CASE REPORT

Nagoya J. Med. Sci. **87**. 368–373, 2025
doi:10.18999/nagjms.87.2.368

Importance of anesthesiologists' non-technical skills in the management of a case of life-threatening cardiac tamponade during robot-assisted thoracic surgery

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ABSTRACT

Deficiency of non-technical skills may increase the number of adverse events in the operating room. Sustained life-threatening hypotension due to intraoperative cardiac tamponade during robot-assisted thoracic surgery is rare, requiring prompt assessment and swift decision-making. A 54-year-old woman was scheduled to undergo robot-assisted thoracic surgery for an anterior mediastinal tumor. During the operation, hemodynamic instability occurred despite the administration of a high dose of vasopressor. Anesthesiologists and thoracic surgeons shared information regarding the situation, and decided to perform echocardiography and call other physicians for assistance. Cardiac tamponade was diagnosed during echocardiography, and an incision was made in the pericardium. The patient recovered from the critical situation and was extubated in the operating room. Particularly in robot-assisted surgery, non-technical skills are indispensable to enable the anesthesiologist to successfully manage critical hemodynamic instability owing to unexplained causes.

Keywords: non-technical skills, rescue transesophageal echocardiography, robot-assisted surgery, skill evaluation

Abbreviations:
NTS: non-technical skills
rTEE: rescue TEE
TEE: transesophageal echocardiography

BACKGROUND

The lack of non-technical skills (NTS) has been linked to adverse events in the operating room, requiring further clinical research worldwide. NTS include cognitive and social skills, and personal factors[1] that collectively contribute to ensuring safe and effective task performance. The influence of technical skills on patient outcomes is well established; however, NTS are as important as that of technical skills during operations. Adverse events in the operating room are

Received: September 5, 2024; Accepted: October 25, 2024
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more likely due to insufficient NTS than poor technical skills.[2-4] The Anaesthetist's Non-Technical Skills system is an assessment tool specifically designed for anesthesiologists, evaluating task management, teamwork, situational awareness, and decision-making.[5] This system has a satisfactory level of acceptability, reliability and accuracy for rating NTS in simulations. Recently, the use of robot-assisted surgery has extended to many fields, including cardiac, esophageal, thoracic, and abdominal surgery, requiring anesthesiologists to focus their attention on more aspects than they do when performing non-robot-assisted surgery.

We encountered a rare case of sustained life-threatening hypotension resulting from intraoperative cardiac tamponade during robot-assisted thoracic surgery, and excellent teamwork successfully improved the situation. This case underscores the pivotal role of anesthesiologists in managing the intraoperative phase, especially in complex and challenging robot-assisted surgery scenarios. The paucity of reports emphasizing the importance of NTS, particularly those of anesthesiologists who are involved in robot-assisted surgery, is notable.

CASE PRESENTATION

A 54-year-old woman (height, 155 cm; weight, 60 kg) was scheduled to undergo robot-assisted thoracic surgery for an anterior mediastinal tumor. General anesthesia was administered using remifentanil (0.08 μg/kg/min), fentanyl (200 μg), propofol (100 mg), desflurane (3.8%), and rocuronium (50 mg). Intubation was performed with a 35 French double-lumen tube (Shiley endobronchial tube left; Covidien/Medtronic, Minneapolis, MN, USA), and an arterial line was inserted for anesthetic management. The patient was placed in the supine position. Robotic and assistant ports were inserted into the thoracic cavity through the right third, fifth, and seventh intercostal spaces, after which the robot (Da Vinci Xi Surgical System; Intuitive Surgical Inc, Sunnyvale, CA, USA) was docked. Carbon dioxide insufflation at 10 cm H_2O was initiated.

During the mid-intraoperative period, the blood pressure gradually decreased and maintaining hemodynamic stability became challenging despite the administration of ephedrine (24 mg, divided into multiple boluses) and increasing the dose of phenylephrine to 0.5 mg/h. When the

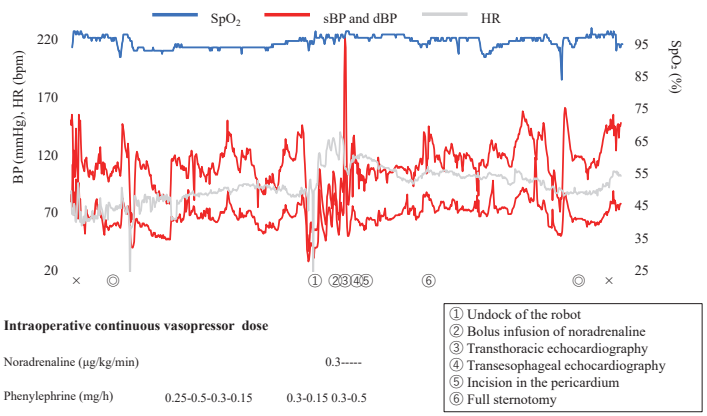

Fig. 1 Intraoperative anesthetic record

SpO_2: percutaneous oxygen saturation
sBP: systolic blood pressure
dBP: diastolic blood pressure
HR: heart rate

