Thoracic Surgery 2019- Robotic in Thoracic Surgery and beyond

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Disclosures

- Grants
  - Canadian Institute for Health Research
  - Heart and Stroke Foundation
  - Ontario Thoracic Society
  - McMaster Surgical Association
  - JCC Foundation
  - Medela Inc
  - NSERC
- Ethicon consult remuneration

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Overview

- Background
- Robotic Thoracic Surgery and McMaster TS Robotic Program
- Digitalization and TS- post discharge programs
- The era of Databases
- Future perspectives- sub-lobar resections, early detection, neuro science based medicine, precision medicine etc

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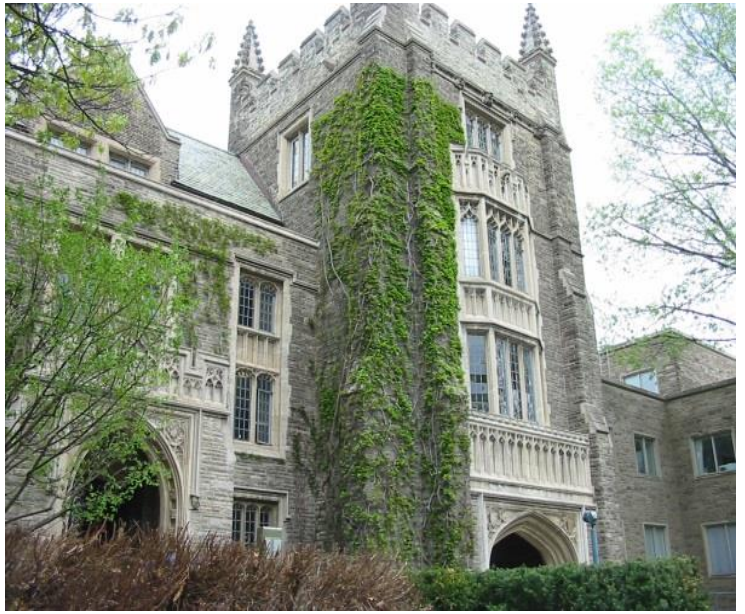
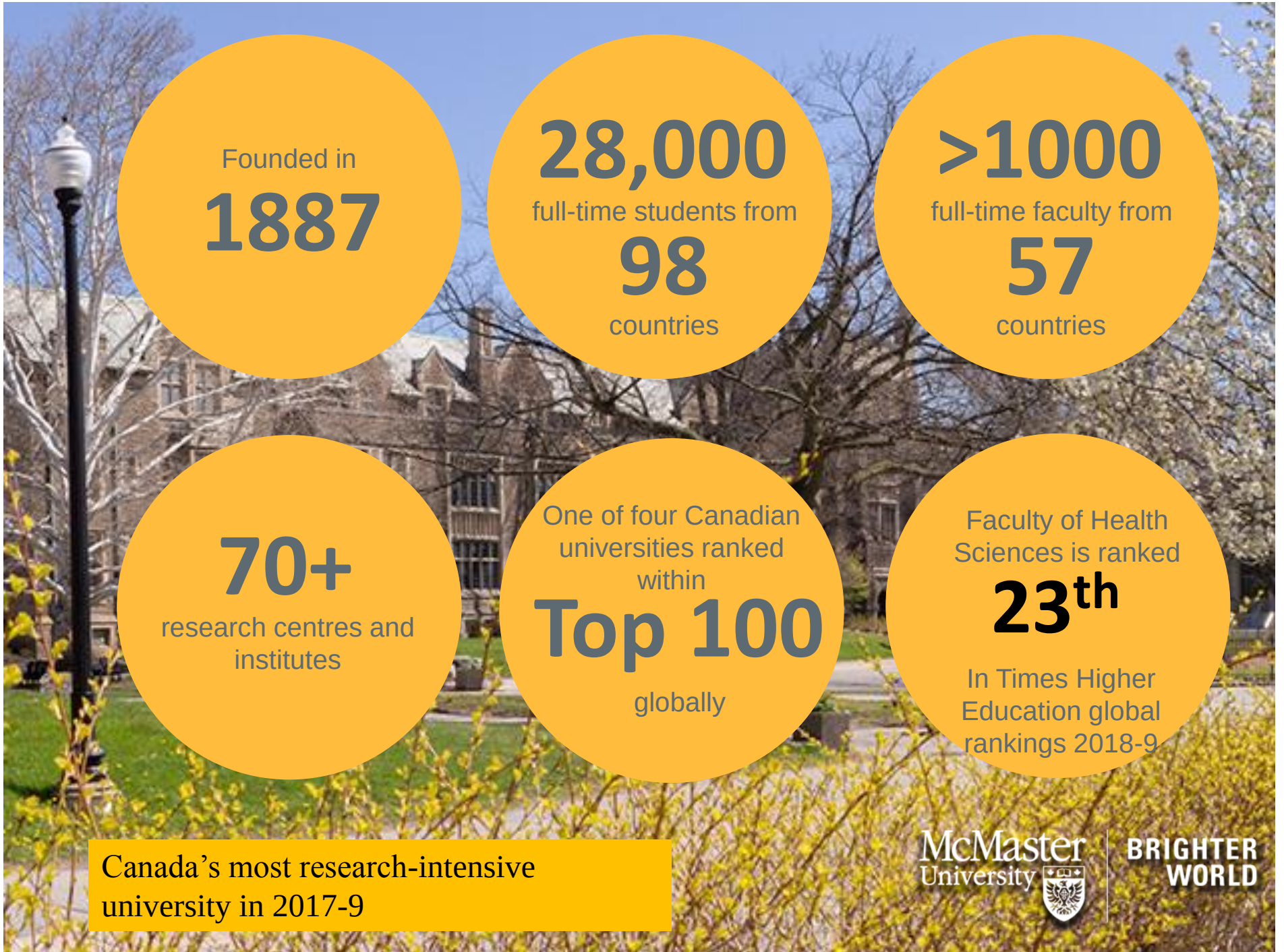
McMaster University
HEALTH SCIENCES



McMaster University, Hamilton, Ontario, Canada



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McMaster University HEALTH SCIENCES

SJHH Hamilton

St. Joseph's Healthcare Hamilton

- <u>The Division of Thoracic Surgery 2019:</u>
  - 4 surgeons, 22 unit beds, 8 SDU beds
  - <u>2018</u>: - 1050 surgeries, 467 major lung resections, 64 Esophagectomies,
  - 1860 endoscopic procedures
    EUS- 155, EBUS- 347, Radial EBUS, NAV bronchoscopy, Laser, Stents,MPE etc
  - 17% of lung cancer resections in Ontario

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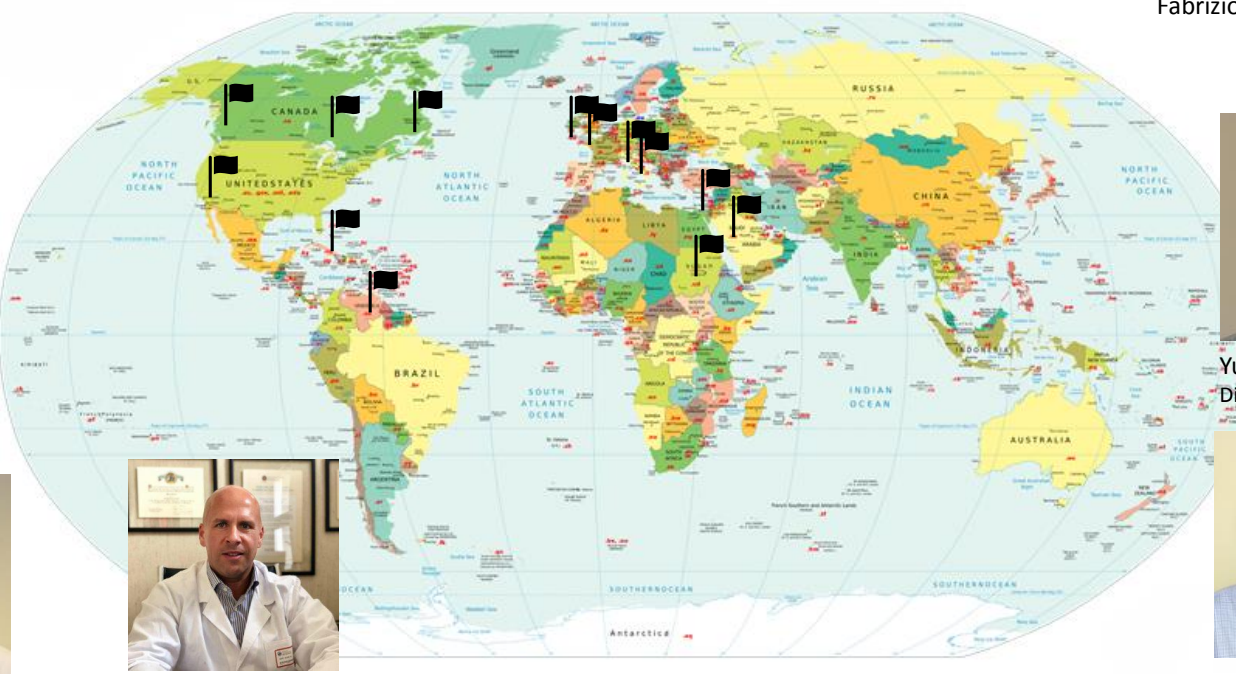
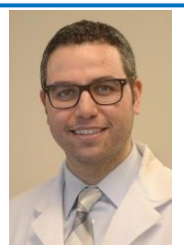
Educational Activity 2010-2019




John Agzarian


Chuck Wen


Jenelle Taylor


Jakub Kadlec


Fabrizio Minervini


Michele De Waele

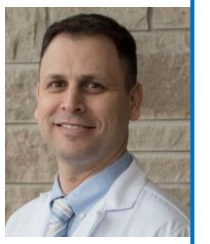

Mauricio Pipkin


Patrice Pinkney


Cheetanand Mahadeo

Marco Scarci
Division Head


Yury Peysakhovich
Division Head


Ronny Ben Avi
Division Head


Nir Golan
Division Head


Abdulhadi Almutairi

1. RCPSC residency Program
2. International Clinical Fellowship Program
3. Interventional Respirology fellowship PROGRAM- Established 2018, collaboration between Thoracic Surgery and Respirology, based at SJHH FIRH

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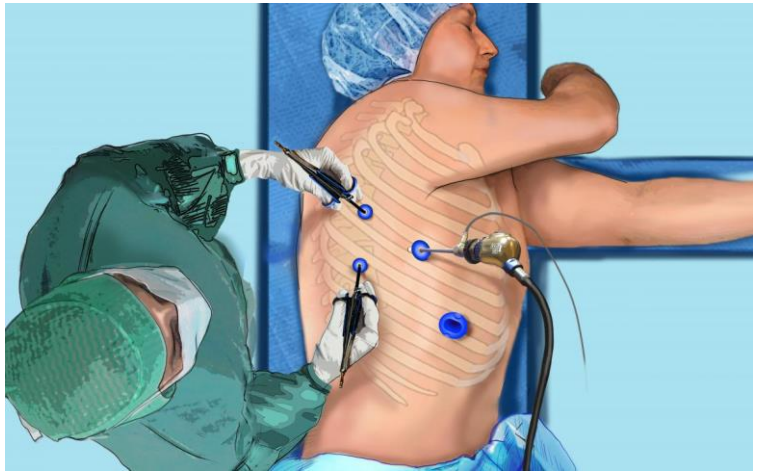
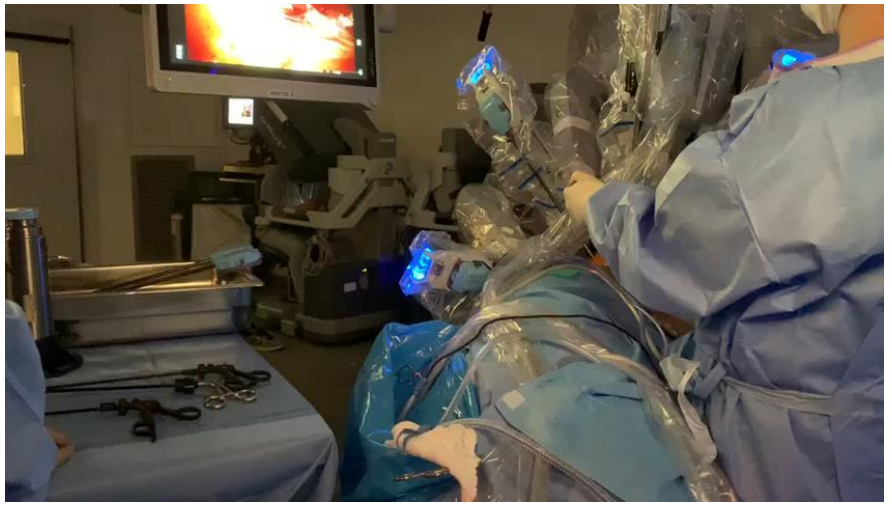
The Evolution of Thoracic Surgery

CIRCA 2000 BC- ~2000:
Open resections



1990th- current: MIS/VATS



2010- current: Robotic (RATS)

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Initial questions and concerns 1:

- Is Robotic Lobectomy a better/worse oncological operation than VATS/Open lobectomy ?
  1. Robotic is better
  2. Open surgery is the best- better visualization, more lymph nodes, better outcomes
  3. Doesn’t matter, as long as you are the following principles of oncological surgery
  4. The jury is not out yet

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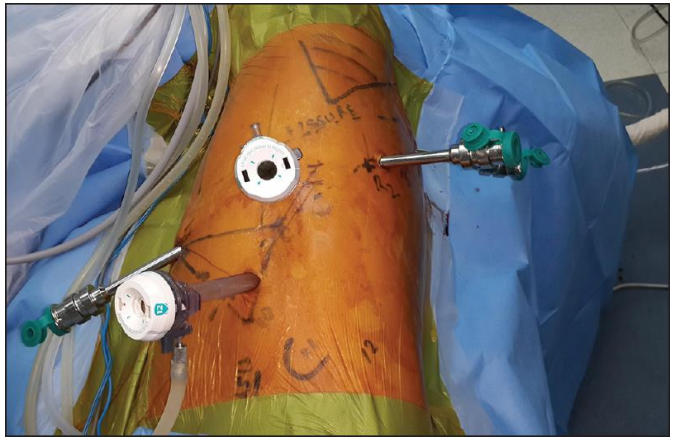
The da Vinci Robot



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The performer

- *Open/VATS surgeon*
  - Human Vision
  - Residual tremor
  - Standing position
  - 2 arms
  - Fatigues with time
  - Headlight 1000 candles
  - Limited access
- *Robot assisted surgeon*
  - 3D Magnified HD Vision
  - Machine precision
  - Sitting position
  - 4 arms
  - Long performance times
  - Light with 5000 candles
  - Enhanced access

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5pm, end of OR day, 3 Robotic vs 3 non-robotic lung resections

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Technical aspects

- *VATS Resections:*
- 2D Vision
- Restricted angles of instrumentation
- Assistant controls camera and exposure
- 1-4 incisions
- Surgeon close to patient
- Haptic feedback
- Simple setup

- *Robotic Resections:*
  - 3D Vision
  - 7 degrees of freedom of motion
  - Surgeon controls camera and all instruments
  - 4 or 5 incisions
  - Surgeon away from patient
  - Visual haptics
  - Potential for integration of future technology
  - Complex setup

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Setup: Robotic vs Video Assisted Thoracic Surgery

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Ergometry, Robotic vs VATS Thoracic Surgery

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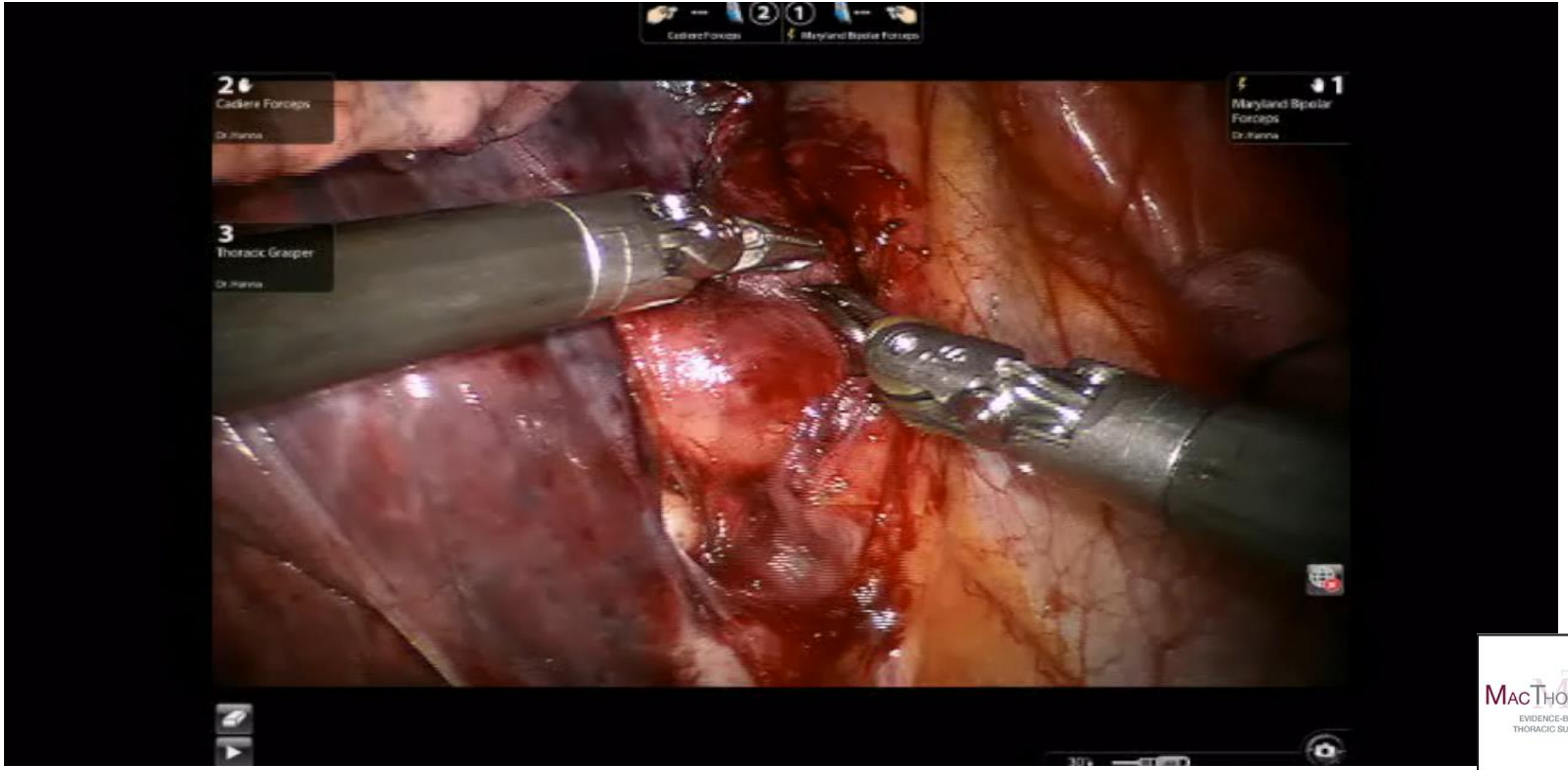
3D Vision for all, magnified.



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Initial questions and concerns 1:

- Is Robotic Lobectomy a better/worse oncological operation than VATS/Open lobectomy ?
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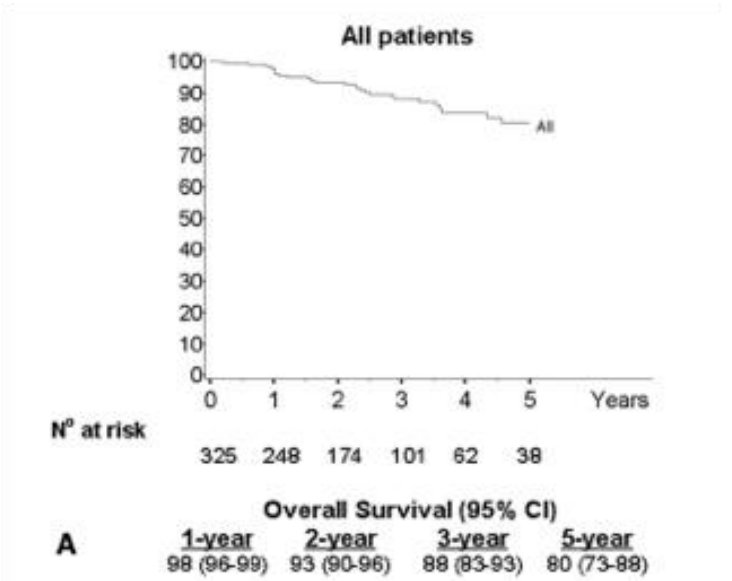
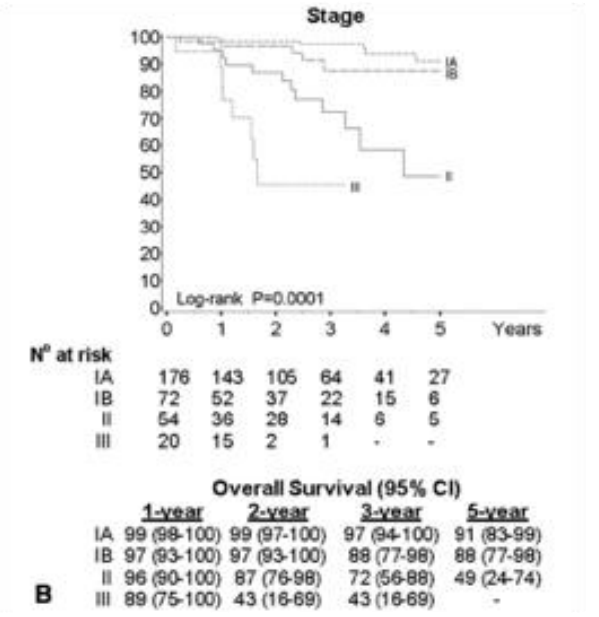
RATS- Oncological outcomes

- Overall 5 year survival 80% (CI 73-88)
  - IA 91%, IB 88%, II 49%





Park B, et al. J Thorac Cardiovasc Surg 2012;143:383-9

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Nodal staging

Nodal Upstaging in Robotic and Video Assisted Thoracic Surgery Lobectomy for Clinical N0 Lung Cancer

Benjamin E. Lee, MD, Mark Shapiro, MD, John R. Rutledge, MAS, and Robert J. Korst, MD

- 158 VATS vs 53 CPRL (Completely Portal Robotic Lobectomy) cases
- Compared number of LNs dissected and nodal upstaging
- Secondary outcome: survival

Lee BE, et al. *Ann Thorac Surg*. 2015;100(1):229-234

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No differences in survival *or* Nodal upstaging

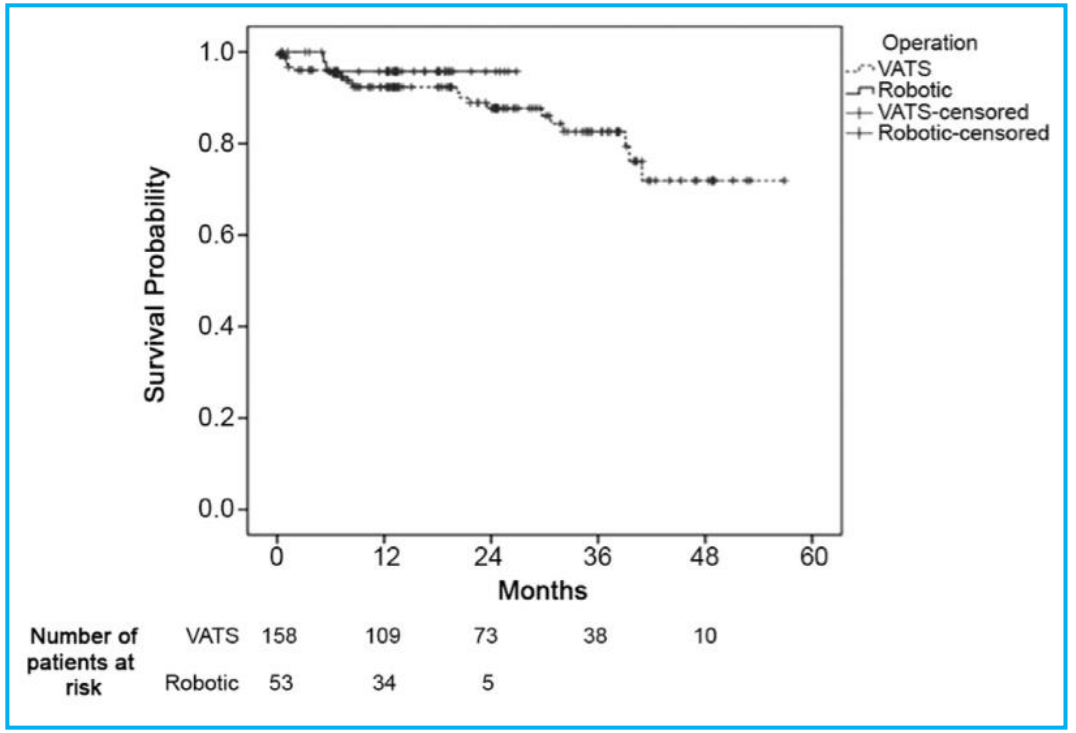

Table 3. Nodal Upstaging in Video-Assisted Thoracic Surgery Versus Robotic Lobectomy (N = 211)

Procedure	T stage	No.	pN0 No. (%)	pN1 No. (%)	pN2 No. (%)	Total (pN1+pN2) No. (%)	*p* Value
VATS	cT1	119	104 (87.4)	8 (6.7)	7 (5.9)	15 (12.6)	0.72
	cT2	36	27 (75)	5 (13.9)	4 (11.1)	9 (25)	
	cT3	3	3 (100)	0	0	0	
Robotics	cT1	40	35 (87.5)	3 (7.5)	2 (5)	5 (12.5)	
	cT2	10	8 (80)	2 (20)	0	2 (20)	
	cT3	3	3 (100)	0	0	0	

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Initial questions and concerns 1:

- Is Robotic Lobectomy a better/worse oncological operation than VATS lobectomy ?
- Robotic and VATS/Open are likely similar in term of oncological outcomes

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Initial questions and concerns 2:

- Robotic surgery is way more expensive than VATS/Open resections
  1. Must be- complex setup, expensive machinery, single company monopoly
  2. Probably cheaper since it is less invasive and hence faster recovery, shorter LOS and less expanses overall
  3. Depends who is asking and who is answering

Open, Video-Assisted Thoracic Surgery, and Robotic Lobectomy: Review of a National Database

Michael Kent, MD,* Thomas Wang, PhD,* Richard Whyte, MD, Thomas Curran, MD, Raja Flores, MD, and Sidhu Gangadharan, MD

Division of Thoracic Surgery and Interventional Pulmonology, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston Massachusetts; Department of Economics, Harvard University, Cambridge, Massachusetts; and Division of Thoracic Surgery, Mount Sinai Medical Center, New York, New York

- Series on 843 procedures
- National Cancer Database (NCDB)
- Matched comparison VATS vs CPRL vs Open
- CPRL offers lower mortality and morbidity
- No cost data

Ann Thorac Surg 2015

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The Use of Robotic-Assisted Thoracic Surgery for Lung Resection: A Comprehensive Systematic Review

John Agzarian, MD, MPH,[*] Christine Fahim, PhD(c), MSc,[†] Yaron Shargall, MD,[*] Kazuhiro Yasufuku, MD, PhD,[‡] Thomas K. Waddell, MD, PhD, MSc,[‡] and Waël C. Hanna, MDCM, MBA[*]

Central Message

Systematic analysis establishes RATS as a safe procedure that demonstrates no difference in clinical outcomes, as compared with VATS.

Perspective Statement

This is the most comprehensive review using systematic methods for the use of RATS. Comparative observational studies demonstrate that RATS provides advantages over thoracotomy and appears to be no different than VATS, with an associated increased cost.

Semin Thorac Surg 2016

Performing Robotic Lobectomy and Segmentectomy: Cost, Profitability, and Outcomes

Basil S. Nasir, MBBCh, Ayesha S. Bryant, MSPH, MD, Douglas J. Minnich, MD, Ben Wei, MD, and Robert J. Cerfolio, MD, MBA

Division of Thoracic Surgery, Centre Hospitalier de l'Université de Montréal, Montréal, Québec, Canada; and Division of Cardiothoracic Surgery, University of Alabama at Birmingham, Birmingham, Alabama

- Series on 900 procedures
- No comparison to VATS
- Accounting profit $4,750 per patient undergoing robotic operation
- "Good for Obamacare"

Nasir BS, et al.. Ann Thorac Surg. 2014;98(1):203-209

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Robotic Versus Video-Assisted Thoracoscopic Lung Resection During Early Program Development

Manraj N. Kaur, PT, PhD(c), Feng Xie, PhD, Andrea Shiwcharan, BHS, Lisa Patterson, BSc, Yaron Shargall, MD, Christian Finley, MD, Colin Schieman, MD, Terry Dalimonte, RN, MBA, Christine Fahim, MS, PhD(c), and Waël C. Hanna, MDCM, MBA

School of Rehabilitation Sciences and Health Research Methods, Evidence, and Impact, Faculty of Health Sciences, McMaster University, Hamilton, Ontario; Funding Reform and Case Costing and Boris Family Center for Robotic Surgery Research Program, St. Joseph's Healthcare Hamilton, Hamilton, Ontario; Division of Thoracic Surgery, Department of Surgery, McMaster University, Hamilton, Ontario; Section of Thoracic Surgery, University of Calgary, Calgary, Alberta; and St. Joseph's Home Care, Hamilton, Ontario, Canada

Kaur et al.. Ann Thorac Surg. 2018;105(4):1050-1057

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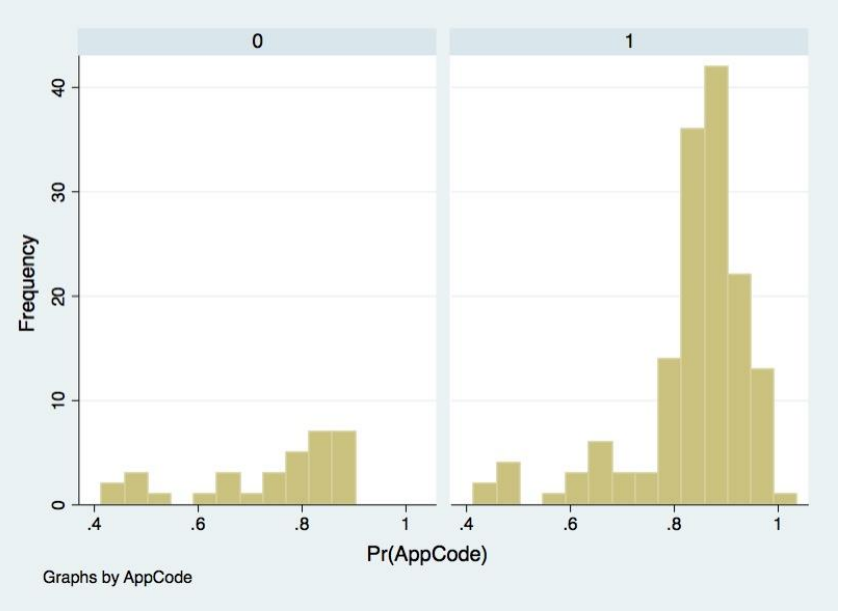
CPRL Lobectomy Generates Cost Savings When Compared to VATS Lobectomy for Early Stage NSCLC



Total expenditure (pre-hospital, operative, in-hospital, and post-discharge) per case was **$14,695.46 ± $6,055.09 for the CPRL** cohort and **$16,257.78 ± $2,6954.79 for the VATS** cohort (p=0.004)

Kaur et al. Ann Thorac Surg 2018

Overall cost, Robotic vs VATS lung resections

Comparing robot-assisted thoracic … cal lobectomy with conventional video-assisted th… surgical lobectomy and wedge resection: Results from a … ospital database (Premier)

Scott J. Swanson, MD,[a] Dani… r, MD,[b] Robert Joseph McKenna, Jr, MD,[c] John Howington, MD,[d] M. Blair Marshall, MD,[e] … Yoo, MD,[f] Matthew Moore, MHA,[g] Candace L. Gunnarsson, EdD,[h] and Bryan F. Meyers, M…

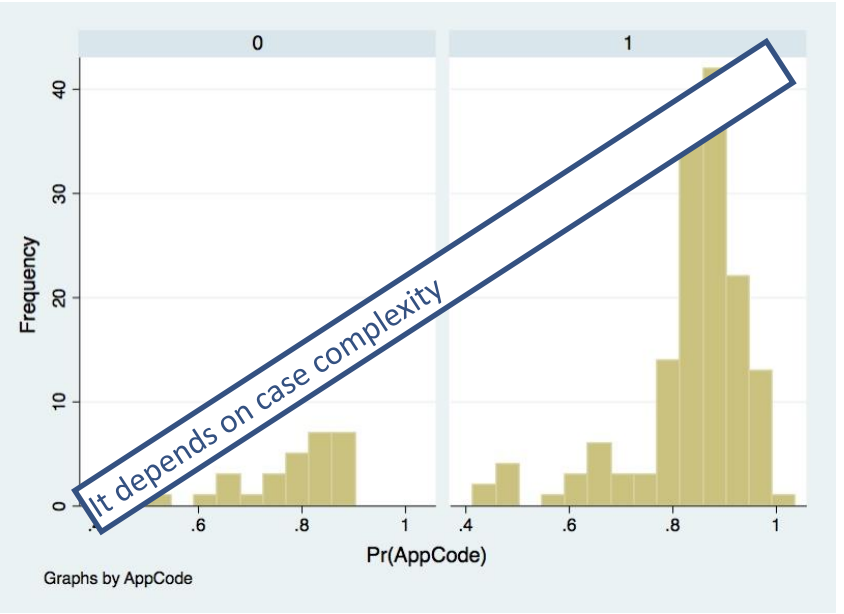
MORE Expensive than VATS

Performing Robotic Lob… y and Segmentectomy: Cos… ofitability, and Outcomes

Basil S. Nasir, MBBCh, A… Bