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ORIGINAL ARTICLE

Impact of reforms and work environment on resident time allocation in a Swiss internal medicine division: a time motion study with a before-and-after comparison

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Summary

STUDY AIMS: Increasing clinical complexity, rising admission volumes and shorter hospital stays have intensified demands on internal medicine residents. A 2015 time and motion study at our institution showed that residents spent nearly half of their day on computer work, with frequent task-switching and limited patient contact. These findings prompted organisational reforms to redistribute workload and improve workflow. We aimed to assess how resident time allocation changed after organisational reforms.

METHODS: We performed a before-and-after time and motion study in the division of internal medicine in a tertiary care centre in Switzerland. Direct observations were conducted over identical periods (May–July) in 2015 (baseline, before implementation of organisational reforms) and 2018 (first assessment after full implementation of these reforms). All residents were eligible. Shifts were randomly selected and stratified by weekday, with two shifts per resident observed whenever possible. Trained observers used a standardised electronic tool to record 22 mutually exclusive activities and contextual factors. The primary outcome was time spent on administrative tasks (patient-related and non-patient-related administration, discharge summaries, information retrieval). Secondary outcomes included task-switching rate, mismatch rate (deviation from planned schedule) and shift duration. Division workload data were collected to adjust analyses.

RESULTS: Seventy-five residents were observed over 142 shifts (1478 hours). From 2015 to 2018, mean administrative time increased from 92 to 139 minutes/day ($p < 0.001$) and mean task-switching from 15 to 20 per hour ($p < 0.001$), while mean mismatch rate decreased (38.8% to 31.7%, $p < 0.001$). The mean shift duration shortened (11h38m to 10h45m, $p < 0.001$), with mean personal time increasing (32 to 63 minutes, $p < 0.001$). Mean bedside time declined (113 to 92 minutes, $p = 0.011$) and mean computer use slightly decreased (327 to 290 minutes, $p = 0.009$). Mean weekly admissions rose (96 to 146, $p < 0.001$) and mean length of stay was halved (15.5 to 8.5 days, $p < 0.001$). Results were consistent after adjustment for division workload.

CONCLUSIONS: Targeted reforms improved schedule alignment and work–rest balance but failed to reduce administrative burden in a high-turnover environment. Local time-management interventions should be integrated with hospital-wide strategies addressing workflow complexity, interprofessional communication and task distribution. These results may inform similar initiatives in other high-pressure inpatient training settings.

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Introduction

Background

Workplace organisation refers to how an institution defines employee schedules, interactions, meetings and responsibilities. While this structure is shaped at the institutional level, the actual content and intensity of work have also evolved substantially. Over the last decades, the job of general internal medicine residents has changed due to escalating polymorbidity and complexity of inpatients, growing volumes of clinical data and increased economic pressure on healthcare systems [1, 2].

In this evolving setting, previous studies have shown that workplace organisation is critical to ensuring high-quality care, sustaining healthcare delivery and fostering long-term professional commitment among physicians [3, 4, 5]. It is the framework for residents to achieve high quality and efficiency of provided care, added-value medical education and work satisfaction [6, 7].

In this context, key concerns are clinical workflow and workload experienced by residents which include administrative burden, work continuity and time spent with patients. Indeed, use of information technologies has increased in healthcare and the role of the electronic medical record (EMR) is crucial. However, negative effects have also been described: increased time spent by physicians on administrative tasks and note writing, and reduced communication with patients [8, 9]. Fletcher et al. observed that the largest proportion of residents' time (40%) was spent on clinical computer work [10]. EMR systems still fail to meet physicians' expectations around harnessing, synthesising and presenting available data [2]. Moreover, on a more human level, teamwork characterises hospitals, but multiplicity of partners can lead to many interruptions, upsetting quality and work continuity. Westbrook et al. [11] showed that doctors multitasked 20% of the time and were interrupted every 21 minutes. Finally, increased time spent with patients improves patient satisfaction, patient education as well as health promotion activities, and reduces inappropriate prescribing and malpractice claims [12, 13]. Block et al. showed that residents spent a minority (12%) of their time in direct patient care [4, 14].

Conceptual framework

We adopted the Job Demands–Resources (JD-R) framework to interpret our findings. This model considers wellbeing and efficiency as the result of a balance between job demands (e.g. workload, task-switching) and job resources (e.g. tools, support, scheduling). In our context, reforms sought to reduce demands and increase resources, allowing us to link specific interventions to observed changes in residents' activities [15].

Local context: a teaching hospital

In 2015, like many teaching hospitals, we sought to improve workplace organisation and logistical aspects of the clinical learning environment in response to growing time pressure on residents. We convened a multidisciplinary working group to identify priority areas for reform, using findings from a local time and motion study and a literature review. This group, composed of physicians, administrative staff and educators, worked iteratively over several months to analyse baseline data, benchmark practices and design targeted interventions. The process and methodological details of this working group are described in the appendix. These efforts led to the implementation of organisational changes with high potential for improving workplace efficiency and resident workflow.

Study objectives

Quantitative evidence on the effects of organisational reforms on resident activities is lacking. We aimed to assess how resident time allocation changed after organisational reforms with a primary focus on time spent on administrative tasks. As these took place in an evolving environment, we also had to assess how residents adapted to an increasing workload.

Methods

Study design

We assessed the impact of organisational and structural interventions by means of a before-and-after comparison. The "before" observation took place between May and July 2015, our baseline study. Its method and results were published by Wenger et al. [16]. Briefly, activities indirectly related to patients predominated, about half the workday was spent using a computer and residents

switched from one task to another up to 15 times per hour [16, 17]. At the time, none of the reforms described below had been implemented. The "after" observation took place between May and July 2018 using the same method regarding training of observers, definition of activities and data collection.

Setting and participants

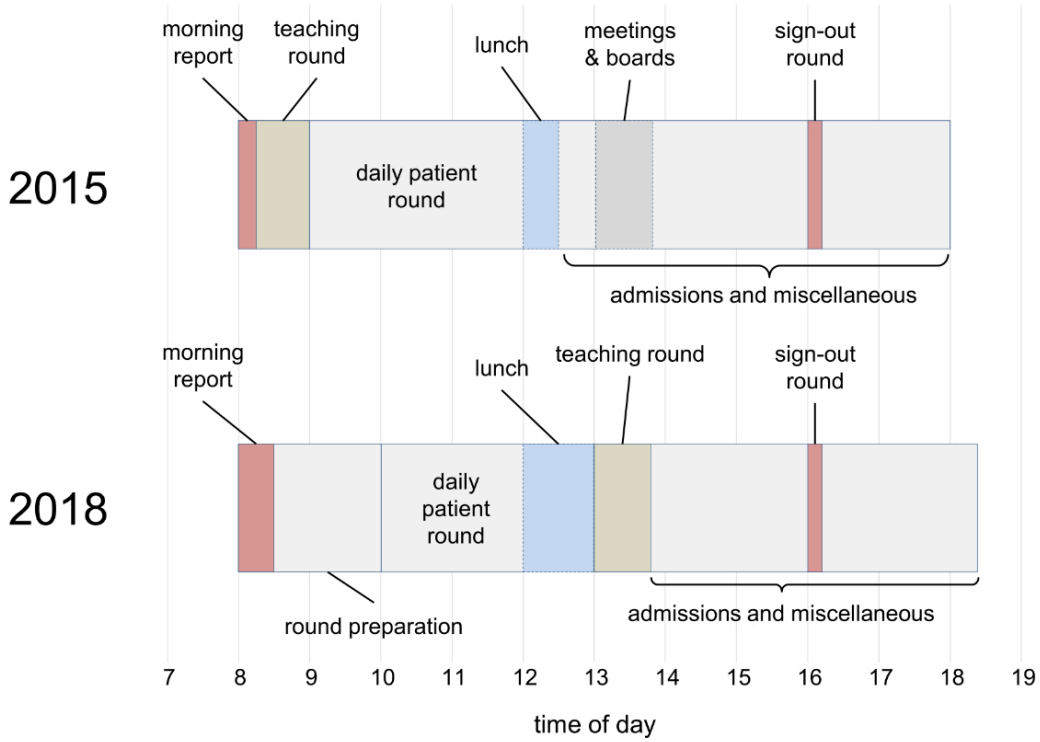
We conducted our study at Lausanne University Hospital, a 1500-bed tertiary care centre in Switzerland. Its division of internal medicine, in addition to its clinical care and research missions, hosts residents for one to two years, usually during the second part of their postgraduate training. Accredited as a Type A university training centre by the Swiss national authority for postgraduate medical education, it constitutes a mandatory rotation in the postgraduate curriculum for internal medicine. Training combines supervised patient care with structured educational activities, including daily bedside rounds, teaching sessions, multidisciplinary meetings and protected academic time.

The division of internal medicine is divided into eight wards. In both before and after periods, each ward was staffed with 1 senior physician, 1 chief resident and 2 to 4 residents. Each resident was responsible for 6 to 10 beds. Resident working hours are legally limited to 50 hours per week, including on-calls, and are usually scheduled between 42 and 50 hours.

