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Allocation of internal medicine resident time in a Swiss hospital: a time-motion study of day and evening shifts

Short title: Allocation of resident's time in hospital practice

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resident work hours; time motion study; electronic medical records; internal medicine; patient-doctor relationship

ABSTRACT

Background: Little current evidence documents how internal medicine residents spend their time at work, particularly regarding the proportions of time spent in direct patient care versus on computers.

Objective: To describe how residents allocate their during day and evening hospital shifts.

Design: Time-motion study.

Setting: Internal medicine residency at a university hospital in Switzerland May-July 2015.

Participants: 36 internal medicine residents with an average of 2.4 years of postgraduate training.

Measurements: Trained external observers recorded the residents' activities using a tablet-based application. Twenty-two activities were categorized as: directly related to patient; indirectly related to patient; communication; academic; non-medical tasks; and transition activities. In addition, the presence of a patient or colleague and use of computer or phone during each activity was recorded.

Results: Residents were observed for a total of 696.7 hours. Day shifts lasted 11.6 hours (1.6 hours more than scheduled). During these day shifts, activities indirectly related to patients accounted for 52.4% of the time; activities directly related to patients accounted for 28.0%; residents spent on average 1.7 hours with patient, 5.2 hours with computer, and 13 min with both. Time dedicated to the computer was scattered during day, with heaviest computer use after 6:00pm.

Limitations: Study involved a small sample from one institution.

Conclusion: At this Swiss teaching hospital internal medicine residents spend more time at work than scheduled. The activities indirectly related to the patient predominate and about half of the work day is spent with a computer.

INTRODUCTION

The practice of hospital medicine is constantly evolving with the increasing complexity of patients (1-4). During their training, residents in internal medicine are educated to manage this complexity and to summarize a wide array of medical information. The structure of a residents' working day also dramatically changed during the last decades, with limitation of working hours per week, a wide implementation of electronic medical records (EMR), and a growing volume of clinical data and administrative tasks (5). Many new scheduling paradigms have been proposed and implemented to address duty hours; these include the separation of inpatient and outpatient rotations (mandatory clinics) (6) and the use of advanced practitioners (nurse practitioners and physician assistants) (7)

Information technologies have been increasingly used in healthcare as they allow a better sharing and availability of medical data. However, negative effects of the EMR have also been described, as their implementation increases the time physicians spend on administrative tasks and writing notes (8). Similarly, Alkureishi (9), Ratanawongsa (10) and Asaro (11) reported that EMR reduce communication and time spent between patients and physician. Recently, Sinsky et al (12) described physician's time allocation in ambulatory practice and confirmed that they spend up to 50% of their time using EMR.

In hospital practice, only a small percentage (9 to 22%) of resident's time is spent with patients, while over half of it is dedicated to activities indirectly related to the patient (13-17). This trend is worrying, as less time spent with patients decreases physician's satisfaction (18), patient education and health promotion (19), and increases inappropriate prescribing and medical malpractice (20). Even if information technologies are improving, EMR still failed to fulfill their promises in today's hospital practice (21).

Few time motion studies focused on how computer use impacts resident's time allocation. We therefore aimed to objectively assess the type and duration of the activities performed by hospital residents along the day. The primary focus was to estimate the time spent with patients and to the computer. The secondary focus was to identify any individual factor influencing the residents' time allocation to the different activities and contexts.

METHODS

Study Design, Setting and Participants

We conducted an observational study between May and July, 2015 at the department of internal medicine of the Lausanne University Hospital, one of the five teaching hospitals in Switzerland, with over 1'471 beds and 47'300 patients hospitalized in 2015 (www.chuv.ch). The hospital implemented the current EMR in 2009 (Soarian®, Cerner Corporation, Kansas City, MO, USA). It compiles medical documentation, labs, X-ray and providers' views, electronic prescription system, and scanned medical archives. The EMR is available on desktop and laptop computers.

The department of internal medicine receives approximately 6'200 patients per year and has 203 beds, organized in eight wards. Each is staffed with one senior physician and one chief resident supervising three residents. Minimum postgraduate training for internal medicine is planned over five years: three years of basic training mostly in internal medicine department and two additional years more freely organized in specialties. At least six months have to be certified in an ambulatory practice. Chief residents have usually at least four years of postgraduate training. Within each ward, a resident is responsible for six to ten patients. There are day (08:00-18:00), evening (16:30-23:30) and night (22:30-08:30) shifts. Scheduling of the residents' daily activities is comparable to US hospitals (**Figure 1**): daily patients round, supervision, training and patients' new admissions. The staff is reduced to two residents and one chief resident (for 203 beds) during evening and night shifts. Evening shifts relate mostly to late patients' admissions, unstable patient care and emergency situations. In this study, only day and evening shifts were considered. Night shifts were not considered as activities are mostly limited to attending emergency situations.

All residents working on internal medicine inpatient wards - which do not cover any critical care or specialty unit - during the study period were eligible for inclusion. There were no exclusion criteria. The Human Research Ethics Committee of canton de Vaud certified that the study was exempt from human subject's ethics review. All residents were informed of the study and signed a written consent. No patient identifier or health information was recorded.