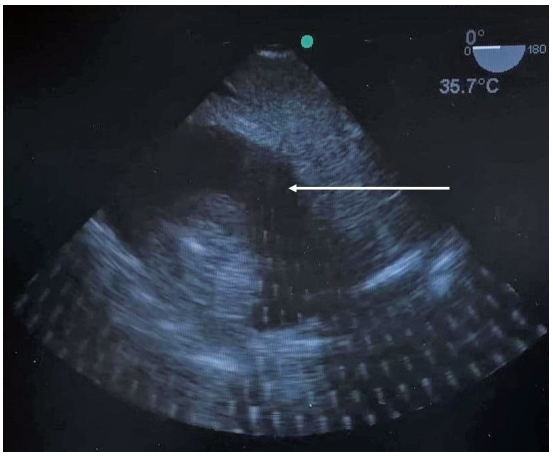

Fig. 2 Transesophageal echocardiography image of the cardiac chamber
The transgastric apical short-axis view of pericardial effusion (arrow).

blood pressure decreased to 40/30 (34) mmHg, carbon dioxide insufflation was terminated and noradrenaline administration was initiated. However, the hemodynamic parameters did not change substantially. Anesthesiologists and thoracic surgeons exchanged information that, although there was no apparent surgical bleeding, the hemodynamic parameters did not stabilize despite bolus and continuous infusion of noradrenaline (0.3 μg/kg/min). It was anticipated that the hemodynamic instability would not improve in the current situation (Fig. 1), and the importance of performing cardiac echocardiography was emphasized to the surgeon to investigate the underlying cause. Subsequently, the cardiac surgery team was called for assistance.

Six minutes after the hypotension occurred, the robot was undocked. After 12 min, pericardial effusion was detected on transthoracic echocardiography. After 8 min, cardiac tamponade was diagnosed based on transesophageal echocardiography (TEE; M-Turbo, SonoSite Inc, WA, USA) (Fig. 2). The thoracic surgeons immediately made an incision in the pericardium via the fifth intercostal space, which led to hemodynamic improvement. The active bleeding site remained detected in the heart, the possibility of bleeding from surface of the heart was suspected due to injuring from robotic arms. Subsequently, the cardiac surgeons joined the operation.

Owing to the complexity, minimally invasive surgery was not feasible for tumor resection. Full sternotomy was performed, the operation was successfully completed and the tracheal tube was removed in the operating room. The operative and anesthesia times were 349 min and 429 min, respectively. The transfusion volume of red blood cells was 560 mL, and that of fresh frozen plasma was 960 mL; 648 mL of blood loss had occurred, and urine output was 1650 mL. The patient's hemodynamic parameters were stable, she was transferred to the intensive care unit, and subsequently discharged uneventfully from the hospital 9 days post-surgery.

DISCUSSION

NTS are considered essential in surgery, and their deficiency is related to poor outcomes.[6,7] Approximately one-third or half of surgical errors are caused by miscommunication and the lack of teamwork.[8,9] Despite the inevitability of such errors, several assessment tools have been developed to address these concerns. The Non-Technical Skills for Surgeons was the first behavior

rating tool for NTS, evaluating the behavior of surgeons, psychologists, and anesthesiologists.[9] The Anaesthetist's Non-Technical Skills system is an assessment tool specifically designed for anesthesiologists for evaluating task management, teamwork, situational awareness, and decision-making.[5] Task management primarily includes prioritizing, and teamwork includes exchanging information and assessing capabilities. Situational awareness involves gathering information, recognizing, understanding, and anticipating situations. Finally, decision making includes identifying options, balancing risks, selecting options, and reevaluating.[10] These are essential skills for all anesthesiologists during surgery; however, acquiring them is difficult for trainee anesthesiologists. Flin et al reported that, at the postgraduate stage, it is important for anesthesiologists to be familiar with the NTS used daily.[10] Additionally, more experienced and trained anesthesiologists should have a detailed knowledge of the Anaesthetist's Non-Technical Skills categories and evaluation system, deploying this expertise through clinical or simulation-based education. The Oxford Non-Technical Skills scale is a well-established assessment tool that does not adapt to robot-assisted surgery.[11,12]