There were day, evening and night shifts. Typical day shifts consisted in a daily patient round, supervision, training and new patient admissions. Medical staffing was reduced to 1 chief resident and 2 residents during evening and night shifts. Evening shifts – from 16:00 to 23:00 – mostly involved late patient admissions and emergencies. Night shifts were not evaluated.

Changes in the setting between the before and after periods occurred within a broader, system-wide trend towards shorter hospital stays and higher patient turnover. In 2015, the division of internal medicine employed 43 residents and operated an average of 196 beds (range: 191–228), admitting 6200 patients that year. By 2018, the division had 40 residents and operated 168 beds (162–178) with 5500 admissions. In line with legislative changes, official shift start and end times were slightly adjusted between 2015 and 2018, as detailed in figure 1.

Figure 1: Division work plan in 2015 and 2018. Time blocks are shown for a standard weekday daytime shift, excluding public holidays, and indicating scheduled periods. "Miscellaneous" includes tasks not predefined in the schedule. "Meetings & boards" in 2015 related to patient orientation meetings and multidisciplinary boards, which did not occur at fixed times and involved only the residents responsible for the patients discussed; therefore, they were displayed as separate scheduled blocks and integrated into the morning report in 2018. Compared to 2015, the 2018 schedule reflects key organisational changes: morning rounds were delayed to allow for extended preparation time, and teaching sessions were moved to the early afternoon to prioritise uninterrupted clinical work in the morning.



All residents employed by the division of internal medicine during the study period were eligible for inclusion. Residents were excluded if they could not be observed on the day of observation (ill or displaced elsewhere) or were not working weekday dayshifts on the observed inpatient wards (research position, intermediate care, night or weekend shift). Owing to routine resident turnover, none of the residents observed in 2015 were among those observed in 2018. Observed shifts were randomly selected and stratified by weekday to ensure representativeness. Two shifts per resident were recorded whenever possible.

Ethics approval and consent to participate

The Human Research Ethics Committee of Canton de Vaud certified that the study was exempt from human subject ethics review. All residents were informed of the study and provided written consent. No patient identifier or health information was recorded.

Consent for publication was part of the consent to participate.

Data collection procedures

To quantify activities, observers followed residents using a dedicated tablet application allowing real-time recording. The observers could document 22 mutually exclusive activities grouped into five categories (appendix table 1). They could select contexts: presence of a patient, presence of a colleague, use of a phone and use of a computer. After selecting an activity or a context, the application automatically recorded the starting time of the selection.

Table 1: Characteristics of participants, first and second surveys. Results are expressed as number of participants (percentage) for categorical data, and as either mean ± standard deviation or median [interquartile range] for continuous variables. Between-group comparisons used the chi-squared test for categorical variables and either student's t-test or Kruskal–Wallis test for continuous variables.

	Year 2015	Year 2018	p-value
Number of participants	36	39	
Age in years, mean ± SD	29.4 ± 2.5	29.9 ± 2.2	0.35
Female, n (%)	23 (64%)	22 (55%)	0.51
Graduation in Switzerland, n (%)	23 (64%)	26 (67%)	0.80
Postgraduate year, median [IQR]	4 [3–5]	3 [2–4]	0.087
Home-to-hospital distance in km, median [IQR]	3.0 [2.2–8.0]	4.1 [2.5–16.4]	0.30

Observers were 22 paid undergraduate medical students (6 in 2015 and 16 in 2018). Training consisted in an e-learning, a teaching session, a 1-hour video of residents engaging in typical medical activities, an 8-hour dry run observing residents and recording, as well as a final session to resolve remaining issues and to ensure reproducibility. Two observers sequentially covered day shifts with a handoff after the first six hours. Observers had continuous access to activity definitions provided in appendix table 1 and to the research team, ensuring clarity if needed.

To characterise participants, we collected sex, age, country of graduation from medical school, year of postgraduate training and distance between home and hospital. To assess the workload of the clinical division, we collected overall mean length of stay (LOS), number of admissions per week and number of patients cared for, for each observed shift.

Organisational interventions

The working group ultimately designed nine interventions, all of which are described in detail in the appendix. The three main axes of reform were:

Firstly, we structurally strengthened administrative support by reallocating resources to hire dedicated medical secretaries, integrated into the medical teams. Before the reforms, one secretary served two wards (≈48 beds) from a separate office, mainly producing discharge summaries. After the reforms, one secretary per ward (≈24 beds) worked within the medical team with additional tasks, doubling total administrative support from 6.3 to 12.6 full-time equivalent (FTE). In parallel, we collaborated with the IT department to streamline the EMR interface by introducing structured templates and auto-filled fields, and continuing to improve the efficiency and consistency of discharge summary production [18, 19].

Secondly, we increased the frequency of case management rounds from twice per week to once daily by transforming the morning handoff into a longer interprofessional decision meeting including discussion about discharges and potential barriers [20–24].

Thirdly, we moved non-clinical activities such as the daily morning postgraduate training sessions (45 minutes long) to the afternoon, increased preparation time by postponing medical rounds by one hour and reinforced the importance of structured medical rounds [25–27].

From a JD-R perspective, our 2018 reforms sought to reduce demands – through the delegation of discharge summaries and other administrative tasks, and the restructuring of interprofessional rounds – while increasing resources via an enhanced EMR interface, improved scheduling and additional administrative support.

Outcomes

The primary outcome was chosen to reflect the administrative burden of residents and was defined as the total time spent on tasks considered delegable, i.e. activities that do not require core medical judgement and can be handled by non-physician staff. This included four activities defined in appendix table 1: patient administrative tasks (e.g. booking appointments), non-patient administrative tasks (e.g. professional e-mails), discharge summary writing and retrieving information from records (e.g. EMR, archives or by contacting providers). In contrast, tasks such as "writing in the medical record" were excluded from the primary outcome due to their reflective nature and contribution to clinical reasoning and coordination.

As secondary outcomes, we assessed day shifts for task-switching rate, defined as the number of times per hour that a resident switched from one activity to another, as described by Méan et al. [17]. We also measured mismatch rate, defined as an activity observed but not scheduled for the corresponding timeframe (e.g. a resident observed handling inpatient admissions at 13:23 during a scheduled postgraduate training session from 13:00 to 13:45). All possible activities were cross-referenced with the timetable prior to the 2015 analysis, independently reviewed by the research team and finalised by consensus. In 2018, two team members reviewed and validated the table before repeating the analysis. Lastly, we compared the effective duration of observed shifts.

Bias

We identified and mitigated many biases related to the before-and-after design. 1) Observation bias was reduced by instructing observers to avoid interacting with residents except to clarify an activity or context. We recruited medical students as observers, as they were more likely to understand and accurately code the activities performed. Observers had no hierarchical reporting line other than the research team. 2) Confounding bias from external workload factors could have arisen from variations in emergency room occupancy, bed availability in critical care, rehabilitation centres and nursing homes, as well as from weekday-related fluctuations. We mitigated these last biases by recording and adjusting the number of admissions and discharges per day, mean LOS, number of patients cared for, number of patient-shift-equivalents cared for and total patients in the division. 3) Seasonal confounding due to variations in occupancy rates and disease patterns was minimised by conducting observations during the same period of the year in both study phases.

Statistical analysis

The sample size calculation was based on other studies and on the results of the 2015 study [10, 11, 14, 16, 28]. We calculated the sample size necessary to detect a 20-minute reduction in the primary outcome (time dedicated to administrative tasks). The following information was used: average time spent on administrative tasks of 92 minutes per dayshift, with a standard error of 36 minutes; one-sided test, significance of 0.05 and power of 0.8. This led to a sample size of 64 in 2015 and 70 in 2018, corresponding to two observed shifts per resident.

In this paper, we present the day shift analysis only. The percentage of time devoted to a specific activity was calculated by dividing the time for that activity by the total shift duration. Statistical analyses were performed using Stata version 16 (Stata Corp, College Station, TX, USA). Residents' characteristics are presented as either a mean (standard deviation [SD]) or median [interquartile range (IQR)] for continuous data, or as a count (percentage) for categorical data. Comparisons between the 2015 and 2018 observation periods were performed using mixed-effects linear regression models to account for repeated observations per resident. Study period (2015 vs 2018) was included as a fixed effect. Models included a random intercept for each resident, representing its vertical shift from the general mean. No random slopes were specified as there was no resident who participated in both surveys. Mixed models were adjusted for individual-level covariates (sex and postgraduate training year) and for division-level workload indicators (mean length of stay, weekly admissions and number of patients cared for per shift), as pre-specified in the study protocol. Results are expressed as means and their corresponding 95% confidence intervals of the time dedicated to each activity. Statistical significance was set at two-sided $p < 0.05$.

The study was conducted in accordance with the registered protocol, and no protocol deviations occurred.

Results

Participants, shifts and division workload

Altogether, the activities of 75 residents were collected. Resident characteristics are presented in table 1. We recorded 66 shifts in 2015 and 76 shifts in 2018, summing 1478 hours of observation. When assessing division workload, mean admissions rose from 96.4 to 146.3 per week (+51.7%) between the observation periods, while mean length of stay decreased from 15.5 to 8.5 days (–45.2%). During daytime shifts, each resident was responsible for an average of 8.6 patients in 2015 and 8.5 in 2018 (table 2). Table 3 shows the distribution of activities during day shifts.

