Title

Time Requirements of Paper-Based Clinical Workflows and After-Hours Documentation in a Multispecialty Academic Ophthalmology Practice

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Time requirements of paper-based clinical workflows and after-hours documentation in a multi-specialty academic ophthalmology practice

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Abstract

Purpose: To assess time requirements for patient encounters and estimate after-hours demands of paper-based clinical workflows in ophthalmology.

Design: Time-and-motion study with a structured survey

- **Setting:** Single academic ophthalmology department.
- **Participants and Observation Procedures**: Convenience sample of seven attending ophthalmologists from six subspecialties observed during 414 patient encounters for the time-motion analysis and twelve attending ophthalmologists for the survey.
- **Main Outcome Measures**: Total time spent by attending ophthalmologists per patient, and time spent on documentation, examination, and talking with patients. The survey assessed time requirements of documentation-related activities performed outside of scheduled clinic hours.

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Results: Among the 7 attending ophthalmologists observed (6 men and 1 woman, mean (SD) age, 43.9 (7.1) years) during encounters with 414 patients (mean (SD) age of 57.8 (24.6) years), the mean (SD) total time spent per patient was 8.1 (4.8) minutes, with 2.8 (1.4) minutes (38%) for documentation, 1.2 (0.9) minutes (17%) for examination, and 3.3 (3.1) minutes (37%) for talking with patients. New patient evaluations required significantly more time than routine follow-up visits and postoperative visits. Higher clinical volumes were associated with less time per patient. Survey results indicated that paper-based documentation was associated with minimal after-hours work on weeknights and weekends.

Conclusions and Relevance: Paper-based documentation comprises a substantial portion of the total time spent for patient care in outpatient ophthalmology clinics but is associated with minimal after-hours work. Understanding paper-based clinical workflows may help inform targeted strategies for improving electronic health record use in ophthalmology.

INTRODUCTION

Data-driven optimization of clinical workflows has been shown to promote efficiency[1–3] and healthcare quality and safety.[4–6] Electronic health records (EHR) have become widely adopted in all medical specialties, including ophthalmology. National surveys demonstrate an increase from 19% of American ophthalmologists using an EHR in 2006,[7] to 47% in 2011,[8] to 72% in 2015–2016.[9] EHR use offers many benefits, such as promoting clinical decision support, care coordination, population health, quality improvement, and clinical research.[10] However, with the high adoption rates, an increasing number of ophthalmologists have expressed negative perceptions of the EHR.[9] The time and complexity associated with EHR documentation are concerning to physicians in general[9,11–13] and are contributing to dissatisfaction and burnout.[14–16] Whether this negative effect originates primarily from changes in the workflow or underutilization of EHR features is unclear. Also unclear is whether time efficiency is equivalent once the transition period from paper to electronic health records is completed and a steady state is achieved. Studies suggest this phenomenon is unique to the United States, where regulatory and billing requirements have necessitated more documentation than clinical care alone would dictate.[17]

Several prior studies examining the transition from paper charts to EHR in ophthalmology[18,19] examined clinical volume and revenue but not timing changes. While time requirements associated with EHR use in ophthalmology have been characterized,[1,11,20,21] timing data for paper-based documentation are scarce.[22] This happened presumably because few organizations performed detailed analyses of paper-based workflows and their time requirements before implementing EHRs. Targeted strategies for improving the EHR – an active area of investigation[15,23,24] – can be enhanced by deeper understanding of paper-based methods.

We conducted time-motion analyses of paper-based clinical workflows in outpatient clinics of the University of California San Diego (UCSD) Shiley Eye Institute and Viterbi Family Department of Ophthalmology, which uses paper-based documentation and provided an environment for studying this issue. Additionally, we surveyed ophthalmologists to understand current workflows and estimate after-hours documentation demands. This information fills a critical gap in the current literature regarding clinical workflows and timing information using paper charts prior to EHR implementation and may help inform future improvements in EHR use for ophthalmology.

METHODS

Study Institution

The UCSD Shiley Eye Institute and Viterbi Family Department of Ophthalmology is an academic ophthalmology department that implemented an EHR (EpicCare; Epic Systems, Verona, WI) for patient registration, scheduling, and ambulatory surgery in 2013. At the time of this study, all outpatient clinical encounters were being documented on paper charts. This study adhered to the Declaration of Helsinki and was approved by the UCSD Institutional Review Board with waiver of consent and HIPAA exemption.

Study Design

This prospective mixed-methods study entailed: 1) time-motion observations of outpatient ophthalmology clinic encounters, and 2) a survey of attending ophthalmologists' workflows and documentation demands.

For the time-motion analysis, a convenience sample of seven attending ophthalmologists from six subspecialties (comprehensive, cornea, glaucoma, oculoplastics, pediatrics, and retina) were observed for 17 half-day clinic sessions in September 2018. Inclusion criteria were: full-time faculty members who had worked at UCSD for at least one year, were involved in teaching residents and fellows, and were clinically active (defined as having at least 4 clinic sessions per month) at the time of the study. Attending ophthalmologists were selected for time-motion observations based on the scheduling constraints of when observers were available. All patient encounters during the observed clinic sessions were eligible for inclusion. Demographic information such as age, self-reported gender, self-reported ethnicity, and primary language were recorded for each physician and patient, as well as visit type (new patient, routine follow-up, or post-operative visit within the 90-day global period), trainee involvement (defined as resident or fellow examining the patient prior to the attending), and whether the patient was dilated. The number of exam rooms, technicians, trainees, and patients ("clinic volume") were recorded for each clinic session.

Data on the following outcomes per patient were recorded: total time spent by the attending ophthalmologist on the patient, as well as time spent a) documenting (whether during patient encounters or between encounters), b) examining, and c) talking with the patient. The protocol for collecting time-motion data was based on previously published methods.[11] Documentation was broadly defined to include reviewing notes and images, writing notes, writing orders or prescriptions, and billing-related paperwork. If talking with the patient occurred simultaneously with another activity, the non-talking activity was recorded. Time spent performing procedures, talking with trainees or staff, and waiting for patients to be ready was also recorded. Time-motion data were collected by SLB (physician), HEG (medical student), and 6 trained student observers (1 medical student, 1 postbaccalaureate student, and 4 undergraduates) using a standardized data entry tool (Numbers; Apple, Inc, Cupertino, CA) with pre-loaded dropdown lists to reduce inter-observer variability. Pilot training sessions were conducted over seven halfday clinics preceding the study. Parallel observations were performed between the lead author (SLB) and all observers during the pilot phase to verify consistency, as measured by intraclass correlation coefficient exceeding 0.8 (calculated with the *icc* function in the *psych*[25] package in R). Pilot data were not included in the analysis.

The survey was developed de novo and validated by three physicians (SLB, MM, and REK) outside of the study cohort to establish face validity, resolve any issues with wording, evaluate for forced choice, floor and ceiling effects, and ensure clear branching logic. Inclusion criteria were the same as the time-motion analysis. The survey was deployed after time-motion observations were complete. Survey data were collected and managed using REDCap, a secure web-based application supporting data capture for research studies.[26] Survey items included years of practice, clinical volume, and type and timing of documentation-related work (see supplemental survey instrument).

