

Hospital doctors' workflow interruptions and activities: an observation study

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ABSTRACT

Background: Interruptions of hospital doctors' workflow are a frequent stressor, eventually jeopardising quality of clinical performance. To enhance the safety of hospital doctors' work, it is necessary to analyse frequency and circumstances of workflow interruptions.

Aim: To quantify workflow interruptions among hospital doctors, identify frequent sources and relate sources to doctors' concurrent activities.

Methods: Within a typical hospital, 32 participant observations of doctors' full work shifts were carried out. Time–motion information was collected on types of workflow interruption and doctors' activities and analysed with logit–linear analyses.

Results: The frequency of workflow interruptions was high, especially on the intensive care unit and emergency ward. Telephones and beepers were the most frequently recorded type of work interruption. The combined analysis of doctors' activities and concurrent workflow interruptions revealed that the likelihood of the occurrence of certain types of interruption depended on the tasks being carried out by the doctor.

Conclusion: The present method may be useful for quantifying and distinguishing sources of hospital doctors' workflow interruptions and useful in raising awareness of organisational circumstances.

INTRODUCTION

Workflow interruptions are a frequent stressor for doctors in hospitals.^{1–4} The consequences are manifold: they hamper the performance of duties and cause a constant challenge to task prioritisation, thus jeopardising the quality of clinical performance and eventually patient care.^{5–6} Studies indicate that workflow interruptions can lead to dispensing errors in pharmacy, surgical errors, erroneous clinical decision making, disruptions of communication or poor hygienic behaviour.^{4–7–8} This may have an impact on patients' safety and the efficiency

of work practices.² Interruptions may hinder effective communication during various activities, such as registration procedures and shift changes.^{6–9} It has been shown that work places with high levels of interruptions are perceived by employees as uncontrollable and unpredictable.^{10–11} Interruptions are a source of fatigue, stress and frustration.¹² A study among English general practitioners found that interruptions were one of the major stressors leading to lower job satisfaction.¹³

Most previous research on workflow interruptions has been carried out in emergency units^{3–14–16} and operating theatres.^{4–17–19} Doctors in emergency departments have been observed to be interrupted on average up to 10 times during a working hour.¹⁵ Interruptions on wards or intensive care units are frequent as well, though the pattern seems to differ [from emergency departments]; however, there is very little data to substantiate this.^{20–22}

There is a need for more research analysing the frequency, character, and circumstances of interruptions.^{3–14} In other words, if we wish to reduce workflow interruptions and to establish work processes less liable to the negative consequences of interruptions, we need to know *what* kind of interruptions occur under *which* circumstances to understand the types of workflow interruptions, the likelihood of interruptions during certain activities, as well as their differential occurrence in different medical specialities.^{2–17–23–24}

The benefit of structured observational research in healthcare settings and patient research has been repeatedly emphasised.^{25–26} Observational measures are a useful way to quantify workflow interruptions.^{18–27} Time–motion studies are an adequate standard of clinicians' time and activity assessments.^{26–28} But only a few studies report a careful and valid measurement with defined inter-rater

reliability.¹⁷ To obtain a sufficient level of precision and to promote internal validity, extended observations of greater time periods are needed.^{14 26} Thus, full shift observations are a reliable and useful mean to obtain valid data on doctors' daily work routines.²⁹

Based on a sample of doctors in a municipal hospital in Germany this study has the following aims:

- (1) to assess the frequency of workflow interruptions
- (2) to identify and quantify sources of work interruptions
- (3) to relate sources of interruptions to doctors' work activities.

METHOD

Study setting

Participant observations were conducted in a 300-bed municipal teaching public hospital. It can be regarded as a typical German hospital in reference to official statistics.³⁰

The study was approved by the Ethics Committee of the Faculty of Medicine, Munich University, and by the department heads of the hospital. Measures were taken to protect personal data confidentiality. Only workflow interruptions and activities were recorded, and no patient-related information was collected or documented.

Study sample and selection of observation dates

The study focused on hospital doctors in surgery and internal medicine. Physicians currently undergoing or having completed specialist training were included. Eligible doctors (1) had to have worked at least 4 months at the hospital, and (2) had to be working entire shifts on a general ward, emergency ward or intensive care unit. (3) Senior and head doctors were excluded from the study. There were 32 eligible doctors within the four study departments. Participation was voluntary and verbal or written consent was obtained at least 1 day before the observation. Two doctors refused to participate. Only day shifts were chosen because clinicians are assigned to a specific department and clinical unit. On the interdisciplinary intensive care unit (ICU), day shifts are 12 h; on wards and in the emergency ward (EW) 8.5 h. In this particular hospital, internists were part of the staff of the ICU as well as the emergency ward.

