대한심장혈관흉부외과학회
The Korean Society for Thoracic & Cardiovascular Surgery
The 38th KTCVS
Spring Meeting
2024 SEOUL
AAPCHS
The 4th AAPCHS
May 31st - June 1st
Seoul Dragon City Hotel

Developing an educational and crisis management program for RATS

Department of Thoracic and Cardiovascular Surgery
Seoul National University Hospital

Kwon Joong Na

Contents

- Educational program for RATS
- Crisis management program for RATS

Educational program for RATS

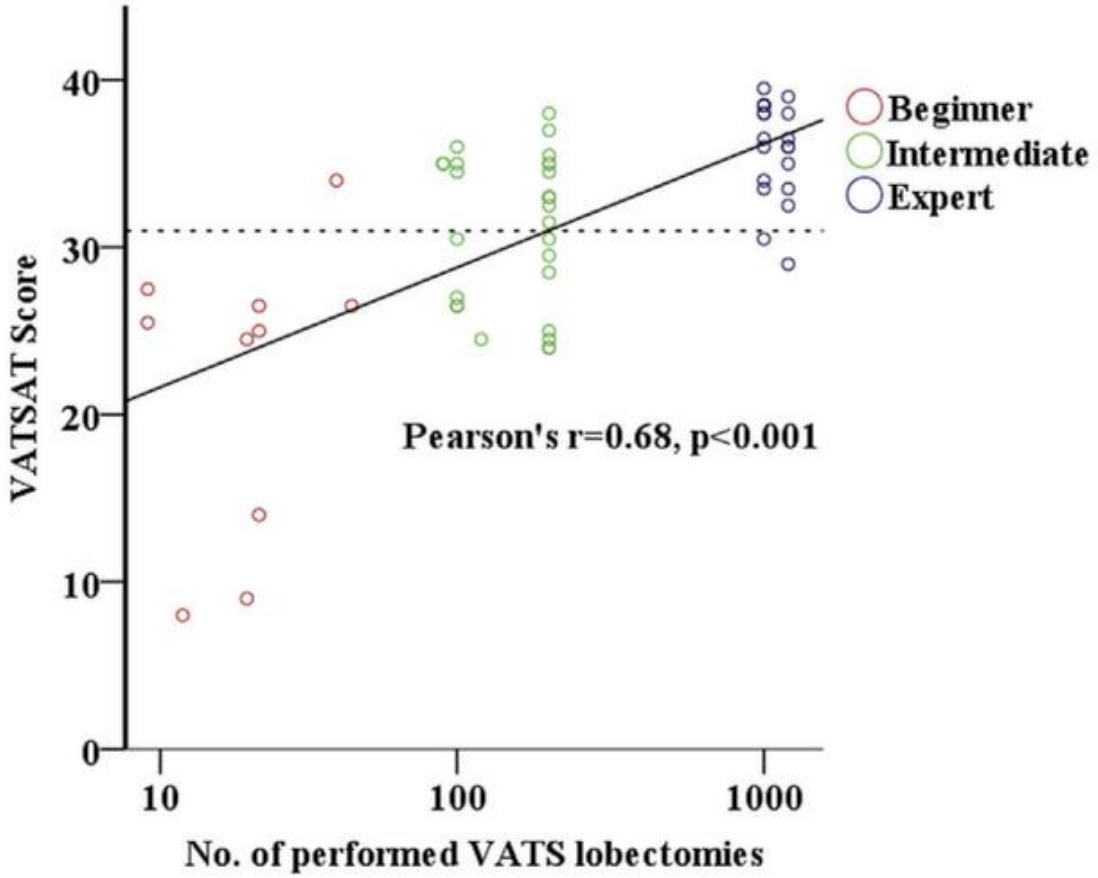
Importance of education

Why surgical training and education is important in surgical residents?

Competence	Development of necessary skills and knowledge
Patient Safety	Reduces risk of errors and complications
Confidence	Builds resident’s confidence in their abilities
Professional development	Facilitates continuous learning and improvement
Clinical decision making	Enhances critical thinking and problem-solving skills

VATS thoracic surgery

- Education and surgical experiences are helpful for trainees to develop their confidence and competence in real surgery.



VATSAT (VATS assessment tools) = 8 items

(1) localization of tumor and other pathological tissue
(2) dissection of the hilum and veins
(3) dissection of the arteries
(4) dissection of the bronchus
(5) dissection of lymph nodes
(6) retrieval of lobe in bag
(7) respect for tissue and structures
(8) technical skills in general

Each item was rated 1 to 5, where 5 was the best score, giving a minimum score of 8 and a maximum score of 40.

Petersen et al., JTC

Why robot surgical training is issue?

- It is quite different from VATS/open training in several ways!

- Surgeon is apart from the patient
- Lack of tactile senses
- CO2 insufflation in robotic surgery
- Difference in port placements
- Difference in lung retraction and dissection
- Difference in vision (3D, not same vision with assistant)

Effects of robot thoracic surgery training

Robotic lobectomy can be taught while maintaining quality patient outcomes

Robert J. Cerfolio, MD, MBA, FACS, FCCP,[a] Kyle H. Cichos, BS,[b] Benjamin Wei, MD,[a] and Douglas J. Minnich, MD[a]

Made several steps for Robot surgery training

TABLE 1. The recorded sequential steps of each lobectomy (in order of conduct) and allotted time to be completed

Step no.	Description	RUL	RML	RLL	LUL	LLL	Allotted time (min)
1	Mark out ports on skin	Same	Same	Same	Same	Same	2
2	Place ports	Same	Same	Same	Same	Same	9
3	Inspect pleura	Same	Same	Same	Same	Same	1
4	Resect inferior pulmonary ligament	Same	Same	Same	Same	Same	2
5	Remove LNs 9, 8, 7	Same	Same	Same	Same	Same	7
6	Identify RUL and RLL bronchus posteriorly	Same	Skip this step	Same	Remove 10L LN off PA	Same	5
7	Divide fissure between RUL and RLL	Same	Between RUL and RML	Same	Divide fissure between LUL and LLL	Divide fissure between LUL and LLL	10
8	Remove LNs 2R and 4R	Same	Same	Same	#5, #6	#5, #6	7
9	Retract the lung with robotic arm 3	Same	Same	Same	Same	Same	1
10	Remove 10R LN under azygous vein	Same	Same	Same	11L off PA and LMSB	11L off PA and LMSB	1
11	Identify and dissect PA arterial branches	Same	Same	Same	Same	Same	10
12	Identify and dissect PV	Same	Same	Same	Same	Same	5
13	Encircle PV	Same	Same	Same	Same	Same	2
14	Encircle PA	Same	Same	Same	Same	Same	2
15	Guide stapler under PA branches	Same	Same	Same	Same	Same	1
16	Guide stapler under pulmonary vein	Same	Same	Same	Same	Same	1
17	Encircle bronchus, guide stapler	Same	Same	Same	Same	Same	1
18	Divide remaining fissure	Same	Same	Same	Same	Same	10
19	Bag specimen	Same	Same	Same	Same	Same	3

RUL, Right upper lobe; *RML*, right middle lobe; *RLL*, right lower lobe; *LUL*, left upper lobe; *LLL*, Left lower lobe; *LN*, lymph node; *PA*, pulmonary artery; *LMSB*, left main stem bronchus; *PV*, pulmonary vein.

Cerfolio et al., JTCVS 2015

Effects of robot thoracic surgery training

TABLE 2. Teaching outcomes

Steps performed	Brief description of steps	Lobectomy 0-100 % perform general surgical resident/thoracic surgical resident	Lobectomy 101-200 % perform general surgical resident/thoracic surgical resident	Lobectomy 201-300 % perform general surgical resident/thoracic surgical resident	Lobectomy 301-400 % perform general surgical resident/thoracic surgical resident	Lobectomy 401-520 % perform general surgical resident/thoracic surgical resident
Dates		2/2010-3/2011	3/2011-4/2012	4/2012-9/2013	9/2013-10/2014	10/2014-12/2015
Steps 1-5	Ports, ligament, inferior N2 LNs	NR/50%	20%/70%	60%/70%	70%/90%	80%/90%
Steps 6-7	Postbronchus and fissure	NR/NR	0%/20%	0%/10%	30%/50%	20%/60%
Step 8	Superior N2 LN	30%/50%	60%/75%	80%/100%	100%/100%	90%/100%
Step 9	Retract lung	NR/NR	NR/NR	0%/15%	30%/40%	0%/20%
Steps 10-12	N1 LN, dissect out PA	0%/10%	0%/60%	20%/50%	50%/60%	40%/70%
Steps 13-14	Encircle PV and/or PA	0%/0%	10%/30%	30%/70%	30%/70%	40%/80%
Steps 15-16	Staple PA and/or PV	NR/NR	NR/NR	0%/0%	10%/30%	20%/60%
Step 17	Bronchus	NR/NR	40%/50%	30%/70%	70%/80%	80%/95%
Step 18	Remaining fissure	NR/NR	NR/NR	0%/0%	30%/70%	50%/70%
Step 19	Bagging	15%/40%	30%/50%	70%/90%	90%/100%	90%/100%

LN, Lymph node; *NR*, not recorded; *PA*, pulmonary artery; *PV*, pulmonary vein.

