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**Integrative Literature Review Examining Factors Affecting Patient Safety With Robotic-Assisted and Laparoscopic Surgeries**

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## **ABSTRACT**

**Purpose:** The purpose of this integrative literature review is to examine the evidence on factors affecting patient safety during robotic assisted and laparoscopic surgeries.

**Design:** Systematic review of papers published between 2011 and 2016 that identified factors affecting safety during robotic assisted and laparoscopic surgeries, in the areas of colorectal, general, urology and gynaecological surgeries.

**Methods:** A systematic literature search of the Cumulative Index to Nursing and Allied Health Literature (CINAHL), Embase and Medline databases were performed. Twelve studies met the inclusion criteria outlining factors affecting safety in robotic assisted and laparoscopic surgeries. All 12 studies selected were quality appraised using the Critical Appraisal Skills Programme.

**Findings:** Using thematic analysis, the outcomes from the 12 studies were categorised into three thematic categories. Intraoperative communication, teamwork and disruptions are the key factors affecting patient safety during robotic assisted and laparoscopic surgeries.

**Conclusion:** This integrative literature review identifies a dearth of evidence examining factors affecting patient safety during robotic assisted and laparoscopic surgeries. It draws attention to the complexities with teamwork, intraoperative communication and disruptions during robotic assisted and laparoscopic surgeries. Although robotic assisted surgery is generally seen as safe and effective, this review highlights the need for education and training that focuses on non-technical skills development, disruption prevention and alertness in anticipating and minimising risk.

**Clinical relevance:** The evidence from this review identifies the different demands and diverse challenges in maintaining safety during robotic assisted and laparoscopic surgery. Although specific technical knowledge and skills are essential, this review highlights the importance of developing new ways of thinking with regards to; assessment and management of disruptions, developing different teamwork patterns and communication skills, in overcoming challenges introduced during technology advanced surgeries. Nurses in the perioperative setting have an increased responsibility to continue professional development and remain vigilant to factors affecting patient safety. Early identification and management of factors leading to disruptions is imperative in the provision of safe perioperative care.

## **KEY WORDS**

Robotic surgery, laparoscopic surgery, nurses, perioperative setting, patient safety.

## **Background**

Laparoscopic or robotic assisted surgeries are central to the new technological surgical environment. Developments in robotic surgery has transformed laparoscopy and as a result robotic-assisted laparoscopic surgery is becoming more popular (Catchpole et al. 2016; Schiff et al. 2016). Robotic surgery differs from laparoscopic surgery, as the surgeon sits at a

computer using hand controls to maneuver and manipulate the robot as opposed to personally holding and manipulating the instrument. Robotic assisted surgery is growing in popularity as current evidence reports fewer post-operative complications and speedier patient recovery times in comparison to more conventional surgical procedures (Aly, 2014; Broeders, 2014; Gill, 2017). Within the literature, integration of such technology is in the early stages with limited evidence demonstrating long-term benefits (Gill, 2017; Rexa et al., 2010). Nonetheless, the increasing reports on how robotic surgical systems have the potential to improve surgical technique and ensure positive patient outcomes have contributed to their growth in popularity (Alpers et al., 2016; Gill, 2017). Although robotic surgery is generally seen as safe with low overall complication rates, the perioperative environment is complex and strategies to assess risk factors and maintain surgical patient safety is paramount. The importance of ensuring patient safety is widely documented in the broader nursing literature (Brasaitte et al., 2015; O' Brien, 2017), however patient safety has received limited attention in the literature discussing robotic assisted surgery. Ahmed et al., (2012) highlight additional risks, unique to the robotic assisted surgical case, for which nurses in the perioperative setting need to remain vigilant.

