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ORIGINAL RESEARCH

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Otolaryngology resident clinic participation and attending electronic health record efficiency—A user activity logs study

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Abstract

Objectives: In an era of increasing electronic health record (EHR) use monitoring and optimization, this study aims to quantify resident contributions and measure the effect of otolaryngology resident coverage in clinic on attending otolaryngologist EHR usage.

Methods: In one academic otolaryngology department, monthly attending provider efficiency profile metrics, data collected by the EHR vendor (Epic Systems Corporation) between January and June 2019 were accessed. Using weekly resident schedules, resident coverage of attending outpatient clinics was categorized by junior (post-graduate year [PGY] 1-3) and senior levels (PGY-4 through fellows) and correlated with attending EHR metrics using linear mixed effect models.

Results: Thirteen attending otolaryngologists on average spent 58.8 minutes per day interacting with the EHR. In modeling, one day of trainee clinic coverage was associated with a 22 minutes reduction (95% CI [−37, −6]) in total daily attending EHR time and a 12 minutes reduction (95% CI [−21, −3]) in per day note time ($P < .05$). When stratifying by trainee level, senior coverage was associated with significantly reduced total daily time in EHR, per day time in clinical review, notes, and orders, as well as per appointment time in notes and clinical review ($P < .05$). Junior coverage was only associated with reduced per day note time ($P < .05$).

Conclusions: Increasing resident clinic coverage was inversely related to attending time spent in the EHR and writing notes. Resident contributions to EHR workflows and hospital system productivity should continue to be studied and considered in EHR use measurement studies.

Level of Evidence: Level 4.

KEYWORDS
electronic health record, resident education, user activity logs, attending physician productivity

1 | INTRODUCTION

Electronic health record (EHR) systems are now becoming widespread in otolaryngology and all fields, improving patient safety, care quality, and efficiency.[1-4] EHRs allow remote, quick, and standardized access of patient information, streamline documentation, facilitate communication between busy providers, automate risk screening and clinical decision support, reduce adverse drug events, and improve hospital cost savings.[1,2,5-9] At the same time, EHR implementation has been associated with greater physician clerical task burden and reduced face to face, quality patient care.[6,10] A recently published large national study cited that attending otolaryngologists spend approximately 70 minutes per day interacting with the EHR, 42% of which is spent writing notes.[11] This workload is recognized as a major contributor to physician burnout.[12,13] Considering these patterns, analyzing physician EHR utilization is key to optimal implementation and improvement strategies.[14] However, few studies have analyzed physician EHR time allocation in otolaryngology.[11,15]

A new field of EHR use measurement is developing as a means of improving EHR workflow, as well as measuring clinician efficiency and productivity.[16] One avenue to better understand clinician EHR use is analyzing the data, timestamps, and logs automatically collected by many electronic systems.[11,14,17,18] The international EHR vendor Epic (Epic Systems Corporation, Verona, Wisconsin) collects data on user interactions with the EHR, which is compiled into a provider efficiency profile (PEP).[1] Studies analyzing PEP data are becoming more common.[11,18-20]

Amongst this landscape, academic physicians and hospital systems must balance and integrate resident education into patient care. Residents in otolaryngology and other fields have been associated with system-wide inefficiencies, such as increased procedural and operative case duration.[21-23] However, residents spend a significant portion of their time on EHR documentation, possibly 30% to 40% of their day.[15,24,25] In emergency department settings, residents have been associated with some positive and negative impacts: increased attending productivity (number of patients seen), decreased efficiency (time to see patients), as well as greater adeptness using the EHR.[26,27] Yet to our knowledge, no studies have examined how these contributions interplay directly with attending EHR use.

To characterize this relationship, this study examined the impact of resident clinic coverage on attending otolaryngologist EHR use by analyzing PEP measures and resident clinic schedules. We hypothesized that increasing resident clinic coverage would be associated with decreasing attending otolaryngologist EHR use.

2 | MATERIALS AND METHODS

2.1 | Study setting & cohort

This was a retrospective cohort study conducted in one academic otolaryngology department from January to June 2019. This study was approved by the University of Washington's Human Subjects Division (Study #8255). The study group included attending otolaryngologists who treat adults in one academic department at two outpatient clinical sites. Exclusion criteria were attendings with irregular clinic schedules during the study period and those who regularly work with advanced practice providers (APPs), which we assumed would reduce attending EHR use. None of the providers used scribes during the study period.

