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Will robots make good perioperative nurses?

New technology is always being introduced into health care and nursing as a profession has had to adapt. Technological advances have changed the practice of nursing from the introduction of the stethoscope to the electronic health record, and now robots and artificial intelligence (AI). With technological advancements occurring at an ever-increasing rate, more and more perioperative tasks will be delegated to robots and AI. The main question for perioperative nurses is, how can we remain relevant in the high-tech operating room of the future?

Perioperative nursing has always been at the forefront of technological change in health care. It is now commonplace during surgery to use advanced technologies such as lasers, stereotactic guidance, advanced imaging and 3D printing, to name a few. These technologies have been tools to aid or augment the skills of the perioperative team but many of the technologies of the future will be autonomous with the potential to complete tasks independently. The introduction of this type of technology into the perioperative environment will require restructuring of roles and new models of care. It is important that perioperative nurses play an active role in deciding these new ways of working and how they are implemented.

A report by the McKinsey Global Institute[1] estimates that 800 million workers worldwide could be replaced by robots by the year 2030. There is already a robotic revolution happening in health care but currently these robots are limited to assistant roles making tasks and procedures more efficient and safer. A typical example is the transportation robots that are frequently seen delivering equipment and supplies around modern health facilities. There are even some well-publicised, albeit inappropriately named, 'robot nurses' but to date these machines are primarily limited to assisting with manual handling.

The use of robots to assist and augment practice is not new to perioperative nurses. Robotic-assisted surgery has been with us for almost two decades. Instruments such as the Da Vinci system allow surgeons to take control of multiple robotic arms through a hand-operated console which gives them much greater dexterity and vision when operating in hard-to-reach areas. These devices are operated by remote control with no automation or intelligence to make decisions. Because of this, some people have even argued that they are not, in fact, robots but are better classified as mere machines[2].

Autonomous surgical robots, like autonomous systems in many other industries, are currently being researched and are in various stages of development. At present, the functionality of surgical robots is limited to specific tasks such as suturing or biopsies. The purported advantage of these robots is they are not affected by human-related problems such as fatigue or momentary lapses of attention. Thus, they can perform repeated and tedious operations with a high degree of safety and efficiency.

Researchers hope that widespread adoption of surgical robots will make specialised surgical procedures safer and more readily available to people worldwide.

The Smart Tissue Autonomous Robot (STAR)[3] is one of the most advanced and most widely publicised systems. It uses 3D and infrared imaging along with pressure sensors to perform an intestinal anastomosis which is said to tolerate twice the pressure of one performed manually. It may seem counterintuitive but this awkward and intricate work is perfectly suited to robots who have unlimited patience and a potentially unlimited number of digits.

Another form of autonomous surgical robot currently in development are micro-robots that can operate intravascularly. Initial animal experiments are focused on cardiac valvular repair where the device is inserted into the vena cava and propels itself to the damaged valve guided by vision and touch sensors. It then wedges into position near the leaking valve where it launches an occluder to plug the leak. Advancement in micro-robotics is said to be the precursor to nano-robots that have the capability of operating at the cellular level.

The difference between current surgical robots like the Da Vinci system and the autonomous robots of the future is the addition of artificial intelligence (AI). The AI is produced by algorithms that give these machines the ability to reason and perform cognitive functions such as problem solving, object and word recognition and decision-making[4]. The influence of AI in surgery is not limited to surgical robots. AI is already being integrated into monitoring, diagnostic and therapeutic devices that can adjust alarm parameters, interpret data and titrate therapies. Currently, AI augments human decision-making but as machines demonstrate their superiority to humans, these actions will become autonomous.

The title of this paper is somewhat facetious. It is very unlikely that robots will replace nurses or surgeons any time soon, but they will become commonplace in perioperative settings. It is most likely that this technology will be introduced gradually, like cruise control and lane-keeping systems have made their way into cars ahead of full self-driving capabilities. Just like the motor vehicle industry, we need to be considering the practical, ethical, and legal implications of working with technology that is autonomous and makes its own decisions. Planning for this should be happening now as the technology is being developed and it must include nurses and other members of the perioperative team.

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COVID-19 and perioperative nursing – inside the NSW State Emergency Operation Centre

For Australia-wide advice and information on the COVID-19 pandemic please see www.australia.gov.au. Links to state and territory information and advice for health professionals are also accessible from this page.

When I was asked to write this editorial, I felt honoured. When I sat down to write it, however, I felt terrified, underqualified and not sure if I was up to the task. As I stopped to reflect, I also realised this is also how I felt when I first walked into the New South Wales (NSW) State Emergency Operation Centre (SHEOC) as a surgery liaison for the COVID-19 response in Sydney.

Like most people, I had only seen the inside of this centre in news broadcasts on bushfires, as this centre is home to the Rural Fire Service and the place from which bushfire response in NSW is led. Being there in person, it felt like I was at the NASA control centre – I was faced with a huge wall of TV screens with world maps, numerous TV channels and COVID-19 figures from across the world and domestically all on display. I saw the NSW Health Minister talking to Premier Berejiklian as I tried to orient myself and listen to what I was expected to do.

At this point, in early March, there had been no alteration to elective surgery in either the public or the private sector but the expectation of increased pressure on ward and ICU beds made it clear that a decision would need to be made. I worked with a colleague, clinical groups and elective surgery managers on what this could look like. We developed guidance for booking officers and ways of identifying patients affected by the pandemic so that in recovery we had a clear picture of what was needed. We spoke on teleconferences, took questions and sought clinical feedback about the way forward to balance the possible bed demands of COVID-19 and essential and urgent surgery. When the federal and NSW governments made the decision to put category 3 elective surgery such as total hip replacements and cataract surgery on hold, our focus moved to communication and consultation with both the public and private sector on case mix, availability of personal protective equipment (PPE) and workforce issues.

As perioperative nurses, we advocate for people when they are at their most alone and vulnerable and we're used to bringing the technical and the personal together[1,2]. We are also used to the dynamics of our work changing in a phone call and to facing challenging situations as a daily occurrence. When I was in the duty officer role at the SHEOC, I found myself seeking advice on everything from clinical waste for hotels being used to quarantine passengers returning from overseas through to reassuring a heavily pregnant woman that she would be allowed to have her partner in the birthing suite despite what she had read in the newspaper. Without a retractor in sight, I was part of the health team that has peeled back the layers of data, opinion and research to steer through issues from the many phone calls that are received.

Although the COVID-19 response is still underway, I have reflected on how I have applied my perioperative nursing skills in this unusual environment and would like to share these thoughts with you.

We are all in this together – even at 1.5 metres apart

The sterile field may now be 1.5 metres rather than 12 inches[3] but this is still teamwork. Just as behind the double doors of the perioperative suite, each person in the SHEOC is interdependent on the rest of the team to ensure the best possible outcome for a patient and the community. Working as part of the COVID-19 response team, the support and trust the team has in each other, regardless of substantive positions, is phenomenal.

Small acts of kindness aren't that small

I arrived on Easter Monday ahead of a 10-hour duty officer shift to find a paper bag filled with chocolates with a handwritten thank you note. Small acts can have big effects. As a perioperative nurse we do this every day, from simple things like bringing a patient an extra blanket to a reassuring squeeze of the hand telling the patient that everything will be OK.

The role of the patient has never been more central

The way the community has embraced staying home except for

essential activities, along with social distancing, washing hands and coughing into elbows, has meant that this has become the new norm in an incredibly short time. In reality, what the community is doing is making as much difference in addressing the pandemic as what we are doing. Empowering our patients in elective surgery through encouraging patient education and prehabilitation programs has a significant impact on patient outcomes[4]. If we can do this for COVID-19 why not for other wicked health problems we face?

I'd like to finish with a message of hope. It has been a privilege to work with such talented and dedicated health and emergency workers during this time. However, COVID-19 isn't the only wicked problem that health and society faces. I hope our efforts are also as unified and innovative in addressing the seven per cent of carbon emissions that are produced by the health sector each year and the up to 70 per cent of waste in health care facilities that is produced by operating theatres[5,6].

Stay safe.

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Pandemics: A COVID-19 perspective

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The world is currently gripped by a pandemic, a term that is on everyone's lips. However, six months ago, many would have found it difficult to define the terms pandemic, epidemic and outbreak, or explain the difference.

The emergence of a novel coronavirus, commonly referred to as COVID-19 has significantly changed our awareness. It has heightened our anxiety, like a primordial fear, leaving us feeling vulnerable, similar to how past generations reacted to pandemics.

Historically, epidemics and pandemics were often considered a calamity inflicted by God. The plagues of medieval Europe, principally caused by bacteria (*Yersinia pestis*) carried on rats, resulted in high mortality, principally because populations had no immunity to the disease[1]. At that time, there was no recognition of microorganisms. The microscope was still to be invented and disease was often interpreted as punishment for wrongdoing, as suggested by the term pathogen, 'patho' being derived from Greek and meaning to suffer.

The pandemic that most closely equates with our current experience was the 1918–1919 Spanish flu pandemic. It was estimated to have infected approximately one third of the world's population, being about 500 million people[2]. The number of people infected by COVID-19 is approaching 5 million[3]. The approach to managing the pandemic that was applied at that time included good personal hygiene, isolation and quarantine, cleaning with disinfectants and limiting public gatherings[2].

More recent approaches to pandemic planning have been informed by the 'bird flu' (H5N1) experience. They recognise the financial impact of a pandemic as well as the social impact[4]. However, a review of Australian influenza pandemic plans conducted in 2018 identified considerable differences between the plan in different states, making it more difficult for hospitals, clinicians and other government agencies to implement them[4].

What we have learned from the past we must remember, even though our understanding of virology has improved in recent times. We have a much better understanding of transmission of infection, using evidence-based guidelines to support our decision making; however, there is still much to learn.

Firstly though, how do we define the terms pandemic, epidemic, outbreak and cluster? They are all important epidemiological terms and understanding them and what is different between them helps us to make decisions. A cluster refers to a group of cases, usually connected by place and time[5]. The number of cases is greater than normal, but there is usually a clear pattern of contact that established the cluster. An example of this is the cluster of cases of COVID-19 identified at a fast food chain in Victoria. The terms outbreak and epidemic have the same meaning, though outbreak is often considered to be limited to one geographical area while epidemic may involve a larger number of geographical areas. In both cases, there is an increase in the number of cases exceeding what would be expected in the normal health of the population[5].

The term pandemic refers to an epidemic that occurs over a very wide area, such as continents and crossing international boundaries. Large numbers of people are infected[6], as has been seen with the COVID-19 pandemic. It has been argued that a key feature of a pandemic is the almost simultaneous spread of the infection[7], as was noted in an earlier pandemic of influenza A virus (subtype H1N1).

