



LJMU Research Online

Basey, AJ, Kennedy, TD, Mackridge, AJ and Krska, J

Delays and Interruptions in the Acute Medical Unit clerking process – an observational study

<http://researchonline.ljmu.ac.uk/id/eprint/2850/>

Article

Citation (please note it is advisable to refer to the publisher's version if you intend to cite from this work)

Basey, AJ, Kennedy, TD, Mackridge, AJ and Krska, J (2016) Delays and Interruptions in the Acute Medical Unit clerking process – an observational study. Journal of the Royal Society of Medicine Open, 7 (2). pp. 1-7. ISSN 1758-1095

LJMU has developed **LJMU Research Online** for users to access the research output of the University more effectively. Copyright © and Moral Rights for the papers on this site are retained by the individual authors and/or other copyright owners. Users may download and/or print one copy of any article(s) in LJMU Research Online to facilitate their private study or for non-commercial research. You may not engage in further distribution of the material or use it for any profit-making activities or any commercial gain.

The version presented here may differ from the published version or from the version of the record. Please see the repository URL above for details on accessing the published version and note that access may require a subscription.

For more information please contact researchonline@ljmu.ac.uk

<http://researchonline.ljmu.ac.uk/>

Delays and interruptions in the acute medical unit clerking process: an observational study

Avril J Basey^{1,2}, Thomas D Kennedy¹, Adam J Mackridge² and Janet Krska³

¹Royal Liverpool University Hospital, Liverpool, L7 8XP, UK

²School of Pharmacy and Biomolecular Sciences, Liverpool John Moores University, Liverpool, L3 3AF, UK

³Medway School of Pharmacy, The Universities of Greenwich and Kent at Medway, Anson Building, Central Avenue, Chatham Maritime, Chatham, Kent, ME4 4TB, UK

Corresponding author: Avril J Basey. Email: A.Basey@2009.ljmu.ac.uk

Summary

Objectives: It is recommended that patients are seen within 4 h of arrival in Acute Medical Units in English hospitals. This study explored the frequency and nature of interruptions and delays potentially affecting the duration of the Acute Medical Unit admission process and the quality of care provided.

Design: The admission process was directly observed for patients admitted to the Acute Medical Unit over four one-week periods, November 2009 to April 2011.

Setting: UK teaching hospital Acute Medical Unit.

Participants: Hospital staff n = 36.

Main outcome measures: Patient waiting times, duration of clerking, number of interruptions and/or delays.

Results: Thirty-five doctors and one nurse practitioner were observed admitting 71 medical patients, 48/71 (68%) patients were clerked within 4 h of arrival. A delay and/or interruption affected 49/71 (69%) patients. Sixty-six interruptions were observed in 36/71 (51%) of admissions, of these 19/36 (53%) were interrupted more than once. The grade of doctor had no bearing on the frequency of interruption; however, clerking took significantly longer when interrupted; overall doctors grade ST1 and above were quicker at clerking than foundation doctors. Delays affected 31/71 (44%) of admissions, 14/31 (45%) involved X-rays or ECGs; other causes of delays included problems with equipment and computers.

Conclusion: Interruptions and delays regularly occurred during the admission process in the study hospital which impacts adversely on patient experience and compliance with the recommended 4-h timeframe, further work is required to assess the impact on patient safety. Data obtained from this observational study were used to guide operational changes to improve the process.

Keywords

Acute medical unit, admission, medical history taking, waiting time, interruption, clerking

Introduction

Acute Medical Units were introduced into acute English hospitals in the 1990s in response to increasing numbers of medical admissions and concerns regarding the quality of care.^{1,2} In 2004, the Royal College of Physicians in England recommended that all Trusts admitting acutely unwell medical patients should have a dedicated area called an ‘Acute Medical Unit’ or ‘AMU’ for managing these patients.³ An Acute Medical Unit facilitates rapid patient review by a consultant, enabling efficient assessment, diagnosis and appropriate specialty referral if necessary. Recent studies have shown that hospital re-organisation and the introduction of an Acute Medical Unit reduce length of stay without affecting readmission rates^{4,5} and reduce mortality.⁴ The Society for Acute Medicine quality standards for Acute Medical Units (2012) recommend that a full clinical assessment should be undertaken and a clinical management plan initiated and documented by a senior decision maker (doctor grade Specialist Trainee year 3 and above) within 4 h of the patient’s arrival on the Acute Medical Unit,⁶ which is in line with Emergency Department 4-h targets.⁷ Interruptions may delay the admission process and they have been shown to adversely affect various aspects of clinical care,^{8–13} a recent editorial highlighted the need for further research into their impact in clinical settings;¹⁴ however, no published studies relating to interruptions during the Acute Medical Unit admission process were located. Nationally, the need for improved efficiency in admission processes has been highlighted due to increasing numbers of emergency hospital admissions.¹⁵ Locally, no data were available regarding the Acute Medical Unit admission process, although anecdotal reports suggested some prolonged delays. Therefore, this study explored the Acute Medical Unit admission process, investigated the duration, identified any delays and/or interruptions and suggested improvements.

Study setting and methodology

Study setting

This study was carried out in the Royal Liverpool University Hospital, an acute UK NHS teaching hospital. At the time of the study, the Acute Medical Unit at Royal Liverpool Hospital had 37 beds and medical staffing comprised seven Acute Medical Unit consultants (four full-time, three part-time), two daily 'post take' consultant physicians from the Trust general medicine pool and 13 ward-based doctors, 9 junior and 4 senior decision makers (doctors grade ST3 and above).

Junior doctors in the UK complete a two-year foundation training programme following their graduation from medical school, first-year foundation trainees are known as grade F1 and second years as F2. They then progress to a specialist training programme and are known as grade ST1, ST2, etc. depending on the number of years of specialist training completed. Doctors grade ST3 and above are known as senior decision makers.⁶

On arrival at the Acute Medical Unit, patients are seen by a doctor or an advanced nurse practitioner who is responsible for taking a history (including medication), assessing the patient, making a provisional diagnosis, documenting a management plan, ordering initial investigations and writing the admission prescription. This process is known as clerking. Patients who are seen initially by a junior doctor are handed over to a senior decision maker (grade ST3 or above) for review immediately following clerking.

Methods

There were four one-week study periods: November 2009, January 2010, April 2010 and April 2011; staff were directly observed while clerking a proportion of the patients admitted in each study period.

Observations

Staff gave informed consent for observations; patients or their carers were offered a study information leaflet and advised that the researcher would leave at any time at their request. Staff were purposively selected to maximise both the range of grades involved and variation in time and day of admission. Patients are clerked in order of arrival; patients whose admissions were observed were those clerked by a participating doctor or nurse. Data, including the time taken for clerking together with details of all interruptions and delays, were recorded on a standard form with additional field notes. Interruptions included were those from an external

source such as a pager or other staff which caused cessation of the activity in which the participating staff member was involved. Delays included were those situations in which a problem encountered necessitated additional action and time to overcome when compared with the usual clerking process.

Data analysis

Data from all four data collection periods were pooled as there were no significant variations in staffing, working practices or procedures between the study periods. Data were categorised where necessary, descriptive analysis was carried out using SPSS version 17; statistical tests were carried out using Minitab version 16.

Results

Details of staff and patients observed

Thirty-six staff were observed clerking 71 patients. Staff comprised 35 doctors (four consultant/specialist registrar, four ST year 4/5; nine ST year 1/2 and 18 F1/F2) and one advanced nurse practitioner.

Observations took place on weekdays only between 9:00 and 20:00, the majority of patients observed were admitted between 10:00 and 18:00, most (66/71; 93%) being referred following a GP consultation during normal surgery hours. Of the remaining patients, two were referred by their Community Matron, one by a Walk-in Centre, one by the Emergency Department and one by another hospital.

Waiting time and duration of clerking

The mean waiting time to be seen by a clinician was 76 min (interquartile range 67), both the mean and median duration of clerking were 75 min, 48/71 (68%) patients were clerked within 4 h of arrival; 18 (18/71; 25%) patients were clerked by the most junior doctors, grade F1, who have less than 12 months post qualification experience, 12/71 (17%) were clerked by doctors grade ST3 or above. For seven patients (7/71; 10%), the time from arrival to documentation of a clinical management plan was longer than 4 h, all arrived on a weekday between 12:30 and 16:00, an F1 doctor clerked two of these seven patients. When doctors with more than two years' experience (grade ST1 and above) were compared with foundation doctors (grade F1/2), those with more experience were significantly quicker at clerking patients, mean time 64 min (interquartile range 41) for grade ST1 and above and 91 min (interquartile range 29) for foundation grade (Mann-Whitney U test $p < 0.001$).