2.2 | Provider efficiency profile metrics

PEP measures for eligible study subjects were downloaded from the propriety EHR web portal, Signal (Epic Systems Corporation). PEP metrics are tracked and reported as follows. Time collection begins when a user interact with activities within the EHR; the activities analyzed in this study included Clinical Review, In-Basket, Notes, and Orders. The user activity log records time while the user is actively interacting (clicking, typing, scrolling, etc.) with the EHR. Time begins upon selection of an activity and continues until either five seconds of inactivity or the user logs out. Even if the EHR is still open, any idle time over 5 seconds is not counted as part of that time value. If another activity is selected, time continues to be recorded but it is attributed to that new activity. For each provider, PEP measures are reported monthly. The main reporting PEP metrics include per day (daily) and per appointment time. Total daily time is a summation of clinical and off-hours EHR use averaged over a month. Daily time for each activity is obtained by dividing the time spent in a certain EHR activity by the number of days with at least one patient on the ambulatory clinic schedule for the month. Per appointment time is obtained by taking the daily time per activity and dividing it by the respective number of patients scheduled for that time period. At the time of this study, these measures were only recorded on physician providers with ambulatory schedules, and do not account for the time ancillary staff, APPs, residents, or fellows spend on these activities for different attendings' patients.

2.3 | Resident clinic coverage

Resident clinic coverage was tallied for attending otolaryngologists per week by examining internal residency weekly coverage schedules. Resident clinic coverage was recorded by seniority level. Junior residents were considered interns through residents in their third clinical year. Senior residents were considered residents in their fourth clinical year through fellows. Resident assignment to attending clinics was confirmed by manually checking that the assigned resident completed at least two notes for that date on the respective attending's clinic day. Half-days of resident coverage, usually occurring when residents were in clinic after being on-call overnight, were recorded as indicated in the schedule.

2.4 | Statistical analysis

Linear mixed effect models analyzed the relationship between increasing resident clinic coverage and attending PEP measures.

Average days of resident coverage per week were treated as a fixed effect. Individual providers and weeks the data were recorded were treated as random effects, thereby controlling for variations in individual providers, practice styles and schedules, patient medical complexity, and clinical volume. Four linear mixed effect model structures were applied to each different EHR activity reporting metric: Per day EHR time by all resident levels, Per day EHR time dividing resident assignment by junior and senior levels, per appointment EHR time by all resident levels, and per appointment EHR time dividing resident assignment by junior and senior levels. Using the study cohort averages for resident clinic assignment, descriptive estimates of the percent reduction in EHR time were calculated. Statistical analysis and figures were created with "rStudio," Foundation for Statistical Computing, Vienna, Austria (URL https://www.R-project.org/; packages "tidyverse"; "lem4"; "stringer").

3 | RESULTS

Seventeen attending otolaryngologists were eligible for inclusion in this study. One provider was eliminated because of insufficient data for PEP analysis. Three providers were excluded because they work with APPs frequently. Thirteen providers were included in the final analysis. The average times spent using different EHR activities per day and per appointment are shown in Table 1. On average, attending otolaryngologists in this sample used the EHR 58.8 minutes (SD 31.1) per day and 8.3 minutes (SD 4.6) per appointment. Note writing accounted for the highest attending time spent in the EHR, 26.5 minutes (SD 18.8) per day and 4.7 (SD 3.2) per appointment. Average resident clinic coverage per attending was 1.43 (SD 0.82) days per week, including 0.71 (SD 0.60) days of junior and 0.72 (SD 0.53) days of senior coverage. When compared to assistant professors, on average, full and associate professors had 1.1 (95% CI [0.6, 1.6], $P < .001$, 1.7 vs 0.6) more days of weekly total clinic coverage.

Table 2 includes individual linear mixed effect models of the impact of resident clinic assignment on different per day attending EHR time by all residents (model A) and stratified by resident level (model B). Using this same data, Figure 1 plots the simple linear models using per day attending EHR time, and Figure 2 plots the simple linear models for specific EHR activities. Examining per day measures by all resident levels (model A, Figure 2), each increasing day of resident coverage was associated with a 22 minutes reduction (95% CI [−37, −6]) in attending EHR time ($P = .02$), and using the average resident assignment in this population, an estimated 37% reduction per day. All resident levels were associated with decreasing attending time spent writing notes; each day of resident assignment decreased note time by 12 minutes (95% CI [−21, −3] minutes), with an estimated average reduction of 43% ($P = .04$). Although resident assignment tended to decrease other per day EHR activity times (Figure 2), these correlations were not statistically significant in our linear mixed effect models (Table 2—model A).

