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Automation angst in robotic surgical emergencies: A discussion paper

Abstract

Introduction: The inclusion of a surgical robot as a team member adds yet another level of intricacy to the already complex environment and roles for perioperative nurses. Over the last twenty years, robotic-assisted surgery (RAS) has gained popularity due to its many benefits, including operative precision, decreased length of stay, and reduced blood loss.

Aim: This discussion paper aims to provide a greater understanding of robotic surgery for perioperative nurses by offering an overview of the incidence and types of intraoperative robotic surgical emergencies and some technical and non-technical responses to these emergency situations.

Discussion: Like all surgical procedures, RAS has inherent risks, with adverse surgical emergencies creating stress, 'automation angst', for the perioperative team members, particularly those who are not familiar or well-practiced with these procedures.

Following thematic analysis of the reviewed literature, this discussion will be presented under the emerging themes, namely, 'Robotic surgical emergencies', 'Non-technical skills for the multidisciplinary team', 'Simulation-based training for crisis management', and 'Implications for perioperative nurses'.

Conclusion: While robotic surgical emergencies are not common, they do occur, and perioperative nurses need to be prepared. During emergency situations, communication must be at a premium, and the lessons from human factors and situational awareness are well documented.

An ongoing message running through the literature was surrounding the need for education, emphasising that continuous education is required to achieve competence of surgical team members in preparing for emergency situations. Simulation may play an important role in this education. Also important will be the development and implementation of an emergency robotic undocking protocol (ERUP) to guide the team when conversion to open or speedy access to the patient is required.

Keywords: robotic surgery, communication, patient safety, simulation-based training, perioperative nurse

Introduction

The inclusion of a surgical robot as a team member adds yet another level of intricacy to the already complex environment and roles in the operating room¹. Over the last twenty years, robotic-assisted surgery (RAS) has gained popularity due to its many benefits, including operative precision, decreased length of stay, and reduced blood loss^{2,3}.

However, both McBride et al.³ and Sakalkale et al.⁴ suggest that a slower uptake has been seen within the Australian public health system due to the high implementation costs. In their

retrospective analysis, McBride et al.³ reported that robotic systems such as the Da Vinci surgical robot cost approximately \$3.9 million AUD to set up, further suggesting that when performed in a large tertiary hospital, the median cost was approximately \$19 269 AUD per case.

Despite the positive health benefits for patients, such as all other surgical procedures, RAS has inherent risks, with adverse events creating stress, 'automation angst', for the perioperative team members as they negotiate this expensive technical surgical equipment⁵⁻⁷.

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Operating theatres are complex environments^{1,8-9}. Therefore, having a full understanding of potential risks and emergency situations that may occur during all surgical procedures is paramount in promoting patient safety.

This discussion paper aims to provide a greater understanding of RAS for perioperative nurses by providing an overview of the incidence and types of intraoperative robotic surgical emergencies and some technical and non-technical responses to these emergency situations.

Discussion

The scholarly literature surrounding RAS was reviewed to provide a deep understanding of the complexities of this type of surgery. Due to a paucity of primary research, both quality improvement studies and grey literature have also been included.

Following thematic analysis of the reviewed literature, this discussion will be presented under the emerging themes, namely, 'Robotic surgical emergencies', 'Non-technical skills for the multidisciplinary team', 'Simulation-based training for crisis management', and 'Implications for perioperative nurses'.

Robotic surgical emergencies

Robotic surgical emergencies fall under two separate classifications; 'technical emergencies', relating to the robotic system, or 'surgical emergencies', relating to adverse events such as unfavourable intraoperative findings (disease progression or intra-abdominal adhesions) or bleeding¹⁰.

In a nationwide retrospective study conducted in the Netherlands, Pliz da Cunha et al.¹⁰ findings revealed that the primary reasons for conversion from robotic to open surgery were 'technical emergencies' (n=134, 32.8%) followed by 'surgical emergencies' (n=71, 17.4%). Despite the root cause, both types of emergencies present common challenges for the multidisciplinary team, as robotic emergencies may differ from those of mainstream surgery¹¹.

