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Physician Time Spent Using the Electronic Health Record During Outpatient Encounters

A Descriptive Study

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Background: The amount of time that providers spend using electronic health records (EHRs) to support the care delivery process is a concern for the U.S. health care system. Given the potential effect on patient care and the high costs related to this time, particularly for medical specialists whose work is largely cognitive, these findings warrant more precise documentation of the time physicians invest in these clinically focused EHR functions.

Objective: To describe how much time ambulatory medical subspecialists and primary care physicians across several U.S. care delivery systems spend on various EHR functions.

Design: Descriptive study.

Setting: U.S.-based, adult, nonsurgical, ambulatory practices using the Cerner Millennium EHR.

Participants: 155 000 U.S. physicians.

Measurements: Data were extracted from software log files in the Lights On Network (Cerner) during 2018 that totaled the time spent on each of the 13 clinically focused EHR functions. Averages per encounter by specialty were computed.

Results: This study included data from approximately 100 million patient encounters with about 155 000 physicians from 417 health systems. Physicians spent an average of 16 minutes and 14 seconds per encounter using EHRs, with chart review (33%), documentation (24%), and ordering (17%) functions accounting for most of the time. The distribution of time spent by providers using EHRs varies greatly within specialty. The proportion of time spent on various clinically focused functions was similar across specialties.

Limitation: Variation by health system could not be examined, and all providers used the same software.

Conclusion: The time spent using EHRs to support care delivery constitutes a large portion of the physicians' day, and wide variation suggests opportunities to optimize systems and processes.

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Most physicians across the United States have adopted electronic health records (EHRs) (1). Access to data and collaboration among care team members is perceived to be improved with EHRs versus paper, but EHR documentation is more time consuming (2–4). McDonald and colleagues (5) found that internists perceived that they spent an additional 48 minutes per day when using an EHR, with 63.9% stating that documentation took them longer than when using paper-based systems. Overhage and colleagues (6) found, using time–motion methods, that ambulatory providers spent 12 minutes per patient encounter actively using their locally developed EHR, compared with 10 minutes and 48 seconds when using paper. In a small time–motion study, Sinsky and colleagues (7) found that ambulatory physicians spent 337 minutes per day (assuming an 11.4-hour workday) on direct EHR use, with 38.5% of that time dedicated to documentation, 6.3% to review, and 4.4% to ordering. Using EHR logs to measure activity times, Tai-Seale and colleagues (8) found that primary care physicians devoted a mean of 190 minutes (SD, 82) per day (28% of total time assuming an 11.4-hour workday) to documentation. Using a similar approach, Arndt and colleagues (9) reported total EHR time as 355 minutes per day for primary care physicians.

Rosenbloom and colleagues (10) found that the perceived time and effort required to document clinical encounters was 1 of the 5 most important factors in physicians' satisfaction with clinical documentation tools and, anecdotally, that documentation using EHRs required more time than documentation on paper. A recent RAND survey found that EHR use was a major contributor to physician job dissatisfaction (11). Not only does documentation take longer, but the resulting notes may be less useful than paper-based documentation (12). Some experts suggest that EHRs have turned physicians into data entry clerks who are required to document not only diagnoses, orders, and patient visit notes but also an increasing amount of data perceived to be clinically less relevant. Some have speculated that part of the reason EHR-based documentation takes longer is because of the need to fulfill regulatory, reimbursement, and quality measurement requirements (7, 13, 14). In response, health systems have devoted substantial resources to optimize EHR workflows with the goal of improving physician efficiency (15). Some practices have employed medical scribes and have demonstrated success in reducing documentation time (16, 17).

To better document the time ambulatory physicians in medical specialties devote to various tasks using EHRs, we undertook a cross-sectional, multi-institutional national analysis of their EHR time measured using EHR log files.

See also:

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Table 1. Mutually Exclusive, Clinically Focused EHR Function Categories*

Clinically Focused EHR Function Category	Reporting Category	Clinically Focused EHR Function Description
Chart review	Chart review	Discover and review clinical results, observations, and notes in the EHR
Documentation	Documentation	Recording documentation and creating notes
Message center	Messaging	Reviewing, responding, and acting on messages
Orders	Orders	Writing orders
Patient discovery	Other	Tasks related to searching for patients, appointment scheduling, and similar activities
Medicine reconciliation	Other	Reconciliation of a patient's medication data and activities
Allergies	Other	Reviewing and updating a patient's list of allergies
Problems and diagnoses	Other	Reviewing and updating the patient's problem list
Alerts	Other	Reviewing and responding to alerts
Health maintenance	Other	Reviewing and responding to health maintenance/preventive care clinical decision-support alerts
Departure	Other	Selecting patient education and materials, completing departure information, and printing materials
Histories	Other	Reviewing and updating history components (e.g., social or family)
Other	Other	EHR times that have not yet been categorized into another specific activity or that represent categories of activities that are too small to uniquely represent

EHR = electronic health record.
* Several categories that individually accounted for small proportions of the total time were aggregated into 1 category called "other" for reporting purposes.

METHODS

Setting and Participants

We included data on EHR use from physicians of any nonsurgical specialty providing care for adults in the ambulatory setting during 2018 in any of the 2191 health care organizations across the United States that are tracked in Cerner's Lights On Network.

Data Source

We extracted deidentified software log data from the Lights On Network database, which is a collection of systems that monitor hardware and software system activity, clinical application activity, and other user activities. The raw log data are recorded at the level of individual software services and are extremely granular. Patterns of software service use are classified into clinical activities, such as ordering. Data, including time spent, keystrokes, mouse movement, and similar metrics, are aggregated across all software services required to perform that activity. Data are then aggregated by encounter and user. To provide reasonable response times given the extremely large amount of data, the system computes summary statistics (counts, mean, median, and SD) for clinical activities per day and month incrementally. These summary statistics for the 1-day, 1-month, and 1-year intervals during 2018 constitute the data set for this analysis. These data can be linked to other data sets to obtain information, such as the user's specialty and role, as well as the venue of the encounter. Because the research does not involve any interaction or intervention with the physicians and patients, and physicians and patients are not individually identifiable, the research does not qualify as human subjects research under 45 Code of Federal Regulations part 46 (18).

Data Analysis

We did a descriptive study using EHR activity log entries that are extremely granular, reflecting individual software modules and services executed while the provider was using the system. On the basis of our detailed understanding of the modules and services that are accessed while providers are doing various clinical tasks, we mapped the log entry patterns to specific clinical tasks, such as writing documentation, placing orders, reviewing historical notes, or reviewing clinical decision-support alerts (Table 1). The algorithm attributed all EHR time to one of these activity categories.

Because users often multitask and may not be actively using the EHR during a log-in period or may leave the work session without logging out, we excluded any time when they logged into the software but were not actively using it. We termed this "active time." We measured active time on the basis of metadata captured in the Lights On Network activity records using a simple 2-tiered categorization. If a user has logged into the system and the activity records are fewer than 45 seconds apart, then the user is considered an active user. We expect users may spend more than 45 seconds on certain EHR functions, such as reviewing results or entering documentation. When the user spends more than 45 seconds on an activity, we begin to monitor mouse clicks, mouse movement, and keystrokes. On the basis of comparison with direct observation in a sample of 337 physicians across 5 health systems, we set a threshold of 3 or more mouse clicks per minute, 15 or more keystrokes per minute, or mouse movement of 1700 pixels or more per minute, which maximizes correct assessments of active time. Independently, to measure the relationship of active time versus elapsed or total time, we measured both for all physicians providing care in the ambulatory setting at 3 health systems in March 2019.

We defined "after-hours" EHR use as any time spent between 6:00 p.m. and 6:00 a.m. local time on weekdays and anytime on weekends. To compute time per encounter, we accumulated all active EHR time in each category during a specific period and then divided by the number of ambulatory encounters completed during that period. We defined completed patient encounters as the physician signing a note for a

unique patient during that period by entering the note directly in the EHR, writing and scanning it in, or dictating it and having it transcribed. We computed time using months, days, and years as the periods. For our primary analysis, we chose data aggregated by months because the longer period allowed for the fact that providers frequently complete encounter-related work at later dates, and months allowed us to aggregate the work for an encounter even when it extended to subsequent days. We included results from days to provide a comparison with the summary over months and to provide a degree of comparability with previous studies. We report the number of encounters from the 1-year interval because it most directly reflects the total number of encounters.

Statistical Analysis

We used structured query language to compute descriptive statistics for active time per patient encounter for each clinically focused EHR function for each period across all health systems. We then summarized the data by specialty using structured query language. Finally, we used Excel, version 1808 (Microsoft), and R, version 3.5.1 (R Foundation), to summarize the data for presentation

Role of the Funding Source

There was no external funding for this study.

RESULTS

Our study included data from approximately 100 million patient encounters by approximately 155 000 physicians (Table 2). The physicians primarily practiced at integrated delivery networks (34%), regional hospitals (30%), physician groups (22%), and academic medical centers (11%) throughout the United States. The geographic distribution of the headquarters of the physicians' associated health systems (many of which have facilities in several states) are shown in the Appendix Figure (available at Annals.org).

On the basis of comparisons for 1482 physicians, we found that physicians were actively using EHRs for 43% of the total time during which they were logged in, with 10% active 0% to 25% of the time, 56% active 25% to 50% of the time, 33% active 50% to 75% of the time, and only 1% active 75% to 100% of the time. The average total active time per encounter that physicians used the EHR was 16 minutes and 14 seconds, with 11% of this time spent after hours. The mean active time for all clinically focused EHR functions combined varied widely within specialty (Table 2).

Across all specialties, chart review was most time consuming, with 5 minutes and 22 seconds (33%), documentation took 3 minutes and 51 seconds (24%), and ordering took 2 minutes and 42 seconds (17%) (Table 3). The Figure shows the breakdown of EHR function time by specialty.

Table 3. Time Spent per Encounter on Major Clinically Focused EHR Functions

Function Category	Time, *s*	Time, *% of total*
Chart review	322	33
Documentation	231	24
Orders	162	17
Message center	101	10
Patient discovery	75	8
Other	47	5
Problem/diagnosis	17	2
Departure	9	1
History	7	1
Health maintenance	2	0
Alerts	1	0
Allergy	1	0

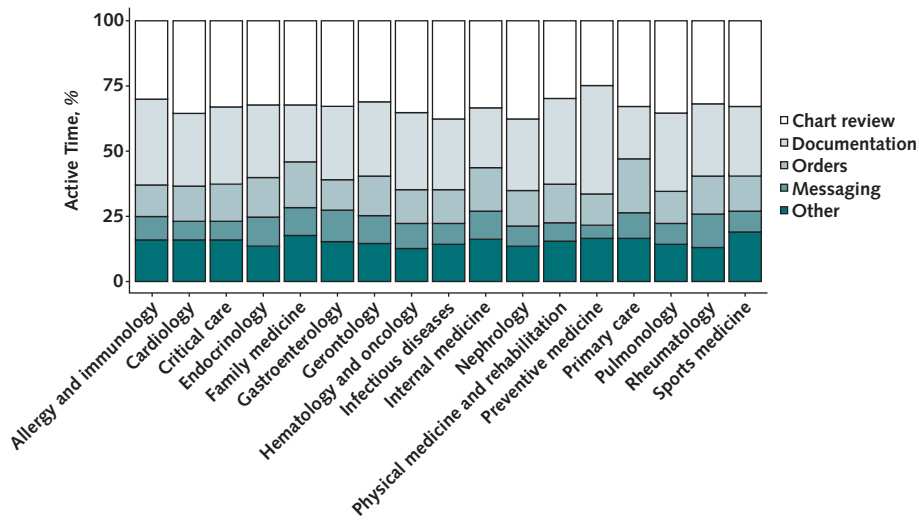
EHR = electronic health record.

Table 2. Number of Physicians, Patient Encounters, and Active Time Using the EHR per Month and Day, by Specialty

Specialty and Subspecialty	Study Physicians, *n*	Patient Encounters, *n*	Mean Active EHR Time per Month (SD), *s*	Mean Active EHR Time per Day (SD), *s*
Allergy and immunology	1506	1 157 420	1063 (2635)	1004 (668)
Cardiology	14 412	6 661 673	682 (2312)	630 (592)
Critical care	1930	333 354	643 (1774)	571 (494)
Endocrinology	2635	2 195 725	1143 (3135)	1078 (706)
Family medicine	49 696	48 050 336	952 (2538)	935 (670)
Gastroenterology	6671	2 848 375	645 (1969)	587 (494)
Gerontology	1999	875 462	1348 (3361)	1252 (787)
Hematology and oncology	7024	3 848 956	952 (2538)	855 (592)
Infectious diseases	3151	711 481	1003 (2129)	887 (591)
Internal medicine	44 348	20 930 266	1099 (3255)	1004 (668)
Nephrology	6208	807 349	1018 (2552)	874 (649)
Physical medicine and rehabilitation	4274	2 218 079	624 (2100)	579 (535)
Preventive medicine	389	305 837	637 (1971)	594 (509)
Primary care	1886	2 458 668	1188 (2663)	1126 (651)
Pulmonology	4886	1 869 214	711 (2220)	656 (577)
Rheumatology	1992	1 699 682	1055 (2780)	979 (656)
Sports medicine	1712	1 240 014	463 (1855)	438 (453)
Total	154 719	98 211 891	1455 (4466)	1241 (1263)

EHR = electronic health record.

Figure. Active time spent per patient on the most time-intensive clinically related EHR tasks, by specialty.



EHR = electronic health record.

DISCUSSION

The physician population monitored by the Lights On Network represents a large sample of U.S. physicians, and the distribution of specialties suggests that the findings should also generalize to nonsurgical physicians caring for adult patients.

Assuming 12.3 patient encounters per day to provide a direct comparison, primary care providers in Tai-Seale and colleagues' study (8) spent similar time per day (3.17 hours) using EHRs as the physicians in this study (3.3 hours). Using the same 12.3 patient encounters per day and Overhage and colleagues' observation, we would expect physicians to spend 2.21 hours per day using paper charts (6). The mean total active time for EHR user per encounter ranged from 463 seconds (sports medicine) to 1188 seconds (primary care), and SDs varied between 1774 seconds (critical care) and 3255 seconds (internal medicine). These ranges suggest but do not prove that more of the variability would be accounted for within specialty provider effect than by specialty effect. The proportion of time spent on each activity was similar across specialties. Because these providers all use the same EHR software, this variability must arise from other factors, such as configuration differences, implementation specifics, practice configuration (for example, how the care team divides tasks among themselves), individual provider choices, and similar factors.

Three functions accounted for almost 75% of EHR time: chart review, documentation, and ordering. However, because of variations in how investigators have categorized and reported clinically focused EHR functions, it is difficult to make comparisons with prior findings. Despite the effort sometimes required to find the relevant data in the EHR (33% of active EHR time devoted to chart review), physicians generally appreciate the improved availability of data. Documentation, on the other hand, accounts for the second-highest proportion of EHR time (24%) and is often a target of physician concern. Documentation may be easier to delegate than some other tasks, in part, because physicians would have to convey complex clinical content to another person or system. For example, Adler-Milstein and colleagues (19) found that physicians delegated only 16% of physical examination documentation and only 29% of the history of present illness documentation, whereas other tasks, such as recording vital signs and medical history, were more commonly delegated (92% and 82%, respectively). Such a task as recording vital signs may be easier to delegate because the delegate can generate and record the data readily, whereas the examiner must share the physical examination findings with the delegate and verify his or her understanding and recording of those findings. Medical scribes have proven to be effective at reducing documentation time (17). Ordering, particularly medication ordering in the ambulatory setting, is an important provider task because it is a basic tool for recording the specifics of the physician's intent and communicating these specifics to other team members. That providers spend almost 8% of their EHR time on patient discovery is somewhat surprising and may represent a relatively easy target to reduce the time spent using EHRs.

The proportion of time physicians of nonsurgical specialties spend on EHR tasks is similar; however, because of the high variability within specialties, little can be concluded about differences or similarities. Acknowledging this limitation, the long mean times spent documenting and short mean times spent coordinating care (messaging) for preventive medicine physicians are consistent with our clinical intuition.

Because providers often complete EHR tasks days after an encounter, the mean active time per patient would be somewhat longer when the summarization

period was a month versus a day. This difference might be expected to be larger for specialties that have average longer active times because there is a higher probability that the work will be broken over days. The large variability precludes concluding that these differences are present, although the means across all specialties are consistent with this expectation. Less expected was that the variability in active EHR time is greater, as reflected by larger SDs, when summarized by month versus day. This effect is most pronounced for nephrology and minimal for sports medicine. A priori, a daily summary might have been expected to have more variability because there would be short fragments of EHR use for an encounter on days after it occurred. One plausible explanation for greater variability by month is that there is simply a larger variation in types of patient encounters over the longer period. A nephrologist, for example, may see new patients on 1 day of the week and have long complex interactions with the EHR for each patient and on other days have shorter, less complex follow-up interactions. This pattern would result in small variation when aggregated by day but larger variation when aggregated by month.

Active EHR times by specialty serve as an important benchmark for providers, health system leadership, payers, and policymakers. Physicians can compare their own EHR time with the reported times for their subspecialty to understand their performance in the context of other providers. Health system leadership can use the data to gain realistic insight into the effort required by physicians to complete their work, including EHR use, and justify investment in optimizing the physician workflow in the EHR. Payers can use the data to understand the level of effort required to complete this important part of a physician's work when using an EHR and consider adjusting their expectations for data capture considering the direct costs. Finally, policymakers may incorporate these data into EHR certification processes and data capture expectations.

In addition to the important findings of the amount of time physicians use EHRs, our study's methods provide the largest scale example of computational ethnography, which Zheng and colleagues (20) defined as "a family of computational methods that leverages computer or sensor-based technologies to unobtrusively or nearly unobtrusively record end-users' routine, in situ activities in health or health care–related domains for studies of interest to human-computer interaction." Using automatically collected software log data increases objectivity, reduces intrusion, improves inclusiveness (capturing data when direct observation by human observers is difficult or impossible), and provides better scalability. The consistency of the estimates of time use from our study and others that have used computerized log files with findings from time–motion, work sampling, survey, and other methodologies suggest that this method is valid. The scale and scope of data that can be evaluated using this method improve the generalizability of the findings.

