EDITOR'S CHOICE

Use of electronic clinical documentation: time spent and team interactions

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ABSTRACT

Objective To measure the time spent authoring and viewing documentation and to study patterns of usage in healthcare practice.

Design Audit logs for an electronic health record were used to calculate rates, and social network analysis was applied to ascertain usage patterns. Subjects comprised all care providers at an urban academic medical center who authored or viewed electronic documentation.

Measurement Rate and time of authoring and viewing clinical documentation, and associations among users were measured.

Results Users spent 20–103 min per day authoring notes and 7–56 min per day viewing notes, with physicians spending less than 90 min per day total. About 16% of attendings' notes, 8% of residents' notes, and 38% of nurses' notes went unread by other users, and, overall, 16% of notes were never read by anyone. Viewing of notes dropped quickly with the age of the note, but notes were read at a low but measurable rate, even after 2 years. Most healthcare teams (77%) included a nurse, an attending, and a resident, and those three users' groups were the first to write notes during an admission.

Limitations The limitations were restriction to a single academic medical center and use of log files without direct observation.

Conclusions Care providers spend a significant amount of time viewing and authoring notes. Many notes are never read, and rates of usage vary significantly by author and viewer. While the rate of viewing a note drops quickly with its age, even after 2 years inpatient notes are still viewed.

INTRODUCTION

The nation is increasingly focused on the adoption of electronic health records. Clinical documentation—which defines the patient—is the core of the electronic health record, forming the foundation on which sit most other functions, including information access, interprovider communication, automated decision support, and registry functions.[1]

Physicians in hospital settings spend much of their daily working time on documentation.[2 3] In a broad study of the perceptions of medical residents about the time they spend on documentation,[4] two-thirds reported spending over 4 h, which was more than they reported spending on direct patient care. Most studies assessing time efficiency have noted a substantial increase in time spent documenting when using an electronic health record compared to paper.[5]

Compared to paper, electronic provider documentation allows faster and more complete access to the patient record, and may improve communication among members of the healthcare team.[6 7] Some evidence exists that electronic documentation may be associated with improved patient outcomes and decreased costs.[8] In contrast to these benefits, evaluators have also identified unintended consequences of adopting electronic provider documentation, including changes to workflow, increased time spent writing notes, and an adverse effect on documentation quality.[5 9 10] Furthermore, residents perceive that they get feedback on their documentation less than 30% of the time.[4]

Many electronic health records have detailed audit logs that permit the monitoring of user behavior, including authoring and viewing clinical notes. These logs are often used to infer suspicious activity with respect to patient privacy,[11] but they may also be used to learn about healthcare. For example, they have been used to infer clinicians' information needs.[12]

We believe that audit logs of the authoring and viewing of documentation can advance the informatics field in three ways. First, by better understanding the use of documentation facilities, it may be possible to improve the electronic health record. For example, its user interface can be tailored to make access to frequently used features or data more efficient. Second, the audit logs can reveal information about individual clinician's behavior. For example, while there is a body of literature on creating documentation,[13–15] few have focused in detail on the viewing of documentation. Third, the audit logs can also reveal information about interactions among team members, potentially diagnosing and offering solutions to communications gaps. In this study, we use clinical documentation audit logs to characterize the generation and use of clinical documentation, as well as the formation of clinical teams and the communication within them.

METHODS

The study was carried out for the inpatient area of an academic medical center. All clinical notes at the center are authored and viewed in the Eclipsys XA (Eclipsys Corporation, Atlanta, Georgia) electronic health record product. We used detailed usage logs for the Eclipsys product (Corman Technologies, Santa Rosa, California), which show user identity, note type, and time spent viewing the note. Institutional review board approval was obtained for the study.

We tallied the rates and timing of authoring and viewing clinical notes among user groups. We employed social network analysis[16] to characterize the relationships among users. Social network analysis has been used in a wide variety of contexts,

including scientific coauthorship, citations, email, sexual contacts, and metabolic networks. Three properties [16] are particularly relevant: the degree of the network, which reflects the mean number of viewings by a viewer of an author's notes; assortative mixing among user groups, which reflects pairwise associations among user groups; and hierarchical community structure, which defines larger groupings of users that view each other's notes. We used APL2 (APL2000, Rockville, Maryland) and igraph (http://igraph.sourceforge.net/) to calculate network parameters.