Data collection procedure

Data collection was performed by undergraduate medical students. They were extensively trained to collect data without interfering with resident's work. The training consisted of a) a dedicated e-learning program on how to categorize the various resident's activities; b) a teaching session, focused on the definition of activities and the use of recording device; c) a two hours practice session based on a one-hour video of residents engaging in typical medical activities; d) eight hours of observation and recording of a resident's activity on the wards (the resulting data was not included in the study), and e) a last session to solve any remaining issues. The reproducibility of the observers was assessed during the one-hour video practice; overall, observers recorded activities and contexts similarly (**Appendix Table 1**).

Recording began upon arrival of the resident at his workplace and lasted until he left. Residents were randomly assigned to an observer. To decrease observation bias, observers had to avoid communicating with the residents and were only allowed to ask for clarification about an activity or context (see below). To optimize observation accuracy, day shifts were sequentially covered by two observers, with handover after the first 6 hours. Evening shifts were covered by only one observer as evening shifts were shorter.

Each activity was recorded in real-time, using a tablet (**Appendix Figure 1**). The application was designed by the investigators and developed with the IT department of the hospital. To promote similar studies, the source code is available "as is" on github.com. The observer selected an activity and/or a context. After hitting a confirmation icon, the application automatically recorded the starting time of the activity or context being performed. Based on expertise and earlier studies (13-17, 22), we defined 22 exclusive activities, grouped in six categories, as listed in **Table 1**. We created a specific category labeled "communication" because we were interested in how much time was dedicated to news delivery (for e.g. bad news, therapeutic orientation) and family meeting. Hence, our department is very keen about quality development and has a particular interest in assessing resident's communication skills. Other types of communication were collected in the category "directly related to the patient" within activities such as admission, patient round, and patient discharge activities. Similarly, four contexts in which the activity was being performed were created: 1) in presence of one or more colleagues (any professional); 2) in presence of the patient; 3) with a computer, and 4) with a phone. Context could change irrespective to the activity being performed.

For each resident, gender; age; country of medical graduation; postgraduate training (in months), and distance between home and the hospital were collected. The number of patients the resident had in charge during the observed shifts was also collected.

Statistical analysis

Based on similar studies (13-17), a pragmatic sample size of 64, corresponding to two shifts per resident, was chosen. Statistics were performed using Stata 14.0 (Stata corp, College station, TX, USA). Descriptive results for residents' characteristics were presented as average (standard deviation) for continuous data or as number of participants and (percentage) for categorical data. As residents could be assessed several times on the same or on different shifts, we used a linear mixed model using resident as cluster to compute means and corresponding 95% confidence intervals of the times dedicated to each activity. We calculated the percentage of a resident's shift time devoted to a specific activity by dividing the time for that activity divided by the total shift duration.

RESULTS

Thirty-six residents were included; 23 were women and their mean (SD) age was 29.4 (2.5) years (range: 25.7-39.4). Thirteen (36%) residents held a foreign medical diploma. Average postgraduate training in internal medicine was 29 (11) months (range: 0-50), and median distance between home and hospital was 3.0 km (range: 1.4-75.7). During day shifts, each resident was in charge of an average of eight patients.

Data from 66 shifts (49 days and 17 evenings) was collected, amounting to 696.7 hours of observation. Because of external factors, i.e. residents' holidays, 9 residents were observed only once. **Table 1** shows the distribution of the 22 activities during day and evening shifts. Day shifts lasted for an average of 11.6 hours (95% CI 11.2 - 12.0). 52.4% of this time was dedicated to tasks indirectly related to patients and only 28.0% to tasks directly related to patients. Academic, non-medical, transition and communication tasks represented 6.3%, 6.1%, 5.1% and 2.3% of total time, respectively. Two of the longest activities (lasting >1 hour) were daily patient rounds and writing in the EMR. Evening shifts lasted for an average of 7.6 hours (95% CI 7.0 - 8.2). Expressed as percentage of total time, the distribution of the main activities (i.e. directly or indirectly related to the patient, communication, non-medical) were comparable between day and evening shifts, except that academic activities were almost non-existent in evening shifts (**Table 1**).

For each category of activities, time spent by residents with patients, with the computer, with both patients and the computer and neither patients nor computer is indicated in **Table 2**. During day shifts, residents spent on average 1.7 hours (101 min) with patients, 5.2 hours (313 min) with computer, and 13 min with both. For activities directly related to patients, residents in day shifts spent the same time with patients and the computer, while residents in evening shifts spent longer time with the computer than with patients. For activities indirectly related to the patient, computer use represented 59.2% of the time in day shifts and 42.3% in evening shifts. The distribution of time spent with patients or with the computer is shown in **Figures 2a and 2b**, respectively; time spent with patients was concentrated from 9:00 to 11:00 (**Figure 2a**), while time spent with the computer was much more scattered, with higher percentages after 18:00 (day shifts) and 23:30 (evening shifts) (**Figure 2b**).

Overall residents spent 48.1% of their time in presence of colleague(s) during day shifts and 30.9% during evening shifts. The usage of phone was similar during day and evening shifts, representing 9.4% of the time.

DISCUSSION

This is the largest observational European study that objectively and comprehensively assessed the organization of a resident's workday in a hospital setting. Most of our findings are in accordance with the literature (13-17): a majority of residents did not fulfill their duties in the scheduled time; activities indirectly related to patients dominated, activities directly related to patients coming only second, and residents spent almost three times more time with the computer than with patients. Finally, no consistent association was found between residents' personal characteristics and time dedicated to the different activities and contexts.

Most residents did not fulfill their duties in the scheduled time. Thus, day shifts lasted on average 1.6 hours more than the official 10 hours scheduled (**Figures 1 and 2**). Activity performed after hours were mostly writing in EMR, a finding also reported in ambulatory practice (12). Almost two thirds of residents were women, which might have an impact on duty hours in case women are working part-time. Still, in this study, all residents assessed were working full-time, so we doubt that gender could have impacted duty hours.In a recent survey conducted in Switzerland residents self-reported spending 27% of their time completing the EMR and 29% with patients (23). Compared to our results, residents seem to overestimate the time they

dedicate to patients and underestimate the burden of computer work. This finding is of importance, because it could mean that time motion studies are a better methodological approach to study how physicians allocate their working time.

Overall, for one hour spent with patients, the residents spent an average of five hours performing other tasks. For day shifts, writing in the medical record and writing the discharge letter/summary were the most time-consuming activities, amounting to approximately two hours per shift. .

During day shifts, most of the time residents spent with patients corresponded to daily patient rounds in the morning and admissions in the afternoon (**Figure 2a**). For evening shifts, the time spent with patients was more evenly distributed, between late patients' admissions, unstable patient care and solving urgent situations. Residents spent roughly 14.6 minutes per patient per day, which is twice as long as reported by Block *et al.* (7.7 min/patient/day) (13). One explanation is that US residents studied have a larger number of patients to care for (25 patients (24) versus 8 in our study). However, the percentage of time spent with patients was comparable between studies (16% in the present study versus 12% in the study of Block *et al*.). Interestingly, compared with studies conducted in the US before the implementation of the EMR in 1994 (22), 1971 (25) and 1961 (26), residents in our study spent approximately the same proportion of time with patients. Assuming that the amount of time with patients did not change substantially during the last decades, the main change is how residents allocate their time to the other tasks.

Regarding the time spent for "communication" activities, time per shift was too short to draw any conclusions, however residents did not use the computer when delivering news to patient or during meetings with families.

Residents spend almost three times more time with the computer than with patients, a finding also reported elsewhere (13-15, 17). However, until now, few time motion studies specifically focused on how, when and why residents used a computer. A previous study concluded that residents spend considerably more time interacting with computers (over 50% of their shift time) than in direct contact with patients (less than 10% of their shift time) (15). However, generalization of these results is limited by the small number of residents observed (seven) and the short observation time (84 hours overall, i.e. one shift per resident).

In the present study, time spent with the computer was evenly distributed during the day (**Figure 2b**), contrary to time with patients, which was more clustered. During extra hours, time allocated to the computer predominated, showing that residents postponed writing notes. Possible reasons include a better summing up of the clinical issues encountered, not being interrupted and not needing to interact with other members of the medical team. Even though residents could be simultaneously with the patient and with the computer, they seldom did so. This attitude differs from the ambulatory setting, where physicians interacted with EMR during one third of the time they spent with patients (12). This is likely due to hospital setting, which does not facilitate the usage of the computer while interacting with the patient. Still, the large amount of time dedicated to computer or other activities not centered on the patient could lead to dissatisfaction of residents due to the limited medical value of such activities and could also increase the risk of burnout (27). Thus, our results suggest the need to rethink residents' work organization to fit the digital age (21).

Based on our results, several interventions targeting resident time allocation could be tested. Firstly, increasing the ratio residents/patients could potentially limit the number of extra hours, but would be prohibitive in many institutions and would also impact educational opportunities for the residents. Secondly, the delegation of administrative tasks (~40 minutes/day in the present study) could allow residents to focus on more valued medical activities. Thirdly, optimization of documentation supports, speech or writing recognition systems, or medical assistants in charge of keying in the data into the EMR could decrease the time residents spend writing in the EMR. Fourthly, continuous improvement of the ergonomics of EMR and redefinition of the documentation procedures could reduce the time spent with the computer. Indeed, despite many promises, EMR still fail to capture and synthesize the growing amount and complexity of clinical data (21). Finally, the residents' timetable and training should be adapted to the challenges of digital medicine (28).

Compared to interview studies, time motion studies are the preferred methodological type of study to assess physicians' time allocation, because they allow an objective estimation of the time dedicated to each activity and avoid recall bias. Further, our study is considerably larger by the number of residents or the observation time than other studies using a similar method (12-16). To highlight this strength we summarized the methods and findings of recently published studies assessing the allocation of time in hospital practice in

Appendix Table 2 summarizes. As performed in another study (12), we recorded separately activity from context, which allows an accurate measure of time with the patient and with the computer.

This study also has several limitations. Firstly, it was performed in a single hospital, so results might not be generalizable to other settings. Still, most published studies were also conducted in a single hospital, and it would be of interest to replicate our study in other settings. Secondly, an observational bias (Hawthorne effect) cannot be excluded, as residents knew they were being observed. Still, this bias is present in all observational studies on the topic (12-17) and it is not possible to assess its direction, i.e. if residents remained longer or left earlier.

In a hospital setting, residents in internal medicine fail to complete their duties in the scheduled shift. The activities indirectly related to the patient predominate and about half of the work day is spent with the computer, notably impacting the later hours. Organizational changes and EMR improvement are required to increase efficiency and face high complex inpatient.

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COMPETING INTEREST

None declared.

DATA SHARING

Study protocol is available upon request. Requests for data should be sent to the corresponding author and are conditional upon a signed data transfer agreement. The source code for the IT application is available "as is" on github.com/agarnier00/MEDAY.

AUTHOR'S CONTRIBUTION

All authors contributed to the concept, design and conduct of the study. Antoine Garnier designed the database and the application interface. Pedro Marques Vidal made the analysis of data. Nathalie Wenger drafted the manuscript and all authors critically revised it. All authors approved the final version to be published. The lead author affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

OTHERS DISCLOSURES

Preliminary results were orally presented on May 26th, 2016 at the first Swiss Society of General Internal Medicine Congress.

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FIGURE LEGENDS

Figure 1. **Official schedule of day and evening shifts at the Department of internal medicine at the University hospital of Lausanne.** During evening shifts, staff is reduced to 2 residents in charge of all wards.

Figure 2. **Heat maps of two contexts of activity: time spent with patients (2a) and time spent with computer (2b)** during day and evening shifts. Time represented with one pixel = 15min. Color ranges from blue (<20%) to red (>80% of dedicated time). * : start and end of day shift. § : start and end of evening shift.

Appendix Figure 1. **Dedicated tablet application to record observations.** The screen is split in three areas: (1) observer set the next activity and/or context. (2) After hitting the “Confirm” icon, preset activity becomes the current activity, exposed in detail in the green area. (3) The log allows editing of past activities. Observers and residents are identified by a number. Once the observation is finished, results are sent by secured email to a designated investigator

Table 1. Distribution of activities according to shift in the department of internal medicine of the Lausanne University Hospital.

		Day shifts §		Evening shifts §§	
		Time in minutes	**% time**	**Time in minutes**	**% time**
Directly related to the patient		198 (177 - 218)	28.0 (24.9 - 31.1)	181 (147 - 214)	39.4 (34.4 - 44.5)
Admission	Anamnesis, clinical examination, communication with the patient. Starts when the resident is looking after a new patient.	27 (10 - 43)	3.4 (0.3 - 6.5)	156 (128 - 183)	34.1 (29.0 - 39.1)
Patient round	Daily medical round of inpatients of which the resident is in charge: EMR review, anamnesis, clinical examination, prescriptions of treatments, orders. Also includes daily sign-out round in the nursing desk.	142 (131 - 154)	20.6 (19.0 - 22.2)	16 (0 - 34)	3.5 (1.1 - 6.0)
Patient discharge activities	Preparation patient discharge: prescription writing, last interview with the patient, delivery and explanation of prescription.	16 (10 - 22)	2.2 (1.4 - 3.0)	1 (0 - 11)	0.3 (0.0 - 1.6)
Clinical procedures	All medical procedures performed by the resident on a patient, including but not limited to: arterial blood gas, ascites puncture, and others.	11 (5 - 17)	1.5 (0.7 - 2.4)	5 (0 - 15)	1.0 (0.0 - 2.5)
Out of unit support	Attendance of the resident alongside the patient outside the ward: oversight during exams, transfer to another department, and emergency situations.	2 (0 - 4)	0.3 (0.0 - 0.5)	1 (0 - 4)	0.3 (0.0 - 0.8)
Communication		15 (11 - 20)	2.3 (1.5 - 3.0)	5 (0 - 12)	1.2 (0.0 - 2.3)
News delivery	Bad news or therapeutic orientations that need a specific additional interview, and patient educational therapy.	5 (2 - 7)	0.7 (0.3 - 1.0)	1 (0 - 5)	0.3 (0.0 - 0.9)
Family meeting	Communication with family, close relative or non-professional caregivers. Time for information, explanation, collecting information, collecting opinions.	11 (7 - 15)	1.6 (NA)	4 (0 - 10)	0.9 (NA)
Indirectly related to the patient		365 (344 - 385)	52.4 (49.6 - 55.3)	216 (181 - 251)	47.9 (43.1 - 52.8)
Looking for information	Looking for info in the paper record, EMR, computer archives, or other medical record. Excludes admission activity.	39 (31 - 46)	5.7 (4.3 - 7.2)	39 (27 - 51)	8.7 (6.4 - 11.0)
Literature reviewing	Looking for scientific data to improve/determine patient management including medical textbooks, scientific papers, websites, etc.	6 (4 - 8)	0.9 (0.6 - 1.2)	2 (0 - 5)	0.4 (0.0 - 0.9)
Writing in medical record	Writing notes, problems list, handoffs, or exams results. Excludes admission activity and discharge report.	110 (99 - 122)	15.8 (14.0 - 17.6)	29 (9 - 48)	6.2 (3.2 - 9.1)
Discharge summary redaction	Any activity related to writing hospitalization reports: brief report, discharge letter. Includes revision of reports.	14 (8 - 20)	2.1 (1.2 - 2.9)	-	-
Handoffs	Giving or receiving handoff, including: preparation of documents, attending a handoff meeting, receiving/giving phone information, or sharing information	16 (12 - 20)	2.2 (1.6 - 2.8)	68 (61 - 74)	14.9 (13.9 - 16.0)
Supervision	Discussion with a senior physician (Chief resident, Chief doctor), focused on a patient and resulting in a decision on patient management.	60 (52 - 69)	8.6 (7.3 - 9.9)	31 (16 - 46)	6.8 (4.7 - 9.0)
Talking with providers/collaborators	Collecting information, booking an appointment, requesting exams or specialized consultation, asking for consultants' advice.	69 (61 - 78)	9.9 (8.5 - 11.3)	45 (30 - 59)	9.9 (7.7 - 12.1)
Patient administrative tasks	Administrative tasks for the patient: booking appointments, writing the voucher for X-ray or specialized consultation, adding laboratory tests.	32 (28 - 36)	4.6 (4.0 - 5.2)	6 (0 - 13)	1.3 (0.3 - 2.3)
Multidisciplinary board	Multidisciplinary boards and meetings between professionals to discuss management of one or more patient(s).	18 (12 - 24)	2.7 (1.8 - 3.5)	-	-

