

Provider interruptions and patient perceptions of care: an observational study in the emergency department

Anna Schneider,¹ Markus Wehler,² Matthias Weigl¹

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¹Institute and Outpatient Clinic for Occupational, Social and Environmental Medicine, University Hospital, LMU Munich, Munich

²Department of Emergency Medicine and Department of Medicine IV, Klinikum Augsburg, Augsburg, Germany

Correspondence to

Anna Schneider, Institute and Outpatient Clinic for Occupational, Social and Environmental Medicine, University Hospital, LMU Munich, Munich 80336, Germany; anna.schneider@med.lmu.de

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ABSTRACT

Background Interruptions are endemic in healthcare work environments. Yet, they can have positive effects in some instances and negative in others, with their net effect on quality of care still poorly understood. We aimed to distinguish beneficial and detrimental forms of interruptions of emergency department (ED) providers using patients' perceptions of ED care as a quality measure.

Methods An observational design was established. The study setting was an interdisciplinary ED of an academic tertiary referral hospital. Frequencies of interruption sources and contents were identified in systematic expert observations of ED physicians and nurses. Concurrently, patients rated overall quality of care, ED organisation, patient information and waiting times using a standardised survey. Associations were assessed with hierarchical linear models controlling for daily ED workload. Regression results were adjusted for multiple testing. Additionally, analyses were computed for ED physicians and nurses, separately.

Results On 40 days, 160 expert observation sessions were conducted. 1418 patients were surveyed. Frequent interruptions initiated by patients were associated with higher overall quality of care and ED organisation. Interruptions relating to coordination activities were associated with improved ratings of ED waiting times. However, interruptions containing information on previous cases were associated with inferior ratings of ED organisation. Specifically for nurses, overall interruptions were associated with superior patient reports of waiting time.

Conclusions Provider interruptions were differentially associated with patient perceptions of care. Whereas coordination-related and patient-initiated interruptions were beneficial to patient-perceived efficiency of ED operations, interruptions due to case-irrelevant communication were related to inferior patient ratings of ED organisation. The design of resilient healthcare systems requires a thorough consideration of beneficial and harmful effects of interruptions on providers' workflows and patient safety.

INTRODUCTION

Workflow interruptions are endemic in clinical environments.¹ Yet, 'interrupt-driven'² emergency departments

(EDs) are particularly affected settings to study the manifold effects of disrupted workflows on provider and care outcomes.^{3–7} EDs are complex socio-technical systems that are repeatedly identified as error-prone environments.⁵ Suboptimal ED patient care is attributed to adverse work system factors.^{8,9} Among these, provider interruptions receive broad attention due to their role in patient safety and quality of care.^{10–12} Emergency physicians and nurses attend to multiple patients in an uncertain and time-critical care setting with high coordination demands.⁴ Past studies identified interruption frequencies in ED providers ranging between 5.1 and 24.9 interruptions per hour.^{2,7,12–16}

Previous empirical evidence on effects of workflow interruptions is inconclusive and suggests ambivalent effects since interruptions are associated with both negative and positive outcomes.^{3,10,14} Adverse effects were postulated on the individual provider level, where experimental evidence showed negative associations with providers' task completion time and rates, decision-making processes, length of care interventions and errors.^{7,15,17} Nonetheless, interruptions may feature an intrinsic value and contribute to effective patient care and improved intra-team coordination.^{1,18,19} Potentially positive effects of interruptions such as time-sensitive communication of high-priority information were suggested.^{3,9,18} Workflow interruptions foster immediate provider responses, timely information exchange, and may preserve fast and safe delivery of care.^{9,14–16,19} In order to develop resilient care systems and to implement work redesign interventions that preserve patient care in dynamic and interruptive clinical environments, we

need to understand how interruptions are detrimental or beneficial to quality of care.³ We additionally need a thorough consideration of how contents of interruptive communication shape negative or positive effects for care.¹⁰