Senior resident clinic assignment more strongly correlated with decreases in attending EHR per day activity as compared with juniors (Figure 2). Looking at the models stratifying per day measures by resident level (Table 2, model B), increasing senior resident clinic coverage was significantly associated with decreasing attending total daily time (−35 minutes, 95% CI [−55, −12], 29% average reduction, $P = .002$).

TABLE 1 Average attending time (minutes) spent in different EHR activities

EHR activity	Per day (SD)	Per appointment (SD)
Clin. Review	7.7 (4.5)	1.4 (0.8)
In-Basket	4.2 (1.7)	0.8 (0.3)
Notes	26.5 (18.8)	4.7 (3.2)
Orders	7.8 (3.2)	1.4 (0.5)
Total	58.8 (31.1)[a]	8.3 (4.6)

Abbreviations: Clin. Review, clinical review; EHR, electronic health record.
[a]Average total per day time exceeds the sums of the activities specified as above as there are other activities which were not analyzed in this study.

TABLE 2 The impact of resident coverage on Daily attending EHR time (minutes)

	Model A: All residents			Model B: Residents by juniors & seniors				
EHR metric	ε_0	β_A (95% CI)	Red.	ε_0	β_J (95% CI)	Red.	β_S (95% CI)	Red.
Clin. Review	9	−0.9 [−3, 1]	14%	10	−0.8 [−3, 1]	6%	−3 [−6, −0.4]*	22%
In-Basket	4	−0.2 [−1, 0.1]	7%	5	0.4 [−1, 2]	−6%	−1 [−3, 0.3]	14%
Notes	41	−12 [−21, −3]*	43%	41	−12 [−24, −1]*	21%	−13 [−22, −3]*	23%
Orders	9	−1 [−3, 0.4]	16%	10	−1 [−3, 2]	7%	−3 [−5, −0.1]*	22%
Total daily	85	−22 [−37, −6]*	37%	88	−13 [−32, 4]	10%	−35 [−55, −12]*	29%

Note: Each row represents a separate linear mixed effect model for the respective EHR Metric, using model A or model B structure. Model A, minutes EHR activity $= \varepsilon_o + \beta X + \varepsilon_{md}$; Model B, minutes EHR activity $= \varepsilon_o + \beta_J X + + \beta_S X + \varepsilon_{md}$; ε_o, intercept of EHR time (minutes) without resident coverage; β, unstandardized coefficient for the minute reduction in EHR time with days of resident clinic coverage by all residents (β_A), and by junior (β_J) and senior (β_S) levels by all (β_A), junior (β_J), and senior (β_S) residents; X, days of resident coverage per week (fixed effect); ε_{md}, intercept for each attending physician (random effect); Red., descriptive % reduction in EHR activity calculated using average resident clinic assignment in this cohort ($X_A = 1.43$, $X_J = 0.71$, $X_S = 0.72$).
Abbreviations: Clin. Review, clinical review; EHR, electronic health record; Red, reduction.
*P-value < .05.

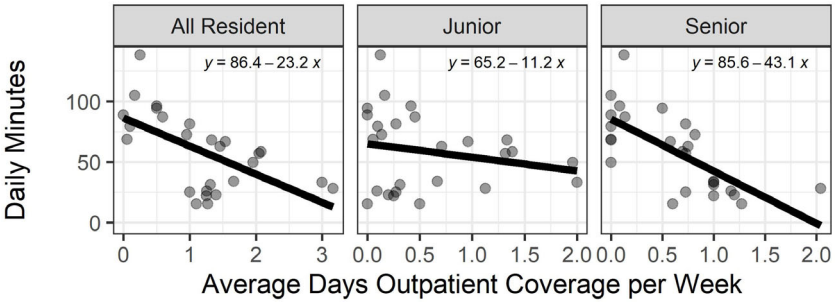

FIGURE 1 Total daily attending electronic health record (EHR) use by average weekly resident clinic coverage. The equations are simple linear regression of the plotted data. Juniors include R1-R3's and seniors include R4-fellows. Increasing resident clinic coverage reduces total daily attending EHR time, but this reduction is stronger if senior residents are assigned to clinic

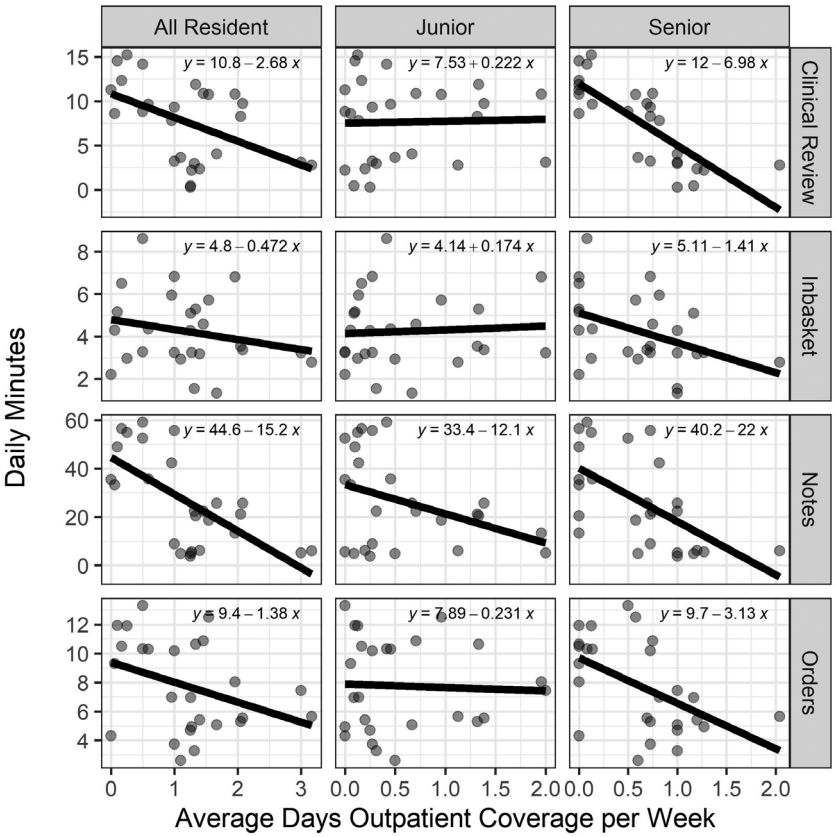

FIGURE 2 Daily attending electronic health record (EHR) use per activity by average weekly resident clinic coverage. The equations are simple linear regression of the plotted data. Juniors include R1-R3's and seniors include R4-fellows. Increasing resident coverage was associated with decreasing per day time for the EHR activities examined. These trends persisted when stratified by resident level, except when junior residents are assigned to clinic, which was associated with increasing time spent in clinical review and In-Basket

This benefit was evident in significant reductions in clinical review (−3 minutes, 95% CI [−6, −0.4], −22% average reduction, $P = .04$), notes (−13 minutes, 95% CI [−22, −3], −23% average reduction, $P = .02$), and orders (−3 min, 95% CI [−5, −0.1], −22% average reduction, $P = .05$). Junior residents only significantly decreased time in notes (−12 minutes, 95% CI [−24, −1], 21% average reduction, $P = .04$).

Figure 3 plots the simple linear models calculated with the per appointment data. Table 3 demonstrates individual linear mixed effect models of the impact of resident clinic coverage on per appointment EHR measures by all residents (model C) and stratified by resident level (model D). Examining all resident levels together (model C), increasing resident clinic coverage was significantly associated with decreasing per appointment time spent in notes (−2 minutes, 95% CI [−4, −0.7], 45% average reduction, $P = .008$). Increasing senior resident assignment to clinic was associated with significantly less attending time spent in clinical review (−0.8 minutes, 95% CI [−1, −0.2], 36% average reduction, $P = .009$) and notes (−3, 95% CI [−4, −1], 26% average reduction, $P = .008$). Junior residents did not significantly impact per appointment attending PEP measures on their own (Table 3—model D).

