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The impact of distractions and interruptions in the operating room on patient safety and the operating room team: An integrative review

Sonia Mackenzie
psmackenzie99@gmail.com

Paula Foran
pmt13@bigpond.com

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Authors

Sonia Mackenzie
MCN (Perioperative), Grad Dip
(Perioperative), RN

Paula Foran
PhD, MACN, FACORN

The impact of distractions and interruptions in the operating room on patient safety and the operating room team: An integrative review

Abstract

Problem identification: In the operating room (OR), distractions and interruptions are frequent, impacting patient safety, coordination and efficiency and causing errors and patient harm. The OR team is impacted while attempting to perform critical work. This review explores the impact of distractions and interruptions in the OR on patient safety and the OR team.

Literature search: Inclusion and exclusion criteria were determined. Six databases were searched with the search criteria for inclusion being in English, peer-reviewed and published between 2014 and 2019. In total 296 papers were identified.

Data evaluation synthesis: Duplicates were removed, and 195 papers were screened using inclusion and exclusion criteria. Fourteen studies were included in the review: 12 were quantitative reviews and two were mixed-method reviews. Methodological quality was assessed using the mixed methods appraisal tool (MMAT), with scores between 60 and 90 per cent. A thematic analysis revealed observational study themes of types, frequency and severity of distractions and interruptions, and impacts upon mental workload, patient safety and the OR team. Simulation study themes included types of distractions and interruptions, and impact on mental workload, clinical decision-making, surgical performance and nurses.

Implications for practice or research: The heterogeneity of the literature and paucity of recent nursing and anaesthetic studies highlights that further research is necessary. Nurses can educate and develop policies and interventions to reduce distractions, enhancing patient safety and decreasing the negative impact upon their colleagues and teams.

Keywords: distractions, interruptions, disruptions, operating room, perioperative, patient safety.

Problem identification

Operating rooms (ORs) are complex environments in which the whole OR team (surgical, anaesthetic and nursing personnel) experiences high levels of cognitive demand while maintaining concentration and performing often difficult and highly precise tasks¹⁻³. In the OR, distractions and interruptions are ubiquitous and varied yet there remains a paucity of empirical literature on the specific effects they have on OR team members and patient safety^{1,4-6}. Nevertheless, the literature confirms distractions and interruptions are a leading stressor for the entire OR team, contributing to unfavourable clinical performance, jeopardising patient care and, potentially, resulting in patient harm^{1,3,4}.

Distractions and interruptions impact communication and team coordination, increase workload and fatigue, disturb concentration and situational awareness and impact workflow^{3,4,7}. This can result in errors, delays, increases in surgical duration and cost, and omission of safety checks^{1,4-8}. It is therefore essential for distractions and interruptions to be minimised^{1,3-8}.

Distractions and interruptions are defined slightly differently between authors. Generally distractions are events which potentially divert one's attention from the primary task and interruptions occur when distractions are responded to, rapidly interrupting and switching attention away from the primary task^{1,4,6,7,9,10}. Psychology and neuroscience research shows shifting attention from a primary task to a secondary task can be detrimental as it increases cognitive load and forces one to perform a dual task, or multi-task^{1,2,10,11}.

This integrative review explores the impact of distractions and

interruptions in the OR on patient safety and the OR team. Despite the paucity and heterogeneity of the literature, the various types, frequency, severity and impacts of distractions and interruptions in real OR settings will be presented, in addition to controlled experiments in simulation laboratories studying the impacts of specific distractions and interruptions.

Literature search

An integrative review methodology was used in this review as outlined by Whittemore and Knafel¹². This method allows varied methodologies including qualitative and quantitative to be included to assist in presenting an extensive and holistic view of a phenomenon¹². An electronic search was conducted to identify suitable literature. Cumulative Index of Nursing and Allied Health Literature (CINAHL) Complete, Medline Complete, PubMed, Scopus, Joanna Briggs Institute EBP and Cochrane Library databases were searched. The reference lists of selected papers were also searched. The search terms, truncations and Boolean operators used were 'distract* OR interrupt* OR disrupt*' AND 'operating room OR operating theatre OR perioperative' AND 'patient safety'.

Inclusion and exclusion criteria

Limiters on database searches were applied, including publication years 2014 to 2019, English language, peer-reviewed (in CINAHL Complete), and full-text. The timeframe was applied to ensure the most contemporary papers were identified. Further inclusion criteria included primary research papers using quantitative, qualitative or mixed-methods methodology; primary outcomes of distraction, interruption or disruption; and settings within an OR or a simulation laboratory. Exclusion

criteria included non-primary research, quality improvement studies, reviews, opinion pieces, guidelines, observational studies focused on only one distraction, and primary research where patient safety was not a focus.

Data evaluation synthesis

Data extraction

The titles and abstracts from qualitative, quantitative and mixed-methods papers were reviewed against the inclusion and exclusion criteria. Data extracted included lead author, published year, country, aim, design, sample, key findings and study limitations.

Data evaluation

The included papers were critically assessed for methodological quality with the mixed methods appraisal tool (MMAT). This tool covers five categories of study design including qualitative, quantitative non-randomised, descriptive or randomised control trials, and mixed-methods¹³⁻¹⁵. The efficiency, validity and reliability of the MMAT tool are well supported^{13,14}. Each category incorporates criteria questions which can be answered and thereby scored between zero and two; 'no' (zero), 'cannot tell' (one) and 'yes' (two). These scores were converted into percentages. The critical appraisal skills programme (CASP) tools were also used to confirm quality^{16,17}.

Data synthesis

As per Whittemore and Knafel¹², the included studies were synthesised using thematic analysis to distinguish themes, differences and relationships. Two categories of studies were determined, observational in ORs and experimental in simulation

laboratories. Themes identified under the category of observational studies include types, frequency and severity of distractions and interruptions, and impacts on patient safety and the OR team. Under the simulation experimental category, themes identified included types of distractions and interruptions, and impact on mental workload, clinical decision-making, surgical performance and nurses.

Table 1: Search results

Database	Number of articles
PubMed	120
Medline Complete	48
CINAHL Complete	64
Scopus	28
Cochrane Library	26
JBI	10
From references	1

Findings

Descriptive findings

The database search identified 296 articles from six databases and one study was found through searching reference lists (see Table 1). Duplicates were removed, leaving 195 titles and abstracts which were screened against the exclusion criteria. Sixteen full-text studies were reviewed; however, two were excluded as the primary measures were not distractions or interruptions. As shown in Figure 1, the preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagram, 14 studies were

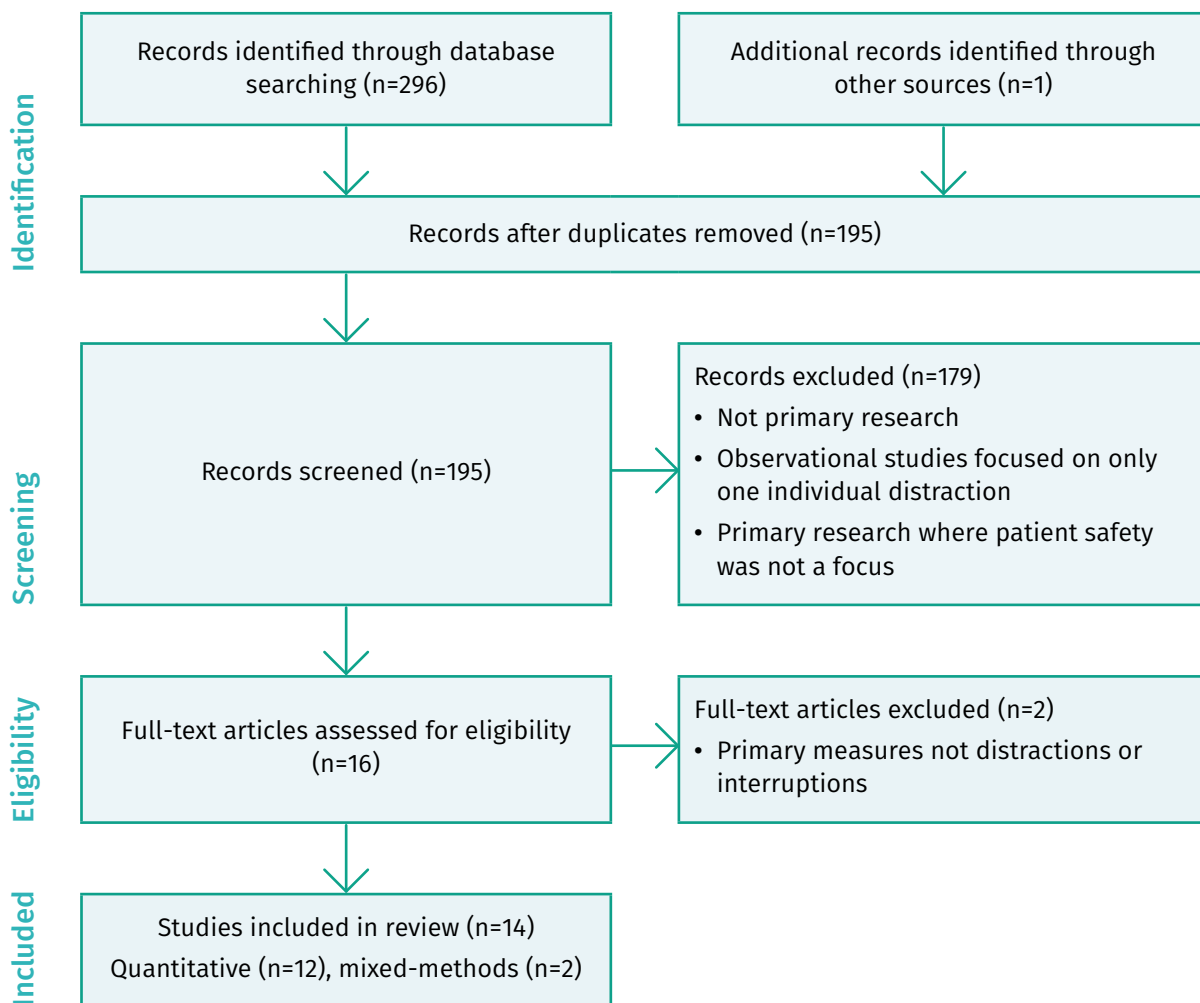


Figure 1: PRISMA flow diagram of papers for inclusion (Moher et al.¹⁸)

included in the review¹⁸. Twelve of these were quantitative studies and two were mixed-methods. Four studies were conducted in Germany, four in the United Kingdom, two in the United States of America, two in Canada, one in China and one across Australia, Thailand and China. The key descriptors of each included study are presented in Table 2 (see supplemental documents). These include primary author, published year, country, design and sampling, study aim, key findings, limitations, implications and MMAT score.

Quality assessment

The methodological quality MMAT scores of the 14 papers ranged from 60 to 90 per cent. The seven quantitative observational studies all scored 60 per cent, while the quantitative simulation experimental studies scored between 60 to 90 per cent, averaging 76 per cent. The two mixed-methods papers both scored 83 per cent against the mixed-methods criteria.

Discussion of findings

Observational studies conducted in real ORs and simulation studies performed in mock OR simulation laboratories are complementary and are able to present diverse data, adding to the knowledge and evidence of distractions and interruptions⁵. However, both types have limitations as well as advantages. Observational studies are inherently subjective, whereas simulation studies are controlled and able to assess objective outcomes, inferring causality, but are not conducted in real ORs^{5,8}. Observational studies use validated and reliable measuring tools to provide a thorough investigation of distractions and interruptions in ORs¹. Simulation studies have the advantage of studying clinicians performing a primary task while

adding a secondary task; this would be unethical and unsafe to conduct with real patients²¹⁹. Virtual reality simulators are validated to measure surgical performance; however, generalisability of simulated studies to real ORs is limited¹⁹. This integrated literature review has identified themes associated with both types of settings to provide a thorough overview of distractions and interruptions in the OR.

Observational studies

Seven quantitative observational studies were included in this review^{1,3,5,7-9,11}. All had small samples, frequently from a single hospital and covering limited specialties yet all used statistical analyses^{1,3,5,7-9,11}. Two mixed-methods studies also incorporated quantitative observational study components within their studies^{6,20}.

Types, frequency and severity of distractions and interruptions

Types

Various distractions and interruptions are discussed in the nine studies; however their heterogeneity is apparent as each study categorised types of distractions differently^{1,3,5-9,11,20}. Types include traffic (personnel entering and exiting the OR), phones/pagers, radio, case-irrelevant communications (CIC – i.e. communication not regarding the patient in the OR), teaching, movement (in front of monitors), crying babies (in caesarean cases), equipment, environmental, procedural, patient, and co-ordination issues^{1,3,5-9,11,20}. Four studies used the same tool which was developed by Healey et al.²¹ in 2006; however, each study modified it to develop different categories. The number of categories in each study ranged from five to twelve, illustrating the types of distractions

and interruptions experienced by OR teams is significant^{1,3,5-9,11,20}.

Frequency

Amongst the studies conducted in ORs, seven focus on distractions and interruptions affecting the whole OR team^{1,3,5,7-9,11}, one on anaesthetists in the preoperative period²⁰ and another on nurses⁶. Due to the heterogeneity of the literature, it is difficult to determine the overall frequency of each type of distraction and interruption. Seven studies present the number per hour, ranging from 3.6 to 21.7 per hour^{1,5-9,11}, averaging out to 10.1 distractions or interruptions each hour, or significantly one every six minutes. The remaining two studies reported frequencies per patient; Al-Hakim et al.²⁰ found three per patient in the preoperative period, and Jung et al.³ two per patient intra-operatively. Noting the heterogeneity of the studies, the highest frequency was CIC, followed by phone/pager, equipment issues and traffic^{1,3,5-9,11,20}.

Severity

Of the nine observational studies, four used the tool developed by Healey et al.²¹ to measure types and severity of distractions and interruptions^{1,5,8,9}. The validated tool for use in ORs uses a nine-point nominal scale and measures visible severity relating to the OR team's involvement in an event^{1,5,8,9}. Scores between 1 and 3 indicate a distraction has potentially or actually affected the circulating nurse, between 4 and 6 suggests one other team member (excluding the circulating nurse) is distracted or interrupted, 7 or 8 means more than one member is affected, and 9 indicates surgical flow is impacted^{1,5,8,9}.

These four studies trained two to three observers and measured high inter-rater agreement/reliability (IRR)

during pilot studies^{1,5,8,9}. In addition, two blinded the observers^{5,8}. Importantly, the pilot period reduced the potential for the Hawthorne effect, whereby subjects alter their behaviour while being observed⁵. Despite this, the studies occurred in single hospitals and across minimal specialties, creating the possibility of selection bias^{1,5,8,9}. Observer fatigue and observer bias are also possibilities^{1,5,8,9}. In addition, Sevdalis et al.⁵ observed a single surgeon's procedures. Despite using the same tool, discrepancies exist regarding which distractions and interruptions had the highest severity^{1,5,8,9}. Acknowledging the heterogeneity, equipment issues had the highest severity followed by procedural issues and CIC^{1,5,8,9}.

Two further studies used another validated tool comprising three levels^{7,11}. Level 1 events are dealt with by the unscrubbed team members (not in the sterile field, for example circulating nurse and anaesthetists)^{7,11}. Level 2 affects one member of the scrubbed staff (within the sterile field) and level 3 affects more than one member, including the primary surgeon^{7,11}. Interestingly both studies showed the same three highest severity distractions or interruptions (level 2 or 3), however in different orders: CIC, others, equipment⁷, compared to equipment, CIC and others¹¹. Notably, Yoong et al.¹¹ determined the three most frequent were also the three most severe. Over 11 per cent of total operative time involved a level 2 or 3 distraction in Willett et al.'s⁷ study. Both studies triangulated the data and used independent observers; Willett et al.⁷ did not report on the training of observers, Yoong et al.¹¹ did, and neither reported on IRR.

The remaining studies used different measures. Jung et al.³ measured post-operatively using a human-factors, self-reported questionnaire

(surgical team assessment record or STAR) to measure the primary surgeon's perceived distraction³. Findings were that OR doors opening and CIC had the highest severity³. Significantly, this tool is subjective; the validity of it has not been completely established and only a single surgeon was studied limiting the generalisability despite a large sample of 265³.

Severity was also measured post-operatively in Al-Hakim et al.'s²⁰ mixed-method study; however, only anaesthetists were in the study group and severity was measured by the amount of time wasted. Times were analysed against semi-structured interview responses regarding perceptions of care coordination issues. The authors established distractions and interruptions caused by staff and coordination within the OR team had the largest impact²⁰. This study occurred in five hospitals across three countries; however, the observers and interviews have the potential to be biased due to subjectivity²⁰. Sirihorachai et al.'s⁶ mixed-methods study is the only one conducted by nurses, and studied only nurses. A validated tool comprising four levels was used: for level 1 the circulating nurse does not respond, for level 2 the primary task is ceased and the secondary task attended to, for level 3 the nurse multitasks, and for level 4 the operation flow is interrupted⁶. The highest severity distraction or interruption was CIC followed by equipment issues and phone/music/pager⁶. The potential for observer bias existed here due to subjectivity and the use of one observer and therefore no IRR⁶. In addition, a single centre and specialty allows for possible selection bias⁶.

Inconsistent categories and tools make it impossible to ascertain which distractions and interruptions have the highest severity. However,

equipment issues comparatively appear to have the highest severity followed by CIC and procedural issues^{1,3,5-9,11,20}. Therefore, the frequency and severity of distractions and interruptions are not correlated¹.

Impacts of distractions and interruptions

Mental workload

Understanding and studying the impact distractions and interruptions have on mental workload is crucial to understanding stress, burnout, training requirements, OR team needs and system demands⁴. Three observational studies used mental workload measurements to determine the association between the frequency and severity of distractions and interruptions and the perceived mental workload of the OR team^{3,8,9}. Weber et al.⁹ and Weigl et al.⁸ used the validated surgery task load index (SURG-TLX) questionnaire which enables subjective assessments, differentiates between complexities of tasks, and specifies objective performance. The OR team answered questions using three elements of the tool: mental demands, situational stress, and distraction^{8,9}. Weber et al.⁹ added productivity and perceived quality. The subjectivity of the tool allows for potential subjectivity and recall bias^{8,9}.

According to Weigl et al.⁸ the perceived mental workload for all team members is correlated to severity of distractions and interruptions. Results were different for each profession. For surgeons, CIC was linked to a decrease in situational stress, yet an increase in perceived distraction; however, individual surgeons respond differently to individual types⁸. This indicates some CIC and small talk may be positive and reduce surgeons' fatigue and stress⁸. Nurses'

situational stress was negatively correlated with telephone/pager calls which were the most frequent and severe, and anaesthetists found CIC the most distracting⁸. Overall, reducing CIC and phone/pager distractions and interruptions reduces the risk of a cumulative effect upon mental workload⁸.

Mental workload and the severity of distractions and interruptions due to coordination and communication revealed statistically significant correlation in Weber et al.'s study using Pearson correlation ($p < 0.05$)⁹. Interestingly, post-operative reporting using the SURG-TLX tool showed anaesthetists ($n = 42$) reported higher levels of mental demands than surgeons ($n = 81$) and nurses ($n = 93$)⁹. Anaesthetists and nurses reported higher distraction rates than surgeons and CIC was linked to higher stress in anaesthetists although this study only observed robotic prostatectomies in a single hospital⁹. The SURG-TLX assesses perceived workload post-operatively; it does not consider workload at different time points intra-operatively.

The study by Jung et al.³ used the human-factors STAR tool and, in contrast to the previous studies, did not include anaesthetists or nurses but just a single surgeon. Through a multivariable analysis, CIC was independently correlated with an increase in surgeon's distraction³, a similar finding to Weigl et al.⁸. CIC is a modifiable distraction and interruption which appears to affect team members' mental workload differently³. Weber et al.⁹ state CIC decreases mental fatigue and stress, yet Weigl et al.⁸ found this was not the case for all OR professions, in particular anaesthetists. However, all three authors agree CIC should be minimised in the OR to reduce the mental workload of all staff^{3,8,9}.

Patient outcomes and safety

Unlike simulation studies, observational studies are unable to infer direct causality, yet four of the nine observed and recorded patient safety and outcome variables^{5,7,11,20}. Yoong et al.¹¹ and Willett et al.⁷ found no post-operative complications or adverse events occurred in any patient, despite distractions and interruptions being prevalent. Both measured case prolongation due to distractions and interruptions – 18.45 minutes per case¹¹ and 11.05 minutes per case respectively⁷. Similarly, Al-Hakim et al.²⁰ determined distractions and interruptions added just under a minute to each preoperative period. This has the potential to increase the risk of adverse patient outcomes and cost and decrease efficiency⁷. Sevdalis et al.⁵ identified distractions involving communication were related to lower completion of patient safety checks. More distractions led to a decline in the number of intra-operative checks completed⁵. Alarming, the teams were experienced, yet endangered patient safety by not completing checks⁵. However, this study was conducted in a single hospital with a single surgeon so generalisability and selection bias is questionable⁵.

OR team members

Distractions and interruptions affect different OR professions differently^{1,5,8,9}. Antoniadis et al.¹ found circulating and anaesthetic nurses were impacted more by the highly prevalent distractions and interruptions caused by traffic and phone calls/pagers as they attended to them while attempting to perform their primary tasks. Similarly, Sirihorachai et al.⁶ found nurses were most distracted by traffic and phones/pagers occurring during critical times of induction, counting and specimen handling. Nurses protected surgeons from traffic and

phones by refraining from asking questions or passing on information at critical times during procedures⁵. Traffic and phone calls can be minimised and nurses are able to develop policies and guidelines to ensure this occurs^{1,5,6}.

There is paucity in the recent observational literature analysing the effect of distractions and interruptions on anaesthetists and nurses with the majority of studies focussing on surgeons. The heterogeneity makes it impossible to ascertain which distractions have the largest impact. Regardless, all nine studies agree that unnecessary distractions should be minimised, and those which cause the whole team to be distracted or interrupted have the largest impact^{1,3,5–9,11,20}.

Simulation studies

Five simulation studies have been included in this review^{2,4,10,19,22}, and one mixed-methods study by Sirihorachai et al.⁶ which combined observational and simulation components. There is also paucity in the simulation literature studying anaesthetists and nurses – no anaesthetic studies were found and Sirihorachai et al.⁶ was the sole nursing study. The five surgeon studies all applied a distraction to novice subjects (medical students or surgical trainees) while they were performing a surgical technique or procedure on a simulator. Clinical decision-making and surgical performance were measured^{2,4,10,19,22}.

Type of distractions and interruptions applied

To improve generalisability of simulation studies, realistic OR distractions should be applied as secondary tasks while subjects are performing primary tasks¹⁹. Four studies applied an auditory and cognitive distraction including phones, pagers and patient complaints of pain^{4,10,19,22}. However,

Gao et al.² used mental arithmetic. Sirihorachai et al.⁶ applied a variety of distractions to nurses. Weigl et al.⁴ randomised 19 junior surgeons to one of two groups; the first were distracted by a phone call, the second by patient discomfort, while performing a vertebroplasty. In the phone call group, the caller insisted on speaking to the surgeon and in the other group, the simulated patient complained of pain, requiring the surgeon to administer more local anaesthetic⁴. Sujka et al.²² studied 12 residents each performing six laparoscopic cholecystectomies, three with pager distractions based on clinical questions regarding ward patients and three with no distraction. The order these were performed was randomised²².

Similarly, Murji et al.¹⁹ used pager distractions and asked questions regarding a pre-read handover sheet. Thirty residents performed laparoscopic salpingectomies either distracted or undistracted, in randomised order¹⁹. Yang et al.¹⁰ used mild and strong phone call distractions involving clinical questions. Thirty medical students were distracted mildly, strongly or not at all, while they performed an easy and difficult laparoscopic task¹⁰. Sirihorachai et al.⁶ applied seven distractions at critical times, including the first and final counts, and team time out to 30 nurses. Distractions included CIC, pager, music, extra equipment and dropping of an instrument.

In contrast, Gao et al.² applied arithmetic questions to 24 medical students. The students answered without operating, and performed a laparoscopic appendicectomy with the arithmetic and without; the order was randomised². The authors believe arithmetic is a cognitive task and therefore appropriate to use as a secondary task. However, Murji et al.¹⁹ disagree, stating arithmetic is not

a meaningful or realistic secondary task.

Impacts of distractions and interruptions

Mental workload

Three studies measured the outcome of mental workload using different tools, adding further to the heterogeneity^{2,4,10}. Weigl et al.⁴ used the SURG-TLX and determined surgeons' perceived workload was statistically significantly higher when distracted than when not distracted ($p < 0.01$). The subjects also experienced increased physical demands and situational stress⁴. Interestingly, mental workload was statistically significant when associated with surgical inaccuracy ($p = 0.04$)⁴. However, this tool is subjective, only measures workload post-operatively and was only used on junior surgeons⁴. Similarly, Gao et al.² used the National Aeronautics and Space Administration (NASA) task load index (NASA-TLX), which the SURG-TLX is adapted from⁸. The authors also used an objective measure to track pupil size and blink rate which represent cognitive load². When performing the dual-task of answering arithmetic questions and operating, mental workload and eye measurements of medical students were higher than those measured during the single task of operating². It is unclear why the SURG-TLX was not used as it is specific to surgery; in addition, the use of arithmetic is questionable^{8,19}.

Yang et al.¹⁰ did not report on their tool; it is assumed subjects rated their distraction levels post-operatively. Subjects reported being more affected when a strong distraction was applied ($p < 0.05$)¹⁰. No return rate or validity information was reported and only medical students were studied¹⁰. As in the observational studies, it is apparent

that when distracted or interrupted novice surgeons experience a higher mental workload than when they are not.

Surgical performance

Surgical performance was measured on simulators; each study used different outcomes including inaccuracy, time to complete, safety, complications, blood loss and specific surgical markers^{2,4,10,19,22}. As discussed, Weigl et al.⁴ found a statistically significant correlation between increased mental workload and inaccuracy ($p = 0.04$). Similarly, Yang et al.'s¹⁰ results showed when performing an easy and hard task while distracted, accuracy decreased. Gao et al.² found several surgical performance factors were diminished when subjects were distracted. The time taken to complete the task was not affected by distraction in three studies^{4,10,22}; however, it was prolonged in two studies^{2,19}. No difference was determined in blood loss, complications or safety between distracted and non-distracted surgery^{19,22}. Studies demonstrated surgical performance is diminished and more inaccuracies occur when novice surgeons are distracted or interrupted^{2,4,10,19,22}. However, the studies have small, selective samples and do not include experienced surgeons^{2,4,10,19,22}.

Clinical decision-making

Three studies measured clinical decision-making as an outcome, two with pager distractions and one with phone calls^{10,19,22}. These clinical decisions regarded invented ward patients – in ORs, surgeons operate (primary task) while answering clinical questions regarding other patients (secondary task)^{10,19,22}. Sujka et al.²² established that, when distracted, surgical residents correctly resolved clinical issues only 25 per cent of the time.

This may be due to the residents focusing on the surgical task, rather than the secondary task, as they were blinded to the purpose of the study²². Likewise, 63 per cent of residents in a powered sample made a minimum of one unsafe clinical decision when distracted with questions; the mean for correct answers was 80 per cent¹⁹. Similarly, medical students made more errors when answering questions from two phone calls in the final study¹⁰. This raises the question about patient safety and care of ward patients managed by surgeons while they are operating^{10,19,22}. However, these studies did not evaluate the effect on experienced surgeons^{10,19,22}.

Nurses

In the simulation laboratory, nurses were distracted while performing first and final counts and team time out⁶. Measures included whether the nurses ignored the distraction, were interrupted by it, or multitasked and performed both the primary and secondary task⁶. Interestingly, all the more experienced nurses (greater than two years) performed team time out with the radio on despite it breaching policy while all the junior nurses turned it off⁶. Over half of the nurses were interrupted by CIC and pager distractions during the first count⁶. Multitasking only occurred during the first count; ten per cent of nurses engaged in CIC while counting⁶. A third of nurses were interrupted by a pager during team time out and 57 per cent at the final count⁶. This is concerning as these three tasks are critical to ensure patient safety⁶. That said the 30 nurses came from a single centre, making generalisability difficult and selection bias possible⁶. Debriefing sessions and qualitative analysis revealed the nurses used cognitive processes of prioritisation and remaining focused on the

primary task when confronted with distractions⁵.

Implications for perioperative nursing practice or research

This review has highlighted reducing distractions and interruptions is essential to enhance patient safety and productivity; maintain safe and effective care, performance, workload and communication; and decrease and mitigate the potential risk to the OR team^{1,3,8,11}. Multidisciplinary collaboration and system-level strategies are required^{1,3}. Improvements in multidisciplinary communication, information transfer, organisation and collaboration are essential for smooth surgical flow^{1,6,8,9}. Distractions and interruptions are usually an indication of system issues which are often upstream from the OR and lead to a lack of coordination between the OR and other departments; therefore, thorough system analyses and improvements are required^{5,9,20}.

Education and training are the initial approaches for resolving system and multidisciplinary coordination issues^{6,7,9}. Multidisciplinary education should create an awareness of the different types of distractions and interruptions which occur in the OR and focus on the potential severity and impact of each⁶. Each profession is impacted differently by individual types and a clear understanding of this from the entire OR team will assist in minimising them⁶⁻⁹. Education may include simulations to further enhance awareness between professions and assist in developing effective strategies^{6,9}. Nurses should be taught how to prioritise and stay focused on primary tasks, especially during critical phases⁵.

Nurses can influence policy and conduct ongoing quality

improvement projects in their own ORs to minimise distractions and interruptions^{5,6}. Quality improvement projects should include observing staff over time to assess frequency and severity of distractions and interruptions⁵. Feedback should be provided to the OR team, followed by discussion to identify effective actions and strategies⁵. Reassessment should occur post implementation⁵. Nursing professional bodies should develop standards and guidelines for minimising distractions and interruptions in ORs⁶.

Several effective strategies have been implemented in numerous ORs^{3,5,8,11}. The sterile cockpit is an aviation concept successfully adapted to the OR environment^{3,5,8}. This involves eliminating non-essential communication during critical phases of a procedure in order to enhance patient safety and reduce effects on the OR team^{5,8}. Preoperative briefings enable effective planning and organisation, reducing unnecessary distractions and interruptions^{5,7,11}.

Further research is essential to fully understand the phenomenon of distractions and interruptions in the OR. Research determining the cumulative effects of avoidable distractions and interruptions on the OR team is required^{1,4,9}. Additional suggestions for research include complex and emergency surgery, OR team familiarity, individuals' stress management strategies and ascertaining the ideal work process design^{5,8,9}. Robust research is necessary to clearly determine which distractions and interruptions have the largest impact on mental workload and lead to adverse patient outcomes and unsafe practice^{1,4,8}. Researching CIC to clearly delineate between positive and negative CIC is vital^{1,8}. Robust studies involving experienced professionals would resolve the paucity in the literature^{3,4,10,19}. It is suggested

that greater experience enables a member of the OR team to develop compensatory measures, resilience and strategies which increase their immunity to the impact of distractions and interruptions^{3,4,10,19}.

Limitations

This review has several limitations. Despite a thorough and systematic search, some papers may have unintentionally been omitted. Papers not written in English were excluded but may have included important research. No qualitative studies were found, yet such research would have enhanced a holistic review of the phenomenon. The quality of the included studies was assessed by one individual and despite using two validated tools (MMAT and CASP), subjectivity was not able to be controlled. Paucity in the recent literature of nursing and anaesthetic studies, particularly in the simulation studies, directed the review to a stronger focus on surgeons and surgical technique. However, this remains vital when discussing the impact on the entire OR team. Overall the heterogeneity of the literature limited consensus regarding which distractions and interruptions have the largest impact on each profession and patient safety.

Conclusion

This integrative review has provided a thorough overview of the recent literature on distractions and interruptions in the OR. It is of concern these studies confirm a distraction or interruption occurs on average every six minutes. It is evident that patients and the OR team are impacted significantly, yet through system analyses, education, planning, research and local quality improvement projects many of these impacts can be avoided. Nurses are central to improving and creating positive change in the perioperative

environment. With guidance from professional OR nursing bodies, nurses can develop and implement standards and local policies to reduce the frequency, severity and impact of distractions and interruptions upon their patients, colleagues and OR teams.

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