Statistical Analysis

Descriptive statistics for attending ophthalmologists, patients, and timing outcomes were generated in aggregate and by subspecialty. To examine the effects of factors related to attending ophthalmologists, patients, and encounters on timing requirements, multivariate linear mixed effects models were developed. Attending ophthalmologists and patients were set as random effects. Separate models were developed designating total time as the dependent variable and documentation time as the dependent variable. Covariates included patient's age, gender, ethnicity, language, visit type, dilation status, trainee involvement, clinic volume, and number of available technicians, trainees, and exam rooms. Statistical significance was defined as $p<0.05$. Analyses were conducted in R[27] using the *lme4* and *lmerTest* packages.[28]

RESULTS

Study Population

Outpatient clinic encounters for seven attending ophthalmologists and 414 patients were observed in six different subspecialties (Table 1). Attending ophthalmologists' mean (SD) age was 43.9 (7.1) years (range: 34 to 55 years), and six (86%) were male. Three (43%) were professors, 2 (29%) were associate professors, and 2 (29%) were assistant professors. Mean years in practice was 11.3 (7.9) (range: 1 to 25). Each attending ophthalmologist was observed for 2–3 half-day clinic sessions. A half-day clinic session included appointment start times spanning 3.5 hours on average (e.g. first appointments at 8:00 AM, last appointments at 11:30 AM). Mean observation time per half-day clinic session was 204.5 (41.9) minutes. Patients' mean age was 57.8 (24.6) years (range: 0 to 96), with 240 (58%) females. Mean clinical volume was 31.4 (12.8) patients. On average, each clinic used 6.9 (1.4) exam rooms and was staffed by 3.8 (1.0) technicians and 1.6 (0.8) trainees.

Timing of Physician Activities

Using paper charts, attending ophthalmologists spent a mean (SD) of 8.1 (4.8) minutes per patient (Table 2). Documentation required 2.8 (1.4) minutes, representing 38% of the total time per patient. Documentation time was recorded whether the attending ophthalmologist was documenting inside the clinic room or in the hallway immediately before or after the face-to-face encounter with the patient. Attending ophthalmologists spent 1.2 (0.9) minutes on examination (17% of total time) and 3.3 (3.1) minutes exclusively talking with the patient (37% of total time). The remaining time was spent on various activities such as talking with staff, talking with trainees, or personal tasks.

Multivariate linear mixed effects models were developed using total time as the dependent variable and using documentation time as the dependent variable. For both total time and documentation time, patient demographics (age, gender, ethnicity, language), dilation status, and space/personnel resources (number of exam rooms, technicians, and trainees) did not have a significant effect. Having a trainee examine the patient first did not influence the attending ophthalmologist's time expenditure. However, as expected, visit type and clinic volume significantly influenced timing outcomes in both multivariate models. Compared with new patients, significantly less total time and documentation time was spent on routine follow-up patients (−3.1 minutes, p<0.001 and −0.7 minutes, p<0.001, respectively) and post-operative patients (−4.3 minutes, p<0.001; −1.5 minutes, p<0.001). Greater clinical volume (i.e. number of patients who were seen during a clinic session) was associated with significantly less total time (−0.13 minutes, p=0.007) and less documentation time (−0.03 minutes, p=0.03) per patient.

After-Hours Documentation Demands on Paper

Of 17 eligible attending ophthalmologists, 12 (71%) responded to a survey regarding workflows that was deployed after time-motion observations had been completed. Age, gender, subspecialty, and academic rank were not asked in the survey in order to preserve anonymity. Survey respondents were mostly mid-career and senior attending ophthalmologists, with half endorsing 11–20 years in practice, and one-third with ≥21 years in practice. Typical self-reported clinical volume was high, with 5 (42%) attending ophthalmologists seeing >30 patients per half-day, 4 (33%) seeing 21–30 patients per half-day, and 3 (25%) seeing 11–20 patients per half-day.

Two (17%) attending ophthalmologists denied any work outside of patients' scheduled clinic sessions. For those who did work outside of clinic, they selected which activities they performed from a pre-specified list on the survey instrument. Common activities were communicating with patients (6 respondents, 50%), communicating with other providers (6, 50%), billing (5, 42%), and interpreting imaging/ancillary studies (5, 42%). One-quarter to one-third of attending ophthalmologists indicated writing orders for medications, labs, or imaging, reviewing operative notes, and writing notes after clinic encounters. None indicated that they prepared notes before clinic.