Academic		43 (32 - 53)	6.3 (4.6 - 8.0)	4 (0 - 21)	0.8 (0.0 - 3.4)
Receiving training	Participation in a training conference or the attending round (medical round supervised by the Chief doctor), self-preparation, and paper review.	35 (26 - 43)	5.1 (3.7 - 6.6)	3 (0 - 17)	0.6 (0.0 - 2.9)
Giving teaching	Resident gives teaching to others: students, collaborators, nurses. The supervision of an admission made by a student is included.	9 (6 - 12)	1.3 (0.8 - 1.8)	-	-
Academic research	Research work, thesis, publications. Excludes literature review.	-	-	-	-
Non-medical tasks		40 (32 - 48)	6.1 (4.5 - 7.6)	23 (11 - 35)	5.2 (2.9 - 7.4)
Non-patient administrative tasks	Activity unrelated to the patient, directly or indirectly. For ex: answering professional emails.	7 (5 - 10)	1.1 (0.7 - 1.5)	5 (1 - 9)	1.3 (0.6 - 1.9)
Personal activities	Time dedicated to the resident's personal needs, unrelated to the clinical activity: food, toilets, private phone, and private use of the computer.	33 (26 - 40)	5.0 (3.7 - 6.3)	17 (7 - 27)	3.8 (2.1 - 5.6)
Transition		35 (31 - 39)	5.1 (4.5 - 5.8)	23 (17 - 29)	5.1 (4.1 - 6.1)
Transition time to the next activity	Time required to transit to another activity: moving, hand washing, dressing, fetching or bringing something.	35 (31 - 39)	5.1 (4.5 - 5.8)	23 (17 - 29)	5.1 (4.1 - 6.1)
TOTAL, minutes		**695 (674 - 717)**		**454 (418 - 490)**	
TOTAL, hours		**11.6 (11.2 - 12.0)**		**7.6 (7.0 - 8.2)**	

Results are expressed as mean (95% confidence interval) obtained using a linear mixed model to account for the repeated measurements by resident.

Negative bounds have been replaced with zero values. -, all values are zero; §, 49 observations from 28 residents; §§, 17 observations from 13 residents; NA, not assessable.

Table 2. Distribution of activities with patients and/or the computer in the department of internal medicine of the Lausanne University Hospital.

	Day shifts §		Evening shifts §§	
	Time in minutes	**% time**	**Time in minutes**	**% time**
Directly related to the patient	198 (177 - 218)	**100**	181 (147 - 214)	**100**
With patients	80 (70 - 91)	41.0 (36.5 - 45.5)	57 (39 - 75)	36.3 (28.7 - 43.9)
With computer	81 (67 - 95)	39.4 (34.4 - 44.4)	98 (74 - 122)	49.5 (41.2 - 57.8)
With patients and computer	10 (6 - 14)	5.1 (2.8 - 7.4)	-	-
None	27 (22 - 32)	14.5 (11.9 - 17.0)	26 (18 - 33)	14.4 (10.3 - 18.5)
Communication	15 (11 - 20)	**100**	5 (0 - 12)	**100**
With patients	8 (5 - 11)	56.5 (43.5 - 69.5)	5 (1 - 10)	100
With computer	0 (0 - 1)	2.1 (0.0 - 5.8)	-	-
With patients and computer	-	-	-	-
None	7 (4 - 9)	41.8 (28.6 - 54.9)	-	-
Indirectly related to the patient	365 (344 - 385)	**100**	216 (181 - 251)	**100**
With patients	8 (4 - 11)	2.0 (1.1 - 2.9)	1 (0 - 6)	0.4 (0.0 - 1.8)
With computer	216 (199 - 233)	59.2 (55.9 - 62.5)	93 (65 - 122)	42.3 (36.8 - 47.9)
With patients and computer	1 (0 - 2)	0.3 (0.0 - 0.6)	-	-
None	139 (126 - 152)	38.5 (35.3 - 41.7)	123 (101 - 144)	57.3 (51.9 - 62.7)
Academic		**100**		**100**
With patients	5 (2 - 8)	8.2 (2.7 - 13.7)	-	-
With computer	10 (6 - 14)	26.9 (15.1 - 38.7)	2 (0 - 9)	100
With patients and computer	2 (0 - 5)	1.7 (0.0 - 5.1)	-	-
None	27 (19 - 34)	63 (50.8 - 75.3)	-	-
Non-medical tasks	40 (32 - 48)	**100**	23 (11 - 35)	**100**
With patients	-	-	-	-
With computer	5 (3 - 7)	14.5 (10.4 - 18.6)	4 (1 - 7)	11.5 (4.6 - 18.5)
With patients and computer	-	-	-	-
None	35 (28 - 41)	85.5 (81.4 - 89.6)	20 (9 - 30)	88.5 (81.6 - 95.4)
Transition	35 (31 - 39)	**100**	23 (17 - 29)	**100**
With patients	-	-	-	-
With computer	-	-	-	-
With patients and computer	-	-	-	-
None	35 (31 - 39)	100	23 (17 - 29)	100
All activities together	695 (674 - 717)	**100**	454 (418 - 490)	**100**
With patients	101 (89 - 113)	14.4 (12.8 - 16.1)	62 (43 - 81)	13.7 (11.0 - 16.2)
With computer	313 (293 - 332)	44.9 (42.3 - 47.5)	198 (164 - 231)	43.7 (39.2 - 48.0)
With patients and computer	13 (6 - 19)	2.0 (1.0 - 3.0)	-	-
None	267 (251 - 284)	38.7 (36.3 - 41.0)	194 (167 - 222)	42.6 (38.5 - 46.5)

Results are expressed as mean (95% confidence interval) obtained using a linear mixed model to account for the repeated measurements by resident. Negative bounds have been replaced with zero values. -, all values are zero; §, 49 observations from 28 residents; §§, 17 observations from 13 residents. See **table 1** for the definition of the activities.

Appendix Table 1. Results of the reproducibility study between observers (n=6).

	Minimum	Maximum	Average	CV (%)
All	68.7	69.3	68.9	0.3
Categories				
Directly related	12.0	12.2	12.1	0.7
Indirectly related	36.8	37.9	37.5	1.3
Academic	1.2	1.5	1.4	9.1
Non-medical	17.4	18.9	17.9	3.3
Contexts				
Patient	0.5	0.9	0.6	29.9
Computer	46.1	50.8	48.4	3.6
Telephone	3.9	6.1	5.1	17.1
Colleague	14.3	19.1	15.8	12.4

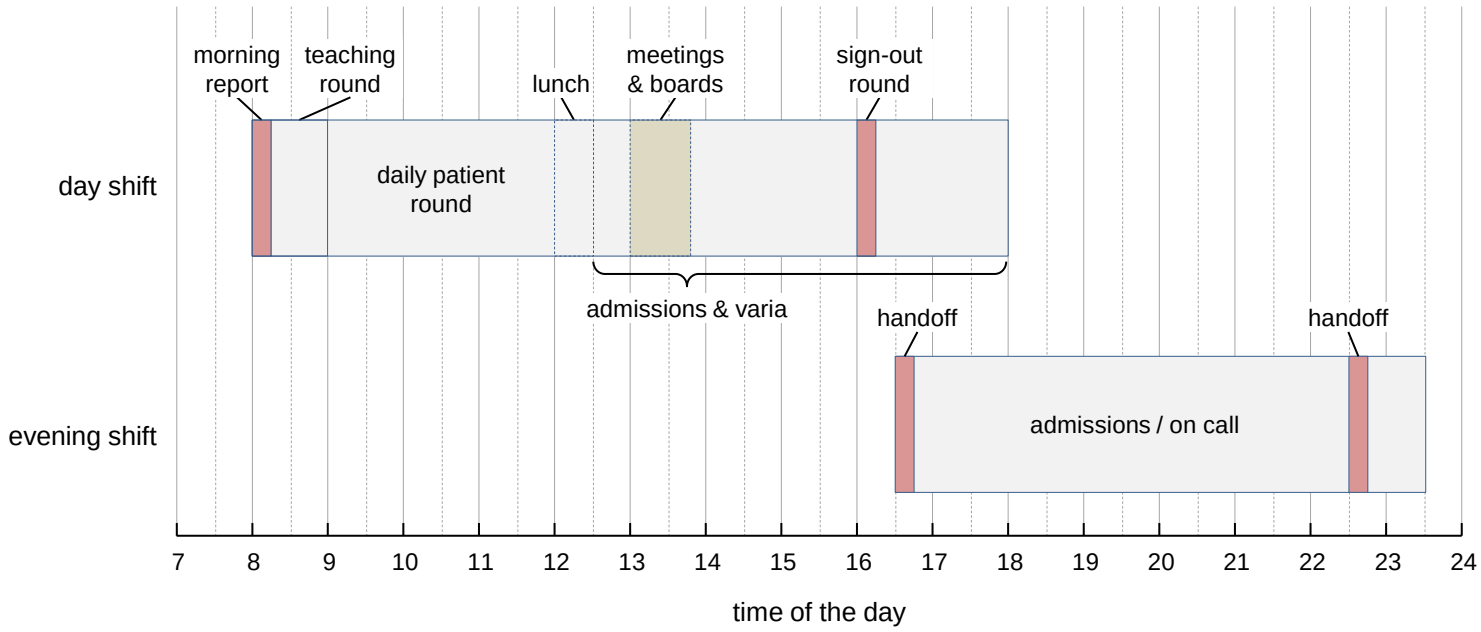
Results are expressed in minutes. CV: coefficient of variation. The high CV for the patient contexts is due to the very short period recorded (less than a minute)

Appendix Table 2. **Comparison of the current study with a non-exhaustive sample of the literature.**

