The impact of intra-operative distractions on patient safety: A prospective descriptive study using validated instruments

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ABSTRACT

Background: An emerging evidence-base documents prevalent distractions in the operating room (OR). Studies have shown negative impact of distractions, but they are mostly done with residents in simulated environments. We tested the hypothesis that intra-operative distractions are associated with deterioration in patient safety checks in the OR.

Methods: 24 elective urological procedures were assessed. Blinded trained assessors (2 surgeons, 1 psychologist) used validated instruments to prospectively assess in vivo frequency and severity of distractions (related to communication, phones/pagers, equipment/provisions, OR environment, other hospital departments, or a member of the OR team) and completion of safety-related tasks (related to the patient, equipment, and communication). Descriptive and correlational analyses were conducted.

Results: Mean case duration was 70mins (mean intra-operative time=31mins). *Distractions*: a mean of 4 communication distractions (range 0-9) and 2.48 other distractions (range 0-5) were recorded per case (distraction rate=1 per 10mins). Distractions coming from external visitors and addressed to the entire team or the surgeon, and distractions due to lack of coordination between hospital departments were most disruptive to OR work. *Safety checks*: patient tasks were completed most often (85-100%), followed by equipment tasks (75-100%) and communication tasks (55-90%). *Correlational analyses:* more frequent/severe communication distractions were linked to lower completion of patient checks intra-operatively (median rho=–0.56, $P<0.05$).

Conclusions: Distractions are prevalent in ORs and in this study they were linked to deterioration in patient safety checks intra-operatively. Surgeons should be mindful of

their tolerance towards distractions. Surgical leadership can help control distractions and reduce their potential impact on patient safety and performance.

Keywords: patient safety, distraction, interruption, education, skill

INTRODUCTION

The issue of distractions and interruptions during clinical work has been receiving increasing attention in the surgical and wider healthcare literature.[1-2] Existing evidence shows that being distracted can have a range of negative consequences.[3,4] These include a higher chance of an error (e.g. when administering medication, or carrying out a surgical procedure), increased workload if distractions are continuous, and inefficiency in care delivery (i.e. time wasting).[3,4]

A number of studies have attempted to measure distractions to surgical work and their impact on surgeons' performance and patient safety. Distractions/interruptions in the operating room (OR) have been quantified.[5,6] In previous research carried out by our group, we found that within an average intra-operative duration of 56mins (open and laparoscopic elective general surgery cases) 14 distractions occurred.[6]. In the same set of cases, we found 3.5 distractions specifically relating to communication (e.g. an external person walking into the OR to discuss another patient with the surgeon).[7] Similar findings have been reported in urology,[8,9] laparoscopic antireflux surgery,[10] and cardiothoracic surgery.[11]

Although interest in distractions stems from concerns about patient safety and performance detriments for surgeons, links between distractions and performance within surgery remain to be firmly established. One cardiothoracic study found that higher rate of distractions was linked to OR team errors[11] – but the rest of the evidence base comes from simulated environments and typically junior surgeons (residents). Such studies have shown that residents' technical performance is

negatively affected by distractions[12-14] – including loud music, which has a detrimental effect on residents.[15]

This study examined the impact of intra-operative distractions on patient safety in elective procedures carried out by an experienced (Attending) surgeon. The following hypothesis was tested:

H_1: Intra-operative distractions are associated with deterioration in patient safety checks during a procedure

METHODS

Design and case sample

This was a prospective observational study of 24 operations. Data were collected from the urology OR of an inner-city London (UK) teaching hospital. To ensure homogeneity in the cases, all cases were carried out by the same Attending surgeon, with assistance by a resident and presence of an Attending anesthesiologist and senior OR nursing personnel. The anesthesia and nursing personnel came from the same 'pool' across all procedures and all OR personnel had ample experience of working together. Prior to data collection, the study was approved as a service quality improvement project and informed consent obtained from all OR team-members.