Table 2: Division-level workload indicators. The table reports key indicators of division workload and patient characteristics during weekday daytime observation periods in 2015 and 2018, including mean weekly admissions, length of stay and case mix index, defined as the mean SwissDRG cost weight per hospital stay. Values are presented as means with 95% confidence intervals. Between-cohort comparisons were performed using two-sided t-tests at the appropriate unit of analysis.

	Year 2015	Year 2018	p-value
Number of beds operated	196	168	
Weekly admissions, mean [95% CI]	96.4 [88.1–104.7]	146.3 [137.6–155.1]	<0.001
Length of stay in days, mean [95% CI]	15.5 [14.4–16.6]	8.5 [8.1–8.9]	<0.001
Number of patients cared for per resident per shift, mean [95% CI]	8.6 [7.9–9.3]	8.5 [7.9–9.1]	0.75
Case mix index, mean [95% CI]	1.55 [1.38–1.71]	1.42 [1.32–1.53]	0.30

Table 3: Time spent on clinical, administrative, academic and personal activities, expressed in minutes per shift. Values are reported as means with 95% confidence intervals. Two estimates are presented for each activity: unadjusted comparisons between 2015 and 2018, and adjusted estimates using mixed-effects linear models accounting for repeated observations within residents. Adjustment was performed for daily workload based on the number of admissions and discharges. Negative confidence bounds were truncated at zero. Activities are defined according to reference [27] in appendix table 1.

	Unadjusted			Adjusted		
	2015	2018	p-value	2015	2018	p-value
Clinical	493 [468–519]	372 [350–394]	<0.001	490 [464–516]	375 [352–398]	<0.001
… Admissions	27 [18–36]	12 [5–20]	0.020	22 [11–33]	16 [7–25]	0.514
… Patient rounds	142 [128–156]	112 [101–124]	0.001	141 [125–157]	113 [100–127]	0.018
… Patient discharge activities	16 [11–21]	4 [0–8]	0.001	15 [9–21]	5 [0–10]	0.017
… Clinical procedures	11 [5–16]	8 [3–12]	0.378	13 [6–19]	6 [1–11]	0.158
… Out-of-unit support	NA	NA				
… News delivery	5 [3–7]	3 [1–5]	0.227	4 [2–7]	3 [1–5]	0.442
… Family meeting	11 [7–15]	10 [7–13]	0.754	10 [6–15]	11 [7–14]	0.918
… Literature review	6 [4–8]	6 [4–8]	0.929	7 [4–9]	6 [4–8]	0.782
… Writing in medical record	110 [98–122]	71 [60–81]	<0.001	111 [98–125]	70 [58–81]	<0.001
… Handoffs	16 [12–19]	7 [4–10]	<0.001	16 [12–20]	7 [4–11]	0.004
… Supervision	60 [51–70]	55 [46–63]	0.373	57 [46–69]	57 [47–66]	0.973
… Talking with providers/collaborators	70 [62–78]	52 [44–59]	<0.001	73 [63–83]	49 [41–57]	0.001
… Multidisciplinary board	18 [12–24]	32 [27–38]	<0.001	21 [14–28]	30 [24–36]	0.075
Administrative	92 [76–107]	139 [125–152]	<0.001	97 [78–115]	135 [120–150]	<0.001
… Patient administrative tasks	32 [24–40]	43 [36–49]	0.035	31 [21–40]	44 [36–51]	0.053
… Discharge summary writing	14 [5–23]	25 [18–33]	0.067	23 [13–34]	19 [10–27]	0.536
… Looking for information	38 [31–46]	59 [52–65]	<0.001	40 [31–49]	57 [50–65]	0.012
… Non-patient administrative tasks	7 [5–10]	12 [10–14]	0.010	8 [5–11]	11 [9–14]	0.144
Academic	50 [39–62]	45 [35–54]	0.465	51 [38–65]	44 [33–55]	0.464
… Receiving training	35 [25–44]	34 [25–42]	0.853	36 [25–47]	33 [24–42]	0.743
… Teaching	9 [5–13]	8 [5–11]	0.760	9 [4–13]	8 [4–12]	0.792
… Academic research	NA	NA				
Personal	32 [21–43]	63 [54–73]	<0.001	30 [18–42]	64 [54–75]	<0.001
… Personal activities	32 [21–43]	63 [54–73]	<0.001	30 [18–42]	64 [54–75]	<0.001
Transit	37 [33–41]	28 [25–32]	0.003	38 [33–43]	27 [23–31]	0.002
… Transition time to the next activity	37 [33–41]	28 [25–32]	0.003	38 [33–43]	27 [23–31]	0.002
Total time in min	697 [676–717]	644 [627–662]	<0.001			
Total time in h	11.6 [11.3–12.0]	10.7 [10.4–11.0]	<0.001			

Outcome data and main results

Primary outcome

In the before-and-after comparison, mean time spent on administrative tasks during day shifts increased to 2018, from 92 to 139 minutes (95% CIs: 76–107 and 125–152) per day, p <0.001, table 3, figure 2). Of the four administrative tasks, "looking for information" increased the most: from 38 to

59 minutes per day (95% CIs: 31–46 and 52–65, p <0.001). Figure 3 presents the distribution of administrative tasks during the day. In 2018, these took place mainly between 08:30 and 10:00 and were scattered throughout the afternoon.

Figure 2: Mean time spent in five activity categories during weekday day shifts in 2015 and 2018. Mean time spent per shift on five activity categories (clinical, administrative, academic, personal, transit), expressed in minutes with percentage of total shift time in brackets. Data are unadjusted; see table 3 for adjusted estimates. Asterisks indicate highly significant changes in duration (p <0.001). Clinical: clinical tasks; admin: administrative tasks; academic: training and academic activities; pers: personal time; transit: transit from a task to another. Percentages are calculated over total shift duration.

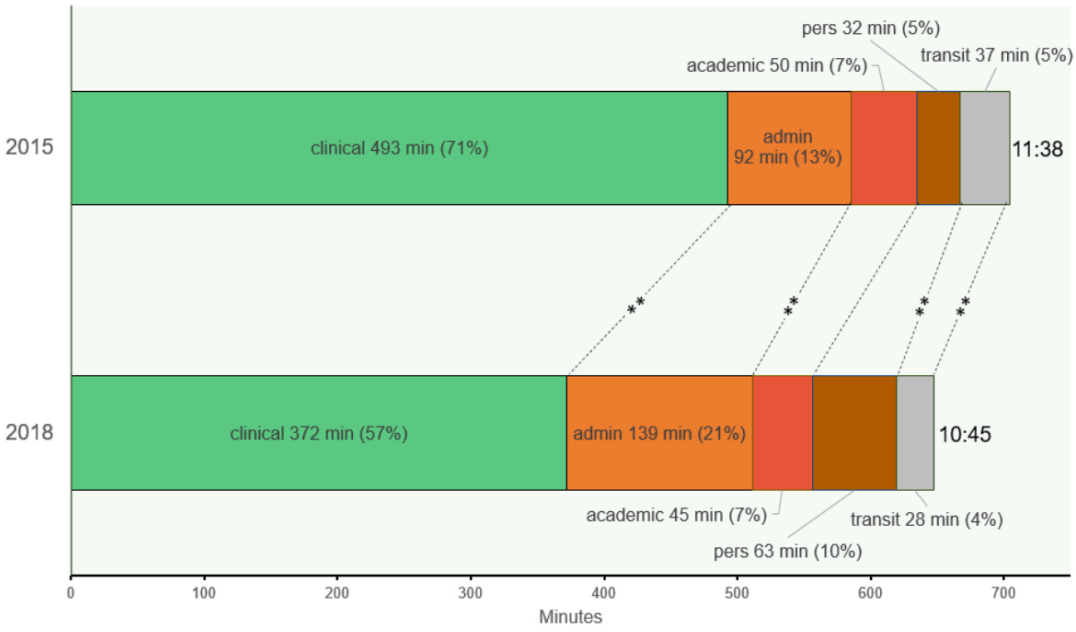
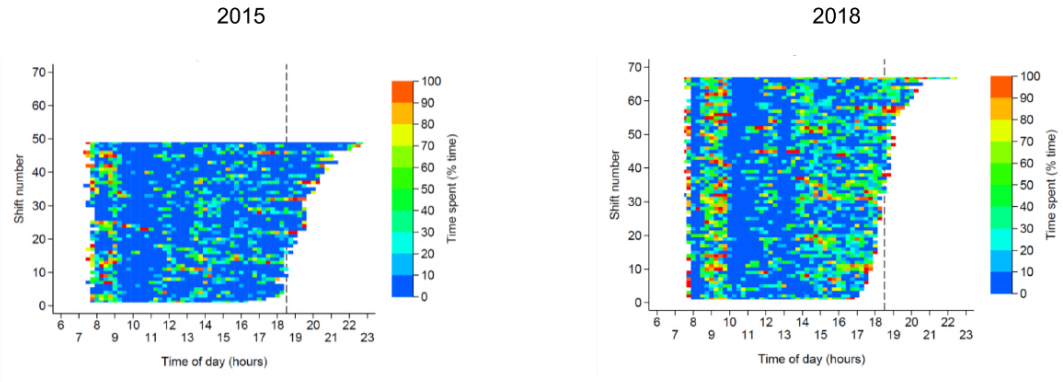


Figure 3: Temporal distribution of administrative tasks during weekday day shifts in 2015 and 2018. The figure illustrates how administrative activities were distributed across the working day and how this distribution changed between study periods. This representation complements the quantitative results by highlighting peak administrative activity and potential targets for workflow interventions. Each line represents one shift, ordered from shorter to longer. Each dot corresponds to a 15-minute interval. The colour scale indicates the percentage of time spent on administrative tasks during each interval.