There are a number of characteristics that influence the potential for a pandemic. Firstly, the microorganism has to be pathogenic, that is, be able to infect and cause disease in humans. Secondly, it needs to be able to easily spread between humans[6], like COVID-19, which is spread by large droplets, fomite and aerosol transmission from airways and through contaminate surfaces as contact transmission[8]. Other considerations include the characteristics and virulence of the pathogen, such as its ability to establish and replicate itself[9] and the level of immunity of the population. COVID-19, while part of the coronavirus family, emerged as a new pathogen therefore the population did not have immunity to it. As well, seasonal patterns of infection, such as winter in the northern hemisphere almost certainly contributed to the susceptibility of the population, increasing exposure due to indoor living in winter conditions and transmission in close confines by

inhalation of droplets or touching contaminated surfaces.

Viruses are different to other microorganisms. They exist as a 'virion' particle and cannot replicate outside a living cell[9]. However, once a cell is infected with a virus particle, it will replicate causing infection. Virused are either structured with a membrane, and referred to as enveloped, or structured without a membrane, and referred to as non-enveloped or naked[9]. COVID-19 is an enveloped virus[10]. This is a small piece of good news in an otherwise challenging pandemic, as enveloped viruses are more easily killed by a range of disinfectants, including '≥70 per cent alcohol, quaternary ammonium compounds … or diluted household bleach'[11]. This is an important consideration in perioperative nursing, as decontamination and cleaning of surfaces is an essential element. Early evidence from epicentres of COVID-19 infection have demonstrated that some people remain asymptomatic yet appear to be able to transmit the infection. The response should be sustained decontamination of equipment and environmental cleaning, regardless of COVID-19 infection status. Another risk associated with perioperative care and COVID-19 is aerosol, resulting from ventilation and suction[8]. Good use of personal protective equipment, including correctly fitted P2/N95 masks, along with effective environmental cleaning of surfaces will minimise risk.

Perhaps the greatest risk that we face is complacency. As a nation, we have been avant-garde with implementing social distancing and restrictions to human movement into and within our nation. To date, we have done exceedingly well, with only our 100th death reported in the media recently. As health professionals, others look to us for leadership. If we are going to continue to keep the COVID-19 pandemic beyond our borders, we must role model good social distancing behaviours and encourage our family and friends to do the same. We need to be patient and encourage others to continue to abide by restrictions enacted for the greater good of the community. Whatever our health professional role is we can, and do, make a difference … Let's keep it up.

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A daily measure of job satisfaction in the operating room – investigating its value and viability

Abstract

Objectives: This study aims to explore the value, validity and viability of implementing a daily job satisfaction tool in the operating room (OR) setting.

Sample and setting: A daily one-minute survey was developed and trialled with 269 OR staff members (123 nurses) over a three-week period in one New Zealand hospital.

Method: A feedback and validation survey was then administered to staff one week following the trial.

Results: The trial resulted in 569 tool submissions. A daily average of 71 per cent of participants (69% nurses) reported feeling 'pretty good' or 'great' about their jobs, with 'relationships and communication with colleagues' most influential for both a positive and negative day at work. Findings also supported the validity of the tool and highlighted strengths and areas for improvement.

Conclusion: The results of the study provide initial support for the value and feasibility of implementing a daily job satisfaction measurement tool in the OR setting. A daily satisfaction measure has the potential to be a powerful tool for perioperative nursing managers at all levels enabling active measurement and management of nurse job satisfaction from an interprofessional perspective.

Introduction

The association between job satisfaction and burnout, organisational commitment, safety attitudes, the provision of sub-optimal care and reduced patient satisfaction has been repeatedly demonstrated for health care employees[1–8]. Clear correlations between job satisfaction and staff turnover, absenteeism and intention to leave are also well recognised[8,9]. Such findings are very relevant at a time when there is increased concern about retention of both nurses and physicians[10]. Consequently, awareness of how staff are feeling about their jobs is a key priority for operating room (OR) managers.

Common performance measures in the OR relate to surgical volumes, theatre utilisation, durations, turnover and financial incoming and outgoings[11]. Over recent years, an increased focus on decreasing burnout has resulted in greater emphasis on improving staff satisfaction in the OR[4,12]. The subjective nature of job satisfaction, however, makes it difficult to quantifiably and validly measure. Large multi-facet survey methods, traditionally used in the health care setting, often incur low response rates and a high risk of sampling bias. In addition, surveys tend to be conducted infrequently, resulting in outdated information being used by management[13,14].

While more frequent measurement is increasing in popularity in the business sector[15,16], few studies to date appear to have explored real-time measures in the hospital setting with only two hospital studies, that we are aware of, trialling similar tools with hospital employees. Hinsley et al.[17] conducted a study in a cardiac catheterisation lab and cardiovascular operating room of one hospital in the United States of America that had a workforce of 51 employees. This study developed and trialled a daily survey which aimed to provide a user-friendly platform to communicate perceptions of the health of the work environment. The survey was offered in both paper and digital form and employees could choose if they wanted to remain anonymous. Similarly, Frampton et al.[18] conducted a study across 23 different hospital specialty areas in a tertiary teaching hospital in the United Kingdom. They developed and trialled a daily anonymous survey accessed via iPad at multiple kiosks around the hospital. This tool aimed to measure the 'mood' of staff and also provided a broad platform for positive and negative issues to be discussed. These studies will be discussed later in the paper.

Measuring job satisfaction

While job satisfaction can be defined and interpreted in various ways, it is most commonly defined as the extent to which an individual likes or dislikes their job[19]. Many researchers agree that job satisfaction is made up of a combination of dispositional (relating to personality), cognitive (relating to beliefs) and affective (relating to emotions) components[20]. To date, there is no gold standard as to how job satisfaction should be measured. While there are a number of well-established multifacet questionnaires, the use of single-item measures to evaluate global job satisfaction has also been supported by numerous well-recognised studies[21–23].

Objectives

The objectives of this study were:

1. to develop and trial a daily job satisfaction measurement tool specifically for the OR setting
2. to explore issues relating to the implementation of the tool, with a focus on utilisation, practicality and acceptability
3. to test the tool's convergent validity between daily job satisfaction and overall job satisfaction, and predictive validity of daily job satisfaction with affective commitment (a key component of organisational commitment) and emotional exhaustion (a key component of burnout).

This paper includes the main findings of the study with a particular focus on the OR nurses.

Method

This study was initiated by senior management in a New Zealand OR setting and was conducted within one New Zealand hospital's operating room department. A multimethod design was adopted, comprising three phases – a development phase, a trial phase and an evaluation phase.

The development phase

A single-item job satisfaction measurement tool (the 'morale-o-meter') was developed in collaboration with senior management personnel from the OR department at the hospital and with guidance from current literature, an organisational psychologist and a Māori cultural advisor from the hospital (appropriate for the New Zealand context). Once an initial digital version of the tool was developed a short pre-test was conducted within two operating theatres for one day. Participants were invited to test the tool (via iPad) while the first author was present to observe their entries and gather written or verbal feedback relating to their experience of using the tool. Sixteen entries were received leading to numerous modifications of the tool. These changes related to ease of use, comprehensibility and wording as well as technical and reporting requirements.

The morale-o-meter survey was based on a previously validated single-item global measure of job satisfaction used by Dolbier et al.[22] and Warr, Cook and Wall[24]. It asked 'Overall, how are you feeling about your job today?' The traditional Likert response scale was modified into more casual language, to support 'buy in' from staff, while maintaining an anchored five-point Likert scale[25]. In order to provide meaningful information for managers to understand the reasons behind the responses, the survey then asked employees 'What does this mostly relate to?'. The options for this were derived from the existing literature[26,27]. The survey asked for job role and specialty, and for participants to create a username which they would put in on every use. A guide was provided to prevent people from forgetting their usernames and to ensure anonymity[28]. The morale-o-meter took approximately one minute to complete. See Figure 1 for an outline of the morale-o-meter tool.

The trial phase

A three-week trial of the morale-o-meter tool was conducted from the 27 May 2019 to 14 June 2019. All employees working in the OR were invited to participate. Seventeen iPads were placed in desk stands

Question	Prompt
Username	The day of the month of your birthday combined with the first three letters of your mother's name (e.g. 03Jen).
Time of shift	• beginning • middle • end
Job site	*(Options were provided but are not identified here to preserve participant anonymity.)*
Overall, how are you feeling about your job today?	1. 'Great, I love my job today!' 2. 'Pretty good really' 3. 'Neutral, ho hum…' 4. 'Not great, actually' 5. 'Awful, get me out of here!'
What does this mostly relate to?	1. the nature of the clinical work 2. communication and relationships with colleagues 3. organisational factors (e.g. staffing, workload, resources) 4. patient interactions 5. ethnic or cultural wellbeing 6. other (with open text option) 7. I'd rather not say
Job role	• anaesthetist • anaesthetist registrar / fellow • anaesthetic technician • anaesthetic technician trainee • health care assistant • nurse • orderly • senior nurse • surgeon • surgical registrar / fellow • other • I'd rather not say
Speciality	• general surgery • gynaecology • obstetrics • ORL • orthopaedics • urology • other • not applicable • I'd rather not say

Figure 1: Overview of the morale-o-meter tool

across fourteen operating theatres, two tearooms and an anaesthetic technician room. A cell phone option was also made available. The iPad stand displayed instructions asking staff to use the tool once each shift. Recruitment was done via a number of methods: a bulk email invitation was sent to all staff, posters were put up requesting staff participation, and the first author presented at a range of staff meetings to provide more details about the project.

The evaluation phase

One week after the completion of the trial, a link to an anonymous online survey developed by the researchers was emailed to all staff. The feedback and validation survey asked respondents for their morale-o-meter username and demographics (gender, age and ethnicity). It used single-items where possible to encourage completion. It included the following multichoice questions:

- What do you think about having a tool like this in place permanently?
- What device did you prefer to use during the trial?
- What were the barriers to using the tool every shift?

The survey also included an open text section for feedback, comments or suggestions.

The validation question for overall job satisfaction was a well-known single-item global satisfaction question originating from Scarpello and Campbell[29]: 'All things considered, how satisfied are you in your job?' using a 1 (very satisfied) to 5 (very dissatisfied) response scale.

Affective commitment was measured using a single item selected from the subscale of the organisational commitment scale[30]: 'I would be happy to spend the rest of my career with this organisation'. Emotional exhaustion was measured using three items derived from the Maslach Burnout Inventory[31]: 'I feel used up at the end of the workday', 'I feel emotionally drained from my work' and 'I feel burned out from my work.' The response scales for affective commitment and emotional exhaustion were rated from 1 (strongly agree) to 5 (strongly disagree). Internal consistency reliability of emotional exhaustion was 0.80.