Surgical proficiency increased over time for all steps

Cerfolio et al., JTC

Effects of robot thoracic surgery training

TABLE 3. Patient outcomes

Metrics	Lobectomy 0-100	Lobectomy 101-200	Lobectomy 201-300	Lobectomy 301-400	Lobectomy 401-520
Median operative time (skin-to-skin), min	195	160	144	123	126
Median blood loss (range), mL	35 (15-100)	39 (10-3000)	37 (10-650)	43 (10-400)	47 (10-750)
Median No. of LNs removed (range)	21 (12-25)	21 (12-31)	23 (13-43)	24 (10-34)	24 (10-66)
Median No. of N2 LN stations resected	5	5	5	5	5
Median No. of N1 LN stations resected	3	3	3	3	3
Conversion to thoracotomy	12%	10%	7%	4%	3.3%
Major vascular injury	2%	4%	4%	3%	0%
Transfusion in OR	0	0	1%	0	0
Median length of stay (range), d	3 (1-42)	3 (2-12)	3 (1-21)	3 (1-11)	3 (2-11)
Morbidity of any type	50%	45%	12%	14%	4.2%
Major morbidity	16%	16%	5%	6%	2.5%
30-d mortality	0	0	1%	0	0
90-d mortality	0	0	2%	0	0.83%

LN, Lymph node; *OR*, operating room.

Patients' outcome was similar or improved over time

Cerfolio et al., JTC

Essential components for robot education

Faculty Mentor	Robotic surgeons who are beyond their own learning curve (>20 robot lobectomies, 50-150 robotic cases)
Robotic team	Dedicated team of anesthesiologists, surgeons, bedside assistants, nurses and technicians
Simulation education	Devoid of risk to the patient, and shortening the learning curve prior to patient contact, improving operative experience and outcomes
Systematic program	Systematic education program in real surgery

Essential components for robot education

Faculty Mentor

- Education programs direction
- Evaluation of trainees' skills
- Video review of trainees' cases and feedback

Essential components for robot education

Robotic team

- Highly trained team members → Familiarity, Improve efficiency

- Perioperative competencies
  - Arranging robotic system and all its components in the OR
  - Assembling system components
  - Starting the system
  - Draping the patient cart
  - Setting up and calibrating the vision system
  - Setting up the surgeon console
  - Driving and positioning the patient cart over the patient
  - Identifying safety features

Essential components for robot education

Simulation education

- Early phase education program
- Experiencing the robotic system and the surgical skills
- Being proficient before experiencing real surgery

Essential components for robot education

Systematic program

- Suitable programs for resident grades

Suggested programs

- Several phases of robotic education system

- **Preclinical phase (PGY 1)**
  - Online didactics
  - Skill acquisition with simulation models

- **Bedside assistant phase (PGY 2-3)**
  - Learn port placements, docking, instrument exchange, trouble shooting

- **Console phase (PGY 4-5)**
  - Participate in parts of the robotic operation in a progressive fashion

Suggested programs

- Several phases of robotic education system

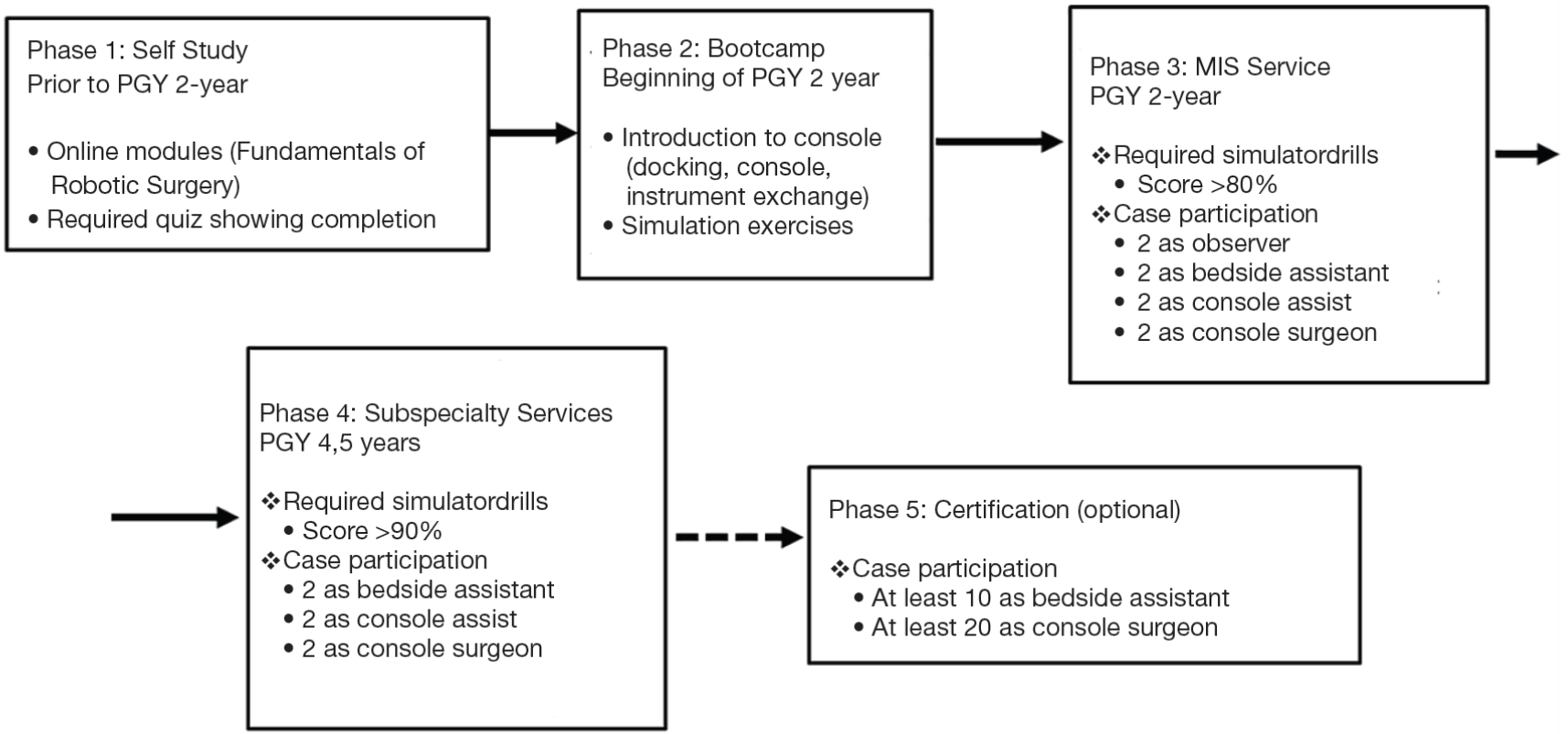


Figure 4 University of Southern California Robotics Curriculum: trainees complete each phase with graduated responsibilities. Most phases are completed by the end of PGY 2 years and simultaneously fulfills requirements to achieve certification by the end of residency training.