Although the majority (10, 83%) indicated they did some documentation-related work outside of patients' scheduled clinic sessions, in general this work incurred minimal after-hours effort. In a typical week, on weeknights after business hours, 9 (75%) did no work, 2 (17%) worked <1 hour, none worked 1–2 hours, and 1 (8%) worked >2 hours. On weekends, 8 (66%) did no work, 3 (25%) worked <1 hour, 1 (8%) worked 1–2 hours, and none worked >2 hours. Work generally occurred during weekday business hours (Figure 1).

DISCUSSION

Documentation time during and outside of clinic remains a prominent concern about EHRs. This is particularly challenging for a high-volume specialty such as ophthalmology.[22] Without detailed timing and workflow data associated with paper-based documentation (the "before"), fully evaluating the changes associated with EHR use (the "after") is difficult. The few existing published studies of paper documentation among eyecare providers used self-reported timing logs,[22,29] which cannot capture task breakdown within encounters in real time. Key findings from this study were: 1) paperbased documentation comprised a substantial proportion of the total time spent on patients, 2) time requirements were significantly influenced by clinic volume and visit type and varied among individual attending ophthalmologists, and 3) after-hours demands were minimal.

Attending ophthalmologists in our study spent 2.8 minutes on paper-based documentation per patient, representing 38% of the total time. In a cohort of academic attending ophthalmologists in Oregon, EHR documentation required 3.0 minutes per patient encounter, representing 27% of the total patient encounter.[11] During the patient encounter itself, documentation time appears similar whether using paper or EHR. Our finding of attending ophthalmologists dedicating about 38% of the total time per patient on documentation was consistent with several prior studies evaluating proportional time expenditure on both EHRs and paper-based records across a wide range of specialties, ranging from 34% to 37%.[30–32] Therefore, among attending ophthalmologists, documenting on paper still represents a sizable source of work and time investment in the context of the whole patient encounter. This finding may be surprising in light of the perception that paper-based documentation is more straightforward and efficient compared with EHR-based documentation, but the substantial proportional time expenditure even with paper charts highlights that clinical documentation can be occupy a significant portion of the total encounter regardless of method.

The second key finding was that visit type and clinic volume significantly affected attending ophthalmologist time expenditures, and that in general time expenditures varied among individual attending ophthalmologists. Attending ophthalmologists spent significantly more time on new patients than on routine follow-up evaluations and on post-operative visits, even when adjusted for other patient characteristics. Clinic volume also significantly affected both total time and documentation time spent by attending ophthalmologists per patient. Attending ophthalmologists with more patients scheduled tended to spend less time with each individual patient. Five of the seven observed attending ophthalmologists saw more than 30 patients in a half day, and one attending ophthalmologist completed almost 60 encounters in a single morning clinic. The mean total time spent per patient by the ophthalmologists observed in this study was 8.1 minutes per patient, which was considerably shorter than that reported by Chiang *et al.*[22] for a retina specialist (15.6 minutes) and a pediatric ophthalmologist (18.4 minutes) in the only other timing study describing academic ophthalmologists using a paper-based documentation system. The mean clinic volume at that institution was 14 patients per half-day,[22] which was less than half of the mean clinic volume (31 patients per half-day) for our study. Thus, the high clinic volumes of the attending ophthalmologists in our study may have contributed to less total time spent per patient and shorter documentation time. Attending ophthalmologists with higher volume practices may have greater efficiency without reduction in quality of care. We caution that any inference be made between reduced time with the patient and quality of care.