Adjustments made for division workload did not modify primary outcome results (table 3).

Secondary outcomes

Between 2015 and 2018, mean task-switching rate increased significantly from 15 to 20 switches per hour (95% CIs: 14–17 and 19–21, p <0.001). Switches occurred more frequently during clinical tasks (+25%, p <0.001) but less during personal time, dedicated to residents' needs (–42%, p = 0.001). Task-switching rate was lower during the newly introduced morning meeting (08:00–08:30), medical rounds (10:00–11:00), lunchtime and teaching rounds (12:30–13:30), but higher during admissions and office work (after 14:00, appendix figure 1).

The mean mismatch rate decreased overall from 38.8% (4.4h/11.5h; 95% CI: 36.1–41.4%) to 31.7% (3.3h/10.2h; 95% CI: 29.4–34.0%, p <0.001). Clinical tasks produced less mismatch (–8.5%, appendix table 2). Personal time created more mismatch in 2018 (+14.8%, p <0.001). Looking at the weekly mismatch distribution, hotspots remained just before lunchtime, at noon and during the nurse desk round at 16:00 (appendix figure 2). Less restrictive periods at the beginning of the day freed residents to resolve most urgent issues before ward wounds.

Mean effective day shift duration decreased from 11h38m to 10h45m (95% CIs: 11h15m–12h01m and 10h30m–10h59m, p <0.001). Simultaneously, personal time increased from 32 to 63 minutes (95% CIs: 22–44 vs 53–72, p <0.001).

Adjustments made for division workload did not modify secondary outcome results.

Contexts

On average, residents were less exposed to patients in 2018 (113 to 92 minutes per day shift, 95% CIs: 101–126 and 80–103, p = 0.011). When expressed as a percentage of the total shift time, the difference was not statistically significant (table 4). Patients were seen mainly during medical rounds and between 14:00 and 17:00, with a similar temporal distribution between 2015 and 2018.

The mean time spent using a computer decreased significantly from 327 to 290 minutes per day shift (95% CIs: 306–348 and 272–308, p = 0.009, table 4). This reduction was particularly seen during patient rounds: percentage of time spent with a computer decreased from 51% (61/118 minutes in 2015) to 37% (35/93 minutes in 2018) (95% CIs: 45–56% and 32–42%, p <0.001), while percentage of time spent with patients remained identical.

Table 4: Time spent in specific clinical contexts, expressed as minutes per shift and percentage of total time. Values are reported as means with 95% confidence intervals. Both unadjusted and adjusted comparisons between 2015 and 2018 are presented. Adjusted estimates are derived from mixed-effects linear models accounting for repeated observations within residents and adjusted for daily workload, based on the number of patient admissions and discharges.

		Unadjusted			Adjusted		
		2015	2018	p-value	2015	2018	p-value
Total shift time in minutes		697 [676–717]	644 [627–662]				
Time spent with patient	As minutes per shift	113 [101–126]	92 [80–103]	0.011	112 [98–127]	92 [80–105]	0.060
	As % of total time	16.2 [14.5–18.0]	14.1 [12.6–15.6]	0.069	16.0 [14.0–17.9]	14.3 [12.6–16.0]	0.246
Time spent with computer	As minutes per shift	327 [306–348]	290 [272–308]	0.009	334 [309–359]	285 [264–305]	0.008
	As % of total time	46.8 [44.0–49.6]	44.8 [42.4–47.1]	0.271	47.2 [43.9–50.5]	44.5 [41.8–47.2]	0.261

Discussion

Key results

Totalling almost 1500 hours of observation, our study shows that administrative time (+49 min per day) and task-switching (+5 per hour) increased between 2015 and 2018. Conversely, the mean dayshift duration significantly decreased (–53 minutes) while personal time increased (+29 min). These changes occurred in the context of a substantial reduction of mean LOS (–45%) and a rise in weekly admissions (+52%). The central question is whether these results reflect the impact of our organisational reforms or are primarily driven by larger system-level pressures.

Interpretation of results in light of reforms

The increases in administrative time and task-switching were unexpected, thus implying complex underlying mechanisms of reforms, and requiring challenging interpretation. Of note, Schuurman et al. [29] found a similar percentage of administrative tasks during a shift. We suggest four effects of reforms that could explain an increase instead of a decrease of administrative time:

1) Delegation to medical secretaries aimed to free residents from non-medical-added-value tasks. However, the quality and completeness of administrative outputs (e.g. discharge summaries) possibly increased thus not reducing residents' involvement in these processes.

2) Rescheduling rounds and teaching sessions may have allowed better medical round preparation but also created space that was filled with administrative work, possibly improving quality without decreasing quantity.

3) Promoting longer uninterrupted work periods was intended to improve efficiency. Yet task-switching increased (from 15 to 20 per hour, +33%), possibly reflecting the need to juggle more activities in a shorter shift within a busier division.

4) Improvement of the EMR by involving senior physicians in IT development aimed to streamline information retrieval. Nevertheless, time spent searching for information increased by 57% and became the main pre-round activity, possibly due to the rising volume of medical data and faster patient turnover [30].

Interpreted through the JD-R model, our reforms partially rebalanced demands and resources. Added resources reduced some administrative and cognitive load, but new or persistent demands (e.g. patient complexity) may have offset benefits. JD-R highlights that gains in wellbeing and efficiency require resources sufficient to counterbalance evolving demands.

Weight of context and systemic pressures

Between 2015 and 2018, the division faced a halving of mean length of stay and an increase in weekly admissions, consistent with a system-wide trend towards shorter hospitalisations and higher patient turnover. This structural shift inevitably increased the number of admissions and discharges per resident, each requiring substantial clinical and administrative work. However, the available data do not allow us to verify this hypothesis. These workload indicators (mean LOS, weekly admissions, patients per shift) were included as adjustment variables in mixed models. Adjustments did not materially change the results, suggesting that the impact of systemic pressures remained pervasive. Possible explanations include variability in how administrative tasks are distributed among residents, the contribution of administrative work unrelated to patient turnover, partial compensation from reforms, collinearity between workload variables and limited power to detect marginal effects of turnover.

This finding highlights a key message of our study: organisational reforms alone, particularly those limited to time reallocation, may be insufficient to counteract the impact of large-scale systemic changes, even if this observation may partly reflect the impact of our organisational reforms, particularly those aimed at streamlining discharge processes.

Other observed effects beyond administrative work

Despite the lack of measurable reduction in administrative time, our reforms coincided with several other changes that may reflect improvements in workflow and working conditions:

- Shorter shifts and reduced mismatch rate suggest better alignment between scheduled and actual activities, even in the face of increased admissions and higher turnover. This may indicate improved planning, smoother handovers and a more predictable daily structure, which are important for both efficiency and resident satisfaction.
- Increased personal time within shifts points towards a healthier work–rest balance, with residents more frequently able to take breaks without sacrificing clinical duties. Such pauses may help maintain concentration, reduce fatigue and promote resilience over the course of the day.
- A stable proportion of time with patients (as a percentage of total shift time) suggests that direct clinical contact was preserved despite a reduction in absolute minutes. This implies that, even under increased workload pressures, residents maintained their focus on patient-facing activities, which is critical for care quality and training. Patients continued to be seen mainly during morning rounds and mid-afternoon in both study periods. We hypothesise that planning medical rounds later in the morning may have improved preparation and the quality of patient contact, but this would require confirmation in a dedicated study.

In addition, time spent using computers decreased in absolute terms despite ongoing healthcare digitalisation, matching other studies such as Wieler et al. [31]. This finding could reflect multiple factors: improved usability of digital tools, better digital proficiency among residents, increased efficiency in data entry and retrieval, and a broader distribution of EMR-related tasks to other members of the care team.

Importance for future management

Our results challenge the idea that targeted organisational changes within a residency programme can, by themselves, substantially reduce administrative workload in a high-pressure health system. Even carefully designed reforms may have a limited measurable effect when systemic trends – such as increased patient turnover and reduced length of stay – exert a dominant influence on daily work patterns.

For residency programme directors and hospital managers, this means that structural changes to time allocation should not be implemented in isolation. They are more likely to yield tangible benefits when combined with broader interventions addressing the complexity of clinical workflows, the efficiency of interprofessional communication and the optimisation of administrative processes across the institution. Such measures may include streamlined discharge procedures, intelligent task allocation across the care team, integration of digital tools with improved usability and proactive workload monitoring.