Study	Method	Time-motion study	Setting	Population	Total time recorded (h)	Main results
Current study (Switzerland, 2016)	Real time recording study. Day and evening shifts. Recorded with a dedicated tablet application.	Yes	University hospital (Lausanne)	36 residents (PGY-1/3)	697	28% of time directly related to patients 53%of time indirectly related to patients 16% of time with patients 47% of time using computer 14.6min/patient/day (average)
Mamykina (USA, 2016)(13)	Real time recording study. Weekday shifts. Recorded with a tablet.	Yes	University hospital (New York)	7 residents (3 PGY-1, 4 PGY-2/3)	98	9% of time with patients 51% of time with computer
Ouyang (USA, 2016)(23)	Retrospective analyze of time-stamped electronic action logs.	No	University hospital (Stanford)	45 residents (PGY-2/3)	NR	47% of time with computer (EMR) Mean of 25 patients in charge
Block (USA, 2013)(11)	Real time recording study. Day, night and admitting shifts. Recorded with a small tablet.	Yes	Two academic hospitals (Baltimore)	29 residents (PGY-1)	873	12% of time with patients 64% of time for indirect patient care 40% of time using computer 7.7min/patient/day (average) 16.6min/admission (average)
Fletcher (USA, 2012)(12)	Real time recording study. On-call shifts. Data recorded with a laptop computer program.	Yes	A VA academic hospital (Milwaukee)	25 interns (PGY-1)	358	12% of time with patients 70% of time for indirect patient care 40% of time using computer
Ammenwerth (Austria, 2009)(15)	Work-sampling of 2 min. Day shifts. Watch beeping / self report.	No	A 200 bed hospital (Tyrol)	8 (1 student, 4 residents, 3 seniors)	40	22% of time with patients 54% of time for indirect patient care 49% of documentation tasks on computer
Westbrook (Australia, 2008)(14)	Real time recording study. Weekday shifts. Data recorded with a handheld computer.	Yes	A 400 bed teaching hospital (Sydney)	19 (7 interns, 5 residents, 7 chief residents)	151	17% of time with patients (for residents) Documentation time is twice the time for direct patient care 30% for communication (for residents)
Guarisco (USA,1994)(20)	Work-sampling of 3.2 recording/hours. On-call /off-call shifts, weekday + weekend. Beeper / self-report.	No	University medical center (Durham)	36 (18 interns, 18 residents)	NR	12% of time with patients (for residents) 12% of time for administrative tasks

NR, not relevant; PGY: postgraduate year; VA: veterans' administration.

Figure 1


morning report
teaching round
lunch
meetings & boards
sign-out round
day shift
daily patient round
admissions & varia
handoff
handoff
evening shift
admissions / on call
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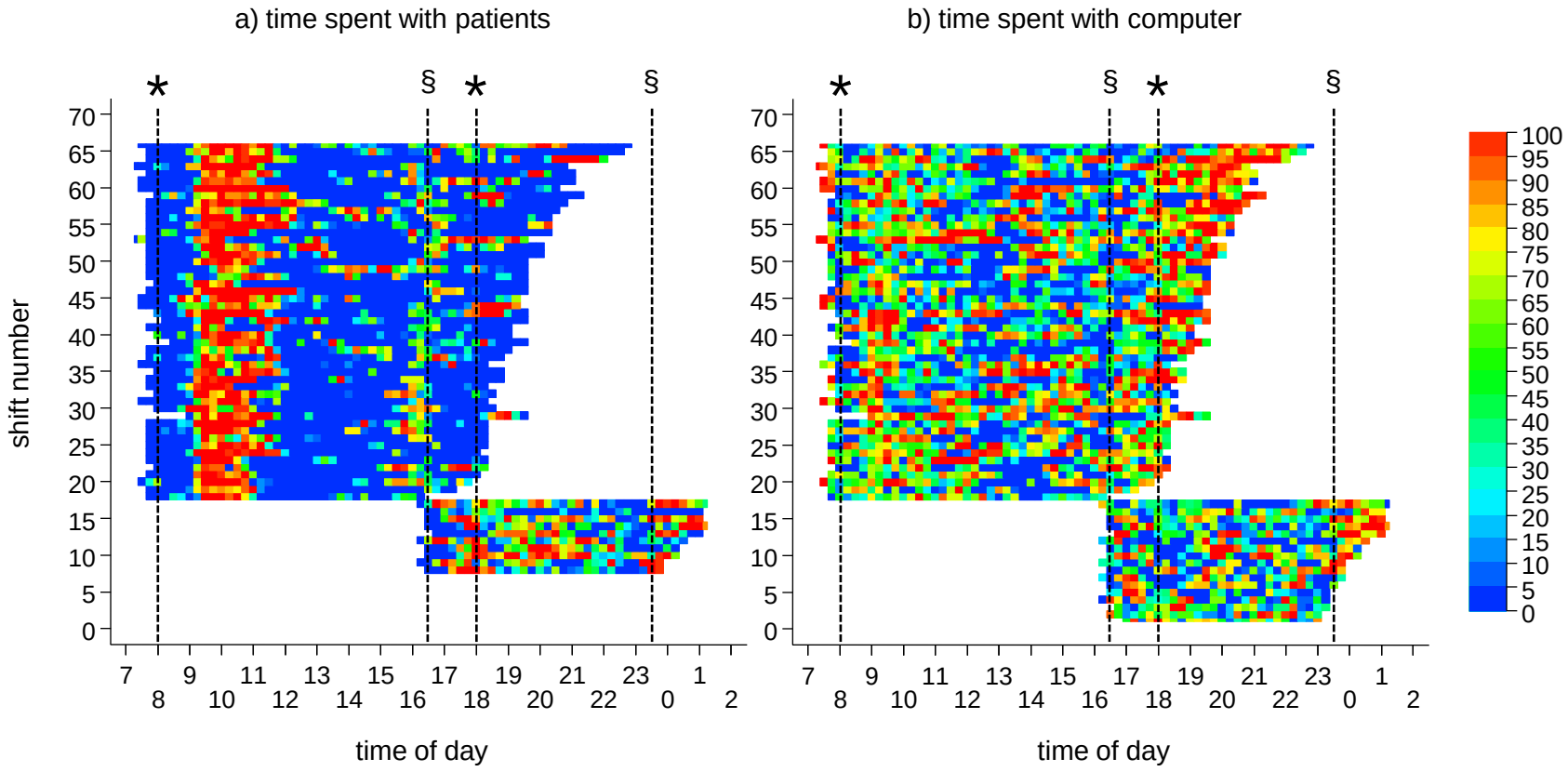
24
time of the day