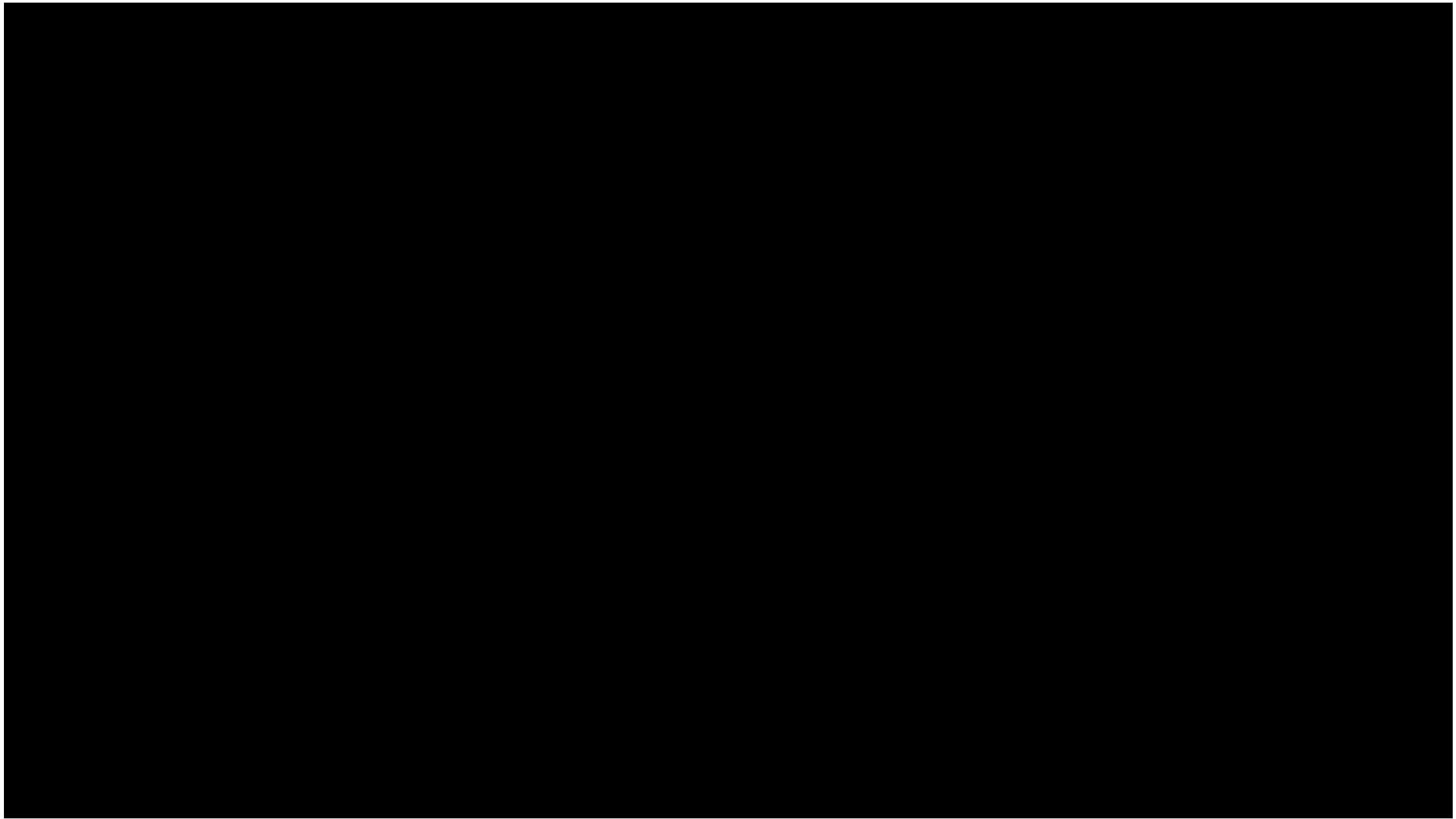
Alicuben et al., J

Preclinical phase

- Learning about robotic system
- Simulation model (VR)
- Simulation kit (lobectomy model)
- Animal model (porcine lung model)

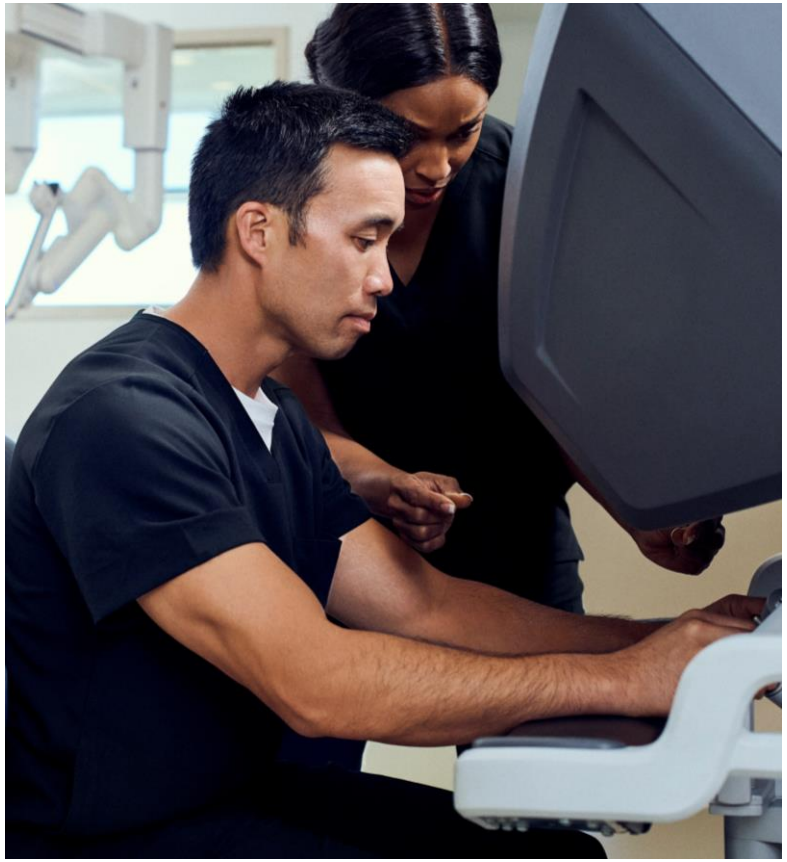
VR model

Courtesy of Intuitiv



VR model

System In-service & Simnow Basic Skills



Courtesy of Intuitiv

VR model

System In-service & Simnow Basic Skills

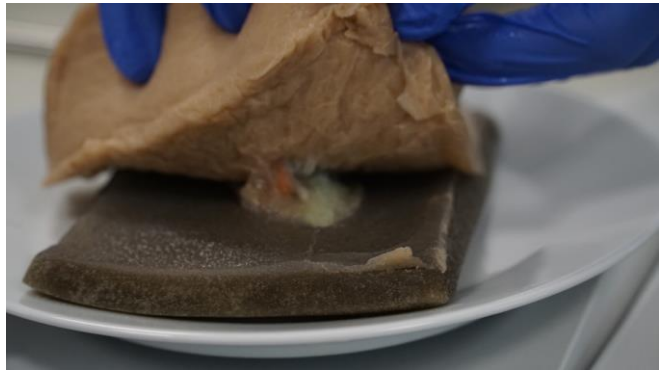
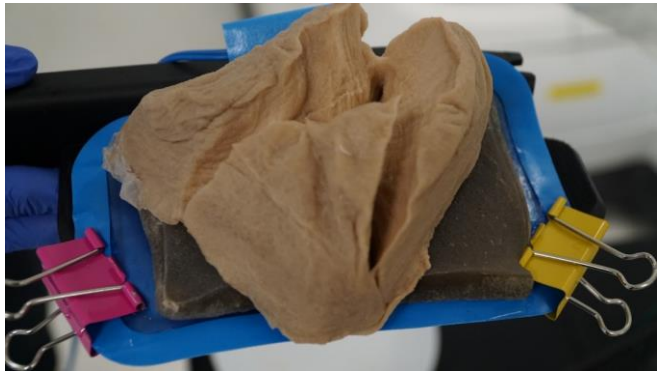
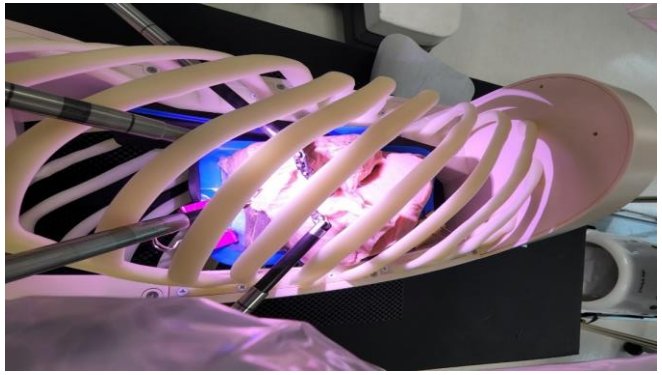
Category	Program	Goal	Score
Endowrist manipulation	Sea Spike 1	80	
	Wrist articulation 1	80	
Clucth	Clutch	90	
Camera Control	Camera 0	70	
Energy pedal selection	Energy Pedal 1	80	
Using the retraction arm	4th arm cutting	80	
	Three arm relay 1	70	

Courtesy of Intuitiv

Lobectomy simulation model

Versatile Training Tissue (VTT) Lung Model (Rt.Lung) (kotobuki medical)