In practice, aligning residency reforms with hospital-wide strategies is crucial to prevent local initiatives from being overshadowed by external pressures. This requires sustained collaboration between educational leaders, clinical managers and hospital administration, supported by robust monitoring of both quantitative (e.g. time-use metrics, workload indicators) and qualitative (e.g. resident satisfaction, perceived efficiency) outcomes. Without such coordinated efforts, the potential benefits of localised reforms risk remaining imperceptible in quantitative analyses, even when they may improve qualitative aspects of work.

Finally, in light of growing concerns about physician burn-out, exhaustion and attrition, our results highlight the importance of monitoring quantitative indicators and their sometimes unexpected evolution, while also adopting a multifaceted approach towards improving physicians' working conditions and wellbeing, thereby aiming at enhancing recruitment and ensuring the future supply of medical professionals, in the inpatient sector and beyond.

Broader perspective

Measuring resident's activities with a stopwatch relies on the scientific management put forward by Frederick Taylor [32]. However, time alone is an imperfect proxy for quality, as people are not machines. Residents need incentives other than wages to compensate for overtime. In a companion qualitative study, we interviewed our residents through focus groups and found that time management remains their main challenge [33]. Time constraints mean constant efficiency-seeking due to more admissions and pressure to reduce costs and lengths of stay.

Reforms to improve work conditions and adapt to the evolution of medicine will always be needed, but time management strategies alone are insufficient. Physicians also need a clear sense of purpose and professional identity to remain engaged. The rapid evolution of hospital medicine – marked by higher patient turnover, shorter lengths of stay and expanding administrative requirements – has reshaped the resident's role. Preserving meaning in daily clinical work, fostering professional identity and maintaining strong engagement with the human aspects of care are essential. In high-pressure environments, these elements may require dedicated reflective practice, mentorship and collaborative models of care, integrated with structural reforms.

Strengths and limitations

Our study presents 1500 hours of observation, making it one of the biggest datasets in this field. This extensive amount of highly contextualised data allows precise quantitative responses. We collected two snapshots three years apart, at the same time of year and using exactly the same method, thus avoiding seasonality and methodological biases. Demographic characteristics were similar in both groups. Another strength is the use of a dedicated electronic tool to record activities in real time, providing granular, accurate and reproducible measurements.

Our study has several limitations. First, measurement-related limitations: despite standardised observer training in both study periods (same tutorial, video material and procedure), coding bias cannot be excluded. For instance, distinguishing between "writing in the medical record" and "looking for information" in the EMR may have been challenging. We did not assess the extent of

implementation of each intervention, limiting interpretation of their actual impact. In addition, all interventions were evaluated together, preventing us from attributing effects to individual components.

Second, limitations affecting internal validity: in a before-and-after design, numerous confounding factors – such as patient complexity, medical student involvement or nurse staffing – could have influenced results. We estimated that the division's workload increased substantially due to shorter length of stay and more weekly admissions; although adjustments for these variables did not alter our results, we cannot exclude an overwhelming effect of workload compared to reforms.

Third, limitations affecting external validity: we observed a limited number of residents in a single division of a university hospital, and our findings reflect only the activity of mainly third-year internal medicine residents during daytime shifts. Our results may not be generalisable to surgical disciplines, outpatient settings or more senior physicians. Night shifts were not observed, and changes in nocturnal activity could have affected administrative tasks during the following day.

Finally, limitations inherent to the time and motion design: this method does not capture quality of care, quality of work or resident wellbeing.

Conclusion

Organisational reforms in residency programmes can improve certain aspects of workflow, but our findings show that they may not be sufficient to offset the impact of broader systemic pressures such as increased patient turnover and reduced length of stay. Addressing administrative burden and task fragmentation in such contexts requires coordinated, institution-wide strategies that go beyond time reallocation, integrating workflow optimisation with initiatives that sustain professional meaning, identity and engagement among residents, aiming at improving physicians' working conditions and wellbeing, and ensuring the future supply of medical professionals.

Data sharing statement

The study protocol is available from Dr Garnier (antoine.garnier[at]h-fr.ch). The statistical analysis code is available from Prof. Marques-Vidal (pedromanuel.marques-vidal[at]chuv.ch). The study dataset consists of individual-level, time-stamped observational and administrative data collected within a single Swiss hospital division. All data used for analysis were deidentified prior to analysis. However, due to the granular temporal structure of the data and the institutional context, there remains a residual risk of reidentification. For this reason, the full raw dataset cannot be deposited in an open public repository. Deidentified aggregated data (e.g. at shift or day level), data dictionaries and related documentation can be made available upon reasonable request to Dr Garnier. Data access is restricted to academic, non-commercial research purposes and is conditional on institutional approval and a signed data transfer agreement. Data will be made available for secondary analyses consistent with the objectives of the present study, without a predefined end date. The source code for the MEDAY application is available "as is" at https://github.com/agarnier00/MEDAY.

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The authors confirm contribution to the paper as follows: Study conception and design: AG, JC, PM-V, FB, MM, DG, MM, OL, PV, GW, VK. Data collection: AG, VK, FB, JC. Analysis and interpretation of results: AG, VK, PM-V, FB, JC. Draft manuscript preparation: AG, VK. All authors reviewed the results and approved the final version of the manuscript.

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Potential competing interests

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflict of interest related to the content of this manuscript was disclosed.

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Appendix

Description of structural and organizational reforms 2016 – 2018

Introduction

This appendix describes the structural and organizational reforms implemented between 2016 and 2018 in the Division of Internal Medicine, Lausanne University Hospital,.

Rationale

After the 2015 time-motion study assessing the type and duration of activities performed by the internal medicine residents (Wenger et al. 2017), the management of the division engaged in several reforms.

The 2015 time-motion demonstrated the following key findings: 1) On average, residents spent 1.5 hours per day on administrative tasks without any added clinical value, 5.2 hours using computers, and 1.7 hours with patients. Activities directly related to patients accounted for 28%. 2) Residents switched from one task to another 15 times an hour. (Méan et al. 2017) 3) There was a significant mismatch between observed activities and the work schedule (Garnier et al. 2018).

The NEXT group

A task force called “NEXT group” was set up to improve residents’ workday. The following aims were identified:

1. to reduce the medical-administrative tasks performed by the residents.
2. to increase the time available for added-value medical tasks.
3. to increase work efficiency, overall and during computer work in particular.
4. to reduce task switching and work interruptions.

The NEXT group included a core of permanent members throughout the reform. These permanent members were residents, chief residents, staff physicians and a head nurse; all were working in our division. Additionally, the NEXT group regularly invited informants during meetings: other professionals (administrator, liaison nurses, physiotherapists), the medical director of the hospital and a team dedicated to continuous improvement (Unit of Organisation and Continuous Improvement, Department of Human Resources, Lausanne University Hospital). Advice outside of our hospital was regularly sought from colleagues who had conducted similar reforms.

Overall, the NEXT group gathered nine times from June 2016 to May 2017. Initial statements regarding the reforms to be implemented were the following:

1. While the reforms' main goal was to improve the structure and organization of the resident's workday, it should be kept in mind that the overarching goal of our division is to provide excellent patient care. At the same time, better work conditions and improved residents' wellbeing will contribute to better patient care delivered by the residents.

2. It is no surprise that such reforms are needed. Indeed, the structure and organization of the residents' workday have little evolved these past decades, even if major changes have impacted our healthcare system:
    a. Increasing patient complexity and multimorbidity; ageing patient population
    b. Need for increasing patient safety, including more defined care processes
    c. Implementation and development of the electronic medical record (EMR)
    d. Restriction of residents' work hours and need for a better professional and private life balance
    e. Increasing pressure on healthcare costs, including shorter length of stay

Based on these two considerations and the previously listed reform aims, the NEXT group used different models and frameworks (such as LEAN's principles or Donabedian's approach) to come up with three reforms to be implemented. The NEXT group was also responsible for managing the change process within the division.

Additional reforms implemented in the Division of Internal Medicine

Six other reforms influenced the Division of Internal Medicine. These were decided either by the top management of the hospital or by our division itself.

Table A summarizes the reforms. Table B describes the change management process, the benefits, the issues, and the lessons learnt, and the costs for each reform.

Table A

Description and rationale of structural and organizational reforms 2016-2018 in the Division of internal medicine, Lausanne University Hospital

Designation	What did the reform consist in?	What was the rationale for its implementation?	Aims	Main JD-R category	Link to JD-R model
Medical secretary allocation and delegation	We structurally increased the administrative support available for residents by hiring new medical secretaries, to allocate one to each ward unit (i.e., one medical secretary for 2 to 3 residents). Each medical secretary worked in the same office as the residents to facilitate communication and collaboration. Members of the work group (WG) asked residents to establish a list of tasks to be delegated to the secretary (specifications of the medical secretary function). Medical secretaries were trained appropriately.	In the MEDAY study, we observed that our residents spent on average 92 minutes per day on administrative tasks. Administrative tasks performed by residents should be regularly reassessed for suppression or at least reduction. If possible, they should either be automated with an effective EMR or delegated.(Castioni et al. 2017; Erickson et al. 2017). A common principle in human resources requires to respect the competence domain of each professional, as much as possible.	● to reduce medical-administrative tasks ● to increase time for added-value medical task ● to increase work efficiency	Increase in resources	Frees residents from low–medical-value administrative tasks, increasing time for clinical duties and reducing administrative burden.