Interruptions

During the study 66 interruptions were observed, affecting 36/71 (51%) of the admissions, of which 19 (53%) were interrupted more than once. Eighteen (18/35; 51%) doctors were interrupted during at least one patient clerking; however, the nurse was not interrupted during any of the three patient clerkings observed. There was no significant difference in the number of foundation doctor clerkings interrupted (17/30; 57%) when compared with doctors grade ST1 and above (19/38; 50%), Chi-square test $p=0.584$. The mean duration of clerking was significantly longer when staff were interrupted (84 min) than when no interruptions occurred (65 min), Mann–Whitney U Test $p=0.014$. One F1 doctor was interrupted seven times while clerking a patient, the duration of this clerking was 121 min; details are shown in Figure 1.

Doctors grade ST1 and above were more often interrupted for general advice and assistance, whereas foundation doctors were more often asked to input to another patient (Table 1).

Delays

A total of 32 delays were observed affecting 31 of the 71 admissions (44%), 14/32 (44%) involved either an X-ray or an ECG. In five cases, the patient

was in radiology when the doctor was ready to commence clerking, and on nine occasions, the arrival of an ECG technician delayed the clerking process. Problems with medical equipment or Trust documentation availability or operation resulted in a delay in six cases, and on four occasions, the ward/office space or computer availability compromised efficient working, these and a system problem, in which a difficulty was encountered as a result of a failure in the usual process, accounted for a further five delays (Figure 2). On one occasion, a doctor spent considerable time trying to locate the ‘post take’ consultant via pager, switchboard and telephone which delayed the clerking of waiting patients. Other delays were noted in three cases: a healthcare assistant was taking a blood sample from a patient when the doctor went to clerk, clarification of the sequence of events prior to admission was needed from a relative who could not be located, and the doctor had to go to the radiology department to discuss another patient. Overall, the admission process was subject to a delay and/or interruption for 49/71 patients (69%).

Routine admission blood samples are usually taken by a suitably trained healthcare assistant or nurse; however, if these staff are unavailable or unsuccessful then this task falls to the clerking doctor. In 22/71 (31%) of the admissions observed,

Figure 1. Case study illustrating interruptions during the medical clerking process.

Patient clerked by F1* doctor

Arrived at 14.12 - Friday

18.29: Clerking commenced

18.29: Asked for incontinence pad by relative of another patient – provided from ward store

19.45: Asked by nurse to prescribe co-codamol for another patient – prescribed

19.48: Asked by nurse to review ECG for another patient – asked F2 doctor to do this as in the process of writing medication chart

20.00: Asked by nurse to take this patient’s blood samples so they can move this patient back to the foyer as there are no free cubicles to clerk patients

20.18: Bleeped by Heart Emergency Centre

20.25: Nurse came from Heart Emergency Centre with query about intravenous fluid regimen

20.30: Asked to prescribe nebuliser for a different patient who is short of breath

20.30: Clerking complete

*Foundation year doctor – first year post qualification

Table 1. Types of interruption observed during the medical clerking process.

Type of interruption	Foundation (F1/F2 ^a) doctor interrupted – number of instances	Doctors grade ST1 ^b and above interrupted – number of instances	Total number of instances observed
General advice and assistance	6	18	24
Input to another patient	17	4	21
Input to patient clerked by this doctor	8	5	13
Other	4	4	8
Total	35	31	66

^aF1/F2 foundation year 1/2 – first/second year post qualification.

^bSpecialist trainee doctor – minimum 2 years post qualification.

Figure 2. Details of delays observed during the medical clerking process.

Problems with medical equipment/Trust documentation availability or operation:

- Blood gas analyser out of order
- No 'pods' (plastic canisters) to send samples to laboratory via air tube system
- Ophthalmoscope not available
- Hospital trolley could not be lowered sufficiently to examine a patient
- Tourniquet not available
- No blank medication charts available for admission prescription to be written

Ward/office space or computer availability compromised efficient working:

- No suitable location available to review case notes
- No bed or trolley available to examine a patient
- No computer terminal available to review blood test results or X-Rays
- Only available computer locked by previous user

System problems, in which a difficulty was encountered as a result of a failure in the usual process:

- No referral letter provided by one GP
- Clerking doctor did not have a password for the electronic X-Ray system
- Two telephone calls required to the radiology department to order urgent scan
- Consultant responsible for leading post take ward round could not be located
- Difficulty in contacting the medical microbiology department regarding appropriate antibiotics

the doctor took the necessary blood samples which prolonged the clerking process.