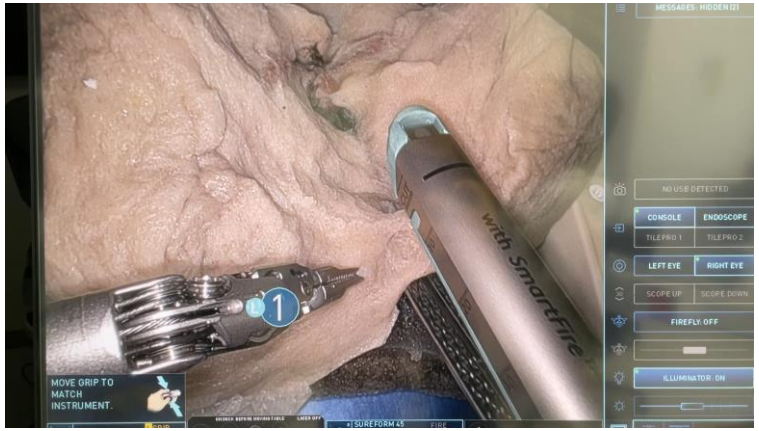



Courtesy of Intuitiv

Lobectomy simulation model

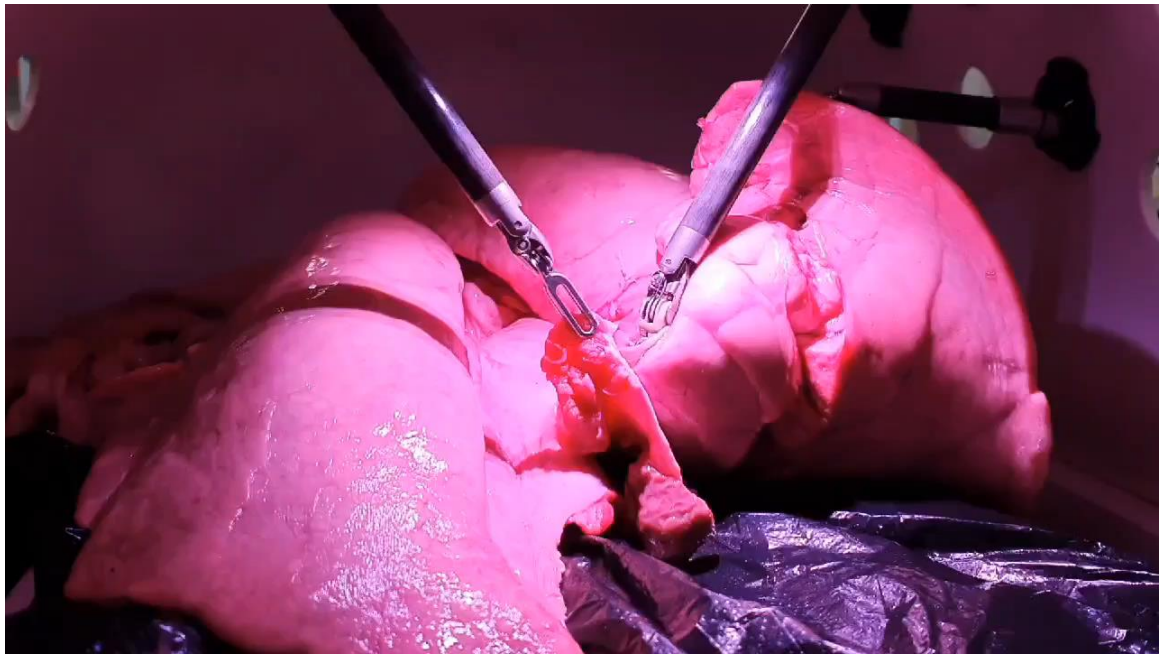
Versatile Training Tissue (VTT) Lung Model (Rt.Lung) (kotobuki medical)

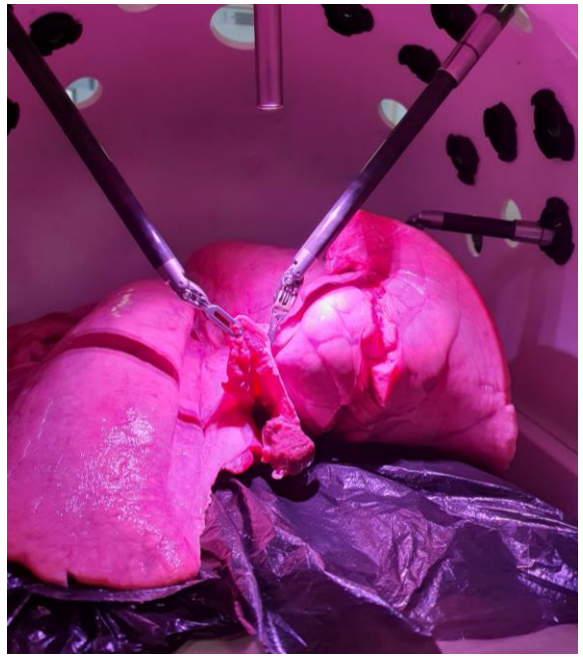


Courtesy of Intuitiv

Animal model

Porcine lung model





Courtesy of Intuitiv

Assistant Surgeon

- Port placement, docking, trouble shooting
- Familiarized with fundamentals of the robotic platform
- Communications between console surgeon and the team members
- Understanding of the whole surgical procedures

Console surgeon

- Step-by-step procedures
- Communication with assistant surgeons and team members
- Trouble shooting

In SNUH

- No systematic education program
- But, tried to give opportunities to residents and fellows for robotic training
- Every residents went to Intuitive center at least once for simulation training.