Early interprofessional decision meeting	We set up a daily 30-minute interprofessional decision-making meeting (also called “point de 8 heures”). This replaced both (1) the daily handoff meeting and (2) the twice-weekly interprofessional meetings. This new session gathers all the medical staff (attending physician; chief resident; residents; students), the head nurse of the ward, the transition nurse, and the medical secretary. Each patient is discussed. Team members take turns at bringing the required information to the others. The discussion targets the care plan, the orientation after the acute care and the discharge date. The medical secretary takes notes in the EMR, which is displayed on a big screen to render the information clear and available to everyone.	Interprofessional team meetings are known to improve communication and coordination between healthcare providers.(Prystajecky et al. 2017; Wild et al. 2004; Geary et al. 2009). However, we observed that interprofessional meetings in our ward were not frequent enough to cope with patient flows and thus forced staff to obtain information in parallel, often duplicating work and causing interruptions. We also observed that the late timing in the day (afternoon) was inefficient.	● to increase work efficiency ● to reduce task switching	Increase in resources	Improves coordination, reduces interruptions, and clarifies the care plan early in the day.

Day and week schedule reorganization	We reorganized the day and week schedule to limit work fragmentation and reduce task switching. An important change was the organization of the interprofessional decision meeting every day at 8:00 AM (see above). Another main change consisted in concentrating the formal teaching in a daily teaching session at 1:00 PM, just after lunch. The third important change consisted in postponing the start of the daily ward rounds to 10:00 AM, instead of 9:00 AM, allowing for more preparation time needed by both residents and nurses.	In the MEDAY study, residents switched from one task to another up to 15 times per hour, which questions work efficiency (Mean et al. 2017). Overall, this reform is self-explanatory: we reschedule activities to have more continuity throughout the day. We also aim at having a more homogenous time schedule from day to day. See above for specific rationale about the interprofessional decision meeting. Finally, interruptions frequently occurred during ward rounds (e.g., phone calls; looking for information required for rounding in files; patients needing to be discharged; etc.). Part of these interruptions were attributed to a lack of preparation time before rounding. For this reason, we postponed the start of the daily round to allow for more preparation time.	● to increase work efficiency ● to reduce task switching	Reduction in demands	Decreases work fragmentation and multitasking, fostering better focus.
Senior physician allocation to IT department	Our Division of Internal Medicine identified up to 4 senior physicians to work with the IT department at a maximum percentage of 50%. They were asked to support a major institutional change within the EMR: the implementation of an electronic prescription module. The IT department aimed at facilitating this implementation and recruited senior physicians within clinical departments to support the process.	In the MEDAY study, residents used a computer for over 5 hours per shift (313 minutes). In addition, previous data gathered in our division (Ergosor study) showed low medical staff satisfaction with the EMR ergonomy. In such circumstances, our division was willing to collaborate with the IT Department to improve the EMR through direct user involvement, such as that of senior physicians of the division of Internal Medicine, willing to (1) get involved in the IT Department and (2) work on new EMR features and improve existing ones.	● to increase time for added-value medical task ● to increase work efficiency	Increase in resources	Enhances EMR usability and efficiency, making residents' work easier.

Proactive management of hospital stays (GPS+ project)	GPS+ is a French acronym for “Gestion Proactive des Séjours”. This reform aimed at both better preparing the transition upon hospital discharge and shortening the hospital length of stay. It was based on (1) the early identification of the senior physician responsible for the patient, (2) the early definition of the therapeutic goals of the hospital stay, and (3) the anticipation of the discharge date, together with its clear communication to the patient. The last two points were discussed within the early interprofessional meeting (see above). The GPS+ project also included a formal recording of the decisions in the EMR .	The GPS+ project was decided by the hospital general management to improve the transition upon discharge and to shorten hospital length of stay by better anticipating the discharge date. In particular, the LOS in the Internal Medicine Division was negatively benchmarked in comparison with other Swiss hospitals of similar size (an average of about two additional days per hospital stay).	● to increase work efficiency	Reduction in demands	Anticipates discharges, reducing delays and workload linked to prolonged stays.
Discharge summary improvement	A continuous improvement process targets the production of hospital discharge summaries. It started in 2013 and covers all production steps: (1) consensus on summary content through survey of recipients, typically GPs (2) accurate documentation in the EMR during the hospital stay to prepare summary content, (3) definition of the role of administrative staff, (4) appropriate training of both administrative and medical staff, and (5) measures to respect the deadlines (set expectations - monitor deadlines – ensure reminders – provide feedback)	The main rationale was the existing delay in sending discharge summaries to their recipients (physicians in charge of the patients in the community), hence affecting the transition between hospital and community. The time needed to send a discharge summary is monitored at an institutional level for quality purposes (Quality indicator). Moreover, the Division of Internal Medicine is willing to improve the discharge summary production process for the benefit of the residents.	● to increase work efficiency	Increase in resources	Optimizes writing and transmission processes, lowering stress linked to deadlines.

Clinical practice recommendations	We developed clinical practice recommendations for the ten most frequent diagnoses in our division. The recommendations were internally developed by an interprofessional team, based on evidence in the scientific literature.	The rationale for our clinical practice recommendations were to (1) improve the efficiency of our care processes, (2) shorten the LOS, (3) reduce potentially avoidable readmissions and (4) better standardize our care despite the many different providers involved. Overall, the work in the units should be facilitated and become more fluid, for the benefit of patients and at a lower cost.	● to increase work efficiency	Increase in resources	Provides standardized tools to improve care quality and efficiency.
Specialty beds in the Division of Internal Medicine	Our division consists of 7 general internal medicine units and of one intermediary care unit. In two of the general units, we gave the following specialties the opportunity to take direct responsibility for their own patients: respiratory medicine, nephrology, immunology, and endocrinology. The project started in April 2018.	The rationale was to ensure a more direct supervision by the specialists of specific inpatients. This prevented too long delays (1) for the advice of specialists acting only as consultants and (2) for specific investigations performed by the specialists (e.g., bronchoscopy).	● to increase work efficiency	Increase in resources	Direct access to specialized expertise, reducing care delays.
Coordination between the Division of Internal Medicine and the Emergency Room	The institutional project “ProMouv” aimed at speeding up the transfer of patients from the ER to the hospital units. The targeted transfer timing was within 6 hours.	The rationale was to quickly transfer patients to the best location for their care and reduce waiting time in the ER.	● to increase work efficiency	Reduction in demands	Speeds up admissions, reducing upstream waiting times and improving patient allocation.

Table B

Change management, benefits, issues and costs of structural and organizational reforms 2016-2018 in the Division of internal medicine, Lausanne University Hospital

Designation	How was the change management process conducted?	What are the main benefits of the reform?	What are the issues and lessons learnt?	How much did the reform cost?
Medical secretary allocation and delegation	We included both residents and medical secretaries in the process. We asked them to establish a list of the tasks to be delegated, those to be accomplished by residents (added-value medical tasks) and finally those that could be suppressed through automated processes (e.g., in the EMR). See Castioni *et al.*, 2017 for further details. Afterwards, we pilot tested two different models of ward organization with medical secretaries. After feedback, we implemented the most effective model (one medical secretary per ward unit, in charge of both delegated tasks and discharge summaries). We needed time to hire new medical secretaries and therefore adequately staff each ward unit.	Each profession can better concentrate on its "core business". Residents felt they had more time available for added-value medical tasks. This reform also allowed medical secretaries to have more diversified tasks. We obtained a qualitative evaluation of the reform through direct feedback from the residents and secretaries, showing increased satisfaction in both professional groups.	It is important that the medical secretary works in the same office to facilitate direct communication and collaboration. Delegation needs to be taught to residents used to doing the job themselves. The job of such a medical secretary is a new professional profile that has consequences for recruitment.	The medical secretaries already working in the division and only tasked with formatting discharge summaries were required to answer to the new expectations (e.g., accomplish tasks delegated by the residents). To do so, we needed to recruit new secretaries, doubling total administrative support from 6.3 to 12.6 FTE in a division of 8 ward units).