4 | DISCUSSION

This study examined the relationship between attending otolaryngologist EHR use and resident outpatient clinic coverage by correlating attending EHR log data with resident clinic assignments. The average total daily time otolaryngology attendings use the EHR in this study was 58 minutes (SD 31.1), which is lower than the average reported in a recent large national study examining otolaryngology EHR use (70 minutes, SD 35.7).[11] However, this difference is understandable

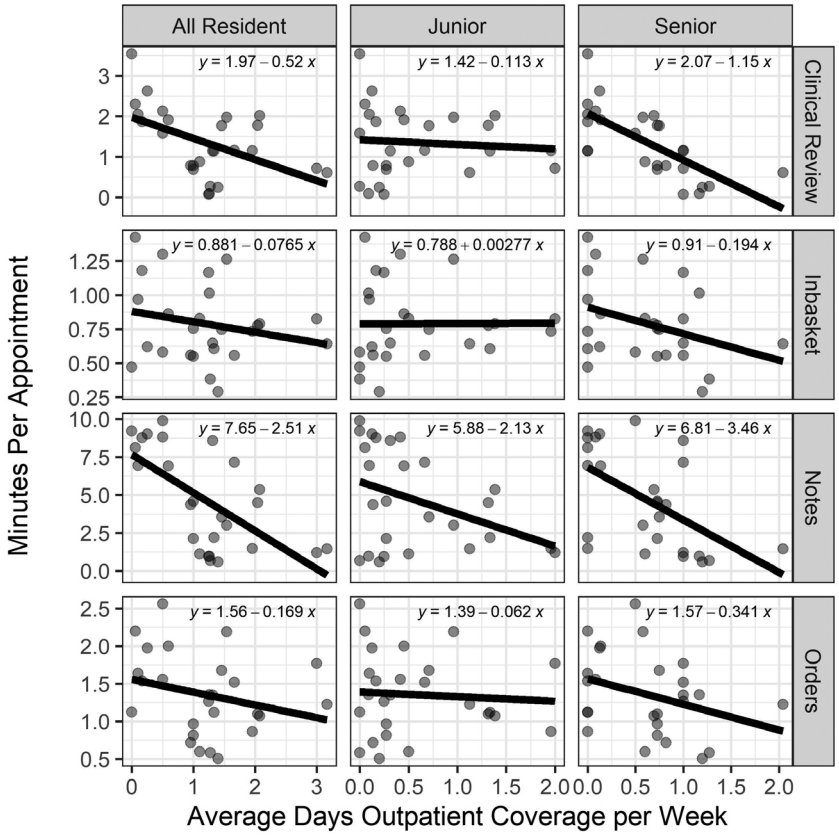

FIGURE 3 Per appointment attending electronic health record (EHR) use by average weekly resident clinic coverage. The equations are simple linear regression of the plotted data. Juniors include R1-R3's and seniors include R4-fellows. Resident assignment to clinic, when analyzed by all resident levels and when stratified by seniority, trended toward reducing attending per appointment EHR time for most EHR activities. The exception was that increasing junior resident assignment to clinic was associated with slight increases in time in In-Basket

TABLE 3 The impact of resident coverage on per appointment attending EHR time (minutes)

	Model C: All residents			Model D: Residents by juniors & seniors				
EHR Metric	ε_0	β_A (95% CI)	**Red.**	ε_0	β_J (95% CI)	**Red.**	β_S (95% CI)	**Red.**
Clin. Review	2	−0.4 [−0.8, 0.1]	29%	2	−0.2 [−1, 0.3]	7%	−0.8 [−1, −0.2]*	36%
In-Basket	1	−0.1 [−0.2, 0.1]	14%	0.9	0.03 [−0.2, 0.2]	−2%	−0.2 [−0.4, 0.02]	16%
Notes	7	−2 [−4, −0.7]*	45%	7	−2 [−4, 0.3]	20%	−3 [−4, −1]*	26%
Orders	2	−0.2 [−0.5, 0.2]	14%	2	−0.1 [−0.4, 0.3]	4%	−0.3 [−1,0.1]	11%

Note: Each row represents a separate linear mixed effect model for the respective EHR Metric, using Model C or Model D structure. Model C, minutes EHR activity $= \varepsilon_o + \beta X + \varepsilon_{md}$; Model D, minutes EHR activity $= \varepsilon_o + \beta_J X + + \beta_S X + \varepsilon_{md}$; ε_o, intercept of EHR time without resident coverage; β, unstandardized coefficient for the minute reduction in EHR time with days of resident clinic coverage by all residents (β_A), and by junior (β_J) and senior (β_S) levels; X, days of resident coverage per week (fixed effect); ε_{md}, intercept for each attending physician (random effect); Red., descriptive % reduction in EHR activity calculated using average resident clinic assignment in this cohort ($X_A = 1.43$, $X_J = 0.71$, $X_S = 0.72$).
Abbreviations: Clin. Review, clinical review; EHR, electronic health record; Red, reduction.
*P-value < 0.05.

