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Paediatric resident workflow observations in a community-based hospital

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ABSTRACT

Objective Residency graduates need to demonstrate competence in prioritising safe patient care through appropriate management of multiple competing tasks and workflow interruptions. This pilot study aimed to characterise and correlate interruptions in paediatric resident workflow at an academically affiliated, community-based hospital.

Methods One of three trained observers followed a resident physician during a convenience sample of 1–2 hour increments, either in the emergency department or on the wards, and recorded all observed activities and interruptions using an established time-motion tool. All participants completed a baseline Multi-Tasking Ability Test (MTAT) and pre-observation and post-observation surveys. Statistical approach included descriptive statistics, logistic regression, mixed model and ORs.

Results 18 paediatric residents were observed for 57.5 total hours (an average of 3.2 hours/resident) which included 329 interruptions, defined as any external event drawing the resident's attention away from a primary task. Interruptions occurred an average of 5.9 times per resident per hour. Interrupted primary tasks were not resumed during the observation period 11% of the time. A personal/social-related interruption yielded an OR of 0.29 that the resident will return to a primary task within 5 min (p=0.007) when compared with patient-related verbal interruptions by the medical team. The MTAT Score indicated decreased efficiency for interns versus postgraduate year 2 residents (p=0.029). Residents' MTAT Scores did not correlate with their time to return to a primary task following an interruption (p=0.11).

Conclusions Paediatric resident workflow interruptions in the hospital were observed to occur frequently and should be expected. Personal/social interruptions were most likely to delay prompt return to a primary task. The MTAT Score, although improved between the first 2 years of residency training, did not correlate with efficient return to a primary task. Interruption management and mitigation strategies should be developed as part of a standardised residency task management curriculum.

Key messages

What is already known on this topic?

► Frequent workflow interruptions have been observed across many medical specialties; the data in paediatrics are limited, and not yet reported from a community-based hospital setting.

What this study adds?

► Paediatric residents were interrupted nearly every 10 min. Personal/social interruptions resulted in a lower OR of timely return to a primary task when compared with patient care-related interruptions.

How this study might affect research, practice or policy?

► Curricula in interruption management and mitigation is not currently a standard part of physician training, and should be developed and studied. Personal/social interruptions and patient safety outcomes could be further explored.

INTRODUCTION

The daily practice of medicine includes frequent competing tasks that must be managed appropriately in order to ensure the best and safest patient care possible. Tasks that are urgent and time-sensitive must be prioritised, organised and balanced with numerous other patient care duties. An additional challenge for physicians in training during this era of regulated hours is the 'work compression' that has occurred, as trainees have limited clinical time in which to learn the practice of medicine,[1 2] and therefore less time to develop the skills required for safe and efficient patient task management.[3]

The integration of electronic health records and advancement of communication technologies has inspired a myriad of healthcare provider workflow studies in emergency medicine,[4–15] internal medicine[16–21] and nursing,[22–25] but to date, only a few in paediatrics.[26–28] In 2015, a multicentre time-motion study was the largest to characterise paediatric inpatient resident workflow, however, did not specifically investigate interruptions.[27]

The patient safety implications of workflow interruptions are great. A literature review of interruptions in healthcare noted that 75% of identified studies that quantified patient safety outcomes showed a correlation between interruptions and errors.[29] Maintaining patient safety and quality patient care by paediatric residents, who are frontline

providers of healthcare for children, is of utmost importance. Improving our understanding of paediatric resident workflow interruptions is the essential first step in determining how to best expect and manage interruptions. Using this data, we can design strategies to assist those who require additional practice to develop these skills.

This study was designed to characterise interruptions of the paediatric resident workflow through direct observation within an academically affiliated community hospital. Our primary aims included measuring the frequency of interruptions, categorising the types of interruptions, the tasks that were interrupted and the time interval in which residents resumed their primary tasks following the interruption. Secondary aims included examining variables that may be related to managing interruptions, including individual factors (ie, year of training, measured multitasking ability, sleep) and clinical setting (emergency department (ED) vs paediatric wards).