Minimally invasive surgery, particularly robot-assisted surgery, is becoming increasingly common for thoracic surgery.[13] When performing robot-assisted surgery, we believe that console surgeons face challenges in simultaneously attending to diverse surroundings while operating independently from team members. Given that adverse events can occur outside the surgical field during robot-assisted procedures, situational awareness becomes paramount. Console surgeons encounter difficulties in visual and verbal communication with team members that hinder their ability to promptly recognize ongoing adverse events. The complex process of performing echocardiography underscores the need to simulate the management of critical situations in robot-assisted surgery. Anesthesiologists continuously monitor the patient's respiratory and hemodynamic status along with the surgical field. Anesthesiologists can share information about the surgical situation with team members and assess the necessity for additional intervention or involvement of other members. Recently, an NTS assessment tool for robot-assisted surgery, the Interpersonal and Cognitive Assessment for Robotic Surgery system, was developed and its reproducibility and validation were established.[14] This assessment tool mainly evaluates the skills of console surgeons, and not those of other team members. Skill assessment includes three categories: cognitive (decision-making and situational awareness), social (communication and cooperation), and personal (leadership and stress fatigue).[1] We believe that evaluating the anesthesiologists' NTS in robot-assisted surgery is indispensable, and they must be trained in routine situations.

In cardiac surgery, TEE is useful for diagnosis and decision-making. Recently, the significance of TEE in noncardiac surgery has been highlighted. In elective noncardiac surgery, there are several indications for performing TEE,[15] including high-risk patients prone to cardiovascular collapse, suspected hemodynamic instability during surgery due the nature of the procedure, and diagnosis. However, a new concept has emerged called rescue TEE (rTEE). rTEE involves any examination performed by a perioperative physician in response to hemodynamic instability. The indications for rTEE include unexplained persistent hypotension, hypoxemia, increasing vasopressor use, cardiac arrest, changes in electrocardiography, and arrythmia.[16] The absence of a clear definition of rTEE makes clinical research challenging.[16] Fayad et al reported the importance of evaluating biventricular contraction, wall motion abnormalities, volume status, significant valvular lesions, ventricular outflow obstruction, pericardial effusion, and intracardiac masses or clots.[15] The decision to perform rTEE is typically entrusted to experienced practitioners who assess the patient's condition, surgical risk, and benefit.[16]

Iatrogenic cardiac tamponade is associated with high mortality and occasionally occurs because of surgical procedures that repair peri-hiatal mechanical defects.[17] The mortality rate for iatrogenic cardiac tamponade is 33.3%.[17] Markin et al reviewed 364 perioperative rTEEs,

reporting an intraoperative cardiac tamponade rate of 2%.[18] Staudt et al documented a 4.2% rate of intraoperative cardiac tamponade based on rTEE in 48 patients.[19] Thus, intraoperative cardiac tamponade in noncardiac surgery is uncommon, and early detection remains challenging. Particularly in robot-assisted thoracic surgery, intraoperative cardiac tamponade is rare and might induce a critical situation owing to the challenges of early intervention, because the patient's surroundings are complex.

In our institution, a training program for improving NTS is regularly conducted for medical and co-medical staff. All anesthesiologists involved this case had attended this program and the anesthesiologists were trained to perform TEE during cardiac surgery. The NTS and TEE training enabled successful management of a critical situation. In a previous report, cardiac anesthesiologists supported the development of rTEE training programs.[16] These programs include training for NTS, the basics of ultrasound physics, and technical skills. NTS are indispensable for anesthesiologists in various situations, except for during the perioperative period.

In conclusion, NTS is important for anesthesiologists performing robot-assisted surgery, especially for the successful management of critical situations. Anesthesiologists from trainees to educators should attend training program for improving their NTS. Continuously developing and evaluating NTS will contribute to improving patient outcomes.

ACKNOWLEDGEMENTS

Ethics approval and consent for publication

This case report was approved by the Institutional Review Board of Nagoya University Hospital (Board Chairman: Dr Shoichi Maruyama; Date of Approval, October 2, 2024; Approval No. 2024-0236). Written informed consent was obtained from the patient for the publication of this case report and its accompanying images.

Author contributions

KY drafted the manuscript. TY reviewed and edited the manuscript. All the authors have read and approved the final version of this manuscript.

Conflict of interest statement

The authors declare that they have no competing interests.

Financial disclosures

This work was not been supported by any specific grant from any funding agency in the public, commercial or non-profit sectors.

Availability of data and materials

Not applicable.

Miscellaneous acknowledgement

The authors thank Editage (www.editage.com) for the English language editing and proofreading.

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