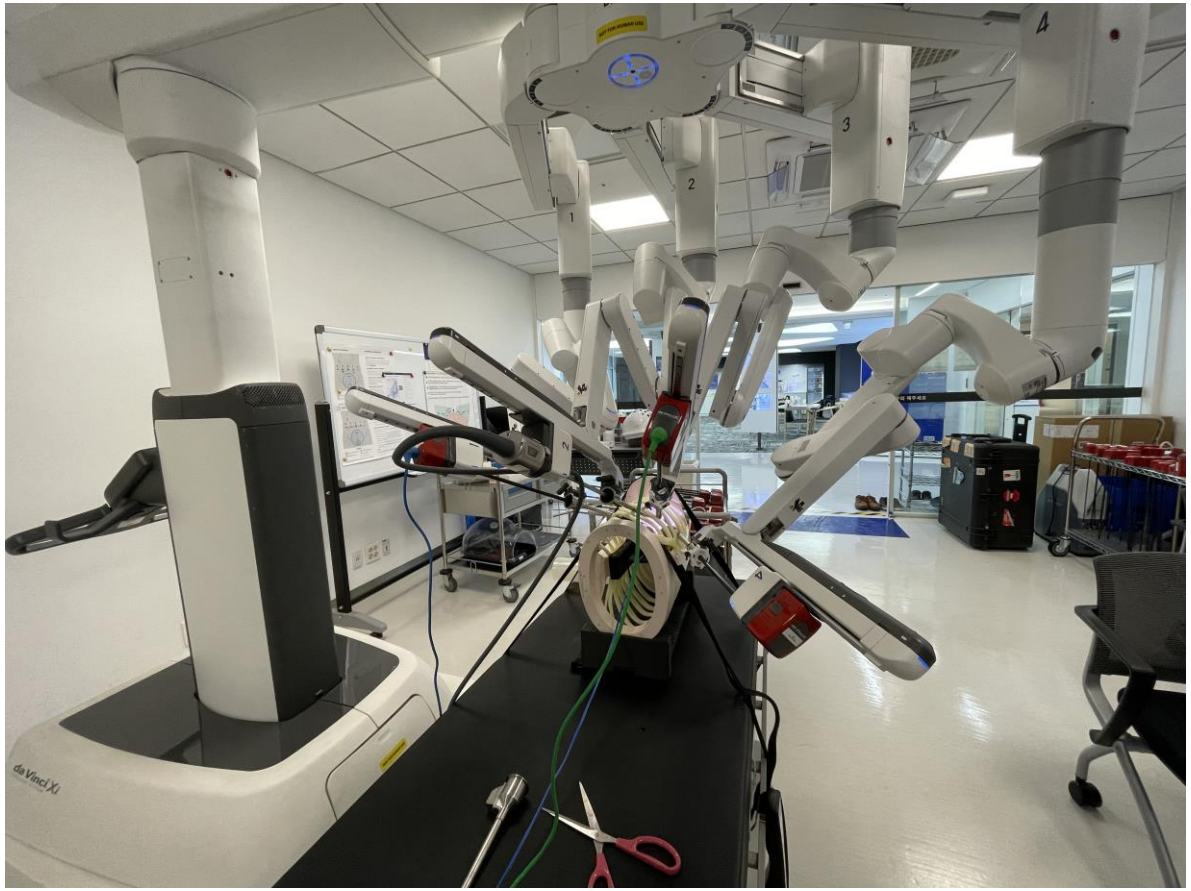
Robot 실습 계획

2023.5.15 Intuitive center

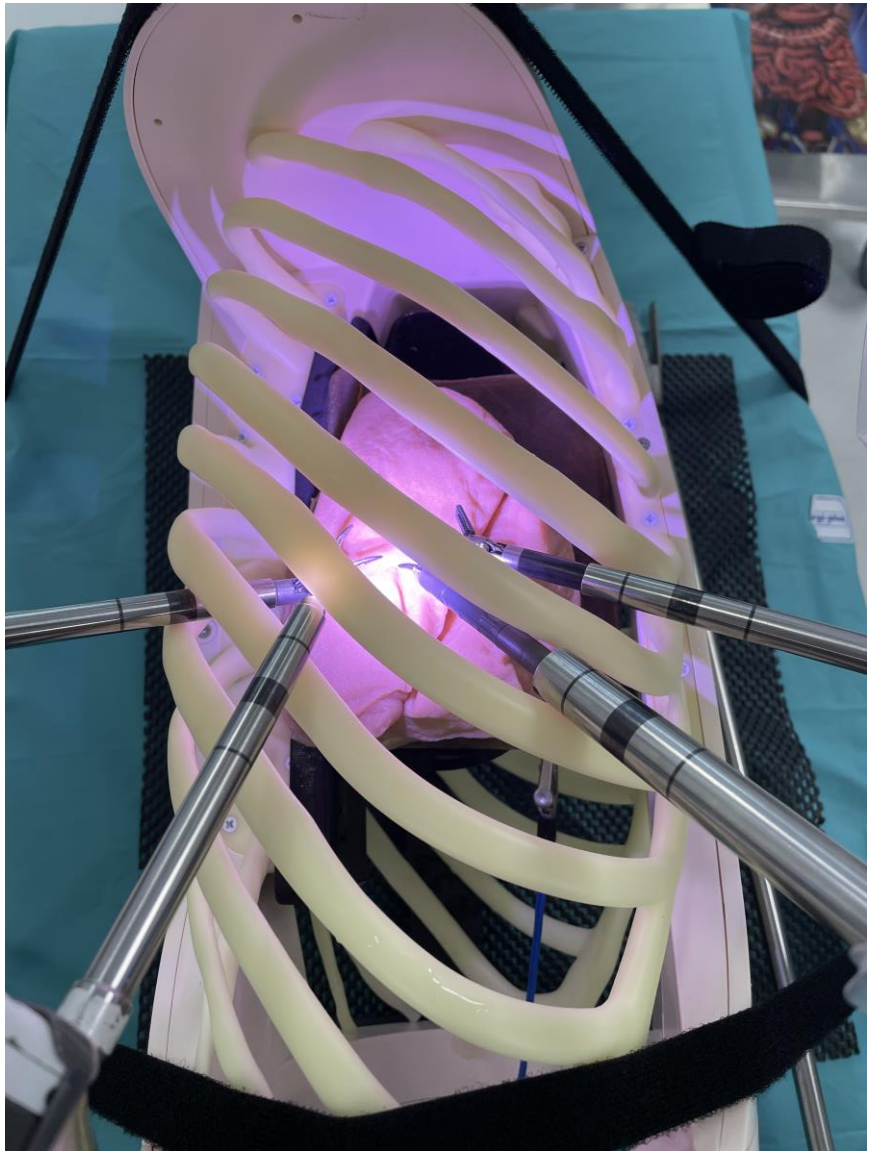
Instructor : 나권중

	Console 1	Console 2
09:00-10:00	Robot 시스템 및 원리, docking 에 대한 설명 진행	
	전공의 3년차	**전공의 4년차**
10:00-11:00	로봇 기본 조작 연습 (시뮬레이션) SimNow 이용한 RLLobectomy	곤약 모델을 이용한 RULobectomy
	전공의 4년차	**전공의 3년차**
11:00-12:00	로봇 기본 조작 연습 (시뮬레이션) SimNow 이용한 RLLobectomy	곤약 모델을 이용한 RLLobectomy

In SNUH



In SNUH



In SNUH

In SNUH

- As an assistant surgeon..
  - Residents participate robotic surgery from grade 2
  - Grade 2 : thymectomy, lung surgery
  - Grade 3/4 : thymectomy, lung surgery, esophageal surgery

- As a console surgeon..
  - Residents have change to do some robotic procedures from grade 4
  - Fellows do many procedures
  - Grade 4
    - Port placement
    - thymectomy substernal dissection
    - IPL division
    - Omental fat division

Crisis management program for RATS

Crisis in thoracic surgery

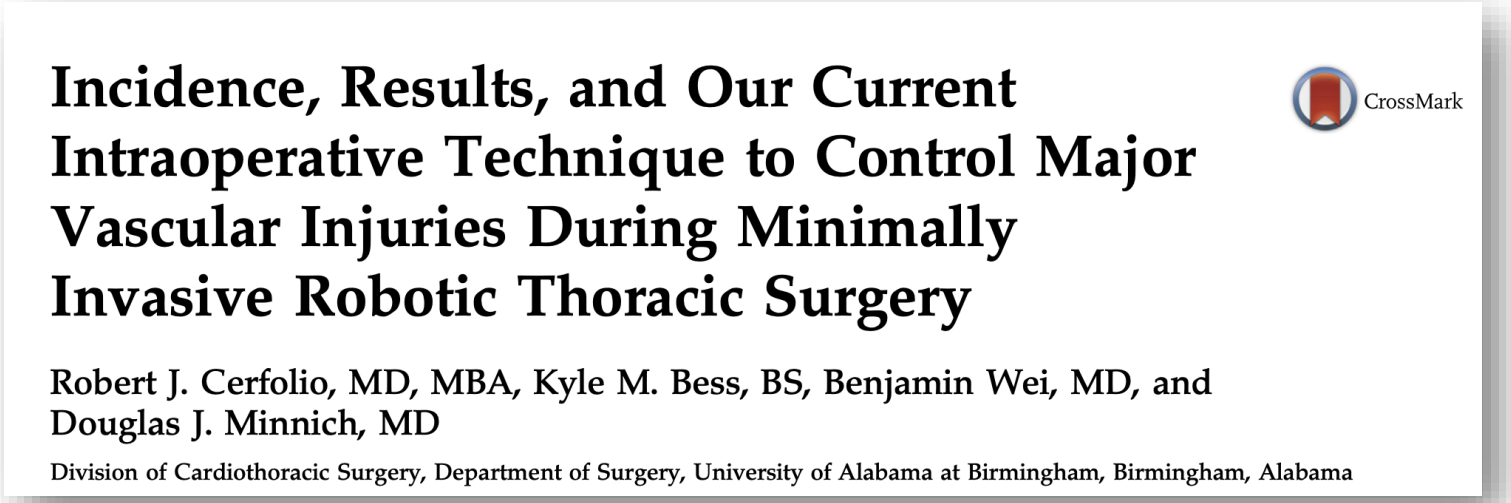
- *Major vessel injury (most fatal)*
- Bronchus injury

Crisis management in RATS

- Because the operative surgeon works on a console located outside the operating field, RATS has radically modified teamwork and inter-professional communication.
- This may create a specific safety risk, which should be given special consideration.

4P concepts

- Poise: *remain calm*
- Pressure: *apply pressure immediately to the bleeding vessel*
- Prepare: *prepare your disaster plan preoperatively and give your anesthesia and nursing team time to prepare after the injury and do not rush to perform a thoracotomy as the patient is bleeding*
- Proximal control: *proximal control of vessel bleeding*



Incidence, Results, and Our Current Intraoperative Technique to Control Major Vascular Injuries During Minimally Invasive Robotic Thoracic Surgery

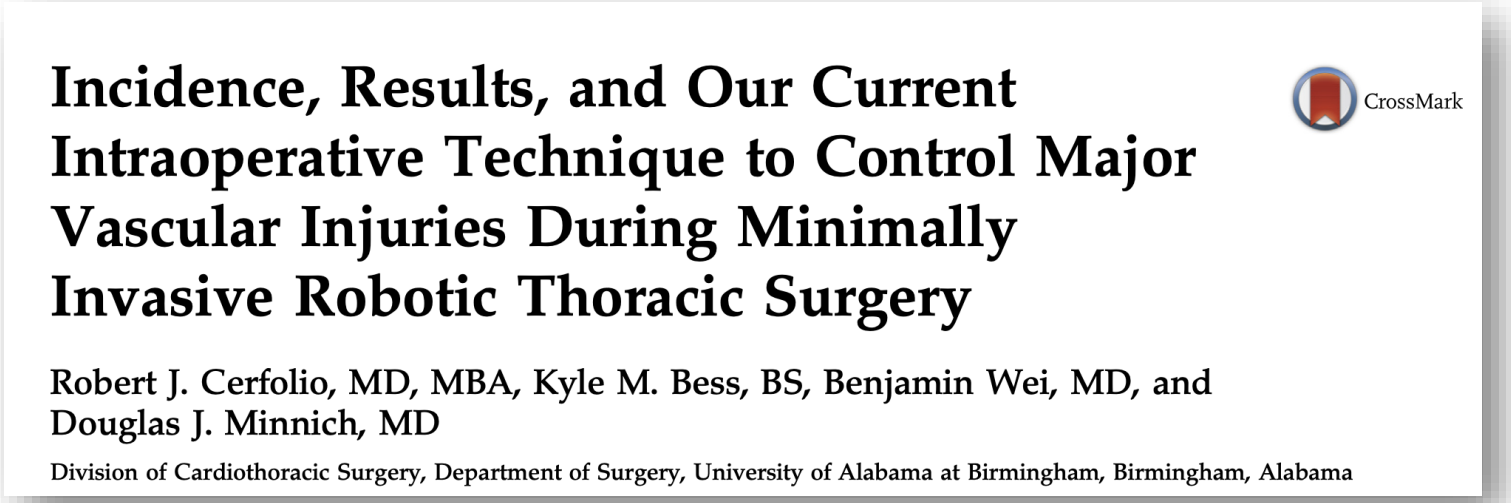
Robert J. Cerfolio, MD, MBA, Kyle M. Bess, BS, Benjamin Wei, MD, and Douglas J. Minnich, MD