RESULTS

Documentation authoring and viewing

Table 1 shows the number of authors and the mean number of notes they authored per week; and the number of users who viewed notes and the mean number of notes they viewed per week. The table is organized by user group, where groups are defined in the system. The row marked 'billing/HIM' includes billing compliance personnel, the health information management department, quality assurance, and administrative coordinators. 'Other clinical' includes pastoral care and certain psychiatry roles. The 'notes authored per week' column shows that the bulk of documentation in the electronic health record consists of nursing, resident, and attending notes. Nevertheless, respiratory therapists, dieticians, and social workers generate more notes per user ('notes authored per user per week'). The groups that view the most notes ('notes viewed per week') are residents and 'billing/HIM,' illustrating the importance of both clinical and administrative functions.

The amount of time users spent authoring and viewing notes is shown in table 2 for the larger, clinically relevant user groups. The first numeric column shows the time per day authoring notes for those days where the user authored at least one note, and the second numeric column shows the time per day for those days with more significant involvement to ensure that the user was actually on service. The latter includes runs of days in which the user authored notes on at least two patients per day, for at least 2 days in a row, and with at least 1 day with at least four patients. The third and fourth columns show time per day viewing notes for those days in which at least one note was viewed, and those days with more significant involvement, defined similarly to column 2, but with viewing instead of authoring. Other than dieticians, users averaged less than 90 min per day authoring notes and 30 min per day viewing notes, even on days with significant involvement. Nurses can author structured or free text notes, which are included in table 2, and they can document in 'flowsheets,' which are not included in the table. The latter include plan of care, vital signs, intake and output, treatment parameters (isolation, wound care, etc), and data for quality initiatives such as falls risk assessment. Therefore, total nursing documentation time is greater than that shown in the table.

We assessed the proportion of notes that were viewed within 3 months and who viewed them. Figure 1 shows the percentage of notes written by an author within one of five user groups that were viewed by users in the same or other groups. To emphasize communication rather than recall, an author viewing their own note was not counted in this graph. The designation 'anyone' refers to all the users in table 2 except the 'billing/HIM' group. This was done to emphasize clinical rather than administrative communication. If billing and records were included, then attending notes were viewed 97% of the time, and resident notes were viewed 99% of the time; the other user groups were less affected. Fewer than 20% of nursing notes were read by attendings or residents, and only 38% were read by other nurses. Attending and resident notes were read more often, but not consistently and not necessarily by attendings, nurses, or residents. Medical students' notes were viewed by at least one attending or resident 72% of the time on the first day after it was written and 81% eventually. The rate of viewing medical students' notes depended on service, with pediatrics and psychiatry lagging behind other services. For all authors, 16% of notes were never viewed by anyone, not even the author or billing and records.

Table 1 Rate of authoring and viewing notes: number of authors and mean number of notes they authored per week, and number of viewers and mean number of notes they viewed per week

User group	Authors*	Notes authored per week	Notes authored per user per week	Viewers*	Notes viewed per week	Notes viewed per user per week
Nurse (non-nurse practioner)	1725	17579.1†	10.2†	1953	44324.2	22.7
Resident	777	8810.2	11.3	926	68688.2	74.2
Attending	704	6627.8	9.4	831	22236.5	26.8
Social worker	199	4151.8	20.9	223	16949.0	76.0
Occupational/physical therapy	166	2828.2	17.0	177	11775.2	66.5
Respiratory therapist	62	2001.8	32.3	59	678.7	11.5
Nurse practioner	86	943.1	11.0	125	3777.8	30.2
Physician assistant	75	828.5	11.0	89	7935.9	89.2
Dietician	25	771.9	30.9	29	5708.5	196.8
Verify chemotherapy	45	553.0	12.3	47	1600.2	34.0
Other clinical	67	543.8	8.1	64	4878.2	76.2
Medical student	156	325.8	2.1	190	5418.9	28.5
Dietetic intern	28	245.4	8.8	28	2729.5	97.5
Child life specialist	3	42.3	14.1	4	141.8	35.5
Speech pathologist	2	27.3	13.7	2	122.8	61.4
Psychologist	1	0.3	0.3	1	4.4	4.4
Pharmacist	0	0.0	0.0	132	2692.7	20.4
Unit clerk	0	0.0	0.0	2	478.5	239.2
Billing/health information management	0	0.0	0.0	622	58212.8	93.6
Total	4121	46280.2	11.2	5504	258353.6	46.9

*Authors and viewers overlap.
†Excludes 'flowsheet' documentation, which includes plan of care, vital signs, intake and output, treatment parameters (isolation, wound care, etc), and data for quality initiatives such as falls risk assessment.

Table 2 Time spent authoring and viewing notes: mean time (min) per day in spent authoring and viewing notes for the larger, clinically relevant user groups from table 1

	Time spent (mean no of minutes per day)			
	Authoring notes		Viewing notes	
	Days with at least one note authored	Days with multiple notes authored*	Days with at least one note viewed	Days with multiple notes viewed*
Dietician/dietetic intern	98.3	102.5	28.4	34.7
Nurse practitioner/physician assistant	63.7	82.6	16.1	21.5
Social worker	59.5	69.4	16.3	19.8
Occupational/physical therapy	54.7	57.6	14.1	17.7
Medical student	54.6	78.5	17.5	25.3
Resident	48.6	65.2	17.3	20.1
Attending	33.5	52.1	7.2	10.4
Nurse (non-nurse practioner)	21.4†	38.2†	9.0	16.9
Other	19.6	25.5	30.0	56.4
All	36.4	54.2	14.5	21.3

*Days with 'significant involvement,' defined as authoring or viewing at least two patients per day, at least 2 days in a row, and at least 1 day with at least four patients
†Excludes time spent on 'flowsheet' documentation, which includes plan of care, vital signs, intake and output, treatment parameters (isolation, wound care, etc), and data for quality initiatives such as falls risk assessment

Figure 2 shows information-seeking behavior. Figures 1 and 2 complement each other: whereas figure 1 plots the probability of a note being viewed, figure 2 plots the probability of a viewer seeking out a note. The bars show how often someone in a user group viewed at least one note by someone in a second user group, given that the note was authored within the previous day. Attendings and residents tended to view notes by other attendings or residents (65–93%) more often than notes by nursing or social work (22–42%).

Notes are generally viewed soon after authoring. For example, as shown in figure 3, most viewings of attending and resident notes by attendings and residents occur within the first day. In this sample, about 26 000 were read in the first day, and 19 000 were read in all subsequent days combined. Nevertheless, notes do get viewed months later at a measurable rate. The nearly linear relationship on the log–log scale indicates a power law relationship,[17] which is common to many natural phenomena. At about 18 months, the fall appears to level off at a rate of 0.01% per day, but more data are needed to confirm the trend.

Table 3 shows the notes most frequently viewed by attendings and residents, and how note viewing evolved with time. We compared immediate viewing of notes during the hospital stay (at 1 day) with subsequent clinical viewing (at 1 year). The top of table 3 shows the 10 physician notes most frequently viewed by physicians by midnight of the following day, and it shows an admission and a progress note, which are both commonly written notes. Internal medicine consult notes were viewed most frequently. The bottom of table 3 shows the five physician notes that were viewed at least 10 times in a 10-day period after 1 year (ie, days 365 to 374). After 1 day, the 'Medicine Resident Admission Note' and the 'Medicine Follow-up Free Text Note' (the new progress note) were viewed about equally frequently. After 1 year, the 'Medicine Resident Admission Note' and 'Medicine Resident Daily Progress Note' (the old progress note) differ in viewing by more than a factor of 5. Therefore, the relative use of the progress note fell faster than that of the admission note.

Team interactions

We studied the constitution of care teams that formed during admissions. Admissions were defined as runs of documentation with no more than 2 days consecutive without new notes where

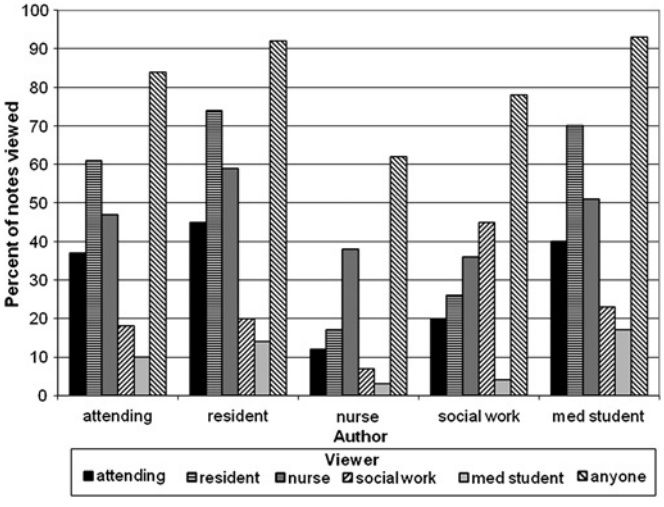

Figure 1 Use of notes for clinical communication. For authors in each user group, the graph shows the percent of their notes that were viewed within 3 months by any user in the same or another user group. Viewing of a note by its author was not counted, and the 'billing/HIM [health information management]' user group was excluded from 'anyone.'

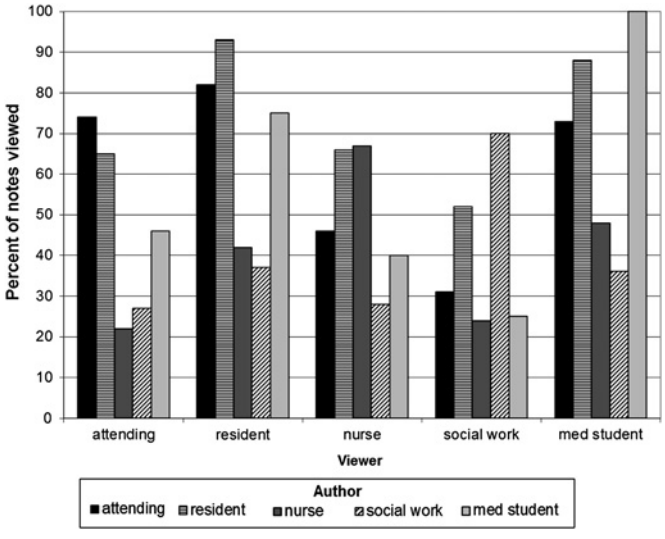

Figure 2 Information-seeking behavior. For each viewer user group, the bars show how often such users sought out information authored by the same or another user group when it was available. Viewing of a note by its author was not counted.

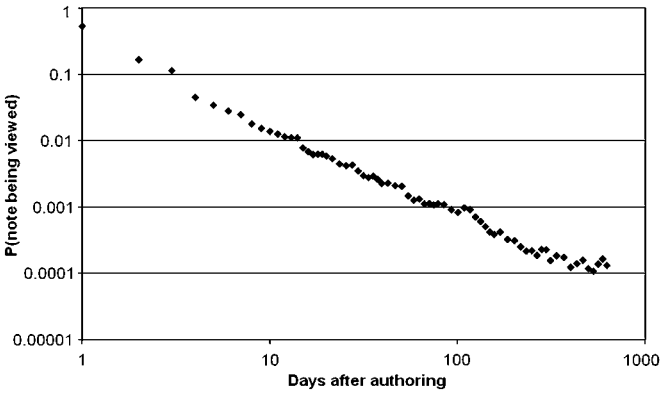

Figure 3 Use of notes over time. Each point represents the probability of a physician (attending or resident) viewing a physician note on 1 day given that the note was authored some number of days in the past. Both scales are logarithmic. The probability of a note being viewed drops quickly but predictably over time.

at least 10 notes were written. This was necessary because the deidentified audit logs lacked the visit data; this iteratively derived definition allowed for documentation outside of the official admission window and ensured significant admissions. We only included those members who had actually written a note, not just viewed one. All but eight of 69 205 so-defined admissions had nurses on the team. The most frequent team (9%) comprised a nurse, attending, resident, and social worker; and the core of a nurse, attending, and resident occurred in 77% of admissions.

To estimate the delay before team members joined a care team, we measured the time from the first note for an admission to any note by an author in a user group. On average, nurses, residents, and attendings wrote a note within the first day. Social workers' notes were documented just over 1 day after the first note, and nurse practitioners and physician assistants documented 2 days later. Dieticians and therapists documented 3–5 days later. Medical students also took 3–4 days, possibly because they were assigned to cases after admission.

We looked for pairwise associations among user groups on care teams: which user groups were more likely to write a note if another one did. Due to the large numbers of observations, almost all pairings were statistically significantly different from chance, but only one pairing showed a significant deviation. Social workers and physical or occupational therapists were more likely to be on a team together with an increased frequency of 10%; all other pairs differed from chance by 4% or less. Residents and nurse practitioners or physician assistants were negatively associated by 4%, most likely because residents did not participate in the daytime care of patients who were covered by a nurse practitioner or physician assistant.

We also studied interactive communication among users. We assessed the RR of a pair of users reading each other's notes. That is, user 1 writes a note, user 2 reads it, user 2 writes a note on the same patient, and user 1 reads it. These cycles are indicative of two-way communication. Table 4 shows the observed probability of a pair of users from two user groups engaging in a cycle, divided by the probability expected by chance. Bolded entries exceed one at $p<0.05$, corrected for the multiple hypotheses contained in the table (all possible pairings). Attendings and residents show the strongest cross-group cycles, and attendings, residents, occupational and physical therapists, dietary workers, and social workers had significant intragroup interaction.

Hierarchical clustering can reveal large-scale organizational structures. We found that users are generally well interconnected. Looking only at sets of users who are extremely highly interactive (viewing at least 50 of each other's notes in 2 weeks), one sees a preponderance of small teams that are likely associated with hospital floors and service teams, most with two to three residents at the core. As soon as one drops the threshold of interactivity (say to 20 views per 2 weeks), a single main set with most of the users in the hospital emerges. That is, there is some link among teams, perhaps consultants, or perhaps workers who cross medical teams (eg, social work). One does not see a preponderance of divisions along medical specialties or buildings, nor does one see a separation between user groups (eg, attending, resident, nurse, etc).

DISCUSSION

A broad variety of healthcare workers author and view notes in the electronic health record. Clinical notes serve several purposes. They augment the author's memory, create a longitudinal record for continuity of care, provide communication between users, support quality assurance, substantiate billing, serve as legal documentation, and support research and education. About a sixth of notes overall go unread, thus playing no direct role in communication, but an unread note may still be useful because of its potential for future use and because of legal requirements. About a third of nursing notes go unread; this higher rate may be due to the use of oral communication between successive nursing shifts and because much of the critical information is contained in flowsheets instead of nursing notes. Medical student notes were read by physicians at a relatively high rate of 81%, implying that supervision is substantial if not perfect.

The rate of attendings' and residents' notes being viewed by other attendings and residents (37–74% in figure 1) corroborates earlier findings at a different medical center campus where physicians in the emergency department viewed clinical notes from previous encounters 47% of the time, given that they knew a note was available.[18] The perception that clinical notes are difficult to find within an electronic health record [19] may contribute to incomplete note review.

Users spent a moderate amount of time authoring and viewing notes, with most less than 90 min per day in aggregate. In the literature, documentation has been reported as 21% of residents' time, 12% of attendings' time, and 7% of emergency nurses' time.[13] Other studies have reported that family practitioners spend 1.2 h per day documenting,[14] and oncologists spend 1.4 h per day documenting.[15] In 1997, internal medicine residents who were on call were reported to have spent 2.6 h on paper chart review and 2.2 h on paper documentation, with an additional half hour on the computer.[20]

Our results contradict a study of medical resident's perceptions of time spent on documentation.[4] We found 65 min per day, whereas residents perceived spending over 4 h. This is likely due to the survey including order entry in the definition of 'documentation.' There is also likely a difference between perception and measured rates. The same study[4] found that medical residents received feedback on documentation less than 50% of the time. Our findings, shown in figure 1, reveal that attendings review residents' notes less than 50% of the time, corroborating this earlier study.

The use of notes over time, shown in figure 3, has implications for system builders. The use of notes drops off rapidly after the first day, but even old notes (up to almost 2 years in this study) got viewed at a low but consistent rate. This implies that recent

Table 3 Most frequently viewed physician (attending or resident) notes

Notes viewed after 1 day*			
No viewed (1 day)	**No authored (1 day)**	**Per-day probability of being viewed**	**Note type**
168	176	0.95	Infectious disease consult note
378	418	0.90	Heart-failure free text note
121	135	0.90	Pulmonary fellow consult note
91	102	0.89	Hematology/oncology attending consult note
100	113	0.88	Rheumatology attending consult note
1397	1586	0.88	Medical intensive care unit attending miscellaneous note
1254	1460	0.86	Medical intensive care unit resident miscellaneous note
131	153	0.86	Nephrology attending admission note
107	125	0.86	Neurology resident admission note
965	1132	0.85	Pediatric critical care attending note
…	…	…	…
621	762	0.81	Medicine resident admission note
…	…	…	…
12054	15649	0.77	Medicine follow-up free text note
…	…	…	…
Notes viewed at 1 year†			
No viewed (10 days)	**No authored (10 days)**	**Per-day probability of being viewed**	**Note type**
14	16 972	0.00082	Neurosurgery resident follow-up note
11	22 397	0.00049	MD ob labor and delivery progress note
14	32 056	0.00044	Medicine resident admission note
13	30 459	0.00043	Ob/gyn miscellaneous
14	184 795	0.000078	Medicine resident daily progress note

The top of the table shows the 10 physician notes most frequently viewed by physicians within 1 day; admission and follow-up notes are added for comparison. The bottom of the table shows the physician notes most frequently viewed after 1 year by physicians. The per-day probability of being viewed is shown for each note.
*Only the 10 most frequently viewed notes and medicine admission and progress notes are shown.
†All those with at least 10 notes viewed in 10 days are shown.

notes should be the most easily accessible, but that older notes should remain accessible for at least 2 years. As one might expect, summary notes like admission notes become relatively more important than progress notes over time. The proven redundancy among progress notes[21] explains some of the per-note drop off: once one progress note is viewed, adjacent ones become less important. Nevertheless, progress notes are still viewed at a measurable rate after a year. Therefore, even progress notes should be retained in the record for some time.

Figure 1 provides relevant information about intergroup communication. Attendings and residents review nursing and social work notes less than a third of the time. This may point to an opportunity for the electronic health record to summarize information and make it readily available, perhaps with the ability of the author to highlight information that may be critical and that has a high priority for communication. Nurses appear to be reviewing attending and resident information at a higher rate. Communication rates within groups tend to be higher, perhaps reflecting the strong relevance of clinical information within groups.

In this medical center, the core care team comprised one or more attendings, residents, and nurses, with a social worker joining the team soon after. Dieticians and therapists tended to join the team later in the stay. Within these teams, the tightest bilateral communication occurred between members of the same user group and between attendings and residents.

Table 4 Bilateral communication between user groups: RR of a pair of users (one from each group) reading each other's notes in a cycle (each user reads the other's note; see text)

	Attending	**Resident**	**Nurse practioner or physician assistant**	**Nurse (non-nurse practioner)**	**Medical student**	**Occupational/ physical therapist**	**Dietary**	**Social work**	**Other**
Attending	**1.824***	**1.555***	1.270	0.307	1.011	0.375	0.247	0.461	0.999
Resident	**1.555***	**1.434***	1.071	0.342	0.978	0.559	0.349	0.356	1.021
Nurse practioner or physician assistant	1.270	1.071	0.738	0.242	0.944	0.722	0.356	0.391	0.864
Nurse (non-nurse practioner)	0.307	0.342	0.242	0.367	0.330	0.135	0.058	0.177	0.121
Medical student	1.011	0.978	0.944	0.330	1.057	0.485	0.410	0.377	0.563
Occupational/physical therapist	0.375	0.559	0.722	0.135	0.485	**1.827***	0.106	0.999	0.213
Dietary	0.247	0.349	0.356	0.058	0.410	0.106	**2.597***	0.059	0.095
Social work	0.461	0.356	0.391	0.177	0.377	0.999	0.059	**1.758***	0.504
Other	0.999	1.021	0.864	0.121	0.563	0.213	0.095	0.504	2.340

*Bold indicates statistically significantly greater than 1 at $p<0.05$, corrected for multiple hypotheses.

The study has several limitations. The study did not capture in-person or telephone conversations. Therefore, some of the uncovered lapses in communication may be met orally. For example, critical results may be more likely to be communicated orally and immediately. While this study limitation is important, the results remain useful, as they represent trends, and the rates may be compared to each other. Another limitation is that we are inferring actions and intentions from artifacts like notes and logs of keystrokes; for example, system idle time while a user carries out other tasks may be counted as authoring or viewing time. A full time–motion study with concrete observation of user activity coupled with a think-aloud protocol to elicit intentions would complement this one. Such a study would reveal deep information about a small number of clinical interactions, while our present study permits a broad view of activity across many user types. As noted above, the documentation analysis excluded nursing flowsheets because of the way they are incorporated into the application, and this will cause an underestimate of nursing documentation time and can affect the analysis of communications. The study was conducted at a single academic medical center, reflecting the workflow of a single institution; a multicenter study would improve generalizability.

CONCLUSION

A detailed log of authoring and viewing clinical notes in an electronic health record revealed documentation workload, team structure, and levels of communication among team members. Communication appeared strong in some cases (eg, supervision of medical students) but weaker in others (eg, nurse to physician information transfer), which may point to opportunities for improvement.

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Competing interests None.

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