The observation dates were selected randomly. Thirty-two shifts were included in the study. Work shifts of 22 physicians were observed (Internal medicine, INT, N=13; Surgery, SURG, N=9). Of this group 10 doctors were observed twice. The majority were female doctors (INT: 61.5%; SURG: 55.5%). The mean tenure within the present hospital was about 7 years (INT: 7.0 years;

standard deviation (SD)=4.6; SURG: 7.2 years; SD=6.0). The percentage of doctors who have completed a specialist training was 37% (SURG) and 38.5% (INT).

Measures: observation of workflow interruptions and doctors' activities

During the participant observations specific information was collected on (1) source of workflow interruption and (2) type of activity.

Assessment of workflow interruptions

We define workflow interruptions as an intrusion of an unplanned and unscheduled task, causing a discontinuation of tasks, a noticeable break or task switch behaviour (ie, answering a phone call during patient's examination, responding to a nurse's question while charting). The initial task is suspended to perform an unplanned task, resulting in discontinuous task performance.^{31 32} Thus, an interruption means that an obvious barrier or obstacle in goal-directed behaviour occurs, hindering work performance, and attention resources have to be allocated to a break-in event.^{11 33} *Impediments* are another kind of workflow interruptions. Compared to interruptions that force physicians to stop the ongoing activity to turn their attention to a disruptive incident, impediments only aggravate or delay current task performance.^{33 34} In hospital work impediments are a frequent stressor and require additional effort.³⁵ In this study we distinguish between information impediments (eg, patient's chart not at hand, diagnostic test results unavailable), waiting time (eg, in front of an elevator, a slow booting computer) and motor impediments (eg, ergonomic problems causing awkward movements).

Three steps were carried out to develop an observation instrument for workflow interruptions. First, we reviewed the available scientific literature and collected a list of potential sources.^{14-16 21 36} Second, this collection was discussed with clinicians from various specialities to focus on most prevalent sources. Final categorisation was based upon a well-validated self-report instrument focussing on work conditions in hospitals.³⁵ Third, non-systematic participant observations were carried out to test the instrument's applicability as well as to discuss scoring problems. As a result, 10 sources of interruptions were specified (see [table 1](#)).

Type of doctors' activities

Doctors' activities were recorded with a standard observation instrument³⁷ and broken down into seven main task categories: (1) direct patient communication, (2) diagnostic activities, (3) therapy, (4) documentation, (5) conversation with staff, (6) conversation with others and (7) other activities (eg, taking breaks).

Table 1 Sources and definition of workflow interruptions in hospital doctors

Category	Workflow interruption	Definition: significant disturbance due to ...
Colleague interruptions	1 Interruptions by doctors	... other doctors' actions (eg, colleague asking for patients charts).
	2 Interruptions by nursing staff	... nursing staff's actions (including nursing trainees)
Telephone/bleeper	3 Interruptions by telephone/bleeper	... telephone or bleeper call and subsequent responding
	4 Interruptions by patients	... patients (eg, patient asks for information)
Interruption by others	5 Interruptions by patients' relatives	... patients' relatives (eg, relatives stopping doctors in hospital corridors)
	6 Interruptions by others	... any other person (ie, physical therapist, social worker)
	7 Interruptions due to equipment or technical malfunctions	... equipment dysfunctions or technical malfunctions (ie, computer system crash; failure of blood gas analysis)
Impediments/delays	8 Information impediments	... necessary work information unavailable (ie, patient's chart or diagnostic findings not available, forms not in stock etc)
	9 Waiting time	... waiting time to continue current workflow (ie, waiting for elevator)
	10 Motor impediments	... physical impediments (ie, noise, additional physical strengths in moving heavy patients)

Test of instrument's reliability

Within a pilot study the instrument's reliability was tested. Six hospital doctors working on wards and in the EW (three internists, three surgeons) were observed by two trained raters simultaneously (six observation periods; range 34.5–69 min; sum 291.5 min). A total of 101 workflow interruptions were coded (Rater 1: N=47; Rater 2: N=54). The resulting κ -coefficient was 0.65 (T=23.9; p=0.00). This is considered substantial agreement and underlines the instrument's good reliability.³⁸

Procedure, data collection and analysis

Two trained observers shadowed the doctors during the shift, recorded activities, the actual time spent on activities, as well as workflow interruptions. To minimise observational effects, the observers kept an appropriate distance³⁹ and were instructed not to interrupt doctors or co-working staff (eg, not to start a conversation).

Data were recorded on clipboard paper sheets, transferred via double data entry into a database, and checked for correctness and implausible values. Subsequent data analyses were performed using SPSS 17.0. Because of the exploratory nature of our study, no multiplicity adjustment was applied. For inferential statistics to explore group differences, Mann–Whitney U Test was used. To explore the likelihood of interruptions under the condition of different activity categories, we used logit–linear model analysis.⁴⁰ This procedure compares the unconditional probability that a workflow interruption happens at any activity with the conditional probability of this interruption occurring during one of the seven activities. Statistical significance is based on χ^2 tests, checking the relationship between the two variables.⁴¹

RESULTS

Hospital doctors were observed during 32 full work shifts, with an overall duration of 277.4 h (16662.2 min). The average shift duration was about 8 h 40 min (SD, 1 h 47 min; range 4 h 54 min–14 h 05 min).

Frequency of observed workflow interruptions

About 1480 workflow interruptions were observed. The following table 2 presents the frequency of workflow interruptions, grouped by clinical speciality and area in the hospital.

On average, we observed about 5.3 workflow interruptions per work hour, which means that hospital doctors' workflow was disrupted every 11.25 min. A significant difference regarding clinical speciality was observed: The workflow of the internists was significantly more interrupted than their colleagues in the surgery departments (Z=-2.66; p=0.01). According to the SD we found a greater variation of average hourly interruptions within surgery than internal medicine. Regarding areas in the hospital, disruptions occur at ICU and EW more frequently than on the ward. Because the sample size was too small (only three full shift observations at ICU), significance testing wasn't carried out completely. Only differences between ward and EW were tested.

Sources of doctors' workflow interruptions

Out of the 1480 workflow interruptions observed, most were caused by nurses (N=551; 37.2%), followed by telephone/bleeper calls (N=324; 21.9%), then fellow doctors (N=257; 17.4%). Other person-related interruptions (N=194; 13.1) were attributed to patients (N=31; 2.1%), patients' relatives (N=35; 2.4%) and

Table 2 Observed workflow interruptions by clinical speciality and area in the hospital

	Number of shift observations	Sum observation time (h:min:sec)	Average duration of shift observation (M; SD; in h:min:sec)	Average sum of interruptions per shift observation (M, SD)	Interruptions per work hour (M, SD)
(Sum)	32	277:42:09	8:40:41 (01:47:39)	46.3 (21.3)	5.3 (2.0)
Surgery	14	118:08:22	8:26:18 (1:41:43)	36.3 (21.1)	4.2 (2.0)
Internal Medicine	18	159:33:47	8:51:52 (1:53:39)	54.0 (18.4)	6.1 (1.6)
p(Z)			0.88 (-1.52)	0.02 (-2.4)	0.01 (-2.66)
Ward	20	170:45:16	8:32:18 (0:31:51)	41.8 (16.01)	4.9 (1.9)
EW	9	70:25:47	7:49:32 (2:22:16)	45.2 (23.6)	5.7 (2.5)
ICU*	3	36:31:06	12:10:22 (1:42:52)	79.3 (22.4)	6.5 (1.2)
p(Z)†			0.32 (-0.99)	0.80 (-0.26)	0.53 (-0.66)

*Longer standard shift duration at ICU compared to ward and EW service (12 h vs 8.5 h).

†Only ward and EW were compared.

M, Mean; SD, Standard deviation; p, significance level (Mann-Whitney U test); EW, Emergency Ward; ICU, Intensive Care Unit.

other persons (N=91; 6.1%). Interruptions due to impediments or delays (N=154; 10.4%) can be divided into either interruptions due to equipment or technical malfunctions (N=37; 2.5%), to information impediments (N=118; 8.0%), to waiting time (N=15; 1.0%), or to motor impediments (N=21; 1.4%). Afterwards the sources of workflow interruptions were categorised (cf. [table 3](#)).

Hospital doctors' activities and concurrent workflow interruptions

To address the likelihood of being interrupted during certain activities, a cross-table of the type of physician activities and concurrent task disruptions, categorised by source, was computed. All interrupting events (N=1480) as well as the concurrent physician activities (N=4163) were taken into account.

[Table 3](#) presents frequencies of concurrent workflow interruptions and doctors' activities. Four combinations cover almost half of all observed events: interruptions by nurses (N=302; 20.4%), interruptions by fellow doctors (N=179; 12.1%), by beepers/telephone (N=131; 8.9%) and other sources (N=106; 7.2%), all happening during documentation and charting activities.