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Early interprofessional decision meeting	The new daily interprofessional meeting required transition nurses to be present daily at 8:00 AM. This needed to be explained, but the advantage of the new meeting appeared obvious to them. The key element of the change management process was appropriate staff training. In other terms: "Who says what at which moment?". We produced a written document as well as a demonstration movie and a formal teaching session for new staff members. The presence of the attending physician at each meeting allowed for continuous coaching and feedback. Finally, it was important for the nurses in charge of the patients on the ward to be informed by the head nurse after the meeting. This supported reform adherence of the whole staff.	One of the expected benefits of the daily interprofessional meeting was to limit interruptions during the workday. Another benefit was to keep up the pace with the increasing flow of the patients. The daily interprofessional meeting allows for early decision making and regular reassessment of each patient. Consequences on the length of stay are illustrated by the reduction of the mean LOS from 11.04 days in June 2016 to 6.42 in June 2018. Lastly, this meeting allows medical secretaries to be kept updated on each patient's situation, and to anticipate tasks accordingly.	In today's clinical environment, interprofessional meetings are crucial to take early and effective decisions. Appropriate training is needed to have the staff follow a predefined, structured discussion of each patient, respecting a rigorous time management. During the interprofessional decision meeting, the secretary writes key decisions in the EMR, such as the discharge date and destination.	Costs only relate to the time dedicated by the staff to the daily meeting (30 minutes each).
Day and Week schedule reorganization	Each member of the WG was asked to suggest a new day and week schedule. This allowed us to explore many different options and come up with the most effective one. The change management process was simple when rescheduling activities internal to our division and staff. When it concerned professionals and colleagues from other Departments, the process required meeting them to explain our rationale for change.	Less fragmentation of the residents' workday; less task switching.	While rescheduling activities appears simple, it requires time to explore the advantages and disadvantages of possible new schedules. Rescheduling activities can have an effective impact on the daily life of the residents.	No additional cost.

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Senior physician allocation to IT Department	The change management process occurred at two different levels: 1) Collaboration between the division of Internal Medicine and the IT Department, to send some senior physicians to work part-time in IT. This required that the senior physicians be willing to get involved with improving the EMR. 2) Actual implementation of the new prescription module, through the contribution of senior physicians from the division of Internal Medicine. The module itself was implemented in our division in June 2016. It required educational sessions for the staff, direct supervision of staff on wards, a hotline, and the capacity to react and quickly make the adaptations needed.	The senior physicians from our division were able to inform the IT Department of specific user needs, especially regarding the new module implementation.	Considering the time spent using a computer, it is crucial for residents to work with an effective EMR. A strong collaboration between the IT and the clinical departments is needed to improve the EMR and have it answer users' needs.	No additional cost for our division (up to two full-time equivalents, paid by the IT)
Proactive management of the hospital stay (GPS+ project)	Two working groups, which included our staff (doctors; nurses) and the GPS+ project leaders, were asked to make concrete decisions regarding the project implementation (e.g., how is the senior physician in charge of the patient identified? Who defines the therapeutic goals? Etc). Eventually, the GPS+ project was integrated within the early interprofessional meeting, as both projects shared similar objectives.	During the early interprofessional meeting, therapeutic goals and the discharge date are discussed daily for each patient. This regular, common, discussion contributes to shortening the LOS (see for example Kraege's presentation at AMEE conference 2018). This means a reduction of the mean LOS from 11.04 days in June 2016 to 6.42 in June 2018.	Interprofessional meetings are critical to discuss and plan the hospital stay of inpatients. Gathering all stakeholders during interprofessional meetings allows for regular and quick decisions.	Costs consist of the time dedicated by staff to the interprofessional meetings.

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Discharge summary improvement	We set up a continuous improvement process whose lead was attributed to two senior physicians of our division. Appropriate staff information regarding expectations is crucial. Hence, information sessions are regularly organized for newcomers. We also set up a system of weekly feedback to all staff concerning current delays and the summary workflow.	We reduced the delays of sending discharge summaries and improved information transmission to the physicians in the community. The mean delay is currently about 3 days.	Training and effective feedback to the staff are crucial. We also developed an internal tool to monitor discharge summary workflow and the production process. This tool proved to be very effective for our weekly feedback report.	Costs related to staff's work
Clinical practice recommendations	We set up a working group to define the overall strategy. The first step consisted in the production of the recommendations themselves. A consensus on each recommendation was obtained through the consultation of key stakeholders across professions (doctors; nurses and physiotherapists). The second step occurred in January 2018, when recommendations were made available online and in the form of a pocket guide. Recommendations were also presented during formal training sessions.	At the time of the study, the impact of implementing these recommendations on clinical indicators, including LOS and readmissions, was unknown.	Measures are needed to ensure that recommendations are followed. Moreover, they need regular updates.	Costs related to staff's work
Specialty beds in the division of Internal Medicine	Preparation was key to anticipate all issues, in particular to consider the organization of a ward with a mix of patients (general & specialty) and to set up the criteria for admitting a patient in a specialty bed. A working group was constituted and included representatives of internal medicine and the various specialties.	At the time of Med2day, the respiratory medicine was responsible for 9 beds and the three other specialties for 6 beds in total r. The model now appears satisfactory enough to be maintained and extended to other specialties.	Many patients could benefit from direct access to the required specialist. An official document was produced to define the principles ruling the collaboration between the GIM units and the other units. This document concerns patient flow, supervision and training of residents.	Costs related to the staff needed to supervise specialty inpatients.

Designation	How was the change management process conducted?	What are the main benefits of the reform?	What are the issues and lessons learnt?	How much did the reform cost?
Coordination between the Department of Internal Medicine and the ER	A transfer within 6 hours from the ER requires (1) adequate transmission of patient cases potentially unstable and (2) adequate staffing in the wards to admit the patients. In such circumstances, in May 2018, we increased the medical staffing in the wards (one chief resident and an additional resident for the night shift).	It appears logical to minimize the time spent by the patients in the ER and therefore reduce the overall waiting time in the ER. It allows the Department of Internal Medicine to assume earlier in the process the responsibility of patient care.	Our anticipation allowed us to admit 100% of the ER patients within 6 hours (during a 4-month observational phase from April to August 2018). The 6-hour delay implies a loss of a buffering zone between the ER and the Department of Internal Medicine. Any increase of inpatient cases in the ER means a similar increase of admissions in the Department of Internal Medicine, including during periods with a reduced medical staff. With this reform, our clinicians assume an increasing number of shifts on evenings, nights, and weekends.	Appropriate (hence increased) staffing of the team in the wards to quickly admit the patients.