The large scale and scope of our study, facilitated by the EHR user activity log file methodology, constitutes a strength, albeit at the expense of not being able to measure non-EHR time use. Another strength is that all sites in the study used the same vendor's EHR software. Recognizing that design and implementation choices influence the time providers take to complete tasks, studying a single vendor's system reduces variability, increases comparability, and enables our ability to distinguish vendor-independent differences across geographic regions. Of course, studying users of a single EHR also limits generalizability through comparability, with results from other methods using different EHRs partially addressing this concern. The providers may have cared for only a portion of their patients using the EHRs we studied, which is largely controlled for by the per-patient-encounter analysis. Not knowing the providers' schedules reduces our confidence in the time we allocated as "after hours." Because we treat any evening (after 6:00 p.m. and before 6:00 a.m.) and all weekend EHR time as after hours, we may have overestimated this amount of time. However, the effect may be somewhat offset by providers who work partial days and that the time they spend between 6:00 a.m. and 6:00 p.m. is counted as after hours. The analysis is also dependent on the local health systems correctly classifying provider roles and specialties. Finally, we were unable to analyze the sources of variation, such as differences in clinical processes or software configurations.

This study provides a reliable estimate of the amount of time nonsurgical physicians providing care to adults devote to using EHRs in the ambulatory setting. It does not answer the question of whether it is an appropriate amount of time. We need to continue to identify and eliminate unnecessary and low-value activities across the entire physician workflow. The wide variability in the time providers within specialties spend using the EHR to care for patients is an important finding and warrants further investigation.

From Cerner Corporation, Kansas City, Missouri (J.M.O., D.M.J.).

Disclosures: Dr. Overhage reports personal fees from Cerner Corporation outside the submitted work. Dr. McCallie reports personal fees from Cerner Corporation during the conduct of the study. Disclosures can also be viewed at www.acponline.org/authors/icmje/ConflictOfInterestForms.do?msNum=M18-3684.

Reproducible Research Statement: *Study protocol and statistical code:* Available from Dr. Overhage (e-mail, marc.overhage@cerner.com). *Data set:* Not available.

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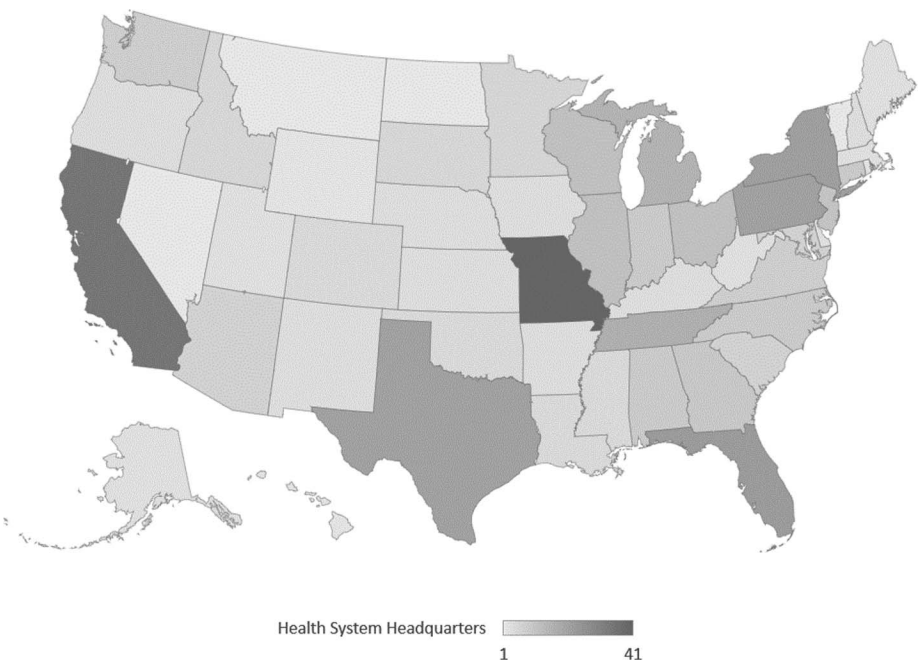
Administrative, technical, or logistic support: D. McCallie Jr.
Collection and assembly of data: J.M. Overhage.

Appendix Figure. Geographic distribution of headquarters of health care organizations with which the physicians are affiliated.



Several organizations have facilities in many states. Shading indicates the range from 1 to 41 organizations by state, with darker shading indicating more organizations.