In a second step we examined which type of interruption is more likely to occur when a certain activity is going on (ie, a certain task performance by a physician; cf. [table 3](#)). The cell probabilities represent the likelihood of a certain workflow interruption in each of the seven categories of doctors' activities. The accumulated probabilities at the bottom row are the overall probability that a workflow interruption occurs due to a certain cause; the accumulated probabilities in the right column represent the probability of this occurring during a certain activity of the physicians. Bold probabilities indicate that an observed workflow interruption is significantly more likely to occur if the respective activity is being performed (ie, conditional probability of a workflow interruption; cf. [table 3](#)). Workflow interruptions due to telephone or bleeper calls occurred significantly more often, when doctors were communicating with patients or were engaged in other activities. Impediments were also significantly more likely to occur when conversations with ward staff or others were observed. Significantly lower probabilities of workflow interruptions occurred in case, presented as shaded in [table 3](#): Interruptions by doctors' colleagues were less likely when physicians were engaged in conversations with patients, or staff, and during other activities. Interruptions by nurses tended to be less likely when physicians were performing other activities (like meetings, teaching). Telephone or bleeper interruptions and impediments were less probable, when doctors were engaged in documentation activities.

Table 3 Number and conditional probabilities of observed physician activities and workflow interruptions (logit–linear analysis, N=1480)

Physician activities	Sources of workflow interruptions					Total N (p _{unc})
	Interruptions by doctors	Interruptions by nurses	Interruptions by telephone	Interruptions by others	Impediments	
	N (p _{cond})	N (p _{cond})	N (p _{cond})	N (p _{cond})	N (p _{cond})	
Communication to patient	6 (0.06**)	37 (0.38)	29 (0.30*)	10 (0.10)	15 (0.15)	97 (0.07)
Diagnostics	15 (0.13)	51 (0.43)	21 (0.18)	20 (0.17)	11 (0.09)	118 (0.08)
Therapy	9 (0.15)	29 (0.48)	12 (0.20)	1 (0.02**)	10 (0.16)	61 (0.04)
Documentation	179 (0.23)	302 (0.39)	131 (0.17**)	106 (0.14)	57 (0.07**)	775 (0.52)
Conversation with staff	34 (0.13*)	92 (0.34)	66 (0.24)	34 (0.13)	44 (0.16**)	270 (0.18)
Conversation with others	1 (0.04)	6 (0.22)	10 (0.37)	2 (0.07)	8 (0.30**)	27 (0.02)
Other activities	13 (0.10*)	34 (0.26**)	55 (0.42**)	21 (0.16)	9 (0.07)	132 (0.09)
Total N (p _{unc})	257 (0.17)	551 (0.37)	324 (0.22)	194 (0.13)	154 (0.10)	1480 (1)

Bold: probability of a workflow interruption under the condition of a specific physician activity (conditional probability) is significantly higher than the unconditional probability of the workflow interruption.

Shaded: probability significantly lowered than expected.

Significance levels of adjusted residuals: *p<0.05; **p<0.01.

N=1480; p_{cond}, conditional probability; p_{unc}, unconditional probabilities.

DISCUSSION

A new instrument for observation and assessment of hospital doctors' work was developed. Participant observations enable reliable quantification of different sources of workflow interruptions in hospital physicians' routine care. Based on 32 full shift observations of doctors' work on internal and surgery wards of a typical hospital in Germany, it is shown that doctors are interrupted on average 5.3 times per hour of work (every 11.25 min) and that most interruptions occur during documentation and charting. The most frequent source is the nursing staff. There is considerable variance in the frequency and the source of interruption depending on what kind of activity doctors were involved in.

This study makes three important contributions: First, it quantifies via reliable measures workflow interruptions in a regular care setting. It was observed, that every 11 min a workflow disruption occurs. This means doctors act within a work environment with a high potential for distracting events. Regarding clinical speciality, internists faced significantly more interruptions than their colleagues in surgery disciplines, outside of the operation theatre. Regarding the specific area in the hospital, doctors working in ICUs and on EWs were also observed to deal with (statistically non-significant) more frequent workflow interruptions. This result is in line with previous observations.^{14 31}

Second, the results reveal the relative contribution of different sources of workflow interruptions.^{18 36} Half of all observed workflow interruptions were attributable to nurses and telephone/bleeper calls. On the one hand,

this reflects a high requirement for communication within interdisciplinary care environments.²⁰ On the other hand, it reveals opportunities to reduce unnecessary interruptions³¹ and to reflect on staff's adoption of 'interruptive communication mechanisms'.²²

Third, this study combines for the first time physician activities with concurrent frequencies and sources of workflow interruptions. The aim was to identify activities with an increased risk of workflow interruptions that can be considered as 'inefficient work practices'.³ The results show that indeed the performance of specific physician activities increases the likelihood of selected workflow interruptions. These incidents may also be associated with a high potential of impaired performance, detrimental results or compromised patient safety.² Most interruptions were observed during documentation and charting activities. This is a time-consuming part of doctors' work in Germany.⁴² Work design approaches are needed that help provide opportunities to document and chart without frequent disruptions.

