Building a (robotic) minimally invasive esophageal surgery program

50th Annual Toronto Thoracic Surgery Refresher Conference

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Disclosures

- None

Outline

- Establishment of the Beaumont Hospital RAMIE program
- Assessing outcomes: local and international experience
- Training pathways for RAMIE
- Future directions

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Introduction

- Beaumont Hospital: university teaching hospital in Dublin, Ireland
- Approximately 1000 inpatient beds
- One of four designated upper gastrointestinal cancer centres in Ireland, approximately 1.5 million in catchment area
- >100 upper GI cancer resections per annum
- Also accept complex referrals nationally
- First RAMIE Spring 2020



Open esophagectomy

- CROSS trial (2012)
  - 45% pulmonary complications
  - 20% cardiac complications
  - 22-30% anastomotic leak rate
  - 7% 30-day mortality

- Neo-AEGIS (2023)
  - 30-40% pulmonary complications
  - 17% cardiac complications
  - 11% anastomotic leak rate
  - 3% post-operative mortality

MIE improves outcomes

Contents lists available at ScienceDirect

European Journal of Surgical Oncology

journal homepage: www.ejso.com

Surgery by a minimally invasive approach is associated with improved textbook outcomes in oesophageal and gastric cancer

Jarlath C. Bolger [a, b, *], Mohammed Al Azzawi [a, b], Jack Whooley [a], Eamonn M. Bolger [a], Luke Trench [a], Jack Allen [a], Michael E. Kelly [b], Conor Brosnan [a, b], Mayilone Arumugasamy [a], William B. Robb [a, b]

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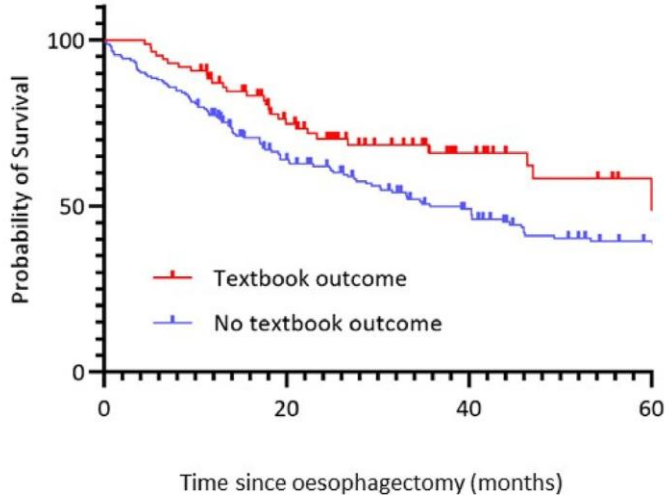
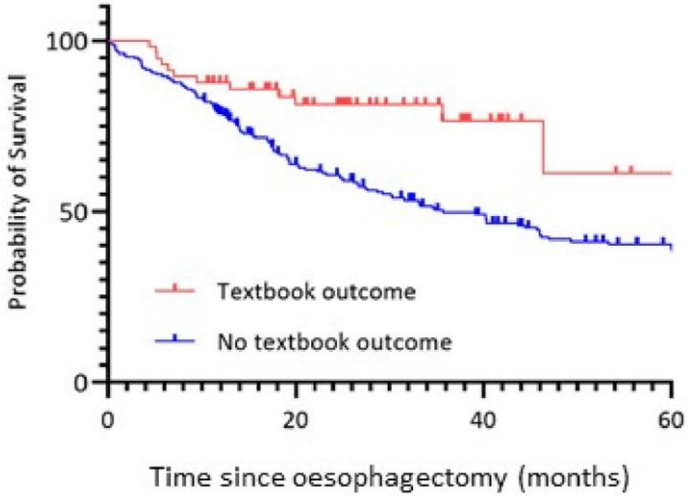


- 269 patients undergoing esophagectomy
- TBO associated with improved long term survival
- MIE had increased median survival
- What happens in the perioperative period matters!



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Establishment of RAMIE program

- First case March 2020 (!)
  - Prior to this >50 benign foregut cases
- Theatre staff underwent comprehensive training and site visit to RAMIE centre
- Initial cases were hybrid: robotic thorax with laparoscopic abdomen and vice versa
- Allowed familiarisation of staff with robotic set up

Establishment of RAMIE program

- Institutional support is essential
- Audit of outcomes is a key component of program
- Comparing with hybrid and standard MIE
- Examining TBOs
- Cost implications particularly ICU

Outline

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- Future directions

Establishment of RAMIE program

ORIGINAL ARTICLE

Check for updates

Quality and safety of Ireland's first robotic oesophagectomy program

Mohammad Al Azzawi[1,2] · Orla Brett[1] · Claire Coleman[1] · Domhnall O'Connor[1,2] · Mohammed Albagir[1] · Jarlath C. Bolger[1,2] · William B. Robb[1,2]