The time expenditure on documentation varied across individual attending ophthalmologists from different specialties. Two attending ophthalmologists in oculoplastics spent the least amount of time on documentation in both absolute (1.7 minutes) and proportional (28%) terms, which may reflect the reduced documentation requirements for that subspecialty. Although the second shortest amount of documentation time was in retina (2.9 minutes), this represented the highest proportion of total time spent per patient (47%). In contrast, for specialties where mean documentation times per patient were longer in absolute terms (3.9 minutes for pediatrics and 3.5 minutes for cornea), the proportion of overall time were not necessarily higher (36% for pediatrics and 25% for cornea). This contrast between documentation time in absolute and proportional terms appeared to be driven by differences in time spent talking (Table 1). This variation was not surprising given expected differences in communication and practice styles. Furthermore, workflow patterns varied based on each subspecialty's clinical demands – for instance, whether dilation, ancillary imaging, or additional exam elements were needed. Given that these variations exist even with paper charting, future studies of EHR use may be better served by evaluating how well the EHR matches each attending ophthalmologist's desired workflow and practice style rather than evaluating absolute time.

Our final key finding was that although paper-based documentation comprised a substantial proportion of the total time during a clinic session, it was associated with minimal after-hours work. We are not aware of any prior studies examining after-hours documentation among ophthalmologists using paper charts. One-sixth of the attending ophthalmologists we surveyed did not report any documentation-related work outside of patients' scheduled appointments. The remaining attending ophthalmologists reported working primarily during weekday business hours. The majority did not do any documentation-related work on weeknights (75%) or on weekends (66%). Because paper charts could not physically leave the clinic, after-hours documentation at home was impossible. Thus, minimal after-hours documentation was not surprising. In contrast, for attending ophthalmologists in the Oregon study,[11] although EHR use required only 3.0 minutes during the patient encounter, audit logs demonstrated 10.8 minutes of EHR use per patient overall, translating into a mean of 1.6 hours of EHR use outside the clinic session for a full day of clinic. Substantial EHR use outside of work hours has been well-documented in other specialties.[12,16,30] One large-scale study of 471 primary care physicians found that the "natural decline" of EHR log-ins was after 2:00 AM.[33] The physically constrained nature of paper charting being associated with minimal after-hours work suggests that EHR accessibility at home represents a doubleedged sword of flexibility and constant connectivity, blurring boundaries between professional and personal time. With increasing awareness of the association between EHR use, and particularly after-hours use, with physician burnout,[14,16,30,34] recognizing these boundaries and adjusting expectations regarding physicians' after-hours EHR use are warranted. It is also possible that the availability of after-hours connectivity may lead some physicians to log-on even if chart documentation is complete. It is unclear if prior studies were able to separate this group of physicians from those completing required documentation.

A key strength of this study was the large number of observations, with over 400 encounters between attending ophthalmologists and patients, making it the largest cohort undergoing manual time-motion observations on paper charts in an ophthalmology setting. Multiple subspecialties were included, contrasting with prior studies which focused on only one or two subspecialties.[22,35] Finally, timing data were gathered not just on the overall length of encounters but also on specific activity breakdown.

Limitations of the study were that it was limited to an academic ophthalmology department, so findings may not apply to other practice settings or specialties, although we demonstrated that proportional time expenditure on documentation in this cohort was similar to results reported in other fields.[30–32] Another limitation was that after-hours documentation was assessed using a survey, which is subject to self-reporting bias. However, we were not able to practically have observers follow attending ophthalmologists after-hours to record timing data that would be equivalent to an EHR audit log. Finally, observers in the study were trained to be as unobtrusive as possible during data collection, but even with their mere physical presence in clinic, observed healthcare personnel may have changed their behaviors (and subsequently their timing) due to the knowledge that they were being observed. Any manual time-motion study will have this Hawthorne effect, and in this situation manual time-motion observations were necessary in the absence of an electronic audit log.