## **Methods**

The purpose of this integrative literature review was to examine the evidence of the factors affecting patient safety during robotic assisted and laparoscopic surgeries. An electronic search for published studies of the Cumulative Index to Nursing and Allied Health Literature (CINAHL), Embase and Medline databases was undertaken on safety in robotic assisted and laparoscopic surgeries. Further literature searches included grey literature and carrying out a hand search of related articles after checking the reference lists from previous relevant articles retrieved. The keywords selected for the review included; 'robotic surgery', 'laparoscopic surgery', 'safety' and 'perioperative care'. Synonyms were identified ensuring

the specificity and sensitivity of the search. The index terms were then combined using Boolean operators; OR, AND, NOT. Wild cards represented by asterix (\*) were used to expand the search further. A search strategy string was developed using key words, terms, Boolean operators and truncations.

Inclusion and exclusion criteria assisted in the screening process of peer reviewed journal articles (Liberati et al., 2009). Quantitative and qualitative studies focusing on safety in laparoscopic or robotic assisted surgeries across several specialities such as; colorectal, general, urology and gynaecological surgeries were included, as this was the area of expertise of the first author. Studies were included if participating staff were part of the multidisciplinary team working in the perioperative setting during robotic assisted and laparoscopic surgery. General eligibility depended on articles being peer reviewed, published in English, reported on studies carried from 2011 and 2016 on colorectal, general, urology and gynaecological robotic assisted and laparoscopic surgeries.

### **Search Outcome**

The initial implementation of the search methods outlined above retrieved 303 articles. With the support of the librarian, an additional 8 reports/articles were identified through a manual search after checking the reference lists from previous relevant articles retrieved. Following removal of duplicates (n=82), 221 peer reviewed journal articles published between 2011 and 2016 were screened by reading the title and abstract. Out of these, 40 full text articles were assessed for eligibility. After reading the full text articles, 28 were excluded and 12 articles reported on studies that met the review eligibility criteria and were included in this review. Most of the studies excluded did not meet the inclusion criteria, as the primary focus of the studies was not related to factors affecting safety during robotic assisted and laparoscopic surgeries. Complete and transparent reporting of this literature review was ensured using

PRISMA guidelines (Moher et al., 2009), depicting the distinct phases of literature evaluation and the selection process for this review (Figure 1).

Data from selected articles were extracted using the framework created by Kable et al., (2012) where the author, year, title, country, study design, data collection, key findings and limitations were recorded in a table format (Table 1). Findings from the 12 included studies were analysed and incorporated in the data extraction table. The overall quality of the evidence and the risk of bias for each study reviewed were assessed. All 12 studies selected were quality appraised using the Critical Appraisal Skills Programmes (CASP, 2017), which can be used in all research designs, including quantitative, qualitative and mixed method studies (Table 2). This involved adopting a structured approach examining each individual study to determine its strengths and limitations, and therefore, the relevance or weight it should have in addressing the research question (Table 3). Although a number of the studies included demonstrated some limitations, mainly around sample sizes, all research designs were appropriate in meeting the aims of the studies. All included studies identified and discussed study limitations. CASP quality appraisal has been used successfully in previous published integrative literature reviews (Colvin et al., 2013; McCalmén et al., 2014; McLean et al., 2013).

## **Results**

### **Study Characteristics**

The study characteristics are presented in table 4. Six of the 12 studies reviewed focused on laparoscopic procedures (Al-Hakim, 2011; Sevdalis et al., 2012; Hafford et al., 2013; Murji et al., 2016; Silvennoinen et al., 2015; Stavroulis et al., 2013) and 6 focused on robotic assisted surgeries (Allers et al., 2016; Catchpole et al., 2016; Friedman et al., 2013; Jing and Honey,

2016; McCarroll et al., 2015; Randell et al., 2016). Six studies used a qualitative methodology and all of which used thematic data analysis with the exception of Silvennoinen et al., (2015), who quantified types of risks and errors observed. Six studies used quantitative methods, presenting findings as statistical facts and figures. The sample size varied between 10 and 565 and all studies were carried out in hospital settings, with the exception of 1 (Murji et al., 2016), which was carried out in a University surgical laboratory.