Real-time patient surveys offer valuable insights into the personal experience of patients and complement routine indicators of clinical, safety-related and disease-specific outcomes.^{20 21} The Institute of Medicine's influential report suggests that 'the best window on the safety and quality of care is through the eyes of the patient'.²² Patient-centredness is thus one of the six cornerstones of healthcare quality. Integrating patients' preferences, needs and values in care design and delivery is fundamental to preserve high quality. In order to achieve this aim, patient perspectives have to be systematically assessed.²² Patient ratings are a meaningful and feasible alternative to capture extracts of care quality.^{23 24}

Patient experiences are multidimensional and emerge from provider–patient communication, provider skills and interaction, as well as the physical environment.²¹ Provider interruptions could thus interfere with the patient experience on different levels during ED care and ultimately affect satisfaction, care experience and treatment adherence.^{21 23} Using patient experience as a proxy for ED care quality, we aimed to explore associations between provider interruptions, differentiated into sources and content, and patient-perceived care outcomes. We further sought to examine role-related differences in these associations for ED physicians and nurses, respectively.

METHODS

Study design and setting

An observational design was established applying day-level matched data of expert observation sessions of ED providers, patient evaluations of care and ED register data. The study setting is a 24-hour adult ED of an academic tertiary referral hospital with an annual volume of over 80 000 patients. The ED is organised into three sections according to patient's chief complaints: 10 bays for non-surgical patients, five bays for surgical patients, two resuscitation bays, and an observation and clinical decision unit with 24 beds. It is regularly staffed with physicians from internal medicine, trauma surgery and neurology, as well as further specialists on call. Data stem from a larger intervention project on ED work factors, provider well-being and quality of care.

Procedure and selection of ED providers and patients

Data collection was completed in February 2017. Before start, a stratified sampling procedure was established that ensured random and equal allocation of observation sessions across ED sections, professions and days of the week (including Saturdays and Sundays). On-site data collection by a three-member study team

took place from 10:00 to 17:00 to comprise the time of day with the highest patient arrival rates and thus highest workload for ED providers.²⁵ Patient:staff ratios in EDs differ between day, evening and night shifts. Research on the variance of interruption rates during different times of the day is scarce with preliminary findings pointing to non-significant differences across weekdays or time of the day.³ To control for the potential effect of varying patient:staff ratios across observations, an established ED workload measure was included in our analyses (see below).

Observation sessions of 90 min were randomly allocated per day across three ED sections, that is, non-surgical area, surgical area, and observation and clinical decision unit, and ED professions, that is, nurses and physicians. A higher number of nurses than physicians were sampled to reflect the distribution of the study ED's workforce. All senior and junior physicians and nurses working regularly in the ED were eligible. Consultants from other hospital units working occasionally in the ED were not included. On observation days, ED providers from the respective ED section and profession were approached, informed about the study and asked for verbal consent before start. No personal characteristics were obtained from observed ED providers.

For patient surveys, all registered patients undergoing treatment in the ED on days of on-site data collection were eligible. Inclusion criteria were not restricted to literacy, language, age or illness. However, patients with incapability to communicate due to illness severity or other physical and mental constraints were not surveyed. In these cases, accompanying relatives were asked to fill out the survey by proxy. Due to confidentiality constraints, no personal characteristics were obtained from patients.

Identification of workflow interruptions

On each observation day, four observation sessions with ED providers were conducted. Trained observers applied a standardised tool that reliably captures ED workflow interruptions.^{9 26} A workflow interruption was defined as an event that resulted in provider distraction from the task at hand thus causing discontinuation of the primary task, reallocation of attention, or task switching to the interrupting event or secondary task.^{9 26} Interruption sources were classified by observers according to predefined categories²⁷ into interruptions by (1) patients; (2) ED colleagues of the same profession, for example, nurse is interrupted by another nurse; (3) ED colleagues of another profession, for example, nurse is interrupted by a physician; (4) telephone/beeper; (5) patient's relatives; (6) technical malfunctions or missing supplies; and (7) information impediments or problems, for example, necessary information for task completion is missing such as unavailable patient charts. Concurrently, each interruption event was evaluated regarding its content,

that is, information referring to (1) current patient case at hand, (2) parallel case, (3) completed cases, (4) new and time-critical case, (5) coordination activities and (6) patient comfort. A detailed description of the observational tool with definitions and specific examples for each interruption category can be found elsewhere.²⁷ Each observed interruption was classified within one source and content category, respectively. Accordingly, multiple classifications of one specific interruption event within different categories of interruption sources and contents were not allowed. All observers had an educational background in health-care, experience in the clinical setting and familiarity with the ED context.

