furthermore, this study investigated surgical case logs only and was therefore unable to capture nonoperating room training techniques that are now commonly being instituted in orthopaedic training programs. For example, simulators, augmented reality, 3D-printed models of the hand, and cadaver work have all been used to some degree^{8,24-26}. Cadaver simulation in particular was found to improve junior orthopaedic residents' technical and nontechnical skills as well as patient outcomes within just 1 session. Weber et al. found that surgical simulators were similarly beneficial, conferring simulator-trained surgeons with a marked advantage over non-simulator-trained

surgeons²⁶. However, it is important to note that these training techniques are in their infancy and likely do not represent a large enough portion of training to discredit this analysis. Finally, it is important to note that COVID-19 may have impacted case exposure during the latter half of academic year 2019 to 2020. However, case numbers in this study are cumulative over the 5-year residency period, making it less likely that the 4 months affected by COVID-19 would have drastic impacts on case numbers.

Conclusion

After a 2014 decline in case numbers associated with the 2013 update in ACGME case logging expectations, there has been a gradual increase in the number of cases. The rapid decline is most likely a reflection of residents correctly entering 1 primary CPT code for each surgical case, as instructed. Programs should be aware of a general increase in case number since 2014 and acknowledge the fact that some procedure types may be given priority from a logging standpoint when multiple CPT codes apply. Because the increase in cases logged may be associated with an increase in caseload, vigilance surrounding resident well-being is recommended. ■

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