In summary, we gathered detailed timing data to better understand paper-based workflows in ophthalmology. Analysis of clinical workflows using time-motion data can help inform targeted strategies for preparing for changes in health information technology. In the last decade, those changes have largely involved EHR implementation. In the coming years, focus will turn to EHR optimization, upgrades, change of vendors, or integration of new technologies, as health information technology is rapidly evolving. Lessons learned from paper-based documentation, a process refined in the past, will enable us to more effectively shape the future.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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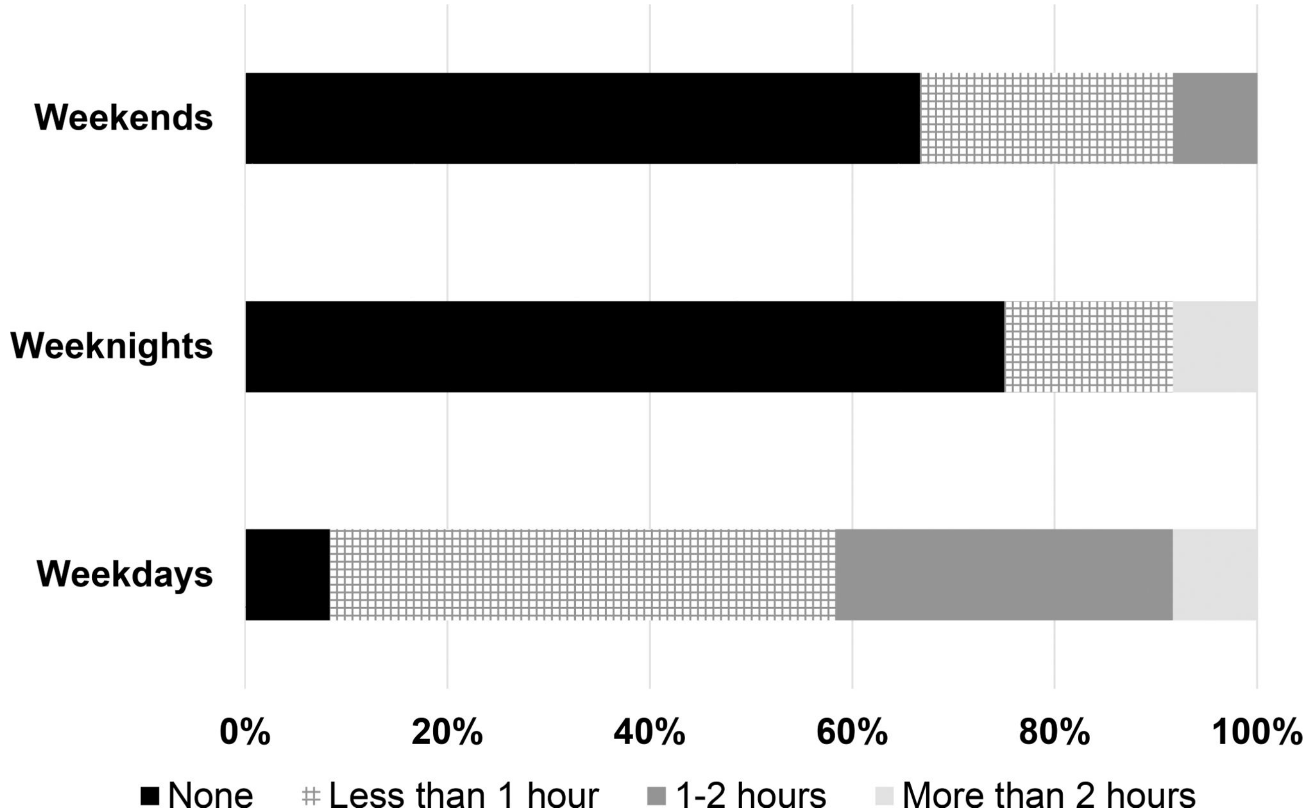

Figure 1. Time requirements for paper-based documentation for patients outside of their scheduled clinic sessions.

Ophthalmologists (n=12) reported how much time they spent on work for scheduled patients outside of their face-to-face encounters during weekday business hours, weeknights after business hours, or weekends. 75% of physicians reported not doing any work on weeknights after hours, and 66% of physicians reported not doing any work on weekends.

Table 1.