- Reported on first 90 cases comparing with hybrid and MIE
- Overall reduced complications (anastomotic leak, pulmonary complications)
- Slight increase in chyle leaks

Establishment of RAMIE program

	Total (n=240)	Non-RAS (n=105)	RAS (n=135)	
Male	176 (74%)	79 (75%)	97 (72%)	
Female	64 (26%)	26 (25%)	38 (28%)	0.65
Age	66.3 (26-86)	65.3	67.2	0.41
ASA Grade				
I	9 (4%)	2 (2%)	7 (5%)	
II	100 (42%)	50 (48%)	50 (37%)	
III	131 (52%)	53 (50%)	78 (58%)	0.29
Tumour Location				
Proximal	5 (2%)	2 (2%)	3 (2%)	
Middle	45 (19%)	21 (20%)	24 (18%)	
Distal	124 (52%)	55 (52%)	69 (52%)	
OGJ	66 (27%)	28 (26%)	38 (28%)	0.75
Histological Diagnosis				
AdenoCa	182 (76%)	78 (74%)	104 (77%)	
SCC	50 (21%)	24 (23%)	26 (19%)	
Other	8 (3%)	3 (3%)	5 (4%)	0.77

Establishment of RAMIE program

Variable	Non-RAS (n=104)	RAS (n=135)	P Value
Neoadjuvant Regimen			
CROSS	66 (63%)	81 (60%)	0.001
FLOT	2 (2%)	35 (26%)	
None	35 (34%)	19 (16%)	
Pathological Staging ((y)pStage)			
I	58 (56%)	55 (41%)	0.69
II		17 (13%)	
IIIa	27 (26%)	36 (27%)	
IIIb	14 (13%)	23 (17%)	
IVa	5 (5%)	4 (2%)	
Nodal yield (mean, SD)	23.2 (9.1)	28.2 (8.4)	0.001
Resection Status*			
R0	95 (91%)	124 (92%)	1.0
R1+	8 (9%)	11 (8%)	

***based on RCPath guidelines**

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Establishment of RAMIE program

Post-operative Complications			
	Non-RAS (n=104)	RAS (n=135)	P Value
Any complication			
No	55 (53%)	85 (63%)	0.14
Yes	49 (47%)	50 (37%)	
Anastomotic leak			
No	93 (89%)	130 (96%)	0.04
Yes	11 (11%)	5 (4%)	
Chyle leak			
No	94 (91%)	108 (80%)	0.01
Yes	10 (9%)	27 (20%)	
Lower Respiratory Tract Infection			
No	77 (74%)	111 (82%)	0.15
Yes	27 (26%)	24 (18%)	
Atrial Fibrillation			
No	89 (85%)	121 (90%)	0.42
Yes	15 (15%)	14 (10%)	
ICU Readmission			
No	93 (89%)	130 (96%)	0.04
Yes	11 (11%)	5 (4%)	
Delayed emptying			
No	95 (91%)	132 (98%)	0.67
Yes	3 (3%)	3 (2%)	
No data	6 (6%)	0	
Length of stay			
Median LoS	13 (7-63)	10 (5-54)	0.54

Establishment of RAMIE program

- Significant decrease in
  - ICU utilisation
  - Anastomotic leak

- Mean LoS for an anastomotic leak is **45 days**

- Anastomotic leak **doubles** healthcare costs at a **minimum**

- Infectious complications increase healthcare costs by **50%**

International Evidence

Diseases of the Esophagus (2026), **39**, 1–8
https://doi.org/10.1093/dote/doag042

DISEASES OF THE ESOPHAGUS

ISDE The International Society for Diseases of the Esophagus

Original Article

Regional characteristics of esophageal cancer and robot-assisted minimally invasive esophagectomy (RAMIE): an analysis of the international UGIRA registry

- International, multicentre analysis of the UGIRA database 2016-2024
- 3,916 RAMIE cases registered, predominantly Europe and Asia

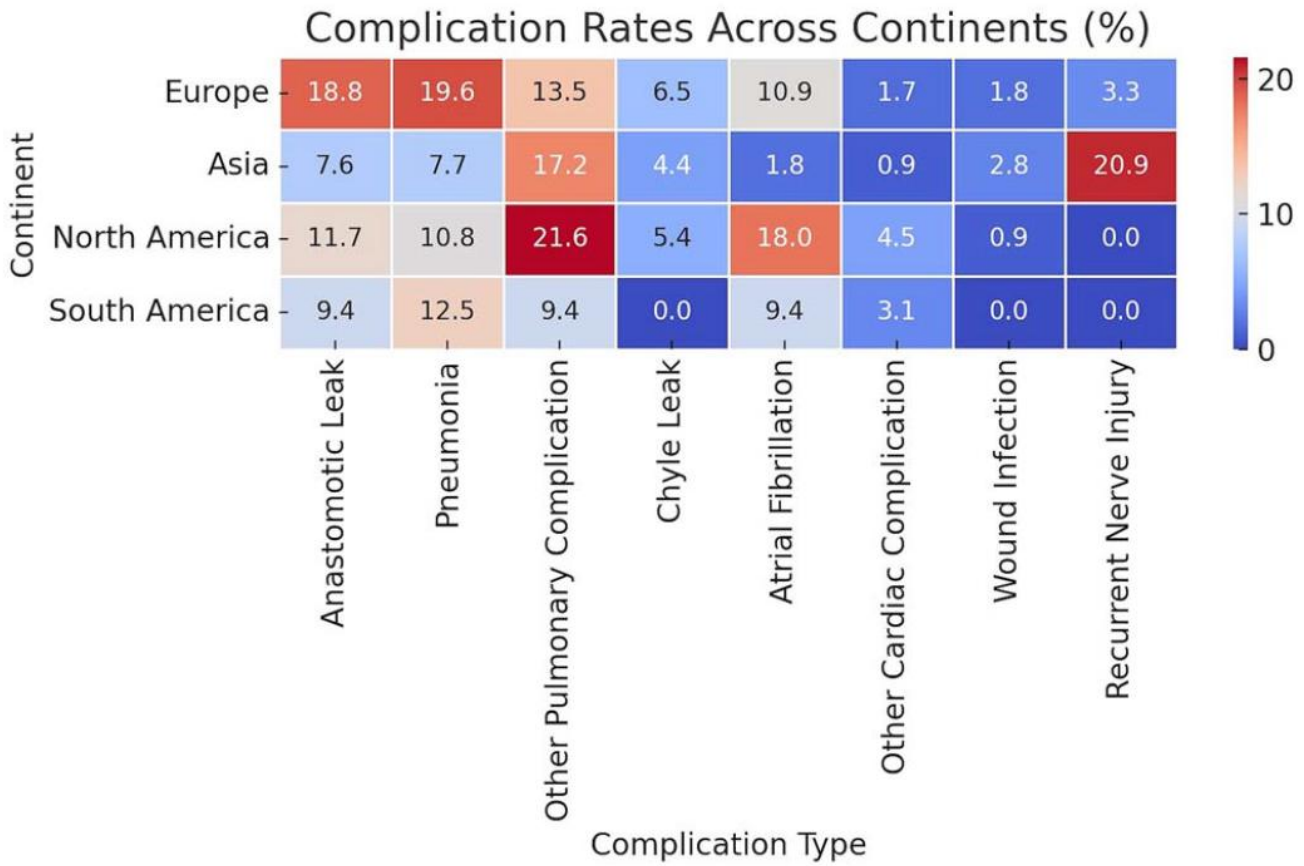
International Evidence

Table 1 Patient characteristics by continent

Variables		Europe	Asia	North America	South America
Total		2643	1130	111	32
Number of Centers		31	6	2	1
Age (median, [IQR])		66 [59, 72]	66 [59, 71]	67 [60, 72]	65 [58, 73]
Sex	Male/Female	2098/545	928/202	96/15	31/1
BMI (median, [IQR])		25.6 [23.2, 28.6]	22.5 [20.5, 24.9]	28.6 [24.2, 31.7]	27.3 [24.3, 32.8]
Comorbidity Category Number (median, [IQR])		1 [0, 2]	0 [0,1]	2 [1,3]	1 [1,2]
ASA Class (median, [IQR])		2 [2,3]	2 [2, 2]	3 [3, 3]	2 [2, 2]
Preoperative Therapy[a]	Chemotherapy Only	813 (31.1%)	323 (28.8%)	19 (17.3%)	8 (25.0%)
	Radiation Only	5 (0.2%)	15 (1.3%)	0 (0.0%)	0 (0.0%)
	Chemoradiation	1405 (53.8%)	220 (19.6%)	73 (66.4%)	15 (46.9%)
Histology	Adenocarcinoma	2044 (78.1%)	64 (5.7%)	101 (91.2%)	26 (81.2%)
	Squamous Cell Carcinoma	487 (18.6%)	1030 (91.2%)	6 (5.4%)	6 (18.8%)
	Other Malignancy	53 (2.0%)	29 (2.6%)	3 (2.7%)	0 (0%)
	Benign Indication	32 (1.2%)	7 (0.6%)	1 (0.9%)	0 (0%)
	Unknown	27 (1.0%)	0 (0%)	0 (0%)	0 (0%)
Approach	Ivor-Lewis	2232 (85.7%)	54 (4.8%)	106 (96.4%)	0 (0%)
	McKeown	324 (12.4%)	1071 (94.9%)	4 (3.6%)	24 (75%)
	Transhiatal	49 (1.9%)	4 (0.4%)	0 (0%)	8 (25.0%)
Anastomosis	Circular Stapled	1397 (53.6%)	684 (60.7%)	97 (87.4%)	0 (0%)
	Linear Stapled	540 (20.7%)	346 (30.7%)	0 (0%)	31 (96.9%)
	Hand-sewn	659 (25.3%)	80 (7.1%)	13 (11.6%)	1 (3.1%)
	No Anastomosis	9 (0.3%)	17 (1.5%)	1 (0.9%)	0 (0%)
ICU Length of Stay (days) (median, [IQR])		2 [1, 6]	1 [1, 2]	2 [1, 4]	5 [3, 7]
Length of Stay (days) (median, [IQR])		13 [9, 21]	11 [8, 16]	8 [7, 13]	12 [10, 15]

[a] Among malignant diagnosis. Abbreviations: IQR, interquartile range; BMI, body mass index; ASA, American Society of Anesthesiology; ICU, intensive care unit.

International Evidence



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International Evidence

Journal of Robotic Surgery (2026) 20:527
https://doi.org/10.1007/s11701-026-03489-0

REVIEW

Short-term outcomes of robot-assisted versus conventional minimally invasive esophagectomy for resectable esophageal cancer: a systematic review and meta-analysis

- Multiple retrospective, non-randomised studies
- 13,321 patients
- RAMIE: reduced blood loss, conversion, pulmonary complications, ICU use and LoS
- Increased LN yield, no difference in R0 rates

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Training

- Access to robotic platforms is rapidly expanding
- RAMIE offers benefits over conventional MIE
- Training residents and fellows for independent practice is key
- Learning curve: evidence unclear

Training

Surgical Endoscopy (2025) 39:6213–6221
https://doi.org/10.1007/s00464-025-11889-w

2025 SAGES POSTER

Learning curve of Robotic Assisted Minimally Invasive Ivor Lewis Esophagectomy (RAMIE): initial experience

Andres Ramos-Fresnedo[1] · Keouna Pather[1] · Chelsea R. Yap[1] · Brian G. Celso[1] · Erin M. Mobley[1] · Ziad T. Awad[1]

- Single surgeon series following introduction of RAMIE
- CUSUM analysis suggested learning curve of 55 cases
- Based on operative time and perioperative complications
- Median console time 281 minutes

Training

Journal of Robotic Surgery (2026) 20:379
https://doi.org/10.1007/s11701-026-03327-3

RESEARCH



Learning curve analysis across three surgical eras in Ivor Lewis esophagectomy

Mazen A. Juratli[1] · Franziska Viola Damhorst[1] · Ann-Kathrin Eichelmann[1] · Jennifer Merten[1] · Nader El-Sourani[1] · Mazen Aldarwish[1] · Andreas Pascher[1] · Jens Peter Hoelzen[1]

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- Single surgeon series following introduction of RAMIE
- CUSUM analysis suggested learning curve of 70 cases for total RAMIE
- Operative duration and perioperative outcomes
- Median operative time 424 minutes for RAMIE

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Training

Robotic-assisted minimally invasive esophagectomy: experience at the University of Pittsburgh Medical Center

Marissa A. Matto[1], Evan T. Alicuben[1], Samuel Luketich[1], Sangmin Kim[1], Nicholas Baker[2], Inderpal S. Sarkaria[3], James D. Luketich[1]

- Examined 83 RAMIE cases
- Included four surgeons
- Did not establish explicit learning curve, other than to state ‘some surgeons remain on learning curve’
- Median operative time 614 minutes

Beaumont Hospital RAMIE training pathway

- 10 step curriculum

- Non-sequential, separate steps

- Each graded along a standardised system, in line with operative assessments from the RCSI
  - 1: Able to assist
  - 2: Able to perform components but guidance required
  - 3: Able to perform most steps but requires guidance/lacks fluency
  - 4: Able to perform independently to the level of a day-1 consultant

Mobilisation of greater curve

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Future directions

- Robotic assisted operations for complex reconstructions?
- 54F, prior sleeve gastrectomy, converted to RYGB
- Developed SCC in distal oesophagus
- Neoadjuvant CROSS
- Robotic approach?

Robotic assisted esophagectomy and colonic interposition

Mr William B Robb, MB, MD, FRCSI

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Future directions

- Introduced DaVinci SP for upper GI resections
- Subtotal and total gastrectomy to date
- Trans-thoracic subcostal approach (10-15 cases)
- Aim for RA MICE (dual robot operating?)



Conclusions

- Institutional commitment and building a team are key
- With careful planning, RAMIE can be introduced with excellent results
- Training curricula are key to ensuring safe, certified surgeons for complex GI pathology
- Expanding suite of robots will increase possibilities

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