METHODS

Patient and public involvement

As this was a resident workflow study, neither the patients nor the public were involved in the design or dissemination of this project.

Setting

This study was conducted on the general paediatric wards and in the paediatric ED at a busy tertiary care community-based hospital which provides the clinical learning environment for a paediatric residency programme with 8 residents per class and 24 total residents.

Data collection

There were three study observers, including a paediatric hospitalist/associate residency programme director and two first year medical students from the sponsoring institution. Over a 6-month period that spanned the second through fourth quarters of the academic year, each participating resident was scheduled for a goal of 4 hours of direct observation. Residents were observed during various times on the wards including during morning rounds, in the afternoons, during evening handoffs and on the weekends. Observation times in the ED were institutionally limited to a short segment in the afternoon. An Agency for Healthcare Research and Quality based time and motion tool previously used by Hanauer *et al*[17] was slightly modified to capture modern electronic health record and communication technology. This tool was used by one of three trained observers for documenting each aspect of a resident physician's activity, including categorising the types of interruptions. Observers were trained to use the tool by engaging in multiple sessions of co-observation of the same resident and recording all activity/interruptions together on separate portable devices, with debriefing sessions following; once kappa statistics yielded acceptable inter-rater reliability between observers, each observer then independently recorded data on individual residents for the remainder of the study. Observers used the tool to perform direct observations of participants in 1–2 hour segments, documenting each activity that the resident performed from the start to the end of the observation time, including interrupting tasks. An interruption was defined as any event that occurred external to the participant and caused any break in the execution of the primary task in which he or she was currently engaged, as previously outlined by Magrabi *et al*.[30] Efficient management of an interruption was defined as having a lower resumption interval (the window of time it took after completing an interrupting task for the resident to return to the primary task). The duration and type of all resident activities and interruptions during the observation period were recorded as accurately and specifically as possible.

Participants completed an online survey at the beginning of the study which included demographics, perception of personal wellness and sleep patterns. Each participant also completed a one-time assessment with the Multi-Tasking Ability Test (MTAT)[31] a commercially available, validated, computer sorting activity, previously demonstrated as an indicator of multitasking-related clinical performance in ED residents.[8] After each 1–2 hour individual observation period, participants documented their preceding hours of sleep and self-assessment by completing the NASA Task Load Index.[32] This validated tool, used in a previous multitasking time-motion study,[20] allowed participants to quantify their perceived mental strain and performance for the specific day they were observed. This was not a blinded study; the residents were informed that each of their actions was being recorded during these observation sessions, and their training level was common knowledge to the observers.

Data analysis

As this was a pilot study with a limited population of paediatric residents available, sample size and power calculations were not performed. Overall Kappa agreement with 95% CI was calculated from three raters. Descriptive statistics were used for summarising participants' demographics, baseline data and observation measures; mean (SD) was reported for normally distributed data; mean/median and IQR were reported for numeric variables with non-normal distribution and frequencies and percentages were calculated for categorical variables. Parametric tests/models were used for normally distributed measures and non-parametric tests/models were used for non-normally distributed measures. Resumption interval time was treated as a repeated measure per each resident. A mixed model was used to test the association between resumption time and other variables after adjustment by status (interns: postgraduate year (PGY)-1, senior residents: PGY-2 and PGY-3). ORs with 95% CI of return to an original activity following an interruption were calculated using a logistic regression model and as the measure of association between interns and senior residents. A p value of <0.05 was considered significant.

Table 1 Paediatric resident participant breakdown		
Total number of residents	18	
PGY-1	5	(28%)
PGY-2	7	(39%)
PGY-3	6	(33%)
Male	7	(39%)
Female	11	(61%)

PGY, postgraduate year.

Statistical analysis was performed using SAS statistical software V.9.4 (SAS Institute).

RESULTS

Eighteen residents, accounting for 82% of all paediatric residents in the programme, participated in the study (table 1).

A total of 57.5 hours of workflow observation was performed by three observers over a 6-month period. Kappa statistics indicated acceptable inter-rater reliability (0.85 (95% CI: 0.79 to 0.92)). Observation sessions focused on 12 residents with 38 sessions on the wards, and 6 residents with 11 sessions in the ED. The mean/median duration that each participating resident was observed was 3.2/3.6 hours (IQR 1.4 hours).

Interruptions occurred in 46 of 49 separate observation sessions, with 329 total interruptions documented. There was a mean/median of 5.9/5.0 (IQR 4.3) interruptions per resident per hour (see online supplemental appendix A for expanded results). The resumption interval had a mean/median of 1.7/0.0 min (IQR 0.6). Over half (55.4%) of the observed time, residents immediately returned to a primary task following an interruption (leading to a resumption interval of 0.0 min). Table 2 summarises the observation session data, including breakdown of the ward and ED. When comparing the two clinical areas, a greater proportion of the interruptions in the ED were instigated in-person instead of by a pager or phone (p<0.0001).

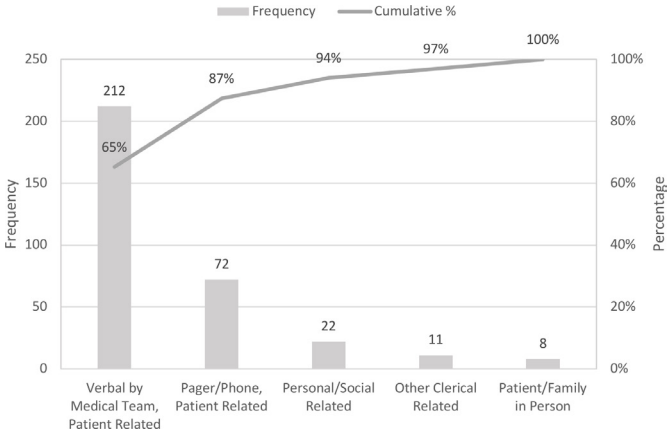

Figure 1 The majority of interruptions were made in-person by other healthcare providers when interacting verbally with a resident while he or she was actively engaged in another task. Other clerical related: included interruptions when handed forms and paper chart data. Missing data prevented the identification of the cause of four interruptions.

Interrupting events are shown by category in figure 1. The majority of interruptions (212 of 329=64%) occurred in-person by a member of the medical team (including physicians, resident colleagues, nurses and staff) who initiated a conversation with the resident about patient care while he or she was actively engaged in another activity. Figure 2 shows the spectrum of medical and non-medical resident tasks that were interrupted. The most common activity that residents were engaged in prior to an interruption was interfacing with the electronic health record (158 of 329 occurrences=48%), including writing notes and reviewing patient information. Of significance,

Table 2 Observation session data			
Variables	**Mean/median (IQR*)**		**P value**
Hours observed per resident	3.2/3.6 (1.4)		N/A
Interruptions per resident per hour	5.9/5.0 (4.3)		N/A
Resumption interval (min)	1.7/0.0† (0.6)		N/A
Breakdown by hospital observation site	**Ward**	**ED**	
Interruptions per resident per hour	5.7/4.1 (4.4)	6.4/5.9 (3.1)	0.30
Resumption interval (min)	2.0/0.0 (0.7)	1.0/0.0 (0.5)	0.16
Interruption type	Frequency (%)		
Verbal by medical team, patient related	139 (59%)	73 (82%)	<0.0001
Pager/phone, patient related	66 (28%)	6 (7%)	
Personal/social related	19 (8%)	3 (3%)	
Other clerical related	7 (3%)	4 (5%)	
Patient/family in-person	5 (2%)	3 (3%)	

*IQR, or the 75%tile–the 25%tile. Median and IQR are also reported as data were not normally distributed.
†A resumption interval of 0.0 min indicated immediate return to a prior task following an interruption.
ED, emergency department.