as the national study included a variety of practice settings and otolaryngology APPs, and both studies report wide variances in otolaryngologist EHR use. In modeling in this study, each day of resident clinic reduced Total Daily attending EHR use by 22 minutes (95% CI [−37, −6]). Having average resident coverage in this department resulted in 31.5 (37%) fewer minutes of total attending EHR time per week. Resident coverage was associated with improved time spent writing notes; average resident clinic coverage reduced attending otolaryngologist daily and per appointment note time by 43% and 45%, respectively. It is not unexpected that resident coverage would have the greatest impact on note writing, as the large proportion of resident time allocated to documentation is well described.[15,24,28,29] The greater mean improvements observed among senior residents compared to juniors provide internal validity to our findings. The senior resident improvements in time spent in Clinical Review and Orders could suggest that attendings spend more time reviewing the EHR when working with junior residents. These results suggest that increasing resident clinic coverage decreases attending EHR use time, most notably in note writing, and highlights a key contribution otolaryngology residents contribute to academic otolaryngology practices.

Although resident education is part of the mission of academic programs, resident education is frequently cited as negatively

impacting systemic efficiency and productivity. Residents have been associated with increased surgical case duration in otolaryngology, as well as lengthened outpatient visits and lower RVUs in other fields.[14,21-23,30] In contrast, this study highlights a key benefit residents provide in academic otolaryngology practices. Residency is a delicate balance of service and education, and how different residency programs balance these needs and determine clinical schedules varies.[31] Monitoring resident and attending EHR use patterns may be helpful in maintaining appropriate parity between these two goals.

Further, understanding the contribution that trainees make to attendings efficiency is important, because in this population, trainee coverage was not distributed evenly. As noted in this study, during the average week, assistant professors received 1.1 fewer days of trainee coverage. This distribution of trainee coverage likely reflects better or more robust educational opportunities in the established and experience practices of senior faculty. Although trainees should continue to pursue the best educational opportunities, recognizing the contribution that trainee coverage provides, should prompt departmental leadership to direct additional paid resources (APPs, scribe, etc.) to junior faculty where the initiative may have the most impact.

This study suggests some workload task shifting in outpatient otolaryngology clinics, although this study does not describe how attending physician time gains were reallocated. These shifts are important because EHRs have been associated with greater physician burnout.[13] At the otolaryngology resident level, EHRs also decrease direct patient care activities and an estimated 76% of residents report moderate burnout.[15,32] Thus it will be important in future studies to monitor how learning and attending EHR use impacts burnout.[12] Next steps could include surveying attending and resident physicians regarding burnout and educational value of different clinic assignments, and understanding how these variables affect EHR metrics.

There are several limitations to our findings, including health care practice, physician, and resident factors which could have influenced our results. Practice factors include variations in patient medical complexity and the quality/quantity of support staff assisting with EHR work; the per appointment metric (in contrast to daily) should account for inter-attending variations in clinical volume. Provider variations affecting our results include differences in the use of transcription services and speech recognition software, as well as skill and comfort with EHRs.[8] Due to the small attending cohort size and to preserve privacy, we did not examine how differences in attending demographics and EHR comfort could have impacted our results. However, we attempted to control for this variability by making individual providers a random effect in our modeling. Resident schedules were used as a proxy of actual resident EHR contribution, which could not be directly measured via the EHR logs at the time of this study. However, with the projected expansion of user activity logs to include different user types (residents and APPs), this variable may be better controlled for in future studies. Additionally, with this anticipated expansion, it will be interesting to compare resident and APPs impact on attending EHR use. Residents have been associated with lengthened clinic visit times in other studies.[14] This study did not examine clinic visits times directly or how the attending time gains in EHR use were reallocated. Although this study was performed at a single institution with a small sample size, we feel our findings are generalizable to other academic otolaryngology practices.

5 | CONCLUSION

In an era of increasing EHR use measurement and optimization, it is important to examine the factors affecting academic otolaryngologist EHR use.[16] This study examined the relationship between resident coverage in clinic and attending otolaryngologist EHR use. Increasing resident clinic coverage was significantly associated with reduced attending EHR use, with much of this reduction appearing to be due to assistance with note writing. These findings highlight a measurable benefit otolaryngology residents provide in academic practices and the importance of monitoring and accounting for resident contributions when evaluating and improving residency educational value and attending otolaryngologist productivity and efficiency.

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CONFLICT OF INTERESTS

The authors declare no conflict of interests.

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