Characteristics of ophthalmology physicians and patients included in time-motion analyses of encounters utilizing paper-based documentation in 2018.

Characteristic	Ophthalmology Physicians (N = 7)	Ophthalmology Patients (N=414)
Mean Age[a] (SD, Range)	43.9 (7.1, 34 to 55)	57.8 (24.6, 0 to 96)
Sex		
Female	1 (14.3%)	240 (58.0%)
Male	6 (85.7%)	174 (42.0%)
Race/Ethnicity[b]		
White	4 (57.1%)	256 (61.8%)
Black or African American	0 (0%)	15 (3.6%)
Hispanic	0 (0%)	65 (15.7%)
Asian	3 (42.9%)	61 (14.7%)
Other Race or Mixed Race	0 (0%)	17 (4.1%)
Primary Language[c]		
English	7 (100%)	386 (93.2%)
Spanish	0 (0%)	15 (3.6%)
Other	0 (0%)	13 (3.1%)
Subspecialty[d]		
Comprehensive	1 (14.3%)	62 (15.0%)
Cornea	1 (14.3%)	40 (9.7%)
Glaucoma	1 (14.3%)	51 (12.3%)
Oculoplastics	2 (28.6%)	115 (27.8%)
Pediatrics	1 (14.3%)	41 (9.9%)
Retina	1 (14.3%)	105 (25.4%)

[a] Age in years at the time of the observed clinical encounter.

[b] Race based on self-report for physicians, and for patients based on self-reported identification in the electronic registration system.

[c] Primary language for patients based on language patient used during the clinical encounter.

[d] Subspecialty for patients indicates the subspecialty of the patient’s treating physician in the observed clinical encounter.

Table 2.

Time requirements for attending ophthalmologist activities for outpatient clinical encounters using paper-based documentation.[a]

The total time spent by the attending physician related to patients seen during the observed clinic sessions was recorded and averaged by subspecialty, as well as the distribution of activities such as documentation, examination, and talking with the patient.

		Total Time[b]	Documentation		Examination		Talking with the Patient	
Subspecialty	**Number of patients**	**Minutes, Mean (SD)**	**Minutes, Mean (SD)**	**% of Total Time[c]**	**Minutes, Mean (SD)**	**% of Total Time[c]**	**Minutes, Mean (SD)**	**% of Total Time[c]**
Comprehensive	62	7.5 (3.4)	3.1 (1.2)	43%	1.2 (0.7)	16%	3.0 (2.1)	37%
Cornea	40	14.7 (5.8)	3.5 (1.6)	25%	1.4 (0.8)	11%	7.8 (4.8)	50%
Glaucoma	51	8.0 (3.7)	3.1 (1.3)	42%	1.6 (0.9)	21%	2.9 (2.1)	34%
Oculoplastics	115	6.4 (4.1)	1.7 (1.2)	28%	1.0 (0.7)	18%	2.9 (2.7)	42%
Pediatrics	41	11.7 (5.4)	3.9 (1.6)	36%	2.0 (1.3)	20%	4.7 (3.5)	37%
Retina	105	6.7 (3.2)	2.9 (1.1)	47%	1.0 (1.0)	15%	2.0 (1.8)	27%
Overall	**414**	**8.1 (4.8)**	**2.8 (1.4)**	**38%**	**1.2 (0.9)**	**17%**	**3.3 (3.1)**	**37%**

[a] Data are displayed per patient for 7 ophthalmologists and were obtained using manual time-motion observations of individual physician activities.

[b] Total time spent by the attending physician on the patient encounter during the clinic session. This was not limited to face-to-face time with the patient in the clinic room, but includes all time spent on the patient's care during the observed clinic session.

[c] Percentages do not add up to 100%, as other activities may have been performed for patient care, such as performing procedures, talking with trainees about the patient, and talking with staff about the patient. Percentage time for each activity was calculated per patient and then averaged, but since not all activities were performed for each patient, percentages do not add to 100%.