The 12 studies reviewed represented divergent types of research designs. Three studies used direct observational methods (Al-Hakim, 2011; Sevdalis et al., 2012; Catchpole et al., 2016) whilst 2 studies combined video recording observations with another method (Silvennoinen et al., 2015; Allers et al., 2016). Two studies analysed records (Friedman et al., 2013; McCarroll et al., 2015); 2 used interviews (Jing and Honey, 2016; Randell et al., 2016) and 3 used questionnaires (Hafford et al., 2013; Murji et al., 2016; Stavroulis et al., 2013), to collect the data. In surgeries of laparoscopic focus the participants for 3 of the studies involved operating room personnel and surgeons (Hafford et al., 2013; Stavroulis et al., 2013; Murji et al., 2016). Three studies observed laparoscopic surgeries and the factors affecting safety during the procedure (Al-Hakim, 2011; Sevdalis et al., 2012; Silvennoinen et al., 2015). Of the 6 studies that focused on robotic surgeries, two reported on identification of safety issues observed during 99 robotic surgical procedures (Allers et al., 2016; Catchpole et al., 2016). Two studies reported on safety issues based on an examination of patient records (n=210) and databases yielding documentation of 565 instrument failures (Friedman et al., 2013; McCarroll et al., 2015). Two studies highlighted information obtained from 92 operating room personnel (Jing and Honey, 2016; Randell et al., 2016). Six countries were represented across the reviewed studies, with the greater number of studies carried out in the USA. Four

studies were conducted in the USA, with the remainder of studies carried out in United Kingdom (n=3), Australia (n=2), Canada (n=1), Finland (n=1) and New Zealand (n=1).

### **Analysis and Synthesis**

The aim of this integrative literature review was to present a synthesis of the findings from relevant studies to identify the main across-study themes and develop recommendations for interventions and future research. Using thematic analysis, the outcomes from the 12 studies were categorised into thematic categories based on their common characteristics. Thematic analysis involved familiarisation with the findings/results of individual studies, generating codes, identifying, reviewing and finalising themes. In accordance with Wakefield (2015), full texts were read and analysed for relevance, noting down initial ideas in capturing the diversity of the data. Interesting features of the data were coded and collated into themes. While the development of themes remained 'close' to the primary research, the analytical themes generated represented new re-occurring patterns within the data. These themes represent ways of understanding the combined meaning of the research articles. Analysis of the factors in these studies resulted in three overarching themes that describe factors affecting safety within robotic assisted and laparoscopic surgeries. Intraoperative communication, teamwork and disruption are the key factors identified that affect patient safety during robotic assisted and laparoscopic surgeries.

### **Intraoperative Communication**

Intraoperative communication was identified as a factor affecting patient safety during robotic assisted and laparoscopic surgery (Al-Hakim, 2011; Allers et al., 2016; Catchpole et al., 2016; Sevdalis et al., 2012). Intraoperative communication is described as the communication and interaction between all members of the surgical team during the procedure from incision to skin closure (Sevdalis et al., 2012). Although effective

intraoperative communication is important during any surgical procedure, this review highlights the complexities of interactions and differing communication patterns during robotic assisted and laparoscopic surgeries. The evidence highlights that there are increased communication requirements and reduced vision ability when using robotic equipment (Allers et al., 2016; Catchpole et al., 2016), and a greater depth of interaction is required (Al-Hakim, 2011; Sevdalis et al., 2012). Intraoperative communication failure is a common contributor to adverse events and although most communication errors are minor, some result in adverse events (Catchpole et al., 2016). Sevdalis et al., (2012) reported that at least two intraoperative communication errors occurred every minute, during laparoscopic surgeries. Poor communication skills, inexperience with use of equipment and less team familiarity were factors affecting reported intraoperative communication errors (Sevdalis et al., 2012; Allers et al., 2016).