Division of Cardiothoracic Surgery, Department of Surgery, University of Alabama at Birmingham, Birmingham, Alabama

Cerfolio et al., A

4P concepts

- Poise: *remain calm*
- Pressure: *apply pressure immediately to the bleeding vessel*
- Prepare: *prepare your disaster plan preoperatively and give your anesthesia and nursing team time to prepare after the injury and do not rush to perform a thoracotomy as the patient is bleeding*
- Proximal control: *proximal control of vessel bleeding*



Incidence, Results, and Our Current Intraoperative Technique to Control Major Vascular Injuries During Minimally Invasive Robotic Thoracic Surgery

Robert J. Cerfolio, MD, MBA, Kyle M. Bess, BS, Benjamin Wei, MD, and Douglas J. Minnich, MD

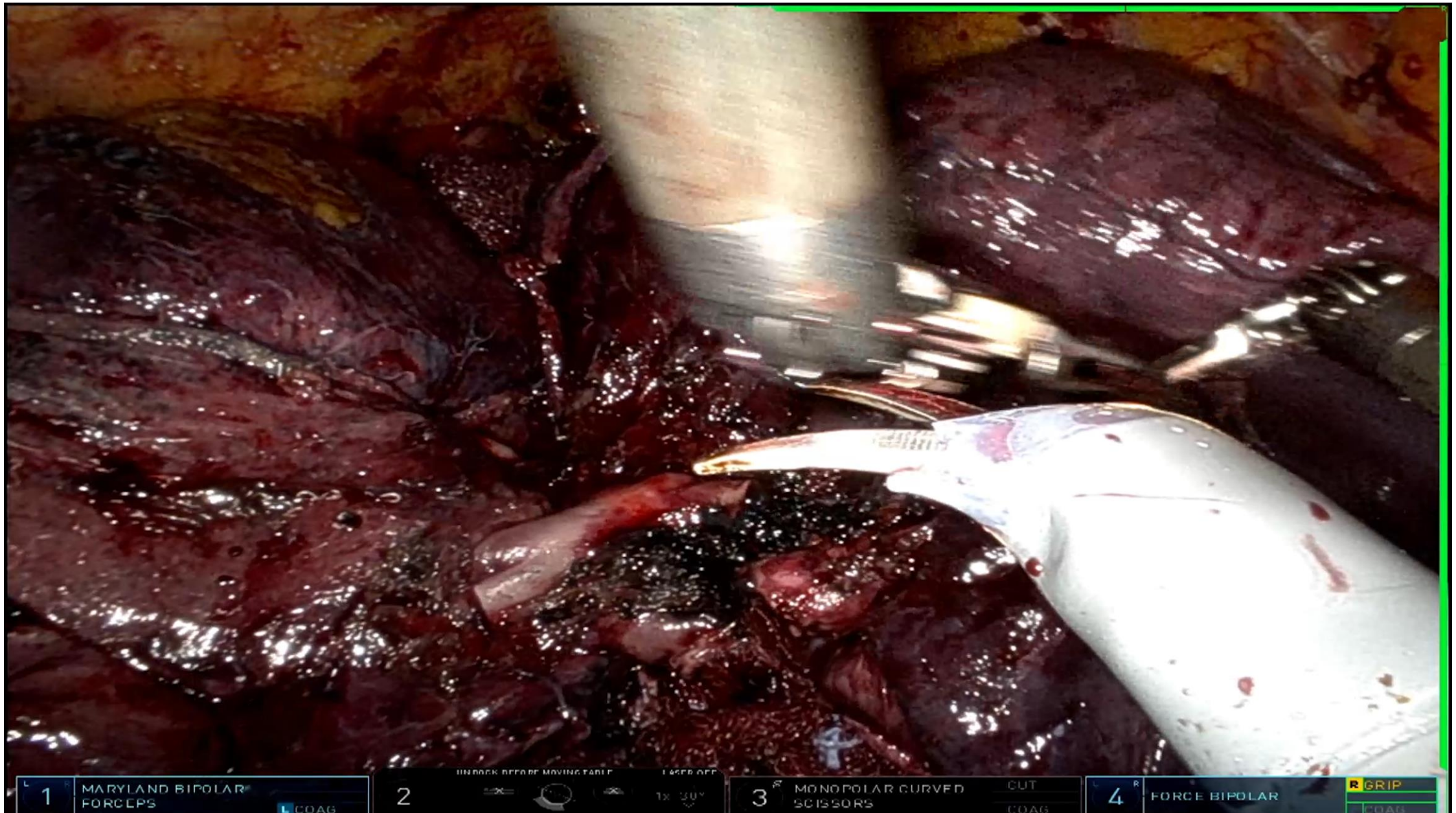
Division of Cardiothoracic Surgery, Department of Surgery, University of Alabama at Birmingham, Birmingham, Alabama

Cerfolio et al., A

Pressure

- Rolled sponge gauze should be ready in the field
- If there is no sponge gauze, the bleeding vessel can be given pressure with robotic arm, but caution is needed for more injury
- Usually, giving pressure with arm on anterior side is recommended, for giving room for assistant surgeon doing posterolateral thoracotomy

Pressure


1
MARYLAND BIPOLAR FORCEPS
COAG
2
3
MONOPOLAR CURVED SCISSORS
CUT
COAG
4
FORCE BIPOLAR
GRIP
COAG

Prepare

- Prepare for open surgery, transfusion and vital signs management
- Simulation-based training of crisis management

Simulation-based training

ORIGINAL SCIENTIFIC ARTICLES

Crisis Checklists for the Operating Room: Development and Pilot Testing

John E Ziewacz, MD, MPH, Alexander F Arriaga, MD, MPH, Angela M Bader, MD, MPH, William R Berry, MD, MPH, MPA, Lizabeth Edmondson, BA, Judith M Wong, MD, Stuart R Lipsitz, SCD, David L Hepner, MD, Sarah Peyre, EDD, Steven Nelson, BA, Daniel J Boorman, BS, Douglas S Smink, MD, MPH, FACS, Stanley W Ashley, MD, FACS, Atul A Gawande, MD, MPH, FACS

Figure 1. Cover of the operating room crisis checklist packet.

J Am Coll Surg 2011

O.R. Critical Event Guide

8: Hemorrhage

Condition: Acute massive bleeding.
Objective: Stop bleeding, maintain hemodynamic stability, avoid coagulopathy.

8

- **Call for help.**
- **IV fluids opened?**
  - **IV access** adequate?
- **Call blood bank:**
  - **Massive transfusion protocol** activated (if available)?
  - **Blood products** ordered (in addition to PRBCs)?
    - **FFP** (consider 1:1 ratio with PRBCs).
    - **Platelets** (if indicated; consider 1:1 ratio with PRBC's).
    - **Cryoprecipitate** (if indicated; 1 unit).
- **Additional lap sponges** requested?
- **Rapid infuser** (or pressure bags) requested?
- **Labs sent?**
  - CBC, PT/PTT/INR, Fibrinogen, Lactate, ABG, Potassium.

Have we considered:

- **Additional surgical techniques and/or personnel?**
  - **Hemostatic agents?**
  - **Vascular instruments or consultation?**
- **Damage control surgery** (pack, close, resuscitate)?
- **Warming** the room and patient?
- **Factor VII** (per institution protocol)?

Transfusion Considerations:

- **Cryoprecipitate to fibrinogen > 100 mg/dL**

If first fibrinogen level is…	
<100 mg/dL	Order 2 more pools of cryoprecipitate
100-200mg/dL	Order 1 more pool of cryoprecipitate

- **Red blood cells to Hematocrit > 21%**
- **Platelets to serum platelet level >50 K/microliter**
- **Fresh frozen plasma to PT/PTT < 1.5 times control**
- **Cell Saver (for nonmalignant, noncontaminated cases)**

Hyperkalemia Treatment:

- Calcium gluconate (10mg/kg) or Calcium chloride 10mg/kg) IV;
- Sodium bicarbonate 1-2mEq/kg, slow IV push.
- Insulin 10 Units regular IV with 1-2 amps D50W (0.1 units insulin/kg and 1mL/kg D50W for pediatric patients).