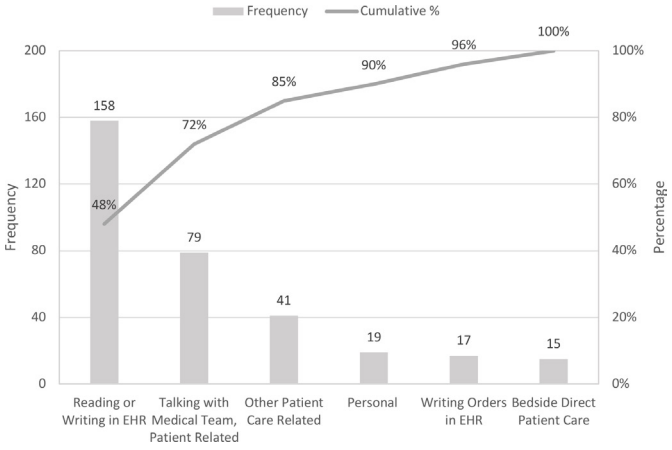

Figure 2 The task most commonly interrupted was reading or documenting in the electronic health record (EHR), with some interruptions occurring while writing orders and/or providing direct patient care at the bedside. Personal: included eating, socialising, email; other patient care related: included reviewing a paper chart, literature searches, writing handoffs or task lists.

35 of 329 (11%) of tasks that were interrupted were never resumed by the end of the scheduled observation period, including two patient examinations and one order writing activity (see online supplemental appendix B for expanded results).

Notably, the mean MTAT Score of 94.3 (SD 15.6) in the PGY-1 class was significantly higher (indicating lower multitasking ability) as compared with a mean of 53.8 (SD 28.3) in the PGY-2 class (p=0.029). Differences in PGY-1 scores did not extend to the PGY-3 class, who had the widest range of scores with a mean of 71.6 (SD 34.7) (p=0.26). There was no relationship between the MTAT Score, adjusted by PGY status and resumption interval (p=0.11).

There was no significant association found between the resumption interval and hours of sleep in the preceding 24 hours, self-reported wellness or overall mental strain.

Factors and return to a primary task within 5 min are shown in table 3, including PGY status, gender of resident, average sleep and MTAT Score.

Unfortunately, if a resident was interrupted by an action that was personal/social in nature, the OR of returning to the primary task within 5 min (0.29, 95% CI 0.12 to 0.71, p=0.007) and 10 min (0.4, 95% CI 0.16 to 1.00, p=0.05) was lower as compared with patient-related interruptions made verbally by the medical team.

Table 3 Factors and return to a primary task within 5 min

Variables	OR*	95% CI	P value
Increasing PGY status			
PGY-1	1 (reference)		
PGY-2	1.02	0.62 to 1.69	0.92
PGY-3	1.13	0.76 to 1.68	0.54
Gender			
Male	1 (reference)		
Female	1.04	0.71 to 1.51	0.85
Average Sleep	1.07	0.84 to 1.37	0.57
MTAT Score	1.00	0.99 to 1.00	0.19
Interruption type			
Verbal by medical team, patient related	1 (reference)		
Pager/phone, patient related	0.67	0.38 to 1.17	0.16
Personal/social related	0.29	0.12 to 0.71	0.007
Other clerical related	0.44	0.11 to 1.80	0.26
Patient/family in-person	0.51	0.088 to 2.99	0.46
Department			
Ward	1 (reference)		
ED	1.08	0.62 to 1.89	0.77

*Used a repeated model with multiple observations per participant.
ED, emergency department; MTAT, Multi-Tasking Ability Test; PGY, postgraduate year.

DISCUSSION

The goal of this time-motion study was to improve our understanding of paediatric resident workflow interruptions on the wards and in the ED. In our academically affiliated community hospital, paediatric residents were interrupted approximately once every 10 min. Most interruptions were made in-person (65%), and the most frequently interrupted activity was interaction with the electronic health record (48%). The majority of the time, residents immediately returned to a primary task, with an average time to resume a primary task of 1.7 min. Eleven per cent of pre-interruption tasks were never resumed during the observation period, and personal/social interruptions made it less likely that the primary task would be resumed within 5–10 min. The resumption time interval was not correlated with resident level of training, preceding sleep or efficiency as predicted by the MTAT Score.

Our findings of interruptions on the wards are similar to those of previous studies. In 2014, Weigl *et al* published a time-motion study of workflow interruptions and the mental workload of paediatricians-in-training in an academic children's hospital. They found that their paediatricians were interrupted an average of 4.7 times per hour[26] compared with our mean of 5.9 times per hour. In 2017, a paediatric intensive care unit observational study of resident physicians noted that they were interrupted an impressive 11.9 times per hour.[28]

Observed interruptions in our ED (mean 6.4 per hour) were far fewer than previously reported in other ED workflow interruption studies (Blocker *et al* reported an average of 11.2 interruptions per hour for their academic emergency physicians).[15] Our results may have been influenced by the time of day that we were limited

to observing residents, which was not during ED peak census. As compared with our wards, a greater proportion of interruptions in the ED were made in-person versus by a page or phone call; this is likely secondary to the physical space of the ED being smaller than the sprawling paediatric wards, precluding the need for electronic communication.

Combining the observations of the current study of paediatric resident workflow with the medical literature yields a remarkable range of 5–12 expected interruptions per hour, depending on the clinical environment.[26 28] This is important to consider for paediatric residents in training who typically rotate monthly through different units with varying levels of acuity, with the need to adjust their management of interruptions accordingly. As our observed personal/social interruptions were associated with a reduced tendency for a timely return to primary tasks, we consider this type of interruption high risk, and specific resident guidance in this area would be helpful. Looking outside of the medical literature, a recent review of 247 publications on workplace interruptions notes that although social interruptions are common and may immediately decrease workflow efficiency, they also yield longer term benefits that are incompletely understood; further work needs to be done to explore this complexity.[33] Anticipation and mitigation of disruptive social interruptions decreases associated stress.[34] Protective measures to preserve workflow such as visual cues[35] and a physical space protected from non-urgent in-person interruptions may be adaptable for our residents at specific times during the workday. A heightened recognition of both the positive and detrimental aspects of social interruptions[36] will be key to mitigation training, as will be exploring specific, practical strategies available for managing interruptions.[37]

The cognitive load that is required to navigate the electronic record of a complex patient is high; interruptions to vulnerable activities such as order-writing could increase the potential for medical errors if not managed properly. In this study, most of the observed interruptions during critical activities were resumed; exceptions include two residents interrupted while examining a patient, as well as one during order entry. For a resident at any level, interrupting a physical examination or order entry may clinically shortchange both the patient and the resident. Patient/parent satisfaction may also be affected by frequent interruptions at the bedside, as parents may surmise that their child's care has less priority and safety if their paediatrician is frequently interrupted or called away during the visit.

Limitations to this study include the sample size and scope with a modest number of paediatric residents at one community-based hospital. Also, the unblinded nature of the study may have resulted in biased observations, especially as one of the observers was the associate residency programme director, and a faculty evaluator of resident performance. However, during the informed consent process, the residents were reassured that their performance during this study would not be part of their assessment. The study observed the type and timing of interruptions and was not designed to address the quality of our residents' actions when managing interruptions, to offer mitigating remedies or to develop solutions for efficient interruption management. Patient safety outcomes related to these interruptions was also not measured by this study.

CONCLUSION

This study confirms that frequent interruptions occur when residents care for paediatric patients on the wards and in the ED. It is critical that all healthcare workers recognise and fully appreciate the implications of such common workflow disruptions, and the potential adverse consequences as they relate to resident performance and patient safety. Future studies and curricula should focus on interruption management and mitigation. Ultimately, efforts may require a change in hospital culture. At a minimum, residents and staff should receive training on interruption mitigation and management. This can be developed as a standardised segment of residency curriculum, which will be our next focus of study.

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Contributors JRDR was the principal investigator and guarantor and designed, implemented, collected and analysed data, performed literature review and was the principal author of this manuscript. CK provided assistance in study design, statistical analysis, contributed to the methods and results portions of the manuscript and approved this final version. MB and SK collected and helped analyse the data, performed literature searches, contributed to the manuscript and approved this final version.

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Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by Western Institutional Review Board (WIRB) Pr. No.: 20160330. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. De-identified participant data are available upon reasonable request from the lead author via ORCID identifier 0000-0002-3731-4922.

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