The importance of coordination, training and effective utilisation of communication skills in improving surgical performance and safety was identified (Sevdalis et al., 2012; Catchpole et al., 2016). Sevdalis et al., (2012) reported their findings based on direct observations during laparoscopic (n=20) and open (n=20) hernia repairs. They found that most intraoperative communication during laparoscopic surgeries were related to the condition of the patient and equipment. Coordination and management related communications were also present but to a lesser extent. Similarly, Cathapole et al., (2016) found that equipment failure adds to the complexity of intraoperative communication and coordination, particularly when equipment is difficult to access, prepare and position. However, Allers et al., (2016) asserts that team familiarity improves intraoperative communication, even within technically challenging perioperative care environments. Even though the magnitude of communication varies



depending on the type of surgery and equipment being used, the surgical team are responsible for ensuring patient safety.

### **Teamwork**

Four of the reviewed studies identified the importance of teamwork in maintaining patient safety during robotic assisted and laparoscopic surgery (Allers et al., 2016; Catchpole et al., 2016; Stavroulis et al., 2013; Randell et al., 2016). The operating theatre team of surgeons, nurses and anaesthesiologists have a combined responsibility to ensure that the operating room is safe for delivery of care and this requires effective teamwork. Teamwork requires a combination of interactions among professionals, whilst adhering to clinical guidelines. Allers et al., (2016) and Catchpole et al., (2016) analysed factors affecting efficiency during robotic surgery and findings from both studies concur that teamwork enhances safety and efficiency. Similarly, a cross sectional survey of theatre teams by Stavroulis et al., (2013) identified that effective teamwork enhanced better performance and reduced stress levels, contributing to positive patient safety outcomes. Although perioperative care has been revolutionised with technological advancements, teamwork remains crucial in enhancing efficiency and safety (Allers et al., 2016). However, Catchpole et al., (2016) identified the challenges with working in teams during robotic assisted surgeries reporting specifically on; distance, obstacles, visual and physical barriers. Randell et al., (2016) noted that the surgeons' situation awareness during robotic surgery is reduced, due to the physical separation from the operating table and their focus on a small specific area. Personnel communication skills are essential in increasing surgeon situation awareness. Effective team communication is essential for relaying information to the surgeon about occurrences outside their field of vision. Allers et al., (2016) and Catchpole et al., (2016) suggest that when

teamwork and cohesiveness are present, tasks are completed on time and adverse events are less likely.

## **Disruption**

Disruptions are classified as interruptions to the surgery, which prolongs surgery time and subsequently can affect the quality and safety of patient care. Catchpole et al. (2016) define disruptions as ‘deviations from the natural progression of an operation’ Assessing disruption risks and avoiding disruptions during robotic assisted and laparoscopic surgery emerged as a theme. Disruptions were classified as avoidable and unavoidable interruptions (Allers et al., 2016). Unavoidable interruptions were related to equipment/technology, supervision/training, and were procedure specific. Avoidable interruptions were related to non-procedural related tasks such as personal conversations and telephone calls. Disruptions emerged as a significant factor in maintaining patient safety and was highlighted in 6 of the 12 studies reviewed (Al-Hakim, 2011; Allers et al., 2016; Catchpole et al., 2016; Friedman et al., 2013; Sevdalis et al., 2012; Silvennoinen et al., 2015). Preventable disruptions caused unnecessary stress and disturbed operative time, thus jeopardising the safety of the patient (Allers et al., 2016; Catchpole et al., 2016; Al-Hakim, 2011). Murji et al., (2016) and Randell et al., (2016) considered the effect of decision making on safety and the implications of distractions which are substantial risks to patient safety. They found that participants were more likely to finish activities in allocated timeframes when they were not distracted or disturbed.

Four studies discussed equipment failure as a factor that affects disruption and patient safety during robotic assisted and laparoscopic surgery (Catchpole et al., 2016; Friedman et al., 2013; Sevdalis et al., 2012; Silvennoinen et al., 2015). Catchpole et al., (2016) highlighted

the predominance and recurrence of equipment issues in workflow disruptions during robotic surgery. Use of complex instruments augmented the prospects for system failures (Catchpole et al., 2016). During the operative phase where robots were in use, surgical flow was interrupted every four minutes. The distraction and stress caused by these delays in the surgical environment presented as a significant threat to patient safety (Catchpole et al., 2016). Through video recordings and interviews, 20 types of failures were identified (Silvennoinen et al., 2015). Insufficient use of the available equipment, blurred image, and threats related to unfamiliar equipment risked patient safety. Mechanical failures during robotic assisted surgical procedures affected the outcome of the procedures and in some incidents leading to surgery cancellations (Friedman et al., 2013). A qualitative analysis of the MAUDE (Manufacture and User Facility Device Experience) data base for da Vinci instrument failures, by Friedman et al., (2013) between 2009 and 2010 is very significant in this context. They categorised 565 reported failures into five themes; wrist or tooltip failures, cautery instrument failures, instrument shaft failures, cable and control housing failures and monopolar curved scissors instrument failures.

Human and organisational factors were also identified as factors affecting disruption risks. Five of the 12 studies reviewed highlighted how human and organisational factors affect the safety of the surgical patient during robotic assisted and laparoscopic surgery. Overall, the robotic surgical efficiency and safety improved with increased knowledge, skills and familiarity with equipment and procedures (Allers et al., 2016; Catchpole et al., 2016; Hafford et al., 2012; Jing and Honey, 2016; Mc Carroll et al., 2015). However, Hafford et al., (2013) assessed perceptions of knowledge and skills required but identified that skills varied considerably, which is a safety issue that requires consideration. Organisational logistics, structures and policies were also found to play an important role in minimising

interruptions, enhancing efficiency and thus maintaining patient safety (Allers et al., 2016; Jing and Honey, 2016; Mc Carroll et al., 2015). These studies highlight that increased operating time is closely associated with poorer outcomes, prolonged recovery, and longer hospital admission times. The use of robotic assisted safety checklists analysed in two of the studies reviewed assisted with the early identification of mechanical failures and team working, which had a positive impact on efficiency and subsequent patient safety (Jing and Honey, 2016; McCarroll et al., 2015).

## **Discussion**

Advancements in technology and surgical procedures are rapidly growing. Calls for ensuring quality and safety are global healthcare policies. Surprisingly, there remains a scarcity of literature exploring factors affecting safety in robotic assisted and laparoscopic surgery. This integrated review synthesised the findings of 12 studies and highlights the diverse challenges in minimising risk and maintaining patient safety during robotic assisted and laparoscopic surgeries. The perioperative environment is a complex, high risk setting (Gill 2017) and ensuring patient safety is a constant concern for perioperative staff (Braisaitte et al., 2015; O' Brien, 2017). These risk factors are exacerbated during laparoscopic or robotic assisted surgery, as it creates other risks for patient safety, that have received less attention within existing literature. Although robotic assisted laparoscopic surgeries are becoming more popular, it requires a distinct set of both technical and non-technical skills compared to conventional laparoscopic surgeries (Catchpole et al., 2016; Randell et al., 2016; Schiff et al. 2016).

Intraoperative communication and teamwork are the cornerstones for effective decision making and maintaining patient safety. Communication errors and the complexity of team working during robotic surgeries have been identified as a major patient safety concern in the

perioperative setting (Allers et al., 2016; Sevdalis et al., 2012). Distractions and disruptions in the operating theatre resulting in stress, human or equipment failure may negatively impact on patient safety (Catchpole et al., 2016; Murji et al., 2016). Ensuring a greater commitment to education and training (Catchpole et al., 2016; Hafford et al., 2013) and organisational structures, systems, policies and protocols should consider the need to assess risks and take precautions to ensure patient safety (Allers et al., 2016; Jing and Honey, 2016; Mc Carroll et al., 2015). Hafford et al., (2013) emphasise the importance of knowledge, education and competence for surgeons and all the multidisciplinary team. However cathpole et al. (2016) highlight the importance of focusing on non-technical skills such as communication and teamwork as well as technical knowledge and skills. Policies and protocols also play a role in ensuring the provision of safe care, in the technologically challenging environment of the operating room (Jing and Honey, 2016).

### **Implications for Perioperative Nursing**

This literature review identifies the complexities with maintaining effective intraoperative communication and teamwork during robotic assisted and laparoscopic surgery. Understanding these challenges identifies the importance of developing education and training around different teamwork patterns, increased vigilance and communication skills. Although all of the multidisciplinary team in the perioperative setting is responsible for minimising risk and maintaining patient safety, the role of the nurse in overcoming challenges with teamwork integration and intraoperative communication in increasing patient safety, is paramount. Although specific technical knowledge and skills are essential, this review highlights the importance of developing new ways of thinking with regards to risk assessment, developing different teamwork patterns and communication skills, in overcoming challenges introduced during technology advanced surgeries. Catchpole et al., (2016) and

Schiffe et al., (2016) classify communication and teamwork as ‘non-technical social and cognitive skills’. Nurses need to be vigilant in anticipating and minimising risk of disruptions during robotic assisted and laparoscopic surgeries in the perioperative setting and further research examining the risk factors and effectiveness is warranted. The implementation of existing checklists and preoperative briefing should be encouraged by perioperative nurses in their practice areas to maximise patient safety. Nurse managers should provide an environment for learning and safe care by providing protected educational time for the staff to attend training sessions in preventing unavoidable disruptions and developing communication and team integration skills during technology advanced surgeries. Team training exercises provide team communication opportunities to learn with and from each other, enhancing multidisciplinary teamworking. Incorporating guided reflection in every day practice ensures that the daily challenges associated with communication, teamwork and procedure related skills are explored, without putting patient safety at risk. Perioperative nurses should take initiatives in conducting and organising in-service education programme and hands on training, when new technology is introduced in their area of practice.

### **Limitations**

This integrative literature review examines the evidence on the factors impacting on patient safety during robotic assisted and laparoscopic surgeries. Limitations in this integrative review, similar to all reviews arise from the choice of studies and methods of analysis used. Bartolucci and Hillegass (2010) consider and discuss this as a ‘real world’ limitation of literature reviews. Although it was challenging at times to synthesise findings from studies included in this review due to the diverse research objectives of the individual studies, incorporating thematic analysis was helpful. Even though there were only 12 studies included, they were the most relevant for this literature review. This review focused on

robotic and laparoscopic surgery in the areas of colorectal, general, urology and gynecological surgeries only, which increases the risk of reporting bias. The search was limited to studies published between the years 2011 and 2016, increasing the risk of study selection bias. Although there were limitations identified with a number of the studies included, such as; limited sample sizes, single location settings and data collection methods, they were included in this literature review due to the limited research available in this area. The reader is required to keep in mind that an integrative literature review should neither be a replacement for a large research study or a reason for a smaller scale study. However, future research is needed to address the limitations highlighted in this review. Further studies are also needed to examine the effectiveness and factors affecting safety in robotic assisted surgery. In addition, studies that use measures to minimise bias and limitations associated with methodology and methods should be considered. Studies using larger sample sizes across a number of settings that explore factors affecting safety during robotic assisted surgery, from the perspective of the perioperative nurse are warranted.

## **Conclusions**

This integrative review presented the factors affecting safety within robotic assisted and laparoscopic surgeries under three themes: intraoperative communication, teamwork and disruption. This assists with .enhancement, understanding and contribution to the development of the role of the perioperative nurse in ensuring patient safety. With robotic assisted and technology advanced surgery increasing internationally, the importance of considering the risk factors is essential. Although robotic assisted surgery is generally seen as safe and effective; this review highlights that greater consideration is needed to explore strategies to ensure risks are assessed and appropriately addressed. Nurses in the perioperative setting need to be cognisant of timely identification and management of factors leading to adverse patient outcomes in the provision of safe surgical care.

## Clinical Resources

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