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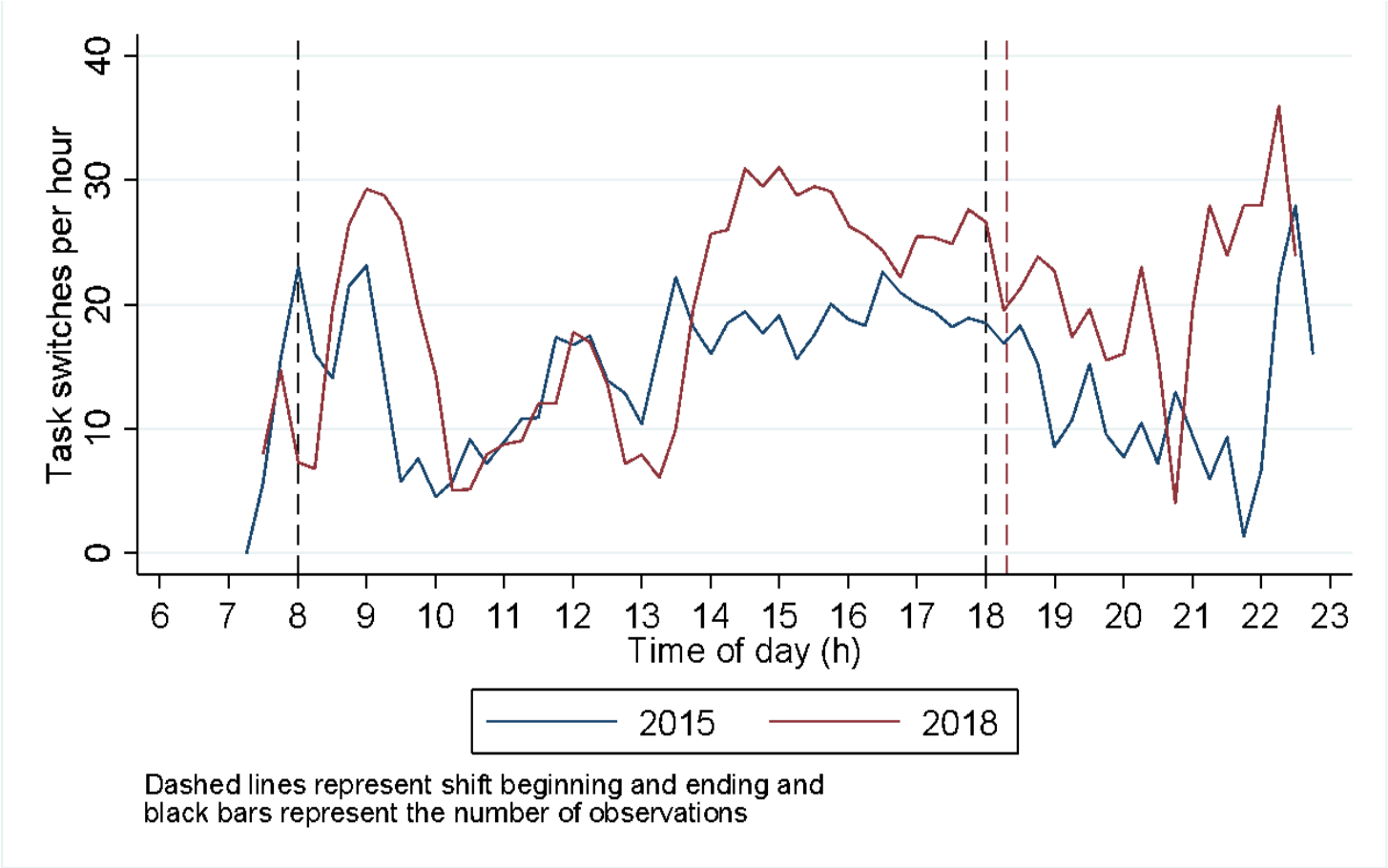
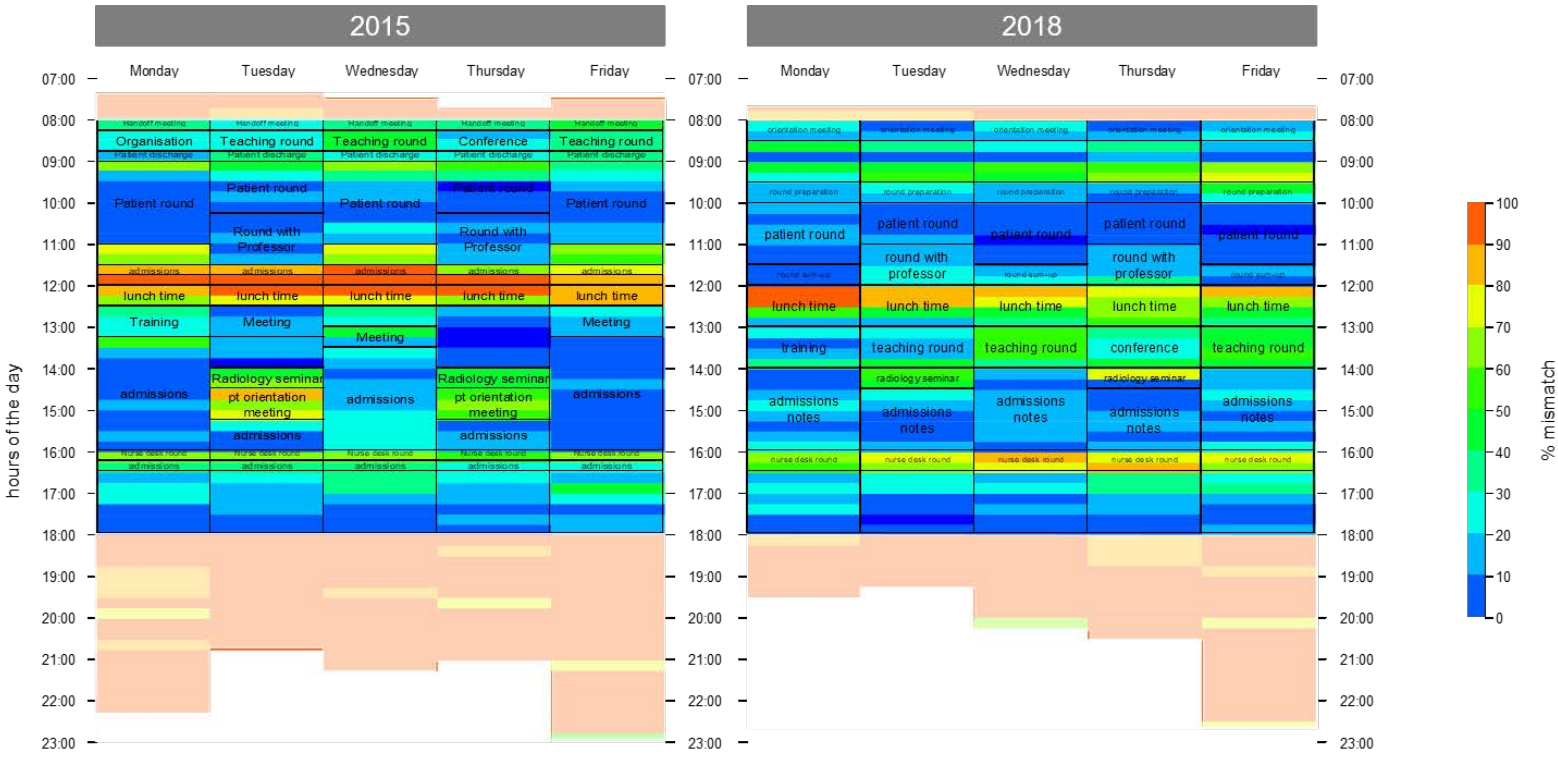
Supplementary information

Appendix figure 1: Task-switching rate (switches/hour) before (2015) and after (2018) reforms. Dashed lines indicate shift start/end; black bars show number of observations. Definition from Méan et al. (2017).



Appendix figure 2. Weekly distribution of mismatch between residents' official schedules and observed activities. Color scale indicates mismatch intensity (red = higher mismatch).



Appendix table 1. Description of the 22 possible activities of the resident, that an observer could record using the dedicated tablet application. Published in Wenger, N., M. Mean, J. Castioni, P. Marques-Vidal, G. Waeber, and A. Garnier. 2017. 'Allocation of Internal Medicine Resident Time in a Swiss Hospital: A Time and Motion Study of Day and Evening Shifts', Ann Intern Med, 166: 579-86. Categories are adapted to isolate the primary outcome.

Category	Activity	Description
Clinical tasks	Admission	Anamnesis, clinical examination, and communication with patients. Starts when the resident looksafter a new patient.
	Patient rounds	Daily medical round of inpatients that the resident is in charge of: EMR review, anamnesis, clinical examination, prescription. Also includes the daily sign-out round at the nursing desk.
	Patient discharge activities	Preparation for patient discharge: Prescription writing, last discussion with the patient, provision and explanation of prescriptions.
	Clinical procedures	All medical procedures performed by the resident on a patient, including, but not limited to, arterial blood gas testing and punctures (e.g., ascites, lumbar, or pleural).
	Out of unit support	Patient overseeing by the resident outside the ward: during examinations, transfers to other departments, and emergencies.
	News delivery	Delivery of bad news or therapeutic orientations that need a dedicated in-depth discussion; patient educational therapy.
	Family meeting	Communication with family, close relatives, or nonprofessional caregivers. Time for providing information, explanations, and collecting information and opinions
	Literature review	Looking for scientific data to improve/determine patient management, including medical textbooks, scientific papers, and Web sites.
	Writing in the medical record	Writing down notes, problem lists, handoffs, or examination results. Excludes admission activity and discharge report drafting.
	Handoffs	Giving or receiving handoffs, including preparation of documents thereof, attending handoff meetings, receiving/giving information on the phone, or sharing information.
	Supervision	Discussion with a senior physician (chief resident or chief physician) focusing on a patient and resulting in a decision on patient management.
	Talking with providers/collaborators	Collecting information, booking an appointment, requesting an examination or a specialized consultation, and asking for a consultant advice.
	Multidisciplinary board	Multidisciplinary boards and meetings between professionals to discuss management of ≥1 patient.
Academic activities and training	Receiving training	Participation in a training conference or attending rounds (medical round supervised by the chief physician), self-preparation, and paper review.
	Teaching	Resident teaching of students, collaborators, and nurses. Includes supervision of admissions performedby students.
	Academic research	Research work, thesis, and publications. Excludes literature review.
Administrative tasks	Looking for information	Looking for information in the paper record, EMR, computer archives, or other medical records. Excludes admission activity.
	Discharge summary redaction	Any activity related to writing hospitalization reports: brief reports and discharge letters. Includes revision of reports.
	Patient administrative tasks	Administrative tasks for the patient: booking appointments, issuing vouchers for radiological examinations or specialized consultations, and adding laboratory tests.
	Non-patient administrative task	Activities unrelated to patients, directly or indirectly (e.g., answering professional e-mails).
Personal	Personal activities	Time dedicated to the resident's personal needs, unrelated to clinical activity: food, restroom, and private use of telephone or computer.
Transition	Transition time to the next activity	Time required for transitioning to another activity: moving, handwashing, dressing, and fetching or bringing something.

Appendix table 2: Proportion of activities performed outside of the expected timeframe, by category of activity. Values represent the mean percentage of time spent in mismatch during a shift, along with 95% confidence intervals, for each activity category. Statistical significance is based on mixed-effects models. *Mismatch* is defined as any activity performed outside its scheduled or expected time slot (e.g., handling admissions during protected teaching time).

	2015 (n=49)	**2018 (n=67)**	***p*-value**
Clinical tasks	41.1 [38.3 - 44.0]	32.6 [30.2 - 35.1]	<0.001
Academic and training	26.0 [15.9 - 36.2]	30.2 [21.5 - 38.8]	0.543
Administrative tasks	37.1 [32.1 - 42.0]	30.5 [26.2 - 34.7]	0.048
Personal time	20.4 [15.0 - 25.9]	35.2 [30.5 - 39.9]	<0.001
Transit to the next activity	10.9 [7.1 - 14.7]	7.7 [4.4 - 10.9]	0.2
Overall	**38.8 [36.1 - 41.4]**	**31.7 [29.4 - 34.0]**	**<0.001**