O.R. Critical Event Guide

9: Hypotension

Condition: Unexplained drop in blood pressure.
Objective: Restore hemodynamic stability.

9

- **Call for help.**
- **Equipment** checked for malfunction (arterial line, blood pressure cuff)?
- **Pulses** checked?
- **Intravenous fluids** opened?
- **FiO_2** increased to 100%?
- Surgical field inspected for **bleeding?** If Bleeding **GO TO:** Hemorrhage Checklist.
- Have we considered:
  - **decreasing anesthesia?**
  - **patient position?**
  - **additional IV?**
- **Have we considered the following causes:**

Surgical

- Retraction
- Vagal stimulation
- Mechanical/surgical manipulation
- Vascular Compression

Nursing

- Other evidence of bleeding:
  - Amount of **blood in suction canister**
  - Number of **bloody sponges**
  - **Blood on the floor**
- Drugs used on the field (i.e. intravascular injection of local drugs)

Anesthesia/OR Team

Airway:
- Unexplained Hypoxia (**GO TO:** Hypoxia Checklist)
- Increased PEEP

Breathing:
- Pneumothorax
- Pulmonary Edema
- Hypoventilation
- Persistent hyperventilation

Circulation:
- Myocardial ischemia
- Pulmonary Embolism
- Anaphylaxis
- Severe sepsis
- Air embolism (**GO TO:** Air Embolism Checklist)
- Other emboli (fat, septic, CO_2)
- Tamponade
- Bradycardia (**GO TO:** Bradycardia – Unstable Checklist)
- Tachycardia (**GO TO:** Tachycardia –Unstable Checklist)
- Bone Cementing (**Methyl methacrylate effect**)
- Malignant Hyperthermia (**GO TO:** Malignant Hyperthermia Checklist)

Drugs/allergy:
- **Recent drugs** given/dose error/allergy

Simulation-based training

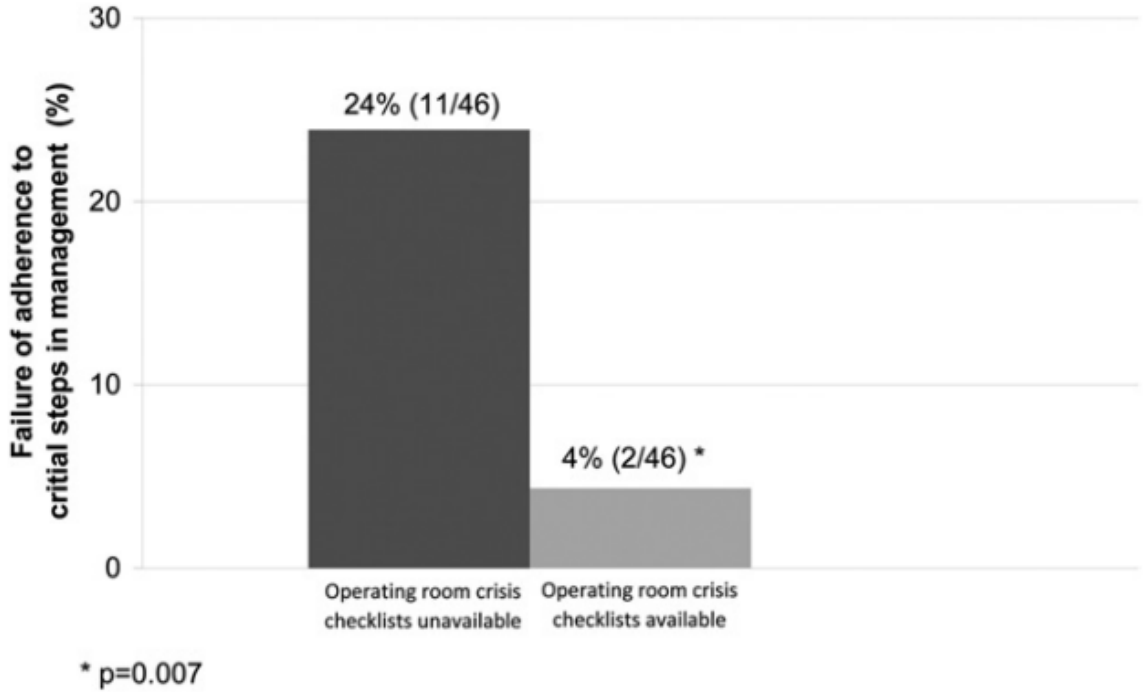


Figure 2. Association between operating room crisis checklist use and failure of adherence to critical steps in management.

Table 2. Checklist Survey Responses

Checklist survey question	Mean Likert response, mean +/− SD (IQR)*
The checklist helped me feel better prepared during the emergency scenario	4.2 +/− 0.95 (4–5)
The checklist was easy to use	4.1 +/− 0.92 (4–5)
I would use this checklist if I were presented with this operative emergency in real life	4.3 +/− 0.75 (4–5)
If I were having an operation and experienced this intra-operative emergency, I would want the checklist to be used	4.4 +/− 0.68 (4–5)

*Mean Likert response across all checklist scenarios (1=disagree strongly, 5=agree strongly); 39–40 responses per question.
IQR, interquartile range.

Checklist and simulation is helpful to the participants
It showed significantly lower failure rate in OR crisis simulation

J Am Coll Surg 2011

Simulation-based training

Table 1. Professional Characteristics of the Participants.

Position	Participants (N = 67)	Years of Experience in Specialty					
		<1	1 to 5	6 to 10	>10 to <15	≥15	Unknown
	no. (%)	*percent*					
Anesthesia attending physician	17 (25)	0	18	47	12	18	6
Surgical attending physician	2 (3)	0	0	50	50	0	0
Anesthesia resident*	10 (15)	0	100	0	0	0	0
Surgical resident*	2 (3)	0	100	0	0	0	0
Operating-room nurse	20 (30)	0	20	15	5	55	5
Surgical technologist	9 (13)	0	56	44	0	0	0
Certified registered nurse anesthetist	7 (10)	29	29	29	0	14	0

* One anesthesia resident who participated was a first-year anesthesia resident at the end of the first year of clinical anesthesia training (second postgraduate year). The remaining anesthesia residents were in their second or third year of clinical anesthesia training, and the surgical residents were in their second or third postgraduate year of training.

Significant improvement in adherence to recommended procedures for the most common intraoperative emergencies

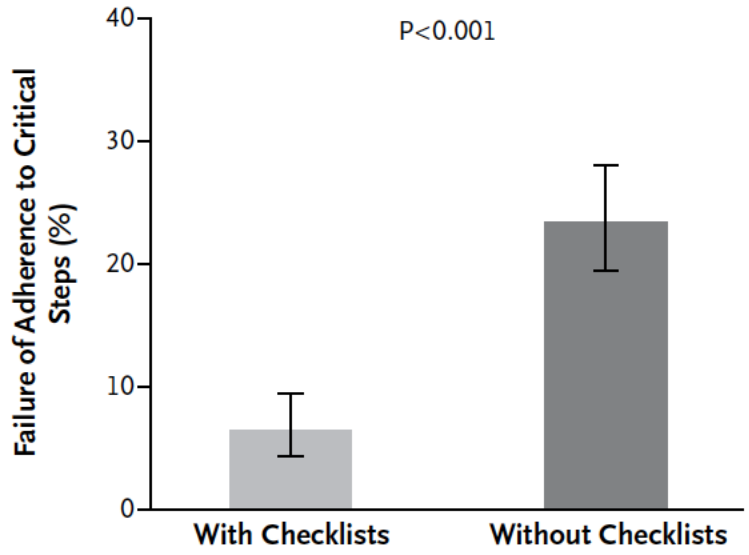


Figure 1. Association between Use or Nonuse of Operating-Room Crisis Checklists and Failure to Adhere to Critical Steps in Management.

The use of checklists during operating-room crises resulted in nearly a 75% reduction in failure to adhere to critical steps in management. Of 371 critical steps in the management of surgical crises, 24 (6%) were missed when the checklists were available, as compared with 89 of 379 steps (23%) missed when the checklists were not available. I bars indicate 95% confidence intervals.

NEJM 2013

Simulation-based training

Table 2. Failure to Adhere to Critical Steps in Management, According to the Presence or Absence of Checklists and the Scenario Type.

Scenario Type*	Failure Rate†		P Value‡
	With Checklists	Without Checklists	
	no./total no. (%)		
ACLS scenario	7/100 (7)	15/89 (17)	0.005
ACLS scenario preceded by hemodynamically unstable condition	14/154 (9)	46/172 (27)	<0.001
Other crisis scenario	3/117 (3)	28/118 (24)	0.002

* Scenario types were as follows: advanced cardiac life support (ACLS) included asystolic cardiac arrest, ventricular fibrillation, and unstable tachycardia; ACLS scenarios preceded by a hemodynamically unstable condition included clinically significant hypoxemia and hypotension followed by unstable bradycardia, and hemorrhage followed by ventricular fibrillation; and other crisis scenarios included malignant hyperthermia, anaphylaxis, hemorrhage, and air embolism.
† The failure rate was calculated as the number of critical steps that were not adhered to in the management of the scenario.
‡ P values were calculated in a model that accounted for clustering by team, with adjustment for time of day and institution.