Data analysis

Data analyses, including descriptive statistics and pairwise correlations, were completed using SPSS and R statistical software, while multi-level modelling was conducted with Mplus 7.0[32]. Multi-level modelling was considered appropriate for the data analysis due to the non-

Table 1: Tool participant job roles

Job role	Number of participants	Percentage
Nurses	123 (20 senior nurses)	45.7
Anaesthetic technicians	41	15.2
Anaesthetists	19	7.1
Surgeons	18	6.7
Surgical registrars / fellows	18	6.7
I'd rather not say	18	6.7
Anaesthetist registrar / fellow	12	4.5
Orderlies	7	2.6
Other	7	2.6
Anaesthetic technician trainee	2	0.7
Health care assistants (HCAs)	4	1.5
Total	**269**	**100**

Table 2: Tool submissions by specialty

Speciality	Number of responses	Percentage
General surgery	251	44
Orthopaedics	147	26
Gynaecology	48	8
Otorhinolaryngology	27	5
Urology	23	4
Obstetrics	19	3
Not applicable	38	7
I'd rather not say	16	3
Total responses	**569**	**100**

independence in the daily-level data where the daily job satisfaction (level 1) responses were nested within individuals (level 2)[33].

Results

Tool utilisation

A total of 269 staff members used the tool over the trial period (78% response rate) and 569 submissions were received. Employees from a wide range of job roles and specialities participated in the trial, with the largest group being nurses (45.7%; see Tables 1 and 2). The daily utilisation response rate was approximately 21 per cent ranging from four to 55 entries per day (including weekends and one public holiday). Individual tool utilisation per participant ranged from one to 14 entries (62% used the tool once, 23% used the tool two or three times and 15% used the tool four or more times). Of the total 569 entries, 39 per cent were completed in the middle of the shift, 32 per cent at the end and 29 per cent at the beginning of their shift. No significant relationship was found between the time of the shift when the tool was completed and the level of job satisfaction. For example, participants were not more likely to report a more positive or negative response at the beginning than at the end of their shift.

Tool results

The job satisfaction response scale was converted to a numerical five-point scale for analysis, i.e. 'Great, I love my job today!' = 1, to 'Awful, get me out of here' = 5. On average, 71 per cent (range 52–79%) of total participants reported a 1 or 2 each day (see Figure 2 for daily breakdown). The mean daily satisfaction score was 2.3 (average daily median 2, range 2–2.8). Specific job roles or department specialties did not make a difference in job satisfaction when comparing job satisfaction mean scores. However, we found that participants who chose the option of 'I'd rather not say' for their job role and speciality were more likely to have a lower mean score of job satisfaction compared to the rest of the participants (see Figure 3). A total of 127 nurses and health care assistants participated in the trial, with a daily average of 69 per cent who reported a job satisfaction score of 1 or 2 on an average workday. There was no

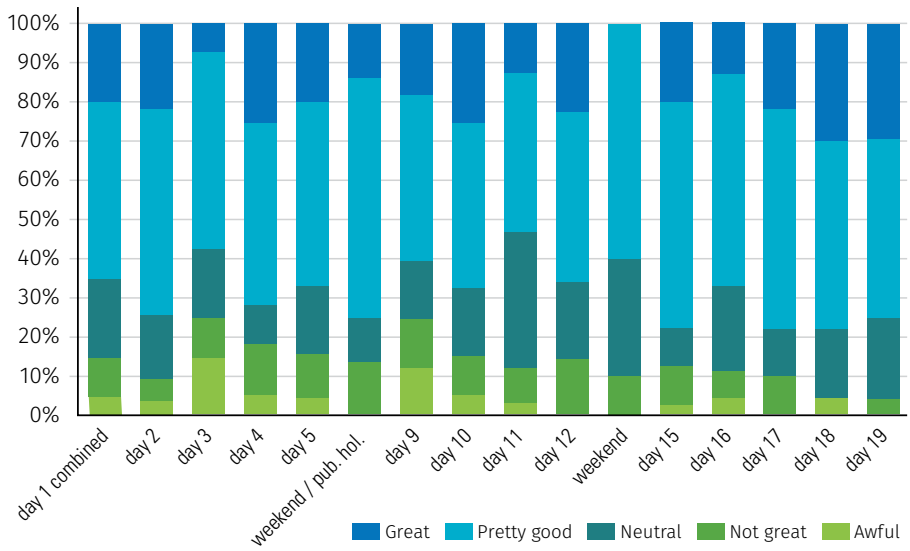

Figure 2: Daily morale-o-meter trial results

Note: 'day 1 combined' is the combination of results from 27 May and includes two additional early submissions from the day before. Entries have been combined on weekends (including the public holiday) due to reduced staffing.

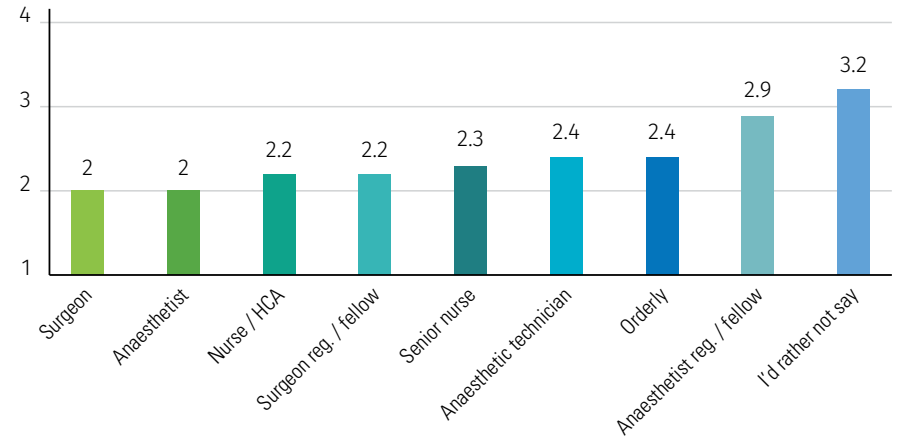

Figure 3: Job satisfaction averages by job role over trial period

Note: mean score scale: 1 = great, 2 = pretty good, 3 = neutral, 4 = not great, 5 = awful

significant difference in overall job satisfaction found between overall mean scores of those who identified as a senior nurse or nurse (2.2 and 2.3, respectively).

Analyses of factors that influenced job satisfaction responses found that positive responses (i.e. 1 or 2) were most commonly influenced by 'relationships and communication with colleagues' (34% and 39%), closely followed by 'the nature of the clinical work' (29% and 28%). Negative responses (i.e. 4 or 5) were most frequently influenced by 'organisational factors' (33% and 33%), very closely followed by 'relationships and communication with colleagues' (33% and 29%). Results for OR nurses followed a similar trend, with 'relationships and communication with colleagues' chosen most frequently as the reasons for both a negative or positive day at work (see Table 3).

Staff feedback

The feedback survey was completed by 38 trial participants (14% response rate). Job roles comprised 47 per cent nurses, 13 per cent anaesthetic technicians, 11 per cent anaesthetists, 8 per cent orderlies and 3 per cent surgeons, with 18 per cent not identified. Sixty-one per cent of respondents reported that they thought it was either a 'good' or 'very good' idea to permanently implement a tool such as this, 34 per cent were 'not sure' and 5 per cent thought that it was a 'bad idea'; no respondents reported that it was a 'very bad' idea. The operating theatre was most commonly identified as the preferred location for the iPads (54%), followed by the tearoom (31%), anaesthetic technician room (11%) and cell phone (4%). The most commonly reported barriers to using the tool were 'forgetting to use the tool' (36%) and 'being too busy' (31%), followed by 'being too tired' (13%) and 'the iPads not working properly' (11%). Two per cent said they didn't feel comfortable answering the question and 18 per cent reported that they found no barriers to using the tool.

Four themes were identified from the qualitative comments on the survey:

1. positive feelings about the tool (e.g. 'It was good. Very easy and quick to fill in.')
2. questioning the tool's accuracy (e.g. 'I saw people fill it in when they were cheesed off about something but not when they were happy.')
3. concern about how the results from the tool would lead to actual change (e.g. 'Not sure if it's actually going to improve morale or make anything happen but if it gives it a chance to improve, I will do it.')
4. preference for the tool being available for short periods (e.g. 'I'd be more inclined to make an effort for a short period of time').

Table 3: Factors influencing job satisfaction responses for OR nurses

Response option (n = no. of nurse responses)	clinical work	relationships and communication with colleagues	organisational factors	patient interactions	ethnic / cultural wellbeing	I'd rather not say	other
Great (n = 67)	27% f = 46	33% f = 58	17% f = 30	14% f = 25	4% f = 7	2% f = 3	3% f = 5
Pretty good (n = 166)	28% f = 94	38% f = 127	20% f = 66	8% f = 27	2% f = 7	1% f = 2	3% f = 11
Neutral (n = 62)	23% f = 21	19% f = 18	35% f = 32	2% f = 2	2% f = 2	8% f = 7	11% f = 10
Not great (n = 33)	10% f = 4	37% f = 15	30% f = 12	f = 0	f = 0	8% f = 3	15% f = 6
Awful (n = 9)	8% f = 1	50% f = 6	34% f = 4	f = 0	f = 0	f = 0	8% f = 1

*Note. n = number of responses from OR nurses over the three-week period.

f = frequency of selection over the three-week period (participants could make multiple selections). For example, 'n = 67' under 'great' indicates that 'great' was chosen 67 times by participants; 'f = 46' under 'nature of the clinical work' indicates that this option was chosen 46 times during the trial when participants chose 'great'.

Tool validity

Matching the daily survey and the validation survey via participant-created username led to a final sample of 31 participants being included in the validity analyses. The mean number of entries per participant in the validation survey was 4.3 (median 3, range 1–14). A significant relationship was found between daily job satisfaction and overall job satisfaction (γ = 0.78, SE = 0.16, p < 0.01) as well as a significant relationship between daily-level job satisfaction with emotional exhaustion (γ = -0.51, SE = 0.2, p < 0.01) and affective commitment (γ = 0.77, SE = 0.11, p < 0.01), demonstrating the convergent and predictive validity of the single-item job satisfaction measure in this study.

Discussion

This study explored a number of factors relating to the value, validity and viability of implementing a daily job satisfaction measurement tool within the OR setting. The overall results from the trial were positive: staff from a wide range of job roles participated in the trial, with nurses making up the largest group. The majority of staff that completed the feedback survey indicated that they thought the tool was a good idea. Aspects of the tool, for example the short length of time required to complete and flexibility in when and where it could be used, appeared to support staff engagement. Many survey respondents identified having the iPads in the theatres as their preferred location. Given that different staff members have varying periods of downtime within the OR, having the iPads in the theatres allowed them to complete the tool during work hours.

The findings also provide initial support for the convergent validity of daily job satisfaction with overall satisfaction, and the predictive validity of daily job satisfaction with both affective commitment and emotional exhaustion (key components of organisational commitment and burnout). The significant relationship between daily job satisfaction and overall job satisfaction provides some reassurance that the tool is indeed measuring what it was intended to measure despite being modified for our purpose, suggesting that the average of daily results can be interpreted as an overall satisfaction score. One of the few studies that has explored this relationship previously was conducted by Ilies and Judge[34] within an administrative setting. They used ecological

momentary assessment methods three times per day for two weeks (n = 33) and similarly found a significant result demonstrating convergent validity between daily job satisfaction and overall satisfaction outcomes. Our significant predictive validity findings are consistent with a recent Canadian study conducted by Lee, MacPhee and Dahinten[12]. They also found a negative relationship between emotional exhaustion and job satisfaction for perioperative nurses (n = 133). Our results suggest that the tool can assist in predicting an increase or decline in the risk of burnout and the level of organisational commitment of employees. The validity of our tool results was further increased by the existence of an anonymous username. This feature provides the ability to distinguish between entries, permitting accurate calculations of the response rate, reducing sampling bias and allowing for time series analysis.

Overall, the job satisfaction results from the cohort in the study found that the majority of OR employees generally felt positive about their job during the trial period. Managers could easily identify the number of 'happy' or 'unhappy' staff on any given day, consider the percentage of the workforce participants represented, and identify what factors may influence responses from either the perspective of a particular job role or for the whole team. This allows for the development of timely and targeted interventions. For example, in our study, relationships and communication with colleagues were major factors influencing both a positive and negative day at work for nurses. This is in keeping with Lee, MacPhee and Dahinten[12] who identified the nurse–physician relationship as a significant predictor of perioperative nurse job satisfaction. In our study, the importance of relationships and communication with colleagues was also clear for the wider workforce, suggesting this would be a logical starting point for any intervention that aims to improve team staff satisfaction outcomes for this cohort.

Our study also identified some key areas that need to be addressed prior to further trialling or implementing the tool. Firstly, while the overall response rate was high, the daily response rate was only 21 per cent and a large number of staff members used the tool only once or twice over the trial period. Many reported that they forgot to use the tool or felt too busy to engage with it. This suggests that a reminder system is required, ideally embedded within daily routine alongside other daily expectations such as surgical briefings and checklists.

Survey feedback from staff suggested that while many were interested in initiatives that would improve overall morale, they questioned how the data would be used and if it would indeed lead to an improvement in job satisfaction. Transparent and regular feedback and action from managers are likely to be essential for the tool's success, with trust likely to develop as staff see evidence of positive change through its use. This was a seen in both the Frampton et al.[18] and Hinsley et al.[17] studies, which were conducted over much longer time frames. Both studies reported an increase in staff engagement as management actively and positively responded to feedback and comments.

Lastly, caution is needed comparing job roles and specialities, as understandably those that were most negative about how they were feeling in their jobs were also less likely to identify their job role or speciality. Feeling comfortable sharing this information is likely to improve as trust is developed over time.

A number of comparisons can be made between our study and those of Frampton et al.[18] and Hinsley et al.[17] As with our study, both studies developed the tool in collaboration with hospital personnel. Both studies used a simple visual system, smiley face and traffic light, and aimed to gain additional information regarding the reasons underpinning staff responses. While the tools from these two studies share a number of similarities with the morale-o-meter, neither study appeared to use pre-validated questions, there were no mechanisms to trace individual entries, and there was minimal consideration of the validity of the results. While this may be sufficient if data were solely used informally at a local level, managers wanting to analyse the data as an additional key performance indicator to influence decision-making and policy need to know the validity of the data.

Limitations

This study was conducted in one hospital with one sample over a relatively short time period, limiting any generalisation of the findings to other populations. In addition, the low response rate at a daily level as well as for the feedback and validation survey may have resulted in some sampling bias. A further possible limitation relates to the power of the analysis of the data via multi-level modelling. Although no research to date has investigated the appropriate sample size for this analysis, it is generally accepted that the number of level-2 units (participants, in this study) is of particular importance[35]. In this study 31 participants were included in the validity analyses by matching the daily survey and the validation survey. When the number of level-2 units is fewer than 50, the standard

errors for the fixed parameters are slightly biased downward[36]. Lastly, any study that requires self-reporting comes with the risk of common method bias[13].

Implications for perioperative nursing

Daily measurement of job satisfaction has the potential to be a highly effective tool for nurse managers at all levels in the OR, enabling up-to-date and valid information which can be tracked and monitored over time. The close nature of the OR team means that job satisfaction is often inter-related between team members and decisions impacting one profession will likely impact on another[26]. Consequently, assessing and meeting the needs of nurses in this setting should not be done in isolation. The morale-o-meter tool allows job satisfaction to be viewed and managed from an interprofessional perspective, building and strengthening healthy inter-professional relations. It also provides the opportunity to give a measure for a team which could be a particular professional group, an individual theatre team, a surgical speciality or the entire theatre team. As the tool is further established, there is potential to monitor for variance and trends over time, and to explore its sensitivity to other theatre metrics (e.g. changes in theatre utilisation, theatre policy or staff changes).

Conclusion

Overall, the results of the morale-o-meter study provide meaningful evidence supporting the validity and viability of using a daily single-item job satisfaction measure in the OR setting. This tool has the potential to change the way job satisfaction is measured and managed in the OR setting, improving job satisfaction outcomes and enhancing outcome measures for staff wellbeing initiatives. Further research is recommended to be conducted across multiple sites for longer periods of time.

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Ethical statement

This project was approved by the Human Participants Ethics Committee at the University of Auckland, reference number 022098.

Conflict of interest

No conflict of interest has been declared by the authors.

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Peer-reviewed article

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What is the scope of practice of the nurse practitioner as a surgical assistant in Australia?

Abstract

Discussion around the scope of practice of all nurse practitioners (NPs) in Australia was a component of the recent review of NPs' eligibility to have broader access to the Medical Benefits Schedule (MBS). This review process has been prolonged and, while the MBS review officially concluded on the 30 June 2020, no information regarding decisions about expanded NP access to the MBS for patient rebates had been disclosed at the time of publication. It is anticipated that the MBS review will contribute little change to NP access to the MBS.

The MBS is the primary funding process for private-sector medical services in Australia and is a barrier to the scope of practice of Australian NPs. Specifically, in the perioperative setting the lack of access to the 'assistance at operations' MBS item numbers limits the NP's scope of practice as it leaves the private sector surgical patient out-of-pocket when an NP provides surgical assisting services. This discussion paper considers the international non-medical surgical assistant experience and relates this to the Australian context exploring the complexities associated with the term advanced practice nursing, regulation of the NP compared to other clinicians, and the matters of funding and protectionism in the perioperative space.

Keywords: nurse practitioner, non-medical surgical assistant, scope of practice, Australian health care system, advanced practice nursing, anticompetitive government policy

Background

The focus of this paper is the Australian nurse practitioner (NP) who practises collaboratively with other health care professionals to improve access to health care in the perioperative environment[1]. At the inception of the NP role in Australia, a defined scope of practice would have limited many of the models of care used by NPs in the wide array of practice settings in which they provided care[2]. However, the lack of a structured scope of practice has caused some confusion for NPs, their colleagues, their employers[3,4] and regulatory and reimbursement bodies such as the Department of Health, the Department of Veteran's Affairs and Medicare surrounding what the scope of practice for the NP should be and how much public funding patients of NPs should receive. Compounding the confusion is the use of the term 'advanced practice nursing' (APN) for roles which exceed entry-level practice for registered nurses (RN).

The notion held by some that the NP's scope of practice should be predetermined and static is incorrect. The NP's scope of practice is fluid. This is consistent with other health care practitioners' scopes of practice to meet continually developing health care best practice[5], the needs of the health care team, and the needs of the patient. The scope of practice of the NP as a surgical assistant is the responsibility of the NP who collaborates with a surgeon in an individual clinical

practice setting. The NP scope of practice is based on the Nursing and Midwifery Board of Australia (NMBA) 'Nurse practitioner standards for practice', 'Safety and quality guidelines for nurse practitioners', decision-making framework and code of conduct. An NP's scope of practice is reliant on the knowledge, skills, training and experience of an individual NP; state and national legislation; the policies of the health care facilities; and the needs of the patients. As a result of the Hilmer report[6] , strictly defined scopes of practice, including that of the NP, are not dictated by the government or a regulatory body. Federal legislation sanctions the advanced practice of NPs to undertake medical and professional services[7]; however, the government unofficially restricts the NP's scope of practice by requiring formal collaborative agreements and limiting access to MBS item numbers. Limited MBS access negatively impacts on the financial sustainability for NP models of care and reduces access to NP services. These restrictions impact on the perioperative NPs by denying patients an MBS rebate for surgical assistant care provided by an NP which results in the patient incurring an out-of-pocket expense which in turn reduces access to the service. Other restrictions imposed on the scope of practice of the NP relate to protectionism, the exclusion of nurses from health care policy development committees, and the lack of advocacy for and active development of the non-medical surgical assistant role by health care professional and regulatory bodies.

The conundrum of advanced practice nursing

In Australia, it is predominately an RN and NP that undertake the role of non-medical surgical assistant[8]; however, an NP offers many clinical and regulatory advantages over an RN in this role. The NP is the only formally regulated APN role in Australia. To ensure public safety, the NMBA requires NPs to achieve and maintain endorsement as well as registration which enables NPs to apply for a provider number which in turn allows access to the MBS and the Pharmaceutical Benefits System[9,10]. Confusion and discussion continue about interpretation and use of the term 'APN' by others practising in this space[2,11,12].

To practice at entry level as an RN or NP in Australia, the NMBA requires clinicians to conform to a code of conduct and meet the standards of practice for registration and endorsement. There are over 67 titles for nurses practising at various levels in Australia[12]. While some RNs are practising at 'top of license'[13], the continued use in the literature of inconsistent language around the term APN for nursing roles which exceed the foundation level of nursing practice but are not an NP role perpetuates misperception and ambiguity when there is debate on fundamental issues such as scope of practice and government policy concerning MBS patient rebates for the advanced practice of the NP[13–17]. In a recent white paper, the Australian College of Nursing (ACN) proposed a solution to the conundrum around the plethora of nursing titles. The ACN proposes that the RN who works in a specialty practice role could be regulated with the addition of a formally recognised APN title which sits under the NP title[12]. However, the changes suggested by the ACN are extensive and would be expensive to implement. The first point to consider regarding the ACN's proposal is that in contrast to all Australian NP master's degree courses which are standardised and accredited by the Australian Nursing and Midwifery Accreditation Council (ANMAC), implementation of the National Clinical Nursing Framework[12] proposed by the ACN would require moderation of specialty-related master's degrees (a level of education stipulated by the ACN for APN) to attain a consistent level of education and practice. The second point for consideration is, would this new APN role meet the requirements to access an MBS Provider Number and public funding? The private sector of the Australian health care system accommodates 67 per cent of all elective surgery[18], so access to the MBS would be a priority for a perioperative APN. Given NPs are currently limited to a total of four time-tiered MBS consultation or telehealth item numbers[19], and no access to procedural item numbers, access that was reduced from this would be of little value to the APN. The third and most crucial point for consideration is the need for a significant shift in ideology by the NMBA who currently relegates the management of specialty nursing practise (other than the NP) to specialty nursing groups[20].