Technical emergencies

Despite the general reliability of robotic surgery, such as all mechanical and

electronic devices, Buffi et al.¹² stated that technical and mechanical failures can occur due to component malfunction requiring troubleshooting or instrument replacement. If the robotic console detects a system failure that cannot be overridden, a red light will blink, indicating that the system must be shut down¹³.

In a qualitative study by Sinmaz et al.⁶ (n=11), this occurrence was reported as engendering palpable fear on the part of perioperative nurses, as the 'red' alert was associated with an irreversible error that could only be rectified by turning the system off. This fear was further exacerbated by the prospect of having to manually undock the robotic device from inside the patient in a safe manner⁶. This anxiety stemmed from their limited knowledge of, and information regarding, the technology in use⁶. This unease, associated with increasing system complexity, is a phenomenon known as 'technostress'⁶.

Surgical emergencies

Surgical emergencies requiring conversion from robotic to open surgery generally stem from uncontrollable bleeding¹⁴. In a large quantitative retrospective analysis study conducted in the United States of America by Abd El Aziz et al.¹⁵ (n = 8351), the need for conversion to open robotic surgery was identified in 427(4.9%) of robotic procedures over a six-year period. Robotics, as a minimally invasive technique, was a statistically significant protective factor in the rate of conversion (P<0.0001), with the patients' comorbidities and disease progression being more relevant indicative factors¹⁵.

In an Italian observational study conducted by Manfredini et al.¹⁶ examining thoracic robotic surgeries (n=460), seven (1.4%) emergencies were identified as a result of intraoperative haemorrhage. Six of these resulted from injuries to the pulmonary artery or subsequent branches, while one was associated with injuries to the thoracic aorta¹⁶. Of these emergencies, five procedures required emergency undocking and conversion to open surgery¹⁶.

Although surgical complications, such as intraoperative haemorrhage in RAS, occur at an infrequent rate, it is essential that the multidisciplinary team understand

how to effectively communicate when such emergencies do arise⁸.

Non-technical skills for the multidisciplinary team

Communicating effectively is essential during emergency situations to promote safe patient care¹. Adverse events experienced during robotic surgery can result from failures in non-technical skills, such as communication¹⁷⁻¹⁸ and reduced situational awareness¹. Dysfunctional multidisciplinary teams that experience breakdowns in communication are a known barrier to safe patient care^{8,19}; hence, the effective use of non-technical skills is paramount to promoting safety in the robotic theatre environment^{1,7}.

Adopting best practices from the aviation industry, the use of closed loop communication has been proven to be an effective tool in crisis management²⁰⁻²¹. In a prospective observational study by Sutkin et al.²¹ (n=78), closed loop communication was seen as beneficial in mitigating the effects of speech communication interference, of which 136 (19.8%) were identified during critical moments of surgery. This finding is further confirmed in a mixed methods multicentre prospective study (n=45) conducted by Cofran et al.²² in Southern California, in which communication flow disruptions were identified as the second most common disruption, occurring at a rate of 6.45 FDs/h (95% CI 5.02-7.89 FDs/h).

Closed loop communication works by communicating a message as the sender and having that request repeated back by the recipient to confirm that the message has been received and actioned²⁰. In a single health simulation study conducted by Gors et al.²³ (n=134), participants viewed clear, audible, closed loop communication as a key facilitator when responding to crisis events in the operating room. Closed loop communication can positively contribute to patient safety, as this practice standardises interactions and verifies the transmission and reception of vital information shared by multidisciplinary team members¹⁸.

In a prospective observational study, Sutkin et al.²¹ (n=78) inferred that active listening and situational awareness are key non-technical skills of perioperative nurses working in robotic surgery, with one observation highlighting

that surgeons need to repeat their request for a haemostatic clip, causing a 24 second delay. While this example demonstrates what appears to be a minor adverse event²¹, it still demonstrates the importance of effective communication by the requesting surgeon and active listening on the part of the perioperative nurse to promptly respond and acknowledge the request. During robotic surgeries, nurses must remain vigilant and be ready to call for help in an emergency, utilising effective communication skills in advocating for patient safety, which is foundational to the role of perioperative nurses^{9,11,24}.