The results of our study should be interpreted in the light of several limitations. The present study is based on a single sample. Although in Germany the work practices of clinical specialities are mainly comparable between hospitals, there may have been a selection bias. Both the activities of physicians and the frequency of interruptions are likely to vary depending on hospital type, a department's quality of work organisation and the doctors' duties. Furthermore, there is a disproportion in our sampling of wards, emergency and IC units, which limits the comparison of the units as well as it affects the sub-analysis (cf. [table 3](#)), since the source of interruption may be nested within the type

of area. And although we undertook various measures to reduce observer effects (ie, Hawthorne effect; cf. Methods), a potential observer bias may influence doctors' and co-workers activity patterns (eg, tendency to take breaks, colleagues' tendency to interrupt).

Careful interpretation of the category "interruptions" is also necessary. In our case, only clearly observed workflow interruptions were registered. One interruption event may not be the equivalent of another. Some workflow interruptions have more significant safety implications than others.⁴³ Workflow interruptions caused by co-workers (ie, nurses, doctors or others) may also have positive effects on a ward's workflow, enabling better clarification, error capture (eg, 'to speak up' if something is wrong) or an immediate response to incoming emergencies. In such cases, there may be a 'reflexive' or 'self-regulating' quality to co-workers interruptions, as colleagues are able to pick a time when it is appropriate to interrupt. In contrast, 'random' interruptions (such as phone calls or technical malfunctions) occur more accidentally or arbitrarily. Thus, it can be assumed that 'random' interruptions are more strongly related to work impairments than 'reflexive' interruptions. Moreover, the doctors' perception of observed interruptions may differ substantially depending on the frequency and the severity,¹ temporal extent,¹⁸ and source of interruptions.¹⁷ Thus no conclusions regarding potential individual and performance outcomes of workflow interruption can be drawn from the present study. This equally applies to potential positive appraisals of workflow interruptions, as when an interruption alerts physicians about a patient's critical condition or provides necessary information for subsequent tasks.¹⁴

Cautious interpretation is also necessary regarding the coincidence of doctors' activities and workflow interruptions; the present study examines only the concurrence of both events but doesn't assume causality or mutual interdependence.

Nevertheless, differentiating between sources of workflow interruptions suggests several implications and opportunities for intervention. To reduce frequent workflow interruptions caused by nurses, a thorough analysis and deliberate re-design of doctor–nurse communication and coordination is essential. Regular coordination, adjusted care processes, communication policies and organised information transfer, for example, may reduce future mistimed enquiries.^{9 22} In order to reduce 'random' telephone or bleeper interruptions, electronic assistance and IT solutions may be a promising approach (eg, electronic whiteboards), as long they are applied well considered and in combination with human behaviour-based interventions.³⁶

Physicians' work in healthcare systems is dynamic and performance impairments or errors are not captured by

single causes but rather arise under complex conditions⁴⁴. The assessment of work interruption in the context of physicians' activities gives due attention to this and offers opportunities to identify tasks which are prone to error or impaired performance.³ Future research should investigate the situations in which situations doctors' psychological capacity to cope with interruptions or distractions may be critically impaired. Memory processes, depending on vigilance among others, may play an important role in the resumption of interrupted tasks.² Finally, addressing work interruptions may improve doctors work life in the hospital and effectively reduce psychophysical strain.¹¹ Besides the above-mentioned detrimental outcomes and compromised patient safety, there might also be positive consequences of workflow interruptions (cf. discussion of study's limitations). More applied studies are necessary to address potential positive effects like reduced feelings of monotony,⁵ enhanced time for problem solving⁴⁵ or perceived effectiveness of intrusion events.⁴⁶ Also outcome measures assessing patient's satisfaction may be of further interest.⁴⁷ Communication requirements and individual perspectives of the concerned persons must be taken into account when reorganisation of work processes is planned.

CONCLUSIONS

Participant observation of doctors' work during full shifts allows us not only to determine the frequency of interruption, but also to identify the source of interruption and the work context in which the interruption occurs. Such participant observation may serve as a solid basis for the improvement of work organisation, leading to improved hospital performance, and help identify environmental, work-related factors in the hospital that contribute to the overall quality and safety of healthcare performance.^{18 48}

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