Figure 2


a) time spent with patients
b) time spent with computer
shift number
time of day
time of day
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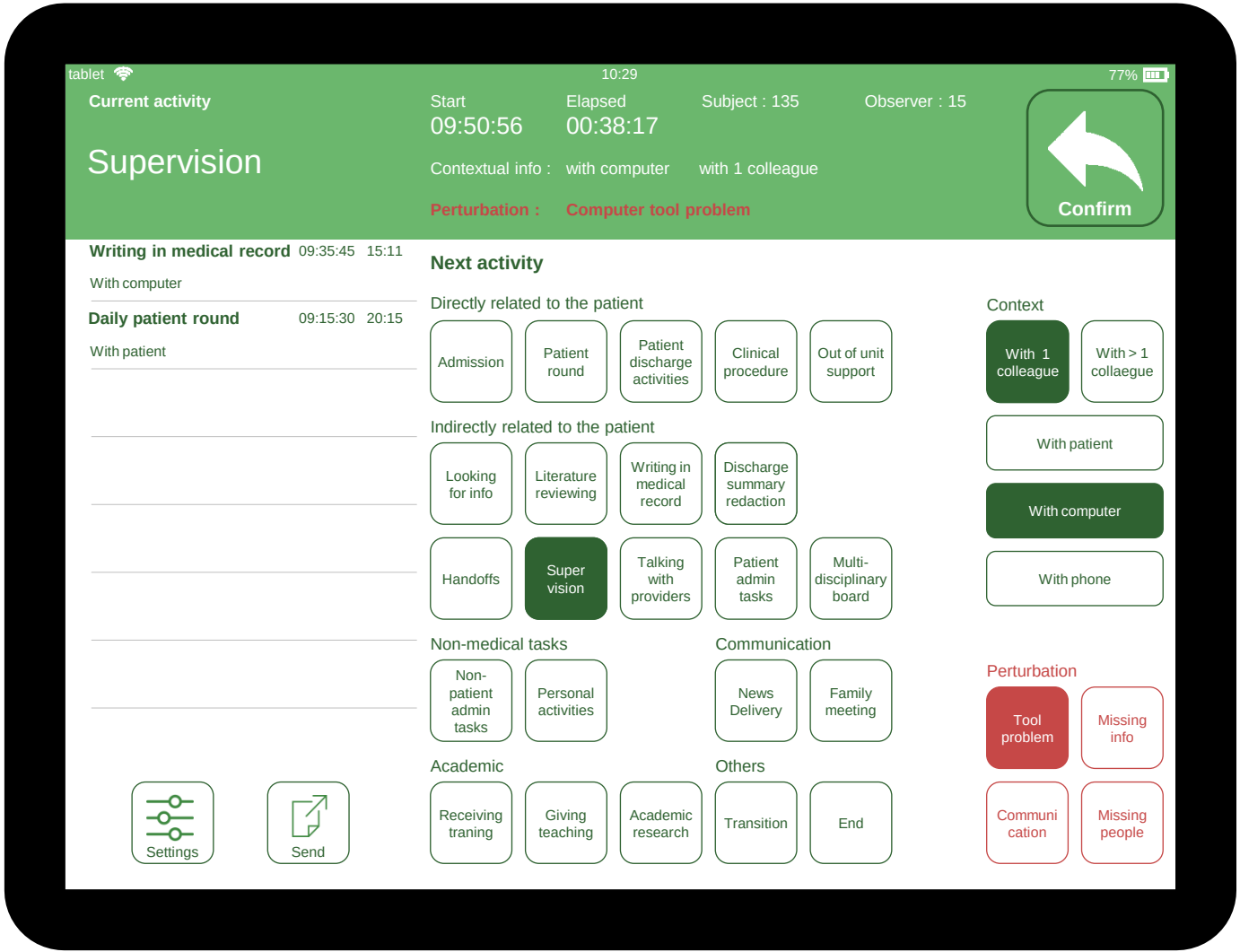
tablet
10:29
77%
Current activity
Supervision
Start
09:50:56
Elapsed
00:38:17
Subject : 135
Observer : 15
Contextual info : with computer with 1 colleague
Perturbation : Computer tool problem
Confirm
Writing in medical record 09:35:45 15:11
With computer
Daily patient round 09:15:30 20:15
With patient
Next activity
Directly related to the patient
Admission
Patient round
Patient discharge activities
Clinical procedure
Out of unit support
Indirectly related to the patient
Looking for info
Literature reviewing
Writing in medical record
Discharge summary redaction
Handoffs
Super vision
Talking with providers
Patient admin tasks
Multi-disciplinary board
Non-medical tasks
Non-patient admin tasks
Personal activities
Communication
News Delivery
Family meeting
Academic
Receiving traning
Giving teaching
Academic research
Others
Transition
End
Context
With 1 colleague
With > 1 collaegue
With patient
With computer
With phone
Perturbation
Tool problem
Missing info
Communi cation
Missing people
Settings
Send

(2)	
(3)	(1)