Discussion

Waiting time and duration of clerking

The mean time spent waiting to be seen was 76 min which is less than the 102 min reported by researchers from an Acute Medical Unit in Plymouth in 2010.¹⁶ However, it is difficult to identify possible reasons for this difference as the Plymouth study provides no details regarding staffing levels or availability of beds.

The results of the present study show that 10% of patients whose admissions were observed were not clerked within 4 h of arrival, all arrived on weekdays between 12:30 and 16:00. The delay was therefore most likely to result from fewer staff being available to clerk over lunchtime, as mandatory education sessions are usually held between 12:30 and 14:00, and the reduced number of doctors available between 15:00 and 17:00 due to attendance on the post take ward round. A recent study from Nottingham¹⁷ showed the impact of breaks and ward rounds on the number of doctors available to clerk in the Acute Medical Unit and used analysis of patient arrival time to redesign rotas and reduce waiting times. In the present study, overall 68% of patients were clerked within 4 h and 12/71 (17%) were clerked by a senior decision maker within this 4-h timeframe; additional patients may have been reviewed by a doctor grade ST3 or above within 4 h but these data were not collected as part of the study. However, improvement is required as it is recommended that all patients are assessed by a senior decision maker within 4 h of arrival.⁶

The mean time taken for the clerking process was 75 min, which is very similar to the mean time of 76.7 min reported in the Nottingham study.¹⁷ No further comparative studies were identified; however, the original Royal College of Physicians guidance for establishing Acute Medical Units³ states that junior medical staff should be allowed 1 h before to clerk each new patient including carrying out interventional procedures, gathering results and writing a medication chart. The Nottingham researchers¹⁷ redesigned their rotas as a result of their findings and now allow 80 min to clerk a patient. A Danish study reported a clerking time of 45 min for acute medical admissions,¹⁸ but in Denmark the medical records were dictated rather than being hand written as is common practice in the UK, which may account for this difference.

Doctors grade ST1 and above were found to be significantly quicker at clerking patients than

foundation doctors. It was thought that this may have been partly due to the 'see and treat' system which operates when the Acute Medical Unit is busy. 'See and Treat' patients are identified by nursing staff as unlikely to require admission and are clerked by a consultant with the aim of making a rapid diagnosis, providing treatment if necessary and discharging the patient within a few hours. However, in the study only one patient, who was clerked in 45 min, fell into this category so this is unlikely to account for the difference in clerking times across all patients.

Interruptions

The present study showed that 66 interruptions, involving 36 of the 71 admissions, took place during clerking, equating to approximately one per patient. This level of interruption is of concern as it may have an adverse impact on patient safety.⁸ No published UK studies investigating interruptions during the admissions process were identified, but the Danish paper reported a rate of two per patient.¹⁸ This difference is likely to be due to differences in procedures between the two countries; there was insufficient detail in the Danish paper to enable further comparison. The present study showed that doctors grade ST1 and above were more likely to be interrupted for advice, while foundation doctors were more likely to be asked to resolve issues with patients whom they had not clerked, and this may be indicative of nursing staff having greater respect for more experienced doctors or the differing perceptions of nurses in skills/roles between the two groups. The nurse was not interrupted during any of the three clerkings observed, which may have been due to the low numbers involved. Alternatively, staff may have felt that a doctor was required to resolve their problem, particularly as the nurse was not a registered prescriber and therefore was unable to assist with prescribing problems.

Interruptions to clinical tasks are of concern as doctors may delay or fail to complete tasks, which may compromise both quality of care and patient safety,⁸ and frequent interruptions may be associated with an increase in doctors' workload.¹⁹ In the present study, at least one interruption occurred during half of the observed patient admissions and therefore presents a considerable risk of error if important clinical tasks are interrupted. In addition, the doctor-patient interaction may be compromised if the doctor is interrupted while speaking to a patient. Frequent interruptions may lead to a reduction in the doctor-patient contact time and may adversely affect the quality of care which can be

provided within available resources. Although an exhaustive literature search did not return any studies which evaluated the impact of interruptions during clerking, which may be due to the complexity of the healthcare environment,²⁰ there is evidence that errors occur when nurses are interrupted during the medication administration process^{12,21} and when surgical procedures are interrupted.¹⁰ The types of interruption observed in the present study are broadly similar to those reported by Weigl et al.,¹⁹ with the majority being made by nursing or medical colleagues, either in person or via a pager. However, it is difficult to compare the results of the present study with those in the literature, as the definitions used for an interruption are not always clear or comparable. The present study included only external interruptions from colleagues in person or via a pager, while other studies may include disruptions such as those due to noise and self-interruptions in which the individual voluntarily takes a break from the task in hand.²²

Delays

There was a difference in the nature of the delays observed, with 44% involving X-rays and ECGs which are essential investigations required to enable accurate diagnosis on admission to hospital. However, the remaining 56% involved problems which are avoidable, such as those with equipment and computers, and changes should be made to overcome these delays whenever possible. As doctors took blood samples in 31% of the admissions observed, training of additional healthcare assistants and nurses to undertake this procedure is likely to reduce the time taken to clerk patients.

Recent operational changes

Since the data collection took place, a number of changes have been made in the study hospital Acute Medical Unit to make it easier for nurses to identify the correct doctor, thus minimising unnecessary interruptions. All Grade F1 doctors now wear purple tunics and trousers, and a whiteboard has been introduced listing the consultants on duty each day and their allocated junior doctors, together with pager numbers. All morning ward rounds are now carried out by dedicated Acute Medical Unit consultants to improve continuity and newly admitted patients are then reviewed throughout the day as the results of their investigations become available, rather than having to wait for a formal ward round. As there is no afternoon ward round, junior doctors are now available to clerk patients throughout the afternoon

helping to minimise waiting times. Junior doctor rotas have been adjusted in order to better match the peaks of demand and there is agreement that at least one doctor does not attend the lunchtime education sessions, instead remaining on Acute Medical Unit to clerk new patients and respond to any medical queries.

Two additional consultation rooms have been created, making a total of four; these are used for Acute Medical Unit clinic sessions on weekday mornings but are free in the afternoons as additional areas for clerking patients to help relieve the afternoon bottlenecks.

Strengths and limitations

The main strength of this study is that the direct observation method used enabled detailed real time data to be collected about the clerking process. Observations involved a range of staff grades and times of day to reduce bias due to differences in staff experience and number of patients waiting to be clerked.

Limitations are that the study was carried out in one hospital and the practices observed may not reflect those in other hospitals. Observations were carried out between 9:00 and 20:00 on weekdays only, practices during evening and weekend shifts may differ. This was a small study carried out over a few isolated weeks; a more in-depth assessment of capacity in relation to demand is required to facilitate further service improvement.

The researcher is a member of the Acute Medical Unit staff which may have affected behaviours during clerking, especially those involving medication.

Conclusion

Interruptions regularly occur during the hospital admission clerking process and may contribute to fewer patients being clerked within the recommended 4-h timeframe. This observational study proved a useful tool in providing an insight into complex healthcare systems and the data generated was helpful in prompting operational changes to improve efficiency and enhance patient experience. Interruptions may have a negative impact on the patient's experience of the admission process and patient care may be compromised. Further work is required to assess the impact of interruptions during the admission process on patient safety.

Declarations

Competing interests: The authors declare that AJB had an unrestricted educational grant from Pfizer UK, PhD fees were paid

by the Royal Liverpool and Broadgreen University Hospitals NHS Trust; JK, TDK and AJM have had no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; AJB, JK, TDK and AJM have no non-financial interests that may be relevant to the submitted work.

Funding: The study was supported by an unrestricted educational grant from Pfizer UK, the funder had no role in the study design; collection, analysis or interpretation of data; preparing the manuscript; or in the decision to submit for publication.

Guarantor: AJB.

Ethical approval: The study was approved by the National Research Ethics Service (Liverpool Central REC Ref 09/H1005/67) and Liverpool John Moores University Ethics Committee (approval no 09/PBS/015). Research Governance approval was granted by Royal Liverpool University Hospital (study no 3862).

Contributorship: AJB, JK, TDK and AJM were responsible for the planning and designing of the study; AJB was responsible for data collection and analysis. AJB wrote the first draft; JK, TDK and AJM provided critical revision, all authors read and approved the final manuscript.

Acknowledgements: The authors thank Dr PH Rowe, Reader, School of Pharmacy and Biomedical Sciences Liverpool John Moores University for assistance with statistical analysis.

Provenance: Not commissioned; peer-reviewed by Derek Bell.

References

- National Confidential Enquiry into Patient Outcome and Death (NCEPOD). *An acute problem? A report of the national confidential enquiry into patient outcome and death*. London: National Confidential Enquiry into Patient Outcome and Death (NCEPOD), 2005.
- Seward E, Greig E, Preston S, Harris RA, Borrill Z, Wardle TD, et al. A confidential study of deaths after emergency medical admission: issues relating to quality of care. *Clin Med* 2003; 3: 425–434.
- Royal College of Physicians. *Acute medicine – making it work for patients. Report of a working party*. London: Royal College of Physicians, 2004.
- Scott I, Vaughan L and Bell D. Effectiveness of acute medical units in hospitals: a systematic review. *Int J Qual Health Care* 2009; 21: 397–407.
- St Noble VJ, Davies G and Bell D. Improving continuity of care in an acute medical unit: initial outcomes. *QJM* 2008; 101: 529–533.
- West Midlands Quality Review Service. *Quality standards for acute medical units (AMUs)*. West Bromwich: The Society for Acute Medicine, 2012.
- Department of Health. *The NHS plan: a plan for investment, a plan for reform*. London: Stationery Office, 2000.
- Westbrook JI, Coiera E, Dunsmuir WT, Brown BM, Kelk N, Paoloni R, et al. The impact of interruptions on clinical task completion. *Qual Saf Health Care* 2010; 19: 284–289.
- Rivera-Rodriguez AJ and Karsh BT. Interruptions and distractions in healthcare: review and reappraisal. *Qual Saf Health Care* 2010; 19: 304–312.
- Feuerbacher RL, Funk KH, Spight DH, Diggs BS and Hunter JG. Realistic distractions and interruptions that impair simulated surgical performance by novice surgeons. *Arch Surg* 2012; 147: 1026–1030.
- Keers RN, Williams SD, Cooke J and Ashcroft DM. Causes of medication administration errors in hospitals: a systematic review of quantitative and qualitative evidence. *Drug Saf* 2013; 36: 1045–1067.
- Prakash V, Koczmara C, Savage P, Trip K, Stewart J, McCurdie T, et al. Mitigating errors caused by interruptions during medication verification and administration: interventions in a simulated ambulatory chemotherapy setting. *BMJ Qual Saf* 2014; 23: 884–892.
- Ryan C, Ross S, Davey P, Duncan EM, Francis JJ, Fielding S, et al. Prevalence and causes of prescribing errors: the prescribing outcomes for trainee doctors engaged in clinical training (PROTECT) study. *PLoS One* 2014; 9: e79802.
- Westbrook JI. Interruptions and multi-tasking: moving the research agenda in new directions. *BMJ Qual Saf* 2014; 23: 877–879.
- National Audit Office. *Emergency admissions to hospital: managing the demand*. London: Department of Health Report, 2013.
- Evans K and Fulton B. Meeting the challenges of acute care quality indicators. *Acute Med* 2011; 10: 91–94.
- Le Jeune IR, Simmonds MJ and Poole L. Patient need at the heart of workforce planning: the use of supply and demand analysis in a large teaching hospital's acute medical unit. *Clin Med* 2012; 12: 312–316.
- Ghazanfar MN, Honore PH, Nielsen TR, Andersen SE and Rasmussen M. Hospital admission interviews are time-consuming with several interruptions. *Danish Med J* 2012; 59: A4534.
- Weigl M, Muller A, Vincent C, Angerer P and Sevdalis N. The association of workflow interruptions and hospital doctors' workload: a prospective observational study. *BMJ Qual Saf* 2012; 21: 399–407.
- Magrabi F, Li SY, Dunn AG and Coeira E. Challenges in measuring the impact of interruption on patient safety and workflow outcomes. *Methods Inform Med* 2011; 50: 447–453.
- Westbrook JI, Woods A, Rob MI, Dunsmuir WT and Day RO. Association of interruptions with an increased risk and severity of medication administration errors. *Arch Intern Med* 2010; 170: 683–690.
- Jett QR and George JM. Work interrupted: a closer look at the role of interruptions in organizational life. *Acad Manage Rev* 2003; 28: 494–507.