Through active listening, perioperative nurses can promptly respond to adverse events that require interventions. In a focus group interview of (n=60) nurses by Çelik et al.²⁵ using interpretative phenomenology analysis, one mitigation strategy employed by robotic nurses to prepare for emergency adverse events is having a conversion setup of instruments and consumables available in the operating room. This finding was supportive of 98.3 percent of respondents²⁵.

England et al.⁵ further support this finding in a simulation study examining intraoperative haemorrhage that surgical instruments for open conversion must be made available and counted. In addition to surgical instruments, surgeons operating on robotic consoles must be re-gowned and gloved in sterile attire to safely assist in emergency conversions⁵.

The role of the circulating nurse includes preparing an environment suitable for the surgeon to don new sterile gown and gloves. Preparing an appropriately responsive environment is supported by findings made by Kalipershad and Peristerakis²⁶, who suggest that the surgeon's gown and gloves be placed on a trolley near the surgeon's robotic console to facilitate emergent conversion.

These simple yet effective strategies, alongside the non-technical and simulation-based options considered above, will help perioperative nurses prepare for the challenges of RAS. Negotiating the altered physical environment during robotic surgery and adapting team communications to manage these tasks will depend on staff

experience, team familiarity, and the complexity of the specific case¹. These non-technical skills could be practiced within the context of simulation-based training for crisis management.

Simulation-based training for crisis management

Interprofessional team training and simulation-based exercises have been identified within the literature as beneficial methods for increasing non-technical skills and team preparedness during emergency situations¹⁸. According to de Almeida et al.²⁷, while the incidence of critical emergencies, such as technical failures leading to system malfunction and intraoperative haemorrhage, are considered rare events within robotic surgery, preparedness by multidisciplinary teams to deal with these eventualities is enhanced if they can refine their technical and non-technical skills through exposure. Thus, crisis management through simulation-based training offers valuable experiential learning opportunities²⁸.

Surgical robot undocking is a complex task that requires clear and precise coordination between the multidisciplinary team²⁸. First, the instruments are required to be detached from the top of the robotic arms, allowing the trocars to be detached from the base of the robotic arms²⁹. After these tasks have been completed, the robot is then able to be removed from the operative field, allowing critical access to the patient²⁹.

If additional time is taken for the multidisciplinary team to complete these tasks safely, this may further delay resuscitation efforts in the event of cardiac arrest or delay the surgical team's access to perform emergent open conversion surgery²⁹. Hence, several studies within the literature support the implementation of an emergency robotic undocking protocol coupled with high-fidelity multidisciplinary training^{14, 27, 29-31}.

In observational simulation-based research with perioperative teams (n=10), a study pre- and post-training using an emergency robotic undocking protocol (ERUP) was performed²⁹. Kadlec et al.²⁹ observed that following training, the time for the console surgeon to command an emergent undock decreased from 30

seconds to five seconds, signifying an 83 percent improvement between pre- and postimplementation. The time to undock the robot also decreased from 74 seconds to 33 seconds, representing a 55 percent improvement of the multidisciplinary team.

These findings are echoed by Saba et al.³¹ in their (n=3) longitudinal analysis of emergency undocking simulation-based training, which resulted in a statistically significant improvement in participants' knowledge of emergency procedures (P<0.004), their confidence levels (P<0.001), and their ability to safely and efficiently undock the surgical robot (P<0.001).

While not a robotic emergency simulation, a study conducted by Gros et al.²³ (n = 134) on interprofessional operating room crisis management through simulation-based training demonstrated that the impact of such training has a positive and statistically significant effect on communication (P=0.0019, r= 0.18), the utilisation of resources (P=0.0014, r=0.18) and the establishment of role clarity (P<0.0010, r=0.22).

These research findings highlight the positive impacts simulation-based training has on multidisciplinary teams' management of intraoperative crisis situations. Through understanding the demonstrable importance and beneficial aspects of non-technical skills and simulation-based training, the applicability of these concepts to robotic surgery emergencies and the role of perioperative nurses may become clearer.

The implications for perioperative nurses

The vital need for ongoing education has been echoed in the literature surrounding robotic surgery and considered a key requirement for perioperative nurses working in this specialty. Sinmaz et al.⁶ emphasised that continuous education is required to achieve competence of surgical team members in preparing for emergency situations and to promote patient safety. By allowing the nurses to reach a satisfactory level of proficiency, they felt more confident in their clinical robotic surgical practice⁶.

Equally important will be the development and implementation of an

'emergency robotic undocking protocol (ERUP)' that may be coupled with high-fidelity multidisciplinary training^{14, 27, 29-31}. Unplanned conversion rates have significantly decreased over time, implying that increased proficiency and careful patient selection may also help prevent unplanned conversions¹¹.

Alongside education and the implementation of robotic surgery comes an expansion in the roles and responsibilities for perioperative nurses^{1,32}. Consequently, examining the implications of this technical innovation for perioperative nurses is imperative if they are to successfully transition to new forms of practice.

Conclusion

This discussion paper has provided an overview of intraoperative robotic surgical emergencies, discussed non-technical skills for the multidisciplinary team, simulation-based training for crisis management, and implications for perioperative nurses.

While robotic surgical emergencies are not common, they do occur, and perioperative nurses need to be prepared. During emergency situations, communication must be at a premium, and the lessons from human factors and situational awareness are well documented.

As an ongoing message running through the literature was surrounding the need for team education (including the perioperative nurses), it is a recommendation of this discussion paper to provide said education and training to the RAS team. It should be emphasised that continuous education is required to achieve competence of surgical team members in preparing for emergency situations.

Simulation and human factors may also play an important role in this education. It is also recommended that each operating theatre that uses RAS develop and implement an 'emergency robotic undocking protocol (ERUP)' to guide the team when conversion to open or speedy access to the patient is required.

It is hoped that implementing these recommendations will help perioperative nurses involved in RAS to feel safer

and more confident should an emergency occur and will provide a safer perioperative journey for patients undergoing RAS.

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References

- Gillespie BM, Gillespie J, Boorman RJ, Granqvist K, Stranne J, Erichsen-Andersson A. The impact of robotic-assisted surgery on team performance: a systematic mixed studies review. *Hum Factors*. 2021[cited 2026 May 31];63(8):1352–1379. doi:10.1177/0018720820928624.
- Myklebust MV, Storheim H, Hartvik M, Dysvik E. Anesthesia professionals' perspectives of teamwork during robotic-assisted surgery. *AORN J*. 2020 [cited 2025 May 5];111(1):87–96. doi:10.1002/aorn.12897.
- McBride K, Steffens D, Stanislaus C, Solomon M, Anderson T, Thanigasalam R, et al. Detailed cost of robotic-assisted surgery in the Australian public health sector: from implementation to a multi-specialty caseload. *BMC Health Serv Res*. 2021[cited 2025 May 5];21(1):108. doi:10.1186/s12913-021-06105-z.
- Sakalkale A, Satheakeerthy S, Yeung JMC, Reid F. Robots down-under: the current climate of robotic-assisted surgery education in Australia. *J Robot Surg*. 2024[cited 2025 May 5];18(1):246. doi:10.1007/s11701-024-01994-8.
- England EC, Spear CR, Huang DD, Weinberg J, Bogert JN, Gillespie T, et al. REBOA as a rescue strategy for catastrophic vascular injury during robotic surgery. *J Robot Surg*. 2020 [cited 2025 May 5];14(3):473–477. doi:10.1007/s11701-019-01011-3.

- Sinmaz T, Kara Ö, Seyhan Ak E, Özbaş A. Experiences of robotic surgery nurses regarding technostress: a qualitative study. *J Robot Surg*. 2025[cited 2025 May 5];19(1):154. doi:10.1007/s11701-025-02320-6.
- Çelik SS, Koken ZO, Canda AE, Esen T. Experiences of perioperative nurses with robotic-assisted surgery: a systematic review of qualitative studies. *J Robot Surg*. 2023[cited 2025 May 5];17(3):785–795. doi:10.1007/s11701-022-01511-9.
- Hibberson M, Lawton J, Whitehead D. Multidisciplinary simulation training for Australian perioperative teams: a qualitative descriptive exploratory study. *J Perioper Nurs*. 2023[cited 2025 May 5];36(4):e14–e35. doi:10.26550/2209-1092.1261.
- Russell B. Understanding the role of the scrub nurse during robotic surgery. *Nurs Stand*. 2022;37(12):71–75. doi:10.7748/ns.2022.e12003.
- Pilz da Cunha G, Sijberden JP, Gobardhan P, Lips DJ, Terkivatan T, Marsman HA, et al. Risk factors and outcomes of conversions in robotic and laparoscopic liver resections: a nationwide analysis. *Surgery*. 2025[cited 2025 May 5];178:108820. doi:10.1016/j.surg.2024.09.004.
- Slavin M, Ross SB, Sucandy I, Saravanan S, Crespo KL, Syblis CC, et al. Unplanned conversions of robotic pancreaticoduodenectomy: short-term outcomes and suggested stepwise approach for a safe conversion. *Surg Endosc*. 2024[cited 2025 May 5];38(2):964–974. doi:10.1007/s00464-023-10527-7.
- Buffi NM, Piccolini A, Moretto S, Paciotti M, Finocchiaro A, Cella L, et al. Reliability of the da Vinci robotic surgical system: a systematic review and pooled analysis of technical failures. *World J Urol*. 2025[cited 2025 May 5];43(1):348. doi:10.1007/s00345-025-05732-z.
- Ogihara A, Omata M, Shidei H, Mitsuboshi S, Aoshima H, Isaka T, et al. Intraoperative robotic surgical system-related problems in robot-assisted thoracoscopic surgery. *Gen Thorac Cardiovasc Surg*. 2024[cited 2025 May 31];72(9):593–598. doi:10.1007/s11748-024-02013-1.
- Watkins AA, Ricard C, Hoagland D, Shehata D, Price M, Trant CJ, et al. Emergency conversion from robotic thoracoscopy to thoracotomy: a safe, reproducible, and effective technique. *Oper Tech Thorac Cardiovasc Surg*. 2025[cited 2025 May 5];30(1):67–74. doi:10.1053/j.optechstcvs.2024.10.005.
- Abd El Aziz MA, Grass F, Behm KT, D'Angelo AL, Mathis KL, Dozois EJ, et al. Trends and consequences of surgical conversion in the United States. *Surg Endosc*. 2022[cited 2025 May 5];36(1):82–90. doi:10.1007/s00464-020-08240-w.

16. Manfredini B, Zirafa CC, Romano G, Bagalà E, Cariello C, Davini F, et al. Intraoperative catastrophes during robotic lung resection: a single-center experience and review of the literature. *Life* (Basel). 2023[cited 2025 May 5];13(1):215. doi:10.3390/life13010215.
17. Restaino S, Paparcura F, Arcieri M, Pellecchia G, Poli A, Gallotta V, et al. Employing the aviation model to reduce errors in robotic gynecological surgery: a narrative review. *Healthcare* (Basel). 2024[cited 2025 May 5];12(16):1614. doi:10.3390/healthcare12161614.
18. Clanahan JM, Awad MM. How does robotic-assisted surgery change OR safety culture? *AMA J Ethics*. 2023[cited 2025 May 5];25(8):E615–E623. doi:10.1001/amajethics.2023.615.
19. Mahendran V, Turpin L, Boal M, Francis NK. Assessment and application of non-technical skills in robotic-assisted surgery: a systematic review. *Surg Endosc*. 2024[cited 2025 May 5];38(4):1758–1774. doi:10.1007/s00464-024-10713-1.
20. Wood TC, Rahman R, Bainton T, Ahmed J, Raza A. The importance of non-technical skills in robot-assisted surgery in gynaecology. *J Robot Surg*. 2024[cited 2025 May 5];18(1):192. doi:10.1007/s11701-024-01956-0.
21. Sutkin G, Steele C, Brommelsiek M, Simonson RJ, Chan YYR, Davies A, et al. Speech communication interference in the robotic operating room. *J Robot Surg*. 2024[cited 2025 May 5];18(1):406. doi:10.1007/s11701-024-02157-5.
22. Cofran L, Cohen T, Alfred M, Kanji F, Choi E, Savage S, et al. Barriers to safety and efficiency in robotic surgery docking. *Surg Endosc*. 2022[cited 2025 May 5];36(1):206–215. doi:10.1007/s00464-020-08258-0.
23. Gros E, Shi R, Hasty B, Anderson T, Schmiederer I, Roman-Micek T, et al. In situ interprofessional operating room simulations: empowering learners in crisis resource management principles. *Surgery*. 2021[cited 2025 May 5];170(2):432–439. doi:10.1016/j.surg.2021.02.011.
24. Redondo-Sáenz D, Cortés-Salas C, Parrales-Mora M. Perioperative nursing role in robotic surgery: an integrative review. *J Perianesth Nurs*. 2023[cited 2025 May 5];38(4):636–641. doi:10.1016/j.jopan.2022.11.001.
25. Çelik SS, Tunçbilek Z, Sarıköse S, Topaktaş G, Canda AE. Roles, experience and views of nurses working in robotic surgery settings: a mixed-methods study. *J Perioper Pract*. 2024[cited 2025 May 5];34(7–8):248–256. doi:10.1177/17504589241231100.
26. Kalipershad SNR, Peristerakis I. The introduction of an emergency safety protocol coupled with simulation training in robotic surgery has enabled a more cohesive and efficient response to emergencies. *Surgeon*. 2022[cited 2025 May 5];20(3):151–156. doi:10.1016/j.surge.2021.03.007.
27. de Almeida TFP, Campos MEC, de Castro PR, Garcia DPC, Junger G, Faria e Silva R, et al. Training in the protocol for robotic undocking for life emergency support (RULES) improves team communication, coordination and reduces the time required to decouple the robotic system from the patient. *Int J Med Robot*. 2022[cited 2025 May 5];18(6):e2454. doi:10.1002/rcs.2454.
28. Chan YY, Zhong J, Jacobs MA, Peters CA. Emergent robot-to-open conversion – multidisciplinary simulation training in crisis management. *J Pediatr Urol*. 2024[cited 2025 May 5];20(4):751–758. doi:10.1016/j.jpuro.2024.06.010.
29. Kadlec KE, Thompson J, Brogdon S, Muckler VC. Developing and implementing an emergency robotic undocking protocol at a community hospital. *J Interprof Educ Pract*. 2020[cited 2025 May 5];21:100385. doi:10.1016/j.xjep.2020.100385.
30. Dunnahoo FC, Thompson J, Muckler VC. Developing an emergency robotic undocking protocol using simulation. *J Interprof Educ Pract*. 2021[cited 2025 May 5];24:100464. doi:10.1016/j.xjep.2021.100464.
31. Saba P, Shuler N, Shepard L, Holler T, Wu G, Rashid H, et al. Design and implementation of an emergency undocking curriculum for robotic surgery utilizing a 3D printing hydrogel bleeding vascular model. *Urol Video J*. 2022[cited 2025 May 5];16:100186. doi:10.1016/j.urolvj.2022.100186.
32. Møller L, Olsen RG, Jørgensen L, Hertz P, Petersson J, Røder A, et al. Training and education of operating room nurses in robot-assisted surgery: a systematic review. *Surg Endosc*. 2024[cited 2025 May 5];38(12):7024–7036. doi:10.1007/s00464-024-11335-3.