Outcome measures

Distractions

Distractions were assessed via in vivo observation in the OR using an instrument that we have previously developed and validated.[6-9] A distraction was defined as '*any event that occurs intra-operatively and that is not directly related to the care of the*

patient who is on the operating table at the time'. The definition is based on psychological theory of task performance – specifically 'task-switching'.[15] Task-switching occurs every time a human operator who is engaged in a primary task is faced with a secondary task. For example, a driver's primary task is driving a car; dealing with a cell phone ringing in the car becomes a secondary task. Likewise, a surgeon's primary task during a cholecystectomy is dissecting around Callot's triangle; dealing with a colleague coming into the OR to ask a question is a secondary 'task'. The task-switching literature shows that secondary tasks can divert attention from the primary task and thus negatively impact on performance.[16]

Sources of distractions were coded as follows:[6-9]

- *Distracting communications*: irrelevant comments by OR team-members (e.g. irrelevant conversations), or external visitors coming to the OR to discuss with surgeon or other team-member
- *Phones/pagers*: incoming phone calls and bleeps
- *Equipment/provisions*: not available/malfunctioning equipment, lack of necessary provisions
- *OR environment*: ergonomic issues, OR uncomfortably hot/cold
- *Distractions caused by other departments*: patient notes or test results unavailable, wrong patient delivered to OR
- *Distractions caused by a team-member*: an OR team-member makes an error or otherwise distracts the team
- *Teaching*: occasions when teaching distracted a team-member or the entire team

Each observed distraction was rated for its visible severity on an anchored 1-9 scale (1=potentially distracting event, 9=operation flow interrupted; see Appendix).

Patient safety checks

Patient safety was assessed via in vivo observation using a checklist developed and validated for use in general and urological surgery.[17] The checklist covers all phases of an operation (pre-, intra-, immediately post-operative) and it is based on existing OR protocols, recommendations for good practice, and expert input. All tasks on the checklist are deemed important contributors to patient safety in the OR. There are three categories of tasks in the checklist (a revised and further validated version of the checklist is reported by Russ et al[18] and is available upon request):

- *patient tasks*: actions or information associated directly with the patient (e.g. safe transfer to operating table, patient notes available in OR, patient's condition monitored by anesthesiologist, etc).
- *equipment tasks*: checking and counting of surgical instruments, having equipment available and correctly set (e.g. diathermy), having swabs and sharps organized and ready, etc.
- *communication tasks*: confirmation of operative site laterality, surgeon asking team if it is OK to start, surgeon offering clear instruction to scrub practitioner on instruments, etc.

Each item on the checklist was marked 'done/not done'.

Study procedure

Observations were carried out at the pre-operative phase (patient arriving at the anesthesia room to patient being rolled into the OR), intra-operative phase (skin incision to skin closure), and post-operative phase (anesthesia reversal to patient being handed over to the recovery room/team).

Training phase

Distractions were observed by a senior psychologist (NS) and the patient safety checklist was completed by either one of 2 surgical residents (JMcD, JG). To ensure reliability and accuracy in the assessments, the following steps were taken:

- The psychologist assessor (NS) was one of the expert developers of the distractions instrument.[6,7] Prior to data collection, 5 procedures were observed by both NS and a second blinded surgeon assessor (SU) to ensure reliability (which was achieved: same distractions noted, no rating differed by more than 1 point on the 9-point scale).
- The 2 surgeon assessors (JMcD, JG) were trained (during 5 procedures, prior to data collection) in the use of the patient safety checklist by a surgeon (SU), who developed the checklist.[17]

Inter-assessor reliability (i.e. agreement at ≥70% of the observations) was thus ensured for both the distractions and the patient safety checklist assessments prior to data collection.[19] The additional benefit of this training phase was to allow OR team-members to get used to the presence of observers – and thus minimize potential for Hawthorne effect (i.e. OR personnel changing their behavior because they were being observed).

Data collection phase

Formal data collection was initiated when the training phase was completed. For data collection, one surgeon (JMcD or JG) and one psychologist (NS) were simultaneously present in the OR and carried out assessments of safety checks and distractions, respectively. Assessors were fully blinded to each other's proformas/scoring throughout the study.

Statistical analyses

Data were analyzed using SPSS v.18.0 (SPSS Inc, Chicago, IL, USA). Descriptive statistics (means, standard deviations for scale scores; percentages and ranges for frequency data) were computed. Analysis of variance (ANOVA) was carried out to determine which distractions were rated as most severe, their sources, and which team-member they affected most. Correlational analyses were carried out (Spearman's rho correlations) to determine relationships between distractions and completeness of the patient safety checklist. Significance was set at $P<0.05$.

RESULTS

Case sample

Of the 24 operations, 5 were used to train assessors – therefore full datasets were available from 19 procedures. Procedure mean duration was 70mins. The intra-operative phase lasted a mean 31mins. Assessed cases included cystoscopies (rigid and flexible), circumcisions, epididymal cyst excisions, stent removals, bladder/prostate biopsies, examinations under anesthesia, transurethral resections of the prostate (TURP), transurethral resections of bladder tumors (TURBT), and cystolitholapaxies.

Patient safety tasks and checks

Table 1 summarizes task completion rates across the 3 operative phases (pre-, intra-, post-operative) and the 3 types of tasks that the OR team has to carry out (patient, equipment, communication tasks). Patient tasks were completed more often than other tasks (minimum completion rate of 85%), communication tasks were least likely to be completed, and tasks relating to OR equipment were in-between. Significant variation

was observed across procedures in terms of the proportion of tasks carried out by the OR team: task completion ranged from 100% (all done) to 0% (none done).

Table 1

Distractions

A total of 136 distracting events were recorded, of which 85 were distracting communications and 52 other types of distractions (Figure 1). During each operation, a mean of 4 communication distractions (range 0-9) and 2.48 other distractions (range 0-5) were recorded – which means that on average 6-7 distractions occurred within the 70min duration of these procedures, or 1 distraction every 10mins. Most of the distractions occurred intra-operatively: 70% (60/85) and 71% (37/52) of communication and other distractions, respectively.

Figure 1

Table 2 summarizes the frequency and observer-rated severity of the recorded communication distractions. Most of these stemmed from OR nurses, and were equally likely to be received by any member of the OR team, or to be addressed to the entire team. Examples of such distractions included queries about other patients, either operated on already or coming later in the list. Regarding distraction severity, an ANOVA revealed significant differences in the sources of these distractions ($F(4, 71)=2.56$, $P<0.05$). Distracting communications instigated by external visitors to the OR were most distracting to the team, matched only by communications stemming from the surgeons. An ANOVA on the recipients of the distractions revealed that

distracting communication received by the surgeons or the entire OR team were statistically the most distracting ($F(3, 81)=3.91$, $P<0.05$). These communications often required the surgeon to stop the procedure, look up (literally) and address the query or comment – hence the high level of disruption.

Table 2

Table 3 summarizes the frequency and rated severity of distractions that were not related to communication. Most of these events were related to equipment and provisions – e.g. malfunction of the endoscopic stack or camera system. The most likely recipient of these distractions was the entire OR team – so that the entire team had to take action to address them. Regarding severity, an ANOVA on the sources of these distractions revealed significant differences ($F(6, 45)=3.92$, $P<0.01$) – lack of coordination with other hospital departments was the most disruptive problem. Examples included the OR team finding out that a patient scheduled for surgery on the day had just been fed in the ward and thus the list should be changed, or the OR team having to reorder the list because the laser equipment that was required for the OR was not available for at least 2 hours due to scheduling confusion. An ANOVA on the recipients of these distractions revealed that distractions involving the entire team were significantly more severe than other distractions ($F(3, 48)=9.34$, $P<0.001$).

Table 3

Correlations between distractions and patient safety check completion

Correlational analyses between checklist completion rates and distractions (Table 4) showed significant negative associations between intra-operative communication distractions and patient tasks (e.g. patient's condition monitored by anesthesiologist, blood/fluids monitored by OR team). These data support our hypothesis, H_1: more intra-operative distracting communications were associated with deterioration of patient safety checks.

Table 4

DISCUSSION

We aimed to investigate in detail and using validated instruments the presence and potential impact of distracting events in elective procedures carried out by an experienced surgeon. The present study extends the evidence-base on surgical distractions.[5-15] Three are the main findings: firstly, we replicated the finding that distractions in the OR are frequent and can be severe; secondly, safety checks in the OR can be variable; thirdly, distractions were linked to fewer safety checks being carried out. We comment on each one of these findings below.

Numerous distractions were found, relating to communications between OR team-members, or between them and visitors, as well as distractions unrelated to communication but related to equipment or the layout of the OR itself. Overall, a rate of 1 distraction per 10mins was recorded. There are currently no absolute criteria regarding what constitutes an unacceptable level of distraction – and in fact, these are likely to depend heavily on the level of expertise of the surgeon (and the rest of the

OR team) and the complexity of the procedure. Residents' performance on simulators has been shown to be negatively affected by distractions[12-15] – and recent evidence shows that novice surgeons are more stressed and their performance suffers more as a result of distractions compared to more experienced surgeons.[20,21] Well coordinated teams that are supportive of the surgeon can be aware of distractions and minimize them (e.g. senior OR nurse taking non-urgent calls to the operating surgeon during the critical part of a procedure). We further propose that surgeons should actively handle distractions in their ORs to protect their own performance (e.g. trainees should ask the team to switch off the radio while they are operating).

We found that safety checks were highly completed for patient tasks (85-100%), slightly lower for equipment tasks (75-100%), and more variable for communication tasks (55-90%). Again, there are no absolute standards – but given that the task checklist we used is based on OR protocols and expert input we take the view that completion rates for such tasks should be consistently high. Effective team performance requires consistency, which in turn ensures that the team output is consistently good. To help OR teams become more aware of these tasks we have recently developed a shorter version of the checklist for easier use in ORs.[18]

An important finding of the study is that more distractions received by the team intra-operatively were linked to fewer safety checks being carried out by the team. This is a novel finding – this study was carried out in real ORs and involved experienced teams. All procedures were carried out by an Attending surgeon, with presence of an Attending anesthesiologist in the OR and at least one experienced OR nurse in the team (typically at least 2 of the nurses were experienced). This means that even in

experienced teams checks may be omitted. Although this pattern may not cause concern in elective, fairly straightforward procedures, getting used to such an environment can gradually erode safety standards: if distractions are the daily reality in the OR, then the surgeon learns to 'live with them' – but this does not address the potential threats to safety or the inefficiencies in preparing patients and equipment for the OR. Analysis of errors in the OR as reported by the senior surgeons, including wrong site/side surgery or procedures left incomplete, commonly report distracting environments, with the surgeon's attention often away from the patient on the table.[22]

This study has limitations – including small sample size, single institution and speciality, simple procedures included, and lack of a direct assessment of patient outcomes (which would have required significantly more observations). These limitations should be addressed in further studies. There is also a potential observation bias in our data in the form of a Hawthorne effect – i.e. personnel changing their behavior because they were being observed. This is a limitation shared by all observational studies. Although we could not eliminate it, we allowed a familiarization period prior to data collection, such that OR teams became accustomed to the observers. Finally, there is a limitation to assessing distractions via observation – although the study is informed by the cognitive psychology of primary vs. secondary task performance, certain tasks are currently inherent to how an OR actually works (e.g. teaching residents or students, managing a changing list throughout the day, etc) and hence it is difficult for an observer to estimate their 'true' impact. This is more easily done in simulation studies, where objective performance indices are available.[12-15] This is a trade-off between the more controllable but more 'artificial' simulation laboratory and the less controllable but very real OR, and hence

both types of study are complementary. Our study also has significant strengths – which include real time assessment of expert OR teams, validated assessment tools, and multidisciplinary trained and blinded assessors (surgeons, psychologist).

These findings have implications regarding how to improve surgeons' working conditions in ORs. Our approach was to feed back our findings to the OR teams involved (Attendings and trainees). Their reaction was firstly that they had been unaware of the level of distraction occurring in their ORs (they all thought it was excessive) and secondly that unnecessary distractions should be minimized. The teams identified a number of actions – mainly in relation to coordination between the OR and other hospital departments, as this was a key cause of major disruption to their lists. Following this experience, we recommend that such studies be conducted as part of ongoing safety and quality improvement projects locally tailored to ORs. Such studies would include assessment of working conditions, including distractions, over a period of time, followed by anonymized feedback to the teams involved, identification of actions to be taken, implementation of the actions and re-assessment. A range of scientific and usable instruments to assess OR working now exist – including the tools reported here, OTAS (that captures how well a team works),[23] and SURG-TLX (that captures workload).[24] Interventions also exist and some of them can be implemented without significant costs – such as pre-list team briefings, and the 'sterile OR' concept, which involves team members avoiding non-essential talk during safety-critical parts of a procedure to allow the surgeon to focus. Future research should identify principles of optimal work process design in the OR – such that unnecessary distractions are kept to a minimum thus enhancing surgeons' performance and patients' safety.

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TABLES

Table 1. Task completion (safety checks) across operative phases (means, min-max)

	Pre-operative phase	Intra-operative phase	Post-operative phase
Patient tasks	100% (64-100%)	89% (63-100%)	85% (0-100%)
Equipment tasks	83% (36-92%)	75% (0-100%)	100% (25-100%)
Communication tasks	75% (40-94%)	55% (0-83%)	90% (0-100%)

Table 2. Frequency and severity of distracting communications

Distracting communication sources									
Surgeons		**Anesthesiologists/ Assistants**		**OR Nurses**		**External visitors**		**Entire OR team**	
N=8		**N=14**		**N=35**		**N=13**		**N=6**	
Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
5.63	1.30	4.21	1.85	4.57	1.50	5.77	2.20	3.67	2.42

Distracting communication recipients									
Surgeons		**Anesthesiologists/ Assistants**		**OR Nurses**		**External visitors**		**Entire OR team**	
N=26		**N=22**		**N=16**		**n/a**		**N=21**	
Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
4.85	1.49	4.09	1.74	4.25	1.18	N/A		5.52	2.27

Note: table entries are frequencies of distracting communications (in brackets) and their observer-rated severity on a 1-9 scale (1=potentially distracting event, 9=operation flow interrupted). On 9 occasions the source was unclear – these were excluded from the table.

Abbreviation: SD=standard deviation

Table 3. Frequency and severity of distractions excluding communications

Distracting event sources

Equipment or provisions		Phones/pagers		Coordination with other departments		OR design/ergonomic issues		Teaching		Team-member's error	
N=25		N=6		N=5		N=6		N=4		N=4	
Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
5.04	2.44	3.67	1.86	9.00	0.00	3.83	1.72	6.00	1.15	5.00	2.45

Distracting event recipients

Surgeons		Anesthesiologists/ Assistants		OR Nurses		Entire OR team		---	
N=14		N=1		N=10		N=27			
Mean	SD	Mean	SD	Mean	SD	Mean	SD	---	
3.21	1.48	5.00	0.00	4.50	1.65	6.63	2.36		

Note: table entries are frequencies of distracting events excluding distracting communications (in brackets) and their average rated severity on a 1-9 scale (1=potentially distracting event, 9=operation flow interrupted). On 2 occasions the source was unclear – these were excluded from the table.

Abbreviation: SD=standard deviation

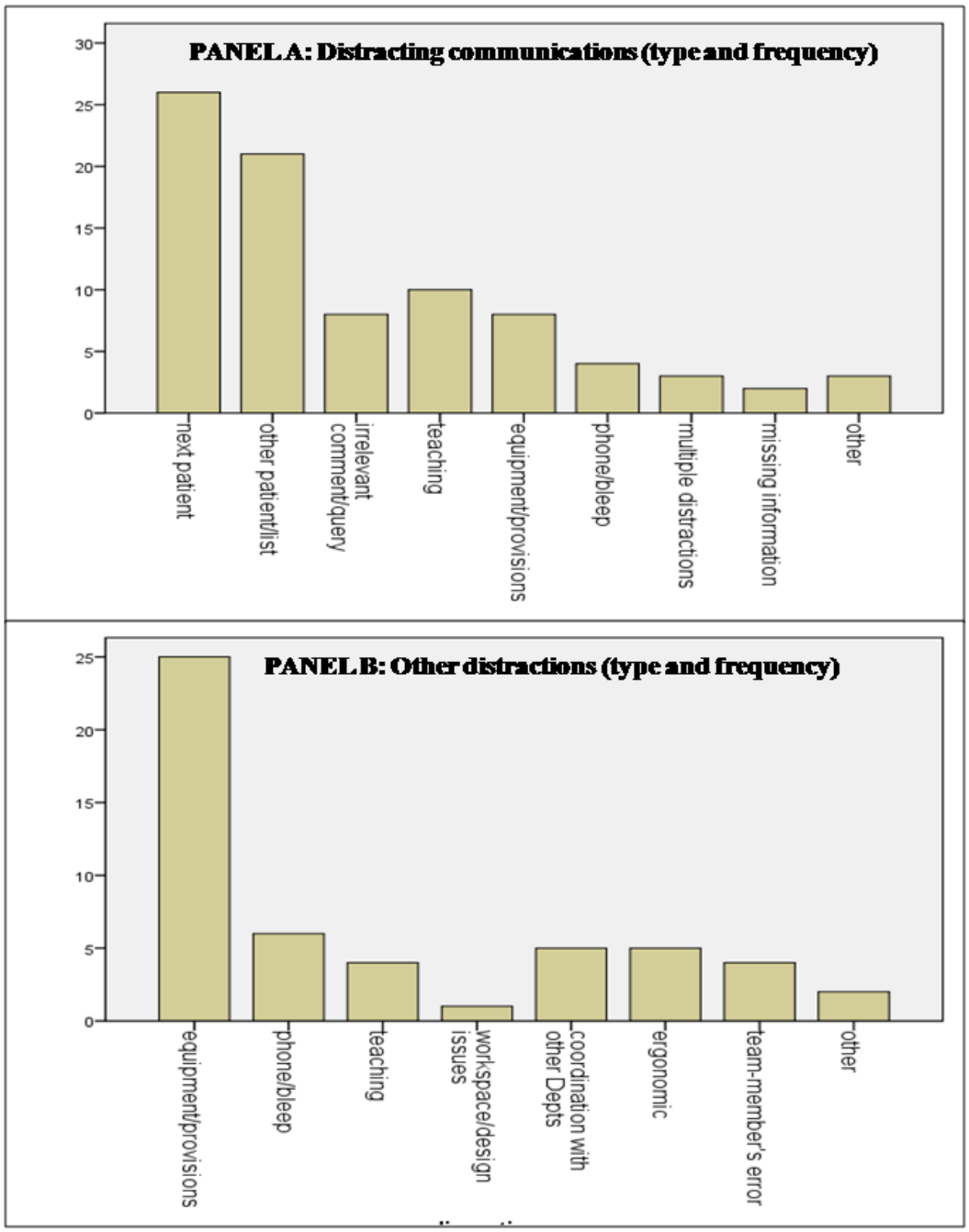
Table 4. Correlations between distractions and task completion (safety checks) intra-operatively

		Communication distractions during case			Other distractions (excluding communications) during case		
		Number of distractions	**Average severity of distractions**	**Total summed severity of distractions**	**Number of distractions**	**Average severity of distractions**	**Total summed severity of distractions**
Patient safety task checklist (% completed per case)	**Patient tasks**	-0.56*	-0.55*	-0.66**	-0.23	-0.35	-0.39
	Equipment tasks	-0.12	-0.22	-0.20	0.26	-0.12	0.15
	Communication tasks	-0.13	-0.41	-0.22	0.25	-0.10	0.30

Note: table entries are Spearman's rho correlation coefficients. *P<0.05; **P<0.01

Figure caption

Figure 1: Type and frequency of distracting events including communications (Panel A) and other events (Panel B)


PANEL A: Distracting communications (type and frequency)
30
25
20
15
10
5
0
next patient
other patient/list
irrelevant comment/query
teaching
equipment/provisions
phone/bleep
multiple distractions
missing information
other
PANEL B: Other distractions (type and frequency)
25
20
15
10
5
0
equipment/provisions
phone/bleep
teaching
workspace/design issues
coordination with other Depts
ergonomic
team-member's error
other

APPENDIX: Distractions rating scale[6,7]

Rating level	Observable effect (for assessor to rate)
1	Potentially distracting event
2	Distraction noticed by floating/circulating team-member
3	Floating/circulating team-member attends to distraction
4	Team-member momentarily distracted from task
5	Team-member pauses current task
6	Team-member attends to distraction
7	OR team distracted momentarily
8	OR team attends to distraction
9	Operation flow interrupted/disrupted

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