According to the NMBA, APN is not a job title, pay grade or specific scope of practice but rather a level of practice[13,21]. Despite that, clear direction, such as the Safety and Quality Guidelines for Nurse Practitioners[22] as set out by the NMBA, is required to guide these roles. Rather than a structured, limiting scope of practice, these guidelines sit within a framework for practice which is able to be individualised[23]. O'Connell and Gardner[24] suggest that while competency standards act as a benchmark for entry to practice, they are inadequate to address the expert practice of the NP role. They suggest that context specificity and situated cognition, which enable flexible parameters and address

real-world health care situations, are more important when defining the NP role[24]. The NP role combines specialty clinical knowledge with advanced practice; demonstrates independence, autonomy and complex decision-making; and can holistically care for the patient in all phases of the perioperative episode of care[14,25–27]. Task divergence exists between the RN and NP in all stages of the patient's perioperative journey. This task divergence is related to patient assessment skills and ordering investigations, diagnostic decision-making skills and critical thinking, initiation of appropriate treatment options, and the contribution to joint decision making in the intra-operative setting[8].

The international non-medical clinician as surgical assistant and scope of practice

Similar to colleagues in the United States of America (USA) and the United Kingdom (UK), the Australian NP as a surgical assistant has a standardised, accredited master's level of education and a fluid scope of practice as well as being sanctioned by federal legislation[28] to undertake an interventional, complex level of surgical care and authorised to provide medical and professional services.

The non-medical clinician as a surgical assistant is well established internationally. This role has been practised in Australia for over 30 years[28]. Non-medical clinicians can undertake an active role in the preoperative, intra-operative and post-operative phases of the patient's perioperative journey[8]. They are particularly valuable as intra-operative surgical assistants in geographical locations or surgical specialties where the number of medical practitioners to fill the role of the surgical assistant is limited, when the skills required to perform the role of the intra-operative surgical assistant are highly specialised, or when the surgeon needs a consistent, experienced assistant[29–31]. The literature outlines that patients find care that is traditionally offered by a medical practitioner acceptable when provided by non-medical clinicians when access to care is improved[32–38]. Studies have also found a significant improvement in access to surgical care is achieved by incorporating non-medical advanced practice clinicians as surgical assistants into the surgical team[29,31,39–42].

The broad concept of advanced practice incorporating both nurses and other non-medical clinicians as a level of practice rather than a specified scope of practice is outlined in recent literature from the UK which elaborates that tasks do not define advanced practice[31,43,44]. This definition leads to a flexible and responsive role that is not bound by a rigid scope of practice. In this way, the NP role gains a fluidity that meets the needs of the patient and, in the perioperative environment, the needs of the surgical team in which it functions[31]. This fluidity was evident and considered an advantage in a report by the Royal College of Surgeons of England (RCSE) on the role of the surgical care practitioner (SCP) in the extended surgical care team[31]. The SCP is a non-medical clinician in UK surgical teams who functions as an intra-operative surgical assistant[45]. As the NP role in the UK is not regulated, and in order to standardise titles in surgical teams, the RCSE, the Perioperative Care Collaborative, the Association for Perioperative Practice and the medical, nursing and health care councils of the UK have taken an active stance on providing a framework and guidelines for the practice for the non-medical clinician as a surgical assistant in the UK. The SCP sits at the top of this hierarchy and is trained and educated to provide interventional assistance[46]. Similar input by the Royal Australasian College of Surgeons (RACS), the Australian College of Perioperative Nurses (ACORN), the NMBA and other nursing professional bodies would add clarity to the roles of RNs and NPs as surgical assistants in Australia and could guide discussions related to eligibility of the NP for MBS patient rebates to reduce patient costs. It would be anticipated that the Australian NP would be at the top of this hierarchy, trained and educated to provide interventional assistance and gain access to MBS 'assistance at operation' funding with their MBS provider number.

This notion of a fluid scope of practice is also reflected in the role of the physician's assistant (PA) in the USA. The PA is a non-medical clinician who has a presence in many specialties. There are more than 44 000 PAs in the USA[47]. As opposed to the NP in the USA, the PA has a significant surgical presence, and one of their functions is as an intra-operative surgical assistant[40]. While some minor variations exist, almost all states in the USA have halted a requirement for the regulatory body to determine a blanket scope of practice for the PA and instead defer to a system where an individual PA's scope of practice is decided on a practice level and in collaboration with a medical professional[48].

The SCP in the UK and the PA in the USA are not considered roles limited to nurses[45]; however, the advanced and interventional nature of their intra-operative practice is comparable to the practice of the Australian perioperative NP[46,49]. The scope of practice of the SCP in the UK, the PA in the USA and the NP in

Australia, in which each undertakes the role of intra-operative surgical assistant, is based on knowledge, skills, training and capabilities, policies of the health care facilities, and the needs of the patients in the individual clinical setting[50,48]. For the PA programs in the USA, SCP programs in the UK and NP programs in Australia a master's degree is the standard level of education which is administered by the respective national regulatory entities[10,48,50,51].

Protectionism in the perioperative space

Despite the reforms that arose from the Hilmer report, medical practitioners as surgical assistants enjoy public funding in the form of a patient rebate from the MBS while NP surgical assistants are not afforded the same privilege. Similarly, medical practitioners are able to gain health care facility credentialling as a surgical assistant with no further qualifications than a bachelor degree, while the NP with a master's degree is unable to secure credentialling as an NP at many private sector health care facilities.

As a result of protectionism from other health care professionals working in this space, it was hypothesised that restricting the scope of practice of the NP may ensure a higher quality of care. The differences in NP and medical practitioner training can be the source of some concern of medical practitioners regarding the quality of care and hence the limitations or restrictions[52,53]. However, evidence from the USA highlights that the NP delivers a high quality of care regardless of whether practice is or is not restricted and that implementing a full scope of practice improved access to health care and demonstrated cost savings[52–55].

The move away from a wholesale and rigorously demarcated scope of practice in Australia was instigated in 1993 following the release of the Hilmer Report. This report recommended the implementation of a national competition policy[6]. A government-dictated standardised scope of practice unwittingly served to protect the monopoly some professionals had on specific tasks[52,56]. While government regulation is an essential feature of health care to protect consumers and public health and safety, regulations of this nature impose anticompetitive restrictions on some clinicians[6]. An example of this is the NP in the intra-operative role of the surgical assistant who meets the criteria for this role as set out by peak professional bodies including the RACS[28] and ACORN[57]. The NP is effective in the intra-operative role[58] and is a legitimate clinician to undertake the role[28]. Still, due to government regulations, the NP's patients are unable to access a patient rebate for intra-operative surgical assisting services as this is restricted to medical practitioners by the wording of the highly medico-centric government-dictated MBS[29].

The undefined scope of practice for the NP is the same for medical practitioners in Australia. If a medical practitioner holds unconditional general registration the Australian Medical Board does not define a scope of practice[59]. Both medical practitioner and NP training requirements are dictated and supervised by their respective accreditation councils[60–62]. As is the case for the NP, the medical practitioner applies for credentialling at health services and hospitals. This credentialling process will investigate if the clinician has the appropriate training to perform the proposed role for which credentialling is sought. Medical practitioners requiring health care facility credentialling to perform the intra-operative role of surgical assistant do not need any qualifications other than their bachelor's degree. This is also the case for the master's degree qualified NP in public sector health care facilities and some private sector health care facilities[63]. However, discussion continues in Australia about the NP credentialling process which is currently inconsistent in the private sector, with some corporate health care groups or individual facilities not credentialling the NP in any capacity.

Restriction of access to an MBS rebate, and limiting the ability to gain health care facility credentialling as an NP, is anticompetitive and contravenes the essence of fair trading by limiting the NP's ability to practise and negatively impacting their financial sustainability[64]. It is the role of the Australian Competition and Consumer Commission (ACCC) to uphold fair trading, encourage competition and regulate national infrastructure[65].

Conclusion

The recent ACN white paper noted that the NP role in Australia was well established and it was now time to focus on 'optimising the service potential of advanced practice nursing'[12]. It is suggested here that the NP role in Australia is not well established as it lacks the government infrastructure required to place the patient at the centre of the health care model. Lack of government funding confers inequitable out-of-pocket expenses on the patient despite the fact that the NP acting as a surgical assistant increases access to surgical care, thereby contributing to equity. The inability to fully access MBS funding limits all NP's scope of practice.

Similarly, the continued protectionism by others in the health care space limits the ability of the NP to gain credentialling at health care facilities which in turn, limits the capability of the NP to work at their full scope of practice. As is the case in the UK, input is required by both the medical and nursing professional and regulatory bodies to allow the NP to practice to their full scope and uphold the spirit of fair trading and the role of the ACCC.

The NP should enjoy a fluid scope of practice that conforms to the NMBA 'Safety and quality guidelines for nurse practitioners' and sits within the NMBA decision-making framework and the Australian NP metaspecialty framework. However, the lack of support by the government, regulatory and peak professional bodies limits the NP's scope of practice.

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Type 1 diabetes perioperative care: Preventing harm to patients

Imagine you lived with a chronic condition that required you to make over 100 self-management decisions every day. Imagine you have been admitted to hospital for a day surgery procedure and the health professionals have refused your request for access to a medication you need for survival. Imagine that as a result of missing this medication you have ended up in an intensive care unit (ICU) with a life-threatening condition. The life-threatening condition is diabetic ketoacidosis (DKA) and the medication you needed is insulin, because you have type 1 diabetes (T1D).

Let's consider why a person with T1D entering the health care system for a simple day procedure can end up in ICU with a life-threatening condition. On admission to hospital, people with T1D are often required to relinquish responsibility for their usual self-management of their condition[1,2]. Furthermore, it is common practice for health professionals to take over T1D management from the individual in hospital[2,3]. However, people in hospital with diabetes are exposed to a variety of errors through health professionals' management of diabetes. These errors include insulin administration errors; inappropriate content, availability and timing of meals; and poor hypoglycaemia management[4]. As a result of these health professional errors a stay in hospital for a person with T1D can be a frightening experience because of the risk of harm they may be exposed to. In the UK in 2017, 1 in 25 in-patients with T1D developed DKA due to health professionals undertreating this patient group with insulin[5]. Not only does an episode of DKA extend the patients length of stay, which leads to additional financial cost to the hospital, the impact on the patient psychologically and physically is significant and can impact on the therapeutic relationship with health professionals.

One of the reasons diabetes management errors occur in hospital is because health professionals do not listen to the patient. Over time, people with T1D are known to become experts in their diabetes self-management through years of lived contextual experience[6,7]. Due to this lived contextual experience people with T1D are knowledgeable and capable of self-managing or contributing to making decisions about how their T1D should be managed in hospital[2,8]. Listening to the patient and learning about their usual T1D management is valuable in the prevention of diabetes mismanagement.

Errors also occur because health professionals are not routinely engaging people with T1D in discussions about their usual diabetes self-management. By not asking about usual T1D self-management, health professionals remain unaware of the preferences and priorities of diabetes management for the individual. Research on the self-management experiences of people with T1D in hospital found the participants experienced limited opportunities for discussing their diabetes management with health professionals[8]. The participants reported experiencing limited discussion about T1D management in their pre-admission appointment, during their episode of hospital care, and around discharge planning. As a result of the limited discussions

initiated by health professionals, the participants initiated discussions with health professionals about how their T1D would be managed in hospital. However, some participants felt judged, dismissed and even ignored by health professionals when they initiated such discussions. As a result of not being listened to and their perspective not being understood, patients feel distressed in hospital and unsafe[9]. Furthermore, limited discussions around T1D led participants to believe their T1D was not important to the health professionals[8].

Effective communication between health professionals and patients is a significant component of ensuring safe high quality health care[10,11]. A review of patients' experiences in Australian hospitals found reciprocal communication and information sharing was important to patients[9]. However, participants with T1D reported limited reciprocal communication and information sharing, which led them to view their interactions with health professionals negatively and impacted on their capacity to trust the health professionals[8].

The lack of discussions initiated by health professionals with the patient about their T1D management may be a result of the recognised knowledge deficit that exists among generalist health professionals about diabetes management[8]. A number of reviewed studies found that generalist health professionals have knowledge deficiencies around diabetes management, with specific deficiencies in the use of insulin[8]. However, regardless of the health professional's discipline, they need to have knowledge about diabetes management for inpatients because diabetes can complicate the person's admission diagnosis[12].

It is recognised that generalist health professionals cannot be experts in the detailed management of all complex conditions such as T1D[13]. While the rising complexity of care and the increase of people with chronic conditions place additional demands on the communication required of health professionals, poor communication is known to increase the risk of errors in health care. Therefore, effective communication is essential to the provision of quality and safe care[11]. In order to feel safe, patients need access to open, timely and accurate communication with health professionals about their care in hospital.

The opportunity to exchange ideas between health professionals and patients supports the ideals of patient participation in health care and a consumer-centred care focus. Castro et al. suggested that these ideals of patient participation and consumer-centred care have been 'buzz concepts for quite some time now'[14, p.1924]. These ideals indicate that patients are no longer just passive recipients of care but rather play an active role in making informed decisions about their own health care[15,16]. In essence, patient-centeredness is an approach to care that meets the patient's 'needs, values and beliefs' through understanding the patient's 'expectations, perceptions and experiences' of their care[14, p1929]. In addition, patients' being actively involved in their health care reduces the gap between the experiential knowledge of the person and the health professionals' knowledge[14].

Another reason for limited engagement by health professionals around T1D management in hospital is because of the reluctance to accept the expertise of the patient. Health professionals have obtained knowledge specific to their role through formal study and clinical experience. Traditionally, health professionals' knowledge is often viewed as authoritative because their knowledge is socially constructed as being both legitimate and dominant[17]. Consequently, those who have knowledge that is considered to be outside the conventional understanding of knowledge, such as those with a lived experience of T1D, may be viewed as having inferior knowledge. Patients with T1D who have in-depth knowledge of their diabetes encounter issues when their expertise is viewed as inappropriate in interactions with generalist health professionals because the person's expertise can be considered as 'non-compliant' by health professionals who are not diabetes specialists[13]. The issue is further exacerbated when generalist health professionals, despite their good intentions, block access to insulin and other supplies needed to safely manage T1D.

So what can be done better in the perioperative environment to reduce harm being caused to people with T1D undergoing surgery? There are local policies in place for managing T1D in the perioperative environment; however, the context of the individual still needs to be taken into consideration when planning care. For example, a person with T1D and gastroparesis, a potential complication of autonomic neuropathy, may need an alteration to the usual recommended fasting time due to delayed gastric emptying. In addition, *Standards for Perioperative Nursing in Australia* (the ACORN Standards) include the ACSQHC National Safety and Quality Health Service (NSQHS) standards of communicating for safety, partnering with consumers, and medication safety as required areas of competence in multiple nursing roles in perioperative nursing[18].

In relation to communicating for safety there are a number of actions

that can be undertaken. Firstly, find out if the person has diabetes, what type of diabetes they have (don't make assumptions based on medications that have been prescribed) and ask about their usual treatment. Improving care and keeping patients safe starts with improving communication. People with diabetes should be involved in discussion to plan their diabetes management in hospital for any elective admission from the pre-admission stage all the way through to the discharge of the patient[4]. Health professionals need to seek information at the beginning of their interaction with a person with T1D to determine whether the person with diabetes wishes to self-manage during their admission[4]. The initial discussion represents an opportunity to ensure appropriate support can be implemented, for the entire admission, that can assist in the prevention of diabetes management errors along with increased patient satisfaction with their care and an improved overall experience while in hospital. In addition, discussion around diabetes management allows for the health professional to develop an understanding of the person with T1D's preferences for their care which can result in the health professional being able to advocate for the person when they are not being listened to by other health professionals.

Partnering with consumers through shared decision making and encouraging consumer participation in their care is essential for safety. To truly partner with consumers, health professionals need to value the expertise and knowledge of the patient as being equal and complimentary to their own knowledge[14]. Recognition and acknowledgement of the patient's experiential knowledge as being able to provide a complementary contribution to health care is required to foster collaboration and to integrate patients into health care teams[19]. Health professionals also need to recognise that the person with T1D and their expertise are valuable resources in the management of T1D in hospital.

Medication safety is essential when considering insulin. In Australia, insulin is considered a high risk medication (HRM) because the risk of the medicine causing significant harm to the patient, or death, is high[20]. While insulin is not necessarily a medication where more errors are made, it is a medication with a narrow therapeutic window so the consequence of an error with insulin can lead to significant harm, including death. Training about the safe use of insulin, and the main harms associated with diabetes and how they can be prevented should be mandatory for all health professionals. If the patient is on insulin consider their need to continue insulin, as ceasing or withholding insulin can cause serious harm, such as DKA, to the patient. If there is uncertainty around the management of insulin for a patient in the perioperative environment, asking the patient and consulting with health professionals with diabetes expertise can reduce the potential risk of harm. According to Flanagan et al[4] a key strategy to improve the safety of insulin administration in hospital is to allow the person with diabetes who has the appropriate skills to self-manage their insulin. An additional strategy is for health professionals to be aware of knowing what they don't know and seeking expertise from others about diabetes management.

In summary, people with T1D who are in hospital need to be able to collaborate with health professionals to negotiate plans of care to keep them safe. Patient participation in care is happening and people with T1D are actively participating in their diabetes management. However, consumer-centred care needs to be improved as a way of ensuring that people are safe in hospital and that the individualised needs of the person with T1D are being met. In order to provide safe and collaborative care for people with T1D in hospital, health professionals need to acknowledge the self-management expertise of these people and use this expertise when negotiating care.

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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

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 tasks[1–3]. 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 Knafl[12]. This method allows varied methodologies including qualitative and quantitative to be included to assist in presenting an extensive and holistic view of a phenomenon[12]. 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-methods[13–15]. 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 Knafl[12], 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

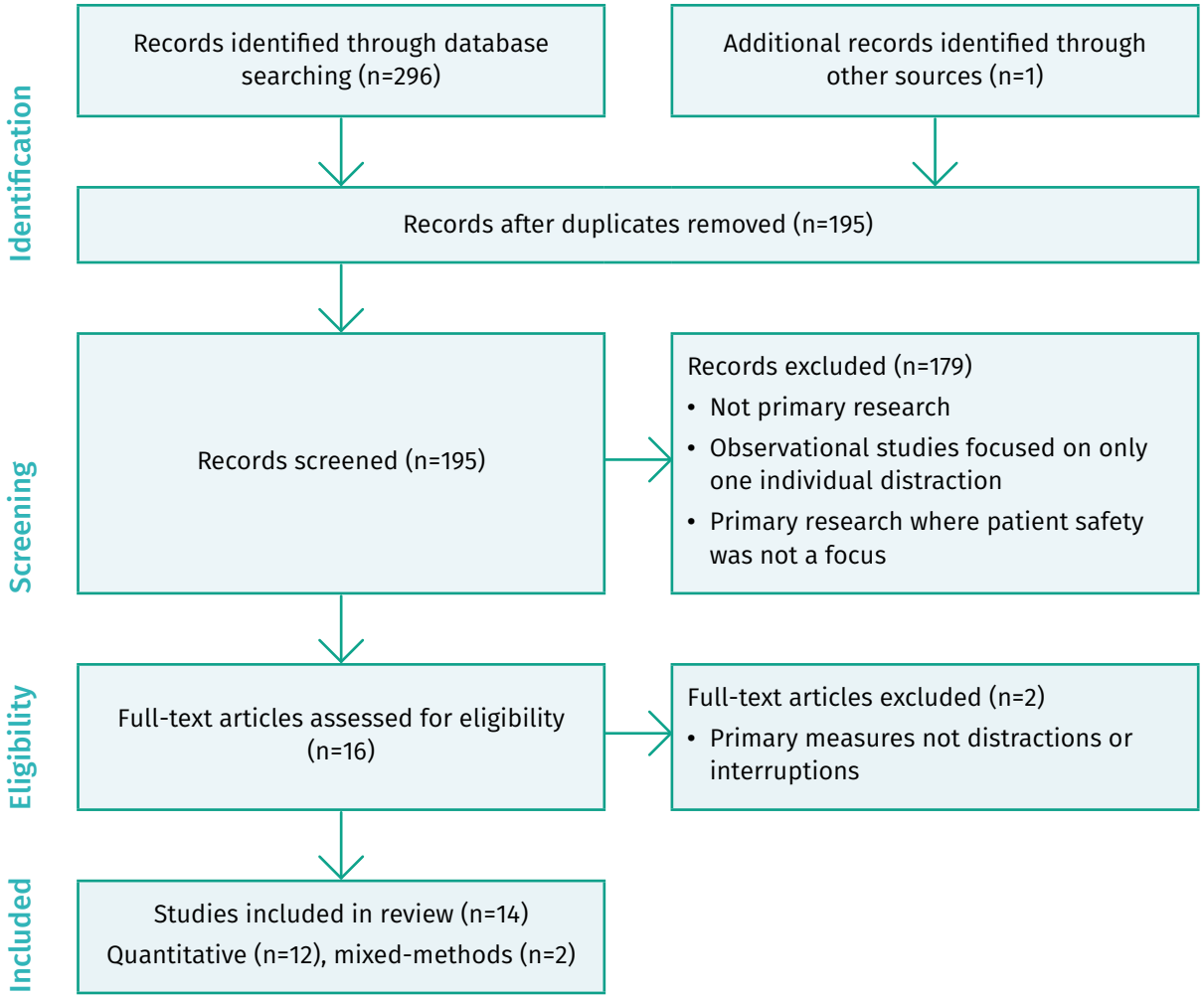

Figure 1: PRISMA flow diagram of papers for inclusion (Moher et al.[18])

included in the review[18]. 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 interruptions[5]. 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 ORs[1]. 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 patients[2,19]. Virtual reality simulators are validated to measure surgical performance; however, generalisability of simulated studies to real ORs is limited[19]. 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 period[20] and another on nurses[6]. 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 observed[5]. 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, equipment[7], compared to equipment, CIC and others[11]. 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.'s [7] 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 distraction[3]. Findings were that OR doors opening and CIC had the highest severity[3]. 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 265[3].