To establish inter-rater agreement, a stepwise procedure was applied.²⁸ First, observers underwent six non-systematic, pilot observation sessions on site to become familiar with the facility and observation tool and to discuss its application with a senior expert observer. Second, pairwise observations of ED providers were conducted to test for reliability in terms of interobserver agreement as well as to ensure calibration across all three observers. Overall, 20 pairwise observations were conducted (sum: 24 hours 41 min, 278 captured interruptions). The resulting kappa coefficient for sources of interruptions was 0.65 as well as 0.53 for interruption content. Both metrics indicate substantial inter-rater agreement and good reliability, given high-paced and complex ED workflows.²⁶

Patient perceptions of ED care

Patients were approached by study team members after their first consultation with an ED physician. After receiving study information and providing verbal consent, patients were asked to fill in the survey. On request, assistance was offered by study team members. A standardised survey instrument was applied, which reliably captures patient-perceived ED care (Munich Patient Inventory, see online appendix for survey items).⁹ Additional versions in English, Russian and Turkish language were available. Four major aspects of patient-perceived care were assessed: (1) *patient information* (two items, Cronbach's $\alpha=0.77$), (2) *ED organisation* (two items, $\alpha=0.49$) and (3) *waiting time* (three items, $\alpha=0.71$). Patients responded in a five-point format indicating better care with higher scores. Additionally, one question with a six-point response format asked patients for their (4) *general satisfaction with ED care* using school grades from 1=excellent to 6=unsatisfactory ("Overall, how do you evaluate care in this ED?").

Confirmatory factor analyses were conducted to scrutinise psychometric properties of the patient survey.²⁹ Fit indices were compared for two models to identify the factor structure best fitting the data, that is, χ^2 , root mean square error of approximation (RMSEA), comparative fit index (CFI) and Tucker-Lewis index (TLI). A one-factor model representing

one general patient satisfaction factor including all seven items ($\chi^2(df)=304.35(14)$, $p<0.001$, RMSEA=0.12, CFI=0.89, TLI=0.78) was tested against the assumed three-factor model including distinct scales for patient information, ED organisation and waiting time ($\chi^2(df)=107.58(11)$, $p<0.001$, RMSEA=0.08, CFI=0.96, TLI=0.91). Fit indices showed superior fit of the proposed three-factor structure ($\Delta\chi^2(df)=196.77(3)$, $p<0.001$). Hence, analyses confirmed factorial validity and psychometric feasibility of our patient survey tool.²⁹

Register data on daily ED workload

Crowding may confound patient evaluations of ED care.³⁰ To control for potential influences of providers' patient load, patients' acuity (Emergency Severity Index: ESI Score) and available staffing, relevant numbers were extracted from ED administrative records and staff rosters. Thereof, an adjusted measure of the Emergency Department Work Index was compiled to represent mean overall and profession-specific workload for each observation day.⁹

Data analyses

Hourly rates for overall and for all individual interruption sources and contents were calculated for each observation session and then averaged across four sessions to obtain mean rates for each of the 40 observation days. Differences in interruption rates between ED physicians and nurses were conducted as supplementary analyses. Unpaired t-tests were applied without prior hypotheses on direction or size of differences between professions and adjustment for multiple testing was performed (Holm-Bonferroni sequential correction procedure).³¹

The final multilevel dataset nested individual patient evaluations within the respective 40 observation days. Two-level mixed-effects linear regression models were used.³² Associations between observed interruption rates and patient-perceived care were modelled, accounting for clustering of patient evaluations within a day.³² First, associations between overall interruption rates and four care outcomes were analysed. Subsequently, associations between interruption rates from different sources and contents and care outcomes were calculated. Again, results were adjusted for multiple testing.³¹ Unadjusted (crude) and adjusted (for daily workload) regression estimates are reported with 95% CIs. Finally, the same procedure was repeated separately in physician and nurse samples. All statistical analyses were conducted with SPSS V.24.0 (IBM).

RESULTS

A total of 160 observation sessions were conducted: 99 with nurses (61.9%) and 61 with physicians (38.1%). All approached ED providers consented to be observed, except two nurses and one physician. Reasons for non-participation were not surveyed.

Table 1 Rates of emergency department (ED) providers' interruption sources and content

	Mean rate (SD)
Overall interruptions	8.70 (4.92)
Interruption sources (interruptions caused...)	
by patients	0.92 (1.19)
by ED colleagues of the same profession	2.55 (2.39)
by ED colleagues of another profession	2.47 (2.13)
by telephone/beeper	1.79 (1.52)
by patient's relatives	0.24 (0.49)
by technical malfunctions or missing supplies	0.42 (0.63)
by information impediments or problems	0.31 (0.60)
Interruption contents (interruption event related...)	
to current case	1.82 (2.08)
to parallel case	2.86 (2.79)
to completed cases	0.79 (1.01)
to new (time-critical) cases	0.16 (0.45)
to coordination activities	1.92 (1.98)
to patient comfort	0.27 (0.56)
Mean rate: interruptions per hour; n=160 observation sessions.	

Overall observation time was 240 hours and 42 min (mean duration of observation sessions: 1 hour 30 min 15 s). Fifty-five observations (34.4%) were conducted in the non-surgical section, 52 (32.5%) in the surgical section and 53 (33.1%) in the observation unit.

Interruption rates

Mean hourly interruption rates per day are presented in [table 1](#). ED providers were most frequently interrupted by colleagues from the same (mean, M=2.55 interruptions per hour; SD 2.39) or another profession (M=2.47; SD 2.13) or by telephone/beeper (M=1.79; SD 1.52). Contents of interruptions referred most frequently to information on parallel cases (M=2.86; SD 2.79), to coordination activities (M=1.92; SD 1.98) and to current cases (M=1.82; SD 2.08).

We additionally compared interruption rates between ED professions (cf., table E-1 in online supplementary material 1). After adjusting for multiple testing, only one difference remained significant: nurses were more often interrupted due to patient comfort issues than physicians.

Patient survey data and ED workload

Register data specified 4454 patients admitted to the ED during observation hours on days of on-site data collection. A total of 1602 patients (36.0%) were approached by the study team. Moreover, 184 patients denied study participation, resulting in a final sample of N=1418 (survey response rate: 88.5%) with a range of 16 to 51 surveyed patients per day. Reasons for non-participation were not surveyed. Mean daily workload, staffing levels and patient numbers in ESI categories are depicted in [table 2](#). Patients reported

Table 2 Daily emergency department (ED) workload data and patient perceptions of ED care

	Range	Mean (SD)
Control variables		
Overall patient no/day	89–171	120.23 (17.37)
ESI1 patients	0–4	0.90 (0.96)
ESI2 patients	2–36	15.95 (9.38)
ESI3 patients	37–100	66.27 (17.87)
ESI4 patients	2–43	17.87 (13.00)
ESI5 patients	0–14	3.70 (4.05)
Provider staffing levels/day	20.36–35.24	27.52 (3.20)
Daily ED workload*	8.09–15.41	11.21 (1.58)
Outcome: patients' perceptions of ED care		
Overall quality of care	1–6	4.69 (1.08)
ED organisation	1–5	3.36 (1.14)
Patient information	1–5	4.05 (1.06)
Waiting time	1–5	3.63 (1.13)
Scale range for overall quality of care (school grade, inversely coded): 1=very bad to 6=very good; scale range for other patient survey scales: 1=no, not at all to 5=yes, very much.		
*Adjusted Emergency Department Work Index.		
ESI, Emergency Severity Index.		

high overall satisfaction with ED care (M=4.69; SD 1.08). Patient evaluations of ED organisation (M=3.36; SD 1.14), patient information (M=4.05; SD 1.06) and waiting time (M=3.63; SD 1.13) were average. Percentage of missing data for care outcomes ranged between 0.56% for ED organisation and 6.49% for overall quality of ED care.

Associations between provider interruptions and patient ratings

Using hierarchical linear regression analyses, association estimates between ED provider interruptions and patient ratings were calculated (see [table 3](#)). The accumulated hourly rate of overall interruptions was positively associated with two patient outcomes: higher rates of workflow interruptions were related to superior patient perceptions of overall quality of ED care (adjusted estimate 0.03; 95% CI 0.01 to 0.06) and ED waiting time (0.04; 95% CI 0.01 to 0.07).

In the next step, we identified four statistically significant associations between individual interruption sources and contents with patient perceptions: patient interruptions were related to higher ratings of overall ED care (0.13; 0.05 to 0.22) and ED organisation (0.19; 0.07 to 0.30). Interruptions concerning information on completed cases were associated with inferior patient ratings of ED organisation (−0.28; −0.44 to −0.12). However, interruptions related to coordination activities were associated with more favourable patient evaluations of waiting time (0.10; 0.03 to 0.17).

Table 3 Fixed regression estimates of associations between emergency department (ED) workflow interruptions and patient perceptions of ED care

Predictors	Outcomes: patient perceptions of ED care							
	Overall quality of care		ED organisation		Patient information		Waiting time	
	Crude (95% CI)	Adjusted (95% CI)	Crude (95% CI)	Adjusted (95% CI)	Crude (95% CI)	Adjusted (95% CI)	Crude (95% CI)	Adjusted (95% CI)
Overall interruption rates	0.03* (0.01 to 0.06)	0.03* (0.003 to 0.05)	0.03* (0.0002 to 0.07)	0.03 (-0.001 to 0.07)	0.02 (-0.002 to 0.04)	0.02 (-0.004 to 0.04)	0.04** (0.01 to 0.07)	0.04** (0.01 to 0.07)
Interruption sources (interruptions caused...)								
By patients	0.14** (0.05 to 0.23)	0.13** (0.05 to 0.22)	0.19** (0.07 to 0.30)	0.19** (0.07 to 0.30)	0.08* (0.0001 to 0.17)	0.08 (-0.002 to 0.16)	0.15* (0.03 to 0.26)	0.14* (0.03 to 0.25)
By ED colleagues of same profession	0.04 (-0.01 to 0.10)	0.04 (-0.02 to 0.09)	0.06 (-0.01 to 0.12)	0.05 (-0.01 to 0.12)	0.03 (-0.01 to 0.08)	0.03 (-0.02 to 0.08)	0.08* (0.01 to 0.14)	0.07* (0.01 to 0.13)
By ED colleagues of another profession	0.03 (-0.04 to 0.10)	0.03 (-0.04 to 0.10)	0.08 (-0.01 to 0.17)	0.08 (-0.005 to 0.17)	0.06 (-0.005 to 0.12)	0.06 (-0.004 to 0.12)	0.08 (-0.001 to 0.17)	0.08* (0.002 to 0.16)
By telephone/beeper	0.07 (-0.02 to 0.16)	0.06 (-0.02 to 0.15)	0.04 (-0.07 to 0.15)	0.04 (-0.08 to 0.15)	0.05 (-0.03 to 0.12)	0.04 (-0.03 to 0.12)	0.09 (-0.02 to 0.19)	0.08 (-0.02 to 0.18)
By patient's relatives	-0.07 (-0.33 to 0.18)	-0.01 (-0.26 to 0.24)	-0.28 (-0.59 to 0.03)	-0.27 (-0.59 to 0.05)	-0.26* (-0.47 to -0.04)	-0.24* (-0.45 to -0.02)	-0.20 (-0.50 to 0.10)	-0.15 (-0.45 to 0.15)
By technical malfunctions or missing supplies	0.12 (-0.12 to 0.36)	0.09 (-0.14 to 0.32)	-0.07 (-0.38 to 0.23)	-0.09 (-0.39 to 0.21)	0.03 (-0.18 to 0.25)	0.02 (-0.19 to 0.23)	-0.05 (-0.34 to 0.24)	-0.08 (-0.36 to 0.20)
By information impediments or problems	-0.05 (-0.23 to 0.14)	-0.10 (-0.28 to 0.07)	-0.24* (-0.46 to -0.02)	-0.28* (-0.49 to -0.06)	-0.14 (-0.30 to 0.01)	-0.18* (-0.33 to -0.02)	-0.11 (-0.32 to 0.11)	-0.16 (-0.37 to 0.05)
Interruption contents (interruption event related...)								
To current case	0.05 (-0.01 to 0.10)	0.04 (-0.01 to 0.09)	0.08* (0.02 to 0.15)	0.08* (0.01 to 0.15)	0.04 (-0.01 to 0.09)	0.04 (-0.01 to 0.08)	0.06* (0.0004 to 0.13)	0.06 (-0.003 to 0.12)
To parallel case	0.05* (0.01 to 0.10)	0.04 (-0.003 to 0.09)	0.07* (0.01 to 0.13)	0.06* (0.004 to 0.12)	0.04 (0.002 to 0.08)	0.04 (-0.003 to 0.08)	0.08** (0.02 to 0.13)	0.07* (0.01 to 0.12)
To completed cases	-0.12 (-0.24 to 0.01)	-0.07 (-0.21 to 0.07)	-0.26** (-0.40 to -0.11)	-0.28** (-0.44 to -0.12)	-0.12* (-0.23 to -0.02)	-0.12 (-0.24 to 0.005)	-0.17* (-0.31 to -0.02)	-0.14 (-0.30 to 0.03)
To new (time-critical) cases	0.03 (-0.34 to 0.41)	0.10 (-0.26 to 0.45)	-0.17 (-0.63 to 0.30)	-0.14 (-0.61 to 0.32)	-0.16 (-0.48 to 0.15)	-0.13 (-0.45 to 0.18)	-0.07 (-0.51 to 0.38)	-0.02 (-0.45 to 0.41)
To coordination activities	0.07* (0.01 to 0.13)	0.06 (-0.002 to 0.10)	0.08* (0.001 to 0.16)	0.08 (-0.003 to 0.15)	0.06* (0.01 to 0.11)	0.06* (0.002 to 0.11)	0.11** (0.04 to 0.18)	0.10* (0.03 to 0.17)
To patient comfort	0.12 (-0.15 to 0.38)	0.12 (-0.13 to 0.37)	-0.01 (-0.34 to 0.33)	-0.01 (-0.34 to 0.33)	-0.07 (-0.30 to 0.16)	-0.07 (-0.30 to 0.15)	-0.05 (-0.37 to 0.27)	-0.05 (-0.35 to 0.25)

Estimates were adjusted for mean daily workload (mean staffing levels and patient acuity); * p<0.05, ** p<0.01; bold: statistically significant unadjusted and adjusted estimates of sources and contents (Holm-Bonferroni correction).
p, probability level.

Role-specific associations between provider interruptions and patient ratings

In the last step, the above described hierarchical linear regression analyses were repeated separately for ED physicians and nurses (see tables E-2 and E-3 in online supplementary material 1). For nurses, after adjusting for nurse-specific daily workload, out of three initially significant associations, only patients' evaluations of waiting times were significantly associated with overall interruptions (0.03; 0.003 to 0.05). Concerning source-specific and content-specific interruption rates and after controlling for multiple testing, interruptions dealing with information on current cases were related to inferior patient perceptions of ED organisation (0.13; 0.05 to 0.21) while frequent interruptions on parallel cases increased ratings of waiting time (0.07; 0.02 to 0.11). After adjusting for nurse-specific daily workload, only interruptions concerning coordination activities were observed being related to superior patient ratings of waiting time (0.07; 0.02 to 0.12). In physicians, neither overall interruption rates nor individual types of interruptions were significantly associated with any of the four patient-perceived care outcomes (online supplementary material 1).

DISCUSSION

This study offers a novel approach to distinguish negative and positive forms of provider interruptions by exploring their associations with patient perceptions of care. Positive associations between overall as well as source-specific and content-specific rates of ED provider interruptions and patient perceptions of overall quality of care, ED organisation and waiting times were identified. The following contributions deserve careful consideration:

Generally, previous research predominantly focused on adverse outcomes of interruptions such as provider distraction, disruption of memory processes, increased risks of unfinished tasks and lapses in patient care.^{1 3 10 33} Broad evidence shows that highly interruptive clinical work environments contribute to providers' mental workload, suboptimal clinical performance and mitigate safety practices in health-care delivery.^{1 15 34} Our findings further advocate the need for a nuanced understanding of potentially desirable as well as harmful effects of workflow interruptions in highly dynamic work and collaborative care systems, that is, by taking into account sources and content of interruptive events.^{3 10 35} Although previous research suggests that any interruption of ED physicians' bedside interactions curbs patient satisfaction,³⁶ our results suggest that effects depend on sources and content of disruptive communication.

Our findings suggest further exploration of role-related differences in provider interruptions of ED nurses and physicians. Across all forms of interruptions, we merely identified one difference: nurses were more often interrupted due to patient comfort issues

than physicians. Additional analyses showed that rates of coordination-related interruptions in nurses were substantially associated with patient perceptions of waiting times. These observations underscore the pivotal role of nurses in coordinating ED patient flow and intraprofessional and interprofessional collaboration in the ED.³⁷

Provider interruptions due to coordination were associated with improved patient ratings of ED waiting times. Frequent communication events are essential in maintaining ED coordination and patient flow considering inevitable intersections in ED care processes, for example, among professions and functional areas.¹⁸ Accordingly, the highest amount of observed interruptions originated from present ED personnel. Interruptions due to coordination activities mostly encompassed professional communication concerning teamwork (eg, allocation of patients), patient flow (eg, assignment of patients to bays or further treatment) or other forms of work organisation (eg, information on absence due to work-related activities outside the ED or personal breaks). Interruptions related to intraprofessional and interprofessional coordination may thus be considered as 'value-adding' interruptions,¹ and contribute to facilitating ED patient flow and shortening waiting times, for example, when ED providers immediately allocate patients to free bays or collectively assign responsibilities for arriving patients.^{5 38} Previous research suggested associations between time to first physician contact, general ED length of stay and increased patient satisfaction.²⁰ Although we do not advocate for increasing coordination-related interruptions, our finding points to the necessity of allowing these interactions in ED work since the resulting activities and mutual information exchange between providers might foster ED patient flow. Interventions addressing proactive forms of coordination activities within provider teams, for example, unit huddles³⁹ or white boards with patient status information,⁴⁰ should further examine whether these innovations lead to fewer coordination-related interruptions and if these approaches fit with ED unit culture, that is, if they are accepted and employed by ED providers.

Second, interruptions concerning information on previous cases were associated with inferior patient perceptions of ED organisation. Post hoc, one potential explanation is that frequent interruptions related to previous cases signify providers' difficulties in the management of multiple patients and effective distribution of case information. Another assumption is that ED provider's mental load is stretched by additional or irrelevant information on previous cases which eventually impairs professionals' cognitive capacity to deal effectively with organisation demands and to communicate and coordinate effectively.^{9 38} Finally, these irrelevant distractions may cause information overload and drag on the delivery of patient care through inefficient care practice.

Third, frequent interruptions by patients were positively associated with patient experience of overall care and ED organisation. Patient-initiated interruptions were largely neglected in interruptions research so far.⁴¹ Thus, it remains unclear whether patients interrupt proactively to share important information with healthcare providers, for example, concerning their medical history, or whether they interrupt as a reaction to insufficient information received, for example, concerning missing discharge information. In our study, patient-initiated interruptions mostly occurred during direct interactions with providers, for example, in treatment areas. Patient interruptions referred to questions concerning treatment (eg, administration of prescribed medication at home) or organisation of their stay (eg, waiting times until admission to inpatient unit). Patient-initiated interruptions may thus increase patients' knowledge about their treatment status and pathway through the ED. However, patient-initiated interruptions may equally contribute to adverse organisational and provider outcomes such as delays in care, medication errors and mitigated provider well-being as shown in previous studies.^{3 42} Thus, instead of exposing ED providers to more frequent patient interruptions, for example, by increasing visibility of providers through physical layout,⁴³ future research should investigate information systems that assure comprehensive and individual patient information with fewer needs to disrupt providers.

Study limitations

Beyond general limitations of observational studies, several unique limitations of this study have to be considered. First, our findings draw on one interdisciplinary ED in Germany which limits generalisability. Our observations need to be replicated within other national healthcare systems, taking into account different characteristics of prehospital and intrahospital emergency care. Limited sample sizes confine statistical power, thus, observed findings should be interpreted with caution with regard to profession-specific analyses as well as non-significant results. Second, patient perceptions are a central pillar of healthcare quality.^{21 23 24} Nonetheless, future studies concerning the role of interruptions should complement patient reports with clinical and safety outcomes of ED care.⁴⁴ One scale of our patient survey instrument showed medium reliability. Nonetheless, confirmatory factor analyses confirmed the proposed factor structure. Future studies in this field should apply tools that are psychometrically robust.⁴⁵ Further, real-time patient surveys in the ED may be biased because of patients' concerns about anonymity, potential consequences for subsequent care or current incapability to respond adequately.³⁰ Third, we matched interruption rates and patient survey results within observation days. Since our patient surveys were not registered with time stamps, an hourly assignment of patient surveys

to the respective observed provider was not applicable, that is, to identify associations between interruption frequency and patient evaluations during particular provider–patient interactions.³⁶ Fourth, although we controlled analyses for ED workload, we acknowledge that our daily approximation may not entirely reflect actual workload during all individual 90 min observation sessions. However, our approach to adjust for ED workload is novel within this literature.³⁰ Future studies should further elucidate the role of patient load or crowding as a potentially mediating or moderating factor in the relationship between provider interruptions and patient perceptions of ED care. Fifth, although research suggests that interruption rates do not differ between times of day or across weekdays per SE,³ our results encompass ED peak patient arrival times during the day, excluding conclusions about interruption effects on patient perceptions during night shifts. Sixth, another potential confounder might be provider characteristics, for example, perceived responsiveness to patient requests or provider well-being. However, interpersonal behaviours and clinicians' personality are of limited influence on patient perceptions of care,⁴⁶ whereas occupational well-being of healthcare providers has a more profound effect on patient satisfaction.⁴⁷

Lastly, consistent to similar approaches, we attributed interruptions to specific sources.^{10 35} However, we cannot exclude that some interruptions were mediated through ED personnel, for example, a patient interrupts a nurse for pain medication who subsequently interrupts the observed physician.¹⁶ Our approach to classify events solely into one category does not take full account of potential multiple meanings and inherent implications of interruptive communication, for example, a nurse alert concerning the arrival of a time-critical patient does often imply subsequent coordination demands.³ Our interruption measure did not account for the assessment of serial or nested interruptions,⁴⁸ task complexities, behavioural strategies to deal with disruptions⁶ or interruption priorities. Altogether, this limits causal inferences concerning potential harm of disruptive events during ED care.^{10 12 14}

Implications for future research and ED practice

Concerning implications for practice, our findings suggest that ED practitioners should carefully identify unnecessary and potentially harmful provider interruptions, and aim to scrutinise potentially interconnected factors of the work environment before introducing interventions to manage interruptions in the ED.³ Instead of avoiding interruptions universally, the resilience of work systems to adverse effects from interruptions should be strengthened by allowing purposeful interruptions that promote professional collaboration, patient satisfaction and safe care.^{10 35} Our findings advocate for further investigations on the profession-specific effects of interruptions, including

sources, contents and type of interrupted activity, with particular attention to role-related sequelae of provider functioning, patient safety, and efficiency of ED care.¹⁰ However, although positive effects of interruptions are postulated, research in this domain should be conducted in light of striving for well-balanced work and care systems that promote safe patient care and well-designed work environments for providers.

CONCLUSIONS

EDs are complex and high-paced care environments with significant demands for providers and patients. Our findings provide first empirical support for the assumption that coordination-related or patient-initiated interruptions may be associated with benefits for ED care from the patient's perspective. Notwithstanding, to maintain high levels of patient safety and provider well-being, the establishment of resilient and well-balanced ED work systems must be prioritised.

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