Table 4. Participants' Perceptions of Crisis Checklists, with Responses across All Checklist Scenarios.*

Survey Statement	Response Score
The checklist helped me feel better prepared during the emergency scenario	4.4±0.81
The checklist was easy to use	4.3±0.84
I would use this checklist if I were presented with this operative emergency in real life	4.5±0.76
If I were having an operation and experienced this intraoperative emergency, I would want the checklist to be used	4.7±0.60

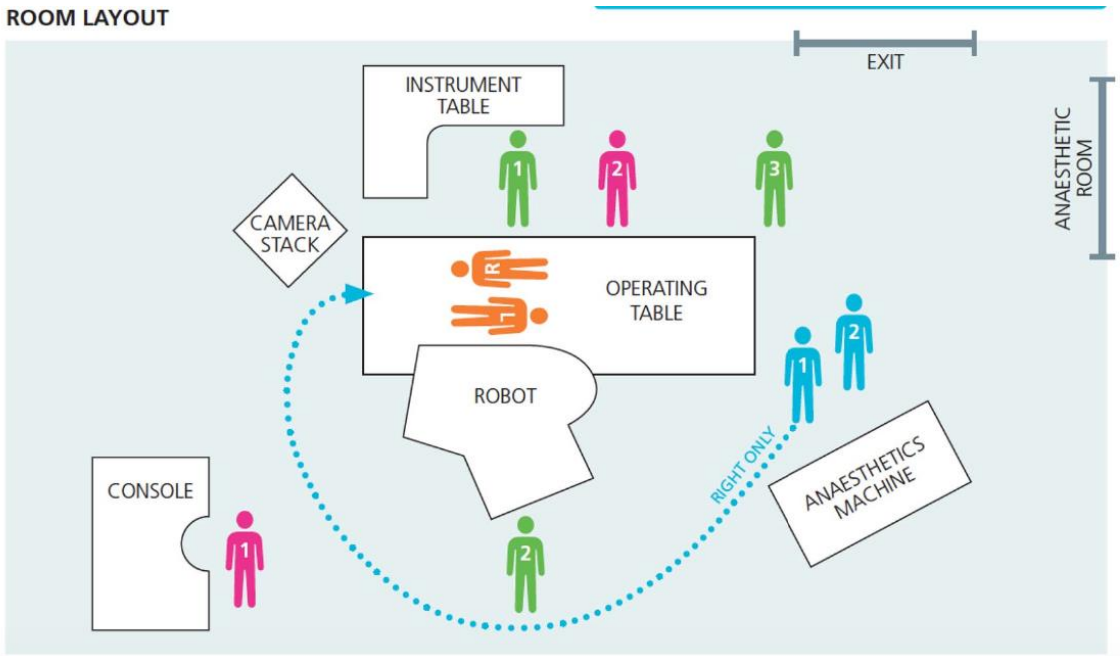
* Plus–minus values are means ±SD. Data included 196 responses from 67 participants. Response scores were on a Likert scale and ranged from 1 (disagree strongly) to 5 (agree strongly).

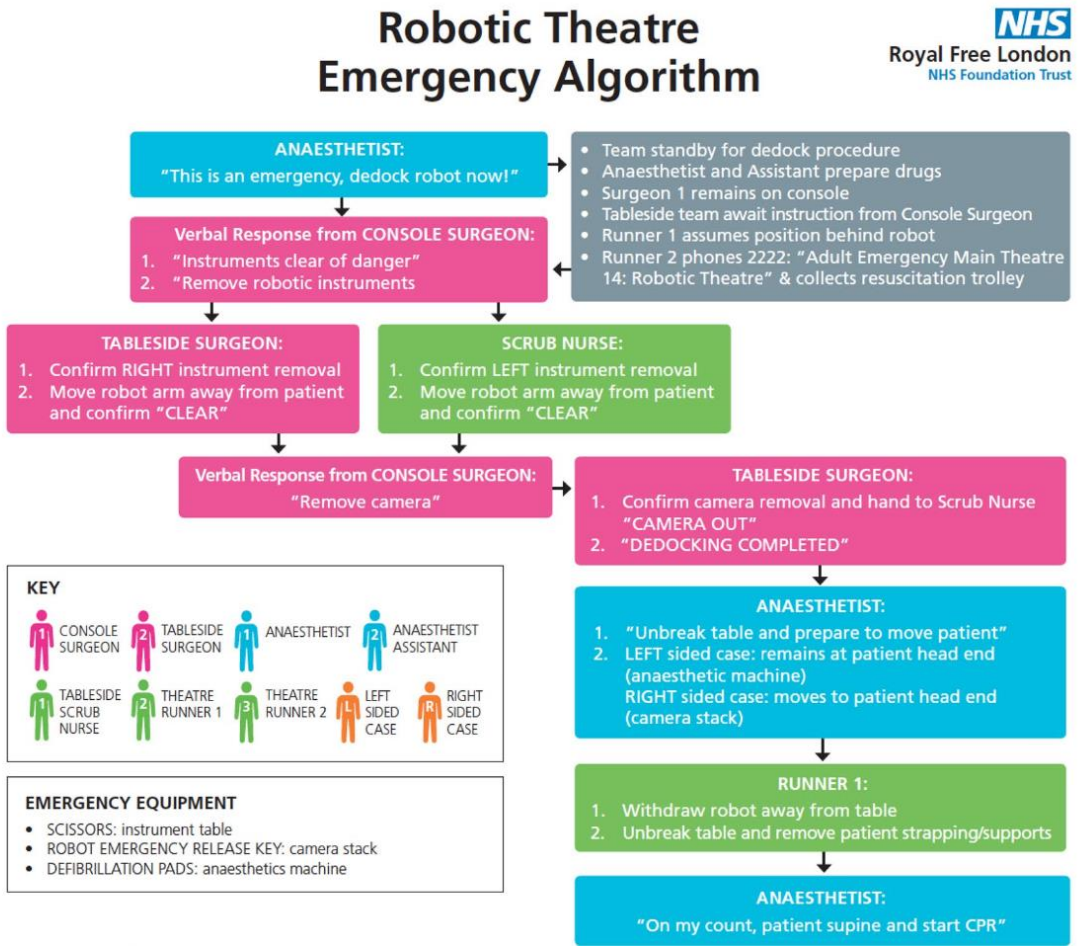
It showed significantly lower failure rate in OR crisis simulation regardless of simulation type
And the participants felt the checklist and simulation was helpful

Simulation-based training

Development of a high fidelity, multidisciplinary, crisis simulation model for robotic surgical teams

Siddhant Patki[1] · Arjun Nathan[2,3] · Craig Lyness[3] · Premala Nadarajah[3] · Stefan Sevastru[3] · Ahmed Mahrous[3] · Pedro De-Silva[3] · Angeline Shoniwa[3] · Shabnam Undre[4] · Prasad Patki[2,3]





Journal of Robotic Surgery 2023

Simulation-based training

Table 1 Team 1—Time taken to complete tasks and total time taken for resolution of crisis scenario from point of 'cardiac arrest call' by the consultant anaesthetist

	First event			Retention validity
	Control	Training	Test	
Time to CPR (s)	101	85	48	69
Time to defibrillator shock (s)	>302	189	86	208
Time to robot undocking (s)	86	48	25	40
Total time taken (s)	702	306	469	660

Shorter time to CPR, Defib, and undocking in simulation-based training group

	Anaesthetic team			Surgical team			Theatre team		
	Control	Test	Validity	Control	Test	Validity	Control	Test	Validity
Communication	3	6	5	3	5	5	3	6	5
Co-ordination	5	6	5	4	6	5	3	6	6
Co-operation	3	6	6	4	6	6	3	6	6
Leadership	3	6	5	4	5	5	4	6	5
Team motivation	3	6	5	4	5	5	6	6	6
Total score	17	30	26	19	27	26	19	30	28

Observation teamwork assessment

Better communication, co-ordination and co-operation in simulation-based training group

Summary

- As the number of robotic surgeries in cardiothoracic surgery continues to increase, there is a need for systematic residents training and crisis management programs.

- The training process should start with training using simulation, animal models, etc. and then a systematic program to train as an assistant surgeon and console surgeon.

- In the event of an emergency in the RATS, the surgeon cannot react immediately, so it is very important to follow the principles and sequence set by the team. The simulation-based training seems very helpful in emergency situation in RATS.