Severity was also measured post-operatively in Al-Hakim et al.'s[20] 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 impact[20]. This study occurred in five hospitals across three countries; however, the observers and interviews have the potential to be biased due to subjectivity[20]. Sirihorachai et al.'s.[6] 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 interrupted[6]. The highest severity distraction or interruption was CIC followed by equipment issues and phone/music/pager[6]. The potential for observer bias existed here due to subjectivity and the use of one observer and therefore no IRR[6]. In addition, a single centre and specialty allows for possible selection bias[6].

Inconsistent categories and tools make it is 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 correlated[1].

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 demands[4]. 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 types[8]. This indicates some CIC and small talk may be positive and reduce surgeons' fatigue and stress[8]. Nurses'

situational stress was negatively correlated with telephone/pager calls which were the most frequent and severe, and anaesthetists found CIC the most distracting[8]. Overall, reducing CIC and phone/pager distractions and interruptions reduces the risk of a cumulative effect upon mental workload[8].

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 hospital[9]. 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 distraction[3], a similar finding to Weigl et al.[8]. CIC is a modifiable distraction and interruption which appears to affect team members' mental workload differently[3]. 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 case[11] and 11.05 minutes per case respectively[7]. 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 efficiency[7]. 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 completed[5]. Alarmingly, the teams were experienced, yet endangered patient safety by not completing checks[5]. However, this study was conducted in a single hospital with a single surgeon so generalisability and selection bias is questionable[5].

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 procedures[5]. 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 is 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 tasks[19]. 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 anaesthetic[4]. 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 randomised[22].

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 order[19]. 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 task[10]. 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 randomised[2]. 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 stress[4]. 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 surgeons[4]. Similarly, Gao et al.[2] used the National Aeronautics and Space Administration (NASA) task load index (NASA-TLX), which the SURG-TLX is adapted from[8]. The authors also used an objective measure to track pupil size and blink rate which represent cognitive load[2]. 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 operating[2]. 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 studied[10]. 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.'s[10] 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 study[22]. 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 cent[19]. Similarly, medical students made more errors when answering questions from two phone calls in the final study[10]. 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 out[6]. Measures included whether the nurses ignored the distraction, were interrupted by it, or multitasked and performed both the primary and secondary task[6]. 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 off[6]. Over half of the nurses were interrupted by CIC and pager distractions during the first count[6]. Multitasking only occurred during the first count; ten per cent of nurses engaged in CIC while counting[6]. A third of nurses were interrupted by a pager during team time out and 57 per cent at the final count[6]. This is concerning as these three tasks are critical to ensure patient safety[6]. That said the 30 nurses came from a single centre, making generalisability difficult and selection bias possible[6]. Debriefing sessions and qualitative analysis revealed the nurses used cognitive processes of prioritisation and remaining focused on the primary task when confronted with distractions[6].

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 each[6]. Each profession is impacted differently by individual types and a clear understanding of this from the entire OR team will assist in minimising them[6–9]. 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 phases[6].

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 interruptions[5]. Feedback should be provided to the OR team, followed by discussion to identify effective actions and strategies[5]. Reassessment should occur post implementation[5]. Nursing professional bodies should develop standards and guidelines for minimising distractions and interruptions in ORs[6].

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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Descriptors of included studies

Author, year, country	Design and sampling	Study aim	Key findings	Limitations	Implications	MMAT Score
Al-Hakim L et al.[20] 2016 Australia, China, Thailand	Prospective cross-sectional observational, mixed methods (qualitative analysis of interviews). 55 cases observed in the preoperative phase in the OR. Elective, general anaesthetic, general, urological and oncological. Five hospitals: two Australia (n = 33), two Thailand (n = 12), one China (n =10). 16 consultant anaesthetists and surgeons, 13 OR nurses interviewed, semi-structured to determine care co-ordination categories.	Evaluate the impact disruptions have on time efficiency in preoperative anaesthetic work and the correlation between them and failures in coordination of care.	Average of three disruptions/case (preoperative). Four types of care coordination emerged from interviews and analysis. Disruptive types measured in amount of time wasted. Most timewasting caused by staff (1), patient (2) and team (3). On average, disruptions caused by staff added one minute to preoperative period in OR. Most frequent care coordination problems: coordination within the OR team (1), between the OR team and preop team (2).	Small number of observations and selective; however, across three countries. Emergency cases not observed. Human observers, potential observer bias. Qualitative analysis of interview data, potential bias as subjective.	Work disruption is preventable and increases inefficiencies. Better teamwork required within the OR and between OR and other departments. Better planning and checking. Problems upstream from OR need to be resolved.	83%
Antoniadis S et al.[1] 2014, Germany	Prospective observational. 65 elective general, orthopaedic/ trauma and plastics procedures under four hours duration. Two centres within single hospital. 89 hours and 57 mins total, mean length 1 hour, 57 mins.	Objectively observe interruption and distraction events in the OR and measure the surgical team's intra-operative interference from these.	High amount of distractions/interruptions in the OR, n = 803, 9.82/hour. Most frequent: traffic in and out of OR (1), telephone/pager calls (2), CIC (3). Highest severity: equipment failures (1), work environment-related (2), procedural issues (3). Frequency and severity are not correlated. Surgeons more affected by single interruptions than nurses or anaesthetists.	Observational design, limitation recognising subjective differences. Unable to factor in expertise and individual's coping strategies. Unable to factor in when CIC interruptions are positive or necessary/legitimate. Selection bias possible, two centres within single hospital. Observer fatigue and possible observer bias. Limited to ortho, general, < 4 hrs duration, possible observer bias.	Team-based interventions required to reduce interruptions/ distractions. Improved organisation within the OR to reduce distractions/ interruptions. Future research: • single and cumulative effect • which distractions/interruptions are beneficial and which contribute to negative outcomes • impact on stress and performance.	60%
Gao J et al.[2] 2019, China	Randomised prospective experimental, simulation. 24 medical students, 12 males, 12 females, blinded to purpose. Performed laparoscopic appendicectomies on simulator. All participated in three situations: 1) operate with no interruption 2) answer cognitive arithmetic questions, no operating 3) dual-task, arithmetic and operating Randomised block design, order permutated.	Confirm the effect of cognitive interference on surgeons' cognitive load and performance while using a simulator.	Measured pupil size and blink rate, incorrect answers, surgical metrics on simulator (objective data) and NASA task load index (NASA-TLX) (subjective data). In dual-task condition, pupil and blink rate, error rate in arithmetic answers, and subjective workload all increased. Operating time also increased in dual-task condition.	Arithmetic task rather than a surgical cognitive task. Small sample. Simulator only. Medical students. NASA-TLX subjective.	External cognitive distractions affect surgeons' mental workload and motor skills and need to be minimised to ensure patient safety. Improve or manage cognitive distractions. Future research: • simulation studies to improve surgeons' experiences of surgery.	90%

Key: OR = operating room; CIC = Case-irrelevant communication; stat. sig. = statistically significant; mins = minutes; preop = preoperative; SURG-TLX = Surgery Task Load Index.

Author, year, country	Design and sampling	Study aim	Key findings	Limitations	Implications	MMAT Score
Jung J et al.[13] 2019, Canada	Prospective cohort. 265 consecutive adult elective laparoscopic general surgical procedures. Mean duration 93 mins. Audio-visual data collected on 'OR black box' and then observed. Single surgeon, single hospital. Used a self-reported human-factors questionnaire to evaluate surgeon's perceived distraction.	Determine which intra-operative system factors are related to surgeons' perceived distraction.	Surgeon reported distraction in 45% of the surgeries. High amount of distractions/interruptions in the OR. Most frequent: teaching (1), equipment issues (2), CIC (3). Highest numbers of cases where perceived distraction by surgeon occurred that was statistically significant: door opening (1), CIC (2). Multivariable analysis revealed CIC was independently associated with an increased probability of surgeon feeling distracted.	Single surgeon, single hospital, potential selection bias. Hawthorne effect, one- year pilot study to familiarise staff with the 'OR black box' recorder. Questionnaire used, validity evidence is preliminary.	'Sterile cockpit' is worthwhile intervention to minimise distraction at critical stages. Future research: • how surgeons interact with distraction to create system-level strategies • more recording to analyse correlations between distraction and surgical performance.	60%
Murji A et al.[19] 2016, Canada	Randomised cross-over, simulation. 30 obstetrics/gynaecology residents, powered. Randomised to a quiet condition followed by distraction condition, and vice versa. All performed two laparoscopic salpingectomies on simulator. Pager beeped and questions asked from a handover sheet, previously viewed.	1) Assess the safety and accuracy of surgeons' responses to clinical questions asked while using a simulator. 2) Determine if pager distractions influence surgical performance (simulated).	Correct answers in distraction phase was 80% mean. 63% made minimum one unsafe clinical decision when distracted. Higher number completed task in set time in the quiet, compared to distraction. No difference between the two conditions for task completion and blood loss. Six months later, in quiet, no surgical tasks, correct response to questions was 93% and only 20% made an unsafe decision.	Lack of blinding of residents. Laboratory conditions, not real-life, therefore limited generalisability; ethics eliminates experimental design in OR. Unable to determine if responses due to baseline knowledge or multi-tasking, although six months later response rate was high when no multi-tasking. Trainees, hence no generalisability for experienced surgeons.	Simulators are validated for assessing surgical performance. Care of patients on wards is diminished when surgeons distracted. Future research: • effect of distractions on experienced surgeons. • effects of distractions on clinical decisions.	80%
Sevdalis, N et al.[5] 2014 UK	Prospective descriptive observational. 19 elective urological procedures. Single hospital. Mean length 70 mins.	Determine if intra-operative distractions are associated with a decline in patient safety checks being performed.	High level distractions n = 136, 6/hour. Most frequent: CIC and equipment issues. Highest severity: coordination issues with other departments or teaching. The highest severity within CIC came from external visitors and surgeons. Safety checks completed most frequently: patient tasks (1), equipment tasks (2), communication tasks (3). The higher frequent and severe communication distractions were associated with lower rates of completion of intra-operative patient checks (statistically significant). Distractions did lead to a decline in intra-operative patient checks performed.	Small sample size. Single hospital. Single specialty. Single surgeon. No data on direct patient outcomes. Hawthorne effect: potential observation bias, controlled for by familiarisation period. Difficult for an observer to assess true impact as some distractions are necessary. Tool not validated. Potential selection bias.	Improving coordination between departments. Implement 'sterile OR/cockpit'. Future research: • direct patient outcomes • how impacts workload and teamwork • optimal work process design.	60%

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Author, year, country	Design and sampling	Study aim	Key findings	Limitations	Implications	MMAT Score
Sirihorachai R et al.[6] 2018, USA	Mixed-methods, (observational, experimental and qualitative) Observations of 15 general surgeries, total 40 hours. Five most frequent interruptions and two most affected tasks incorporated into simulation scenarios. 30 OR nurses participated in scenario and then participated in debrief interviews to explore cognitive processes used.	Identify most frequent interruptions in OR. Develop and test simulation scenarios to assess decision-making when responding to interruptions. Explore circulating nurses' cognitive process when responding to interruptions.	Most frequent: traffic (1), phone/pager/music (2), CIC (3). Highest severity: CIC (1), equipment issues (2), phone/music/pager (3). Distractions occur frequently during critical tasks in OR: induction (1), first count (2), specimen handling (3). Frequent distractions do not always involve circulating nurses. Experienced nurses breached policy more frequently than inexperienced nurses. Nurses used two cognitive processes when distracted, prioritisation and remaining focused on the primary task.	Observation phase: Hawthorne effect. Only one observer, no inter-rater reliability. Single centre, possible selection bias. Only general surgery, not complex cases.	Knowledge can reduce interruptions during critical events/times for nurses. Teach prioritisation and remaining focused on primary task. Influence policy and professional guidelines to suggest unnecessary interruptions are minimised during critical phases. Ongoing safety and quality.	83%
Sujka J et al.[22] 2018, USA	Randomised prospective experimental, simulation. 12 general surgical residents, first to fifth year, from a level 1 trauma centre. Four females, eight males. Each performed six simulated laparoscopic cholecystectomies, three with interruptions (two clinical questions/vignettes from pager for each one, the first question easier than the second, asked at critical stage) and three without interruption. Random number generator determined order the six were performed in.	Determine if pager interruptions affect safety, operative time or patient complications and management of them during a simulated laparoscopic cholecystectomy.	Simulator measured operative endpoints, (including operative time, safety and complications), no significant difference when interrupted or not. Correct management of the pager issues, pass or fail; when interrupted the residents only passed 25% of the time. No difference between the correct management of the first question (easier) and second question (harder).	Small sample size, powered would require 100. Subjective nature of distraction. Vignettes, high failure rate for answers, was validated with surgical director. Only trainees, not experienced staff.	Care of patients on ward, affected from intra-operative distractions. Inability of trainees to multi-task. Future research: • different vignettes and more robust grading system.	80%
Weber J et al.[9] 2018, Germany	Prospective observational. 40 robotic-assisted radical prostatectomies. Total observational time 146 hours, 55 mins. 216 post-operative reports (nurses n = 93, surgeons n = 81, anaesthetists n = 42), using validated survey tool SURG-TLX to assess mental demands, distractions and situational stress. Single hospital.	Identify the frequency and severity of flow disruptions during robotic-assisted surgery and evaluate the association between them and the performance and mental workload of all OR professionals.	High amount of disruptions in the OR n = 2285, mean 15.8/hour. Highest rate of disruptions occurred after insufflation of the abdomen and before console time. Most frequent: traffic in and out of OR (1), CIC (2), procedural (3). Highest severity: equipment (1), instrument changes (2), co-ordination (3). Perceived distractions increased with disruption frequency. Severity of distractions due to communication and coordination correlated with workload (statistically significantly).	Observational, therefore possible observer bias. Single hospital. Only robotic surgery. Could not factor in individual's outcomes from disruptions. Unable to factor in when CIC interruptions are positive or necessary/legitimate. Recall bias in self-report. Could not assess workload ratings throughout case, only at end. SURG-TLX is subjective, but validated. Hawthorne effect.	System-based analyses and solutions required. Further understanding of deep systems problems to enhance patient safety. Multidisciplinary training. Future research: • OR team familiarity, OR team roles, individual's stress management strategies • how high severity disruptions impact surgical outcomes • impact of accumulation of minor disruptions.	60%

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Author, year, country	Design and sampling	Study aim	Key findings	Limitations	Implications	MMAT Score
Weigl M et al.[8] 2015, Germany	Observational, cross study. 56 elective general and orthopaedic cases, under general anaesthetic with less than four hours duration. Total observation time 77.1 hours, mean 1 hour, 37 mins. Two departments, single hospital. 229 post-operative reports (surgeons n = 94, nurses n = 81, anaesthetists n = 54), using validated survey tool SURG-TLX to assess mental demands, situational stress and distractions.	Evaluate the impact different intra-operative workflow interruptions have on the ability of surgeons to manage their workload efficiently and safely.	High amount of disruptions in the OR n = 725, mean 9.78/hour. Most frequent: traffic in and out of OR (1), telephone/pager (2), CIC (3). Highest severity: equipment / OR environment (1), procedural (2), CIC (3). CIC associated with less situational stress and mental fatigue of surgeons. Surgeons reported CIC and procedural disruptions increased their distraction. Nurses and anaesthetists perceive their workload as being affected by intra-operative interruptions.	Observational studies limited, cannot infer causality, only controlled study can. Selection bias possible, two specialities, single hospital. Hawthorne effect. Observer fatigue possibility (did try to control, < four hour duration). Electives, in-hours. Confounding factors unable to control: • complexity of procedure • possibility of subjective bias with SURG-TLX tool • expertise and familiarity of OR team. • Could not assess workload ratings throughout case, only at end.	Reduction in interruptions. Enhanced communication, surgical flow and organisation are required. 'Sterile cockpit'. Future research: • emergency procedures • physiological monitoring during case to assess stress-related variables • appropriate/necessary interruptions • how different interruptions affect increased workload.	60%
Weigl M et al.[4] 2016, Germany	Randomised prospective experimental, simulation. 19 junior surgeons (first and second year), 63.2% male. Randomly allocated to one of two groups: 1) phone call disruption re external case 2) patient discomfort related to case. Performed one step of a vertebroplasty on simulator. Disruptions occurred once needle at a certain depth.	Investigate the effect of surgical flow disruptions on the intra-operative workload and technical performance of surgeons.	Mental workload through the SURG-TLX measured through training and simulation, significantly higher through simulation. Phone calls were more distracting than patient discomfort. Disruptions caused more physical demands and situational stress. In simulation, significant correlation between mental workload and technical inaccuracy. No technical significant difference between groups.	SURG-TLX is subjective, therefore potential bias. Can only measure workload at end of case, not throughout the case. Junior surgeons, not experienced. Only a single step in a single procedure.	Actively manage distractions. Different distractions impact differently on surgeons' mental workload. Future research: • distinguish between appropriate/necessary distractions from unnecessary • effect of different distractions • cumulative effects of distractions.	70%

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Author, year, country	Design and sampling	Study aim	Key findings	Limitations	Implications	MMAT Score
Willett et al.[7] 2019, UK	Prospective observational. Fifty-six caesarean sections, 33 elective and 23 emergency. Total observational time, 38 hours, 29 minutes; mean duration 41.23 mins. Performed by consultants or trainees.	Investigate the frequency and type of distractions during caesarean sections and their impact on patient safety and OR efficiency.	High amount of distractions in the OR n =1396, mean 25.05/patient. Mean number higher during elective cases than emergency. Most frequent: CIC (1), traffic (2) and baby crying (3). Mean level II or III distraction i.e. severity (greater than 1 member or whole team distracted) 13.2/patient. Highest severity: CIC (1), others (2) and equipment (3). 17.89% distractions occurred during critical stage, prior to delivery of baby. 11.25% of operating time involved Level II or III distractions Surgeons' task activity affected, procedure prolonged by 26.8% mean, 11.05 mins/case mean. No intra-operative or post-operative complications.	Small sample. Single procedure. Too small a sample to establish correlation between distracting events and patient complications. Potential selection bias. Single procedure controlled against confounding factor of teaching. Hawthorne effect.	'Sterile cockpit'. Reducing unnecessary prolongation of operating time saves money. Reducing distractions improves efficiency and can lead to improved patient safety. Teamwork, staff training, preoperative briefings to recognise distractions and their impact.	60%
Yang C et al.[10] 2017, UK	Single-centre prospective experimental, simulation. Thirty medical students: 22 females, 8 males. No previous laparoscopic surgery experience. Two tasks, peg transfer (easy) and precision cutting (difficult), performed by each under no distraction, mild distraction (one call and answer question) and strong distraction (two calls and questions).	Assess whether laparoscopic performance in novice surgeons is compromised by intra-operative phone calls.	Easy task (peg transfer): strong distraction was significantly correlated with error, inefficiency and deteriorated performance in addition to an increase in subjective stress levels. Hard task (precision-cutting): task accuracy and quality of answers to clinical questions from phone calls was significantly less in addition to a more subjective disturbance when strongly distracted.	Small sample, unpowered. Applied tasks shorter than real-life surgery. Novice surgeons, not experienced. Subjective perceived disturbance.	Phone calls should be minimised to ensure patient safety. Future research: • influence of phone calls on experienced surgeons.	60%
Yoong, W et al.[11] 2015, UK	Prospective observational. Thirty-five elective gynaecological procedures from 10 consecutive sessions. Single consultant and senior trainees. Total 29.95 hours observed.	Observe and determine the frequency and impact of distractions and interruptions on elective gynaecological surgeries.	High level distractions n = 650, 26/patient. Mean level II or III distraction i.e. severity (greater than one member or whole team distracted) 17/patient, 80.9%. 90% occur in first 30 mins. Surgeries prolonged for mean of 18.46 minutes/case due to distractions. No complications or adverse events were attributable to distractions. Most frequent: equipment issues (1), CIC (2), and) others (3). Highest severity: equipment issues (1), others (2) and CIC (3).	Small sample. Single specialty, single hospital. Hawthorne effect. Potential selection bias.	Implement 'sterile cockpit'. Implement preoperative briefings to enhance planning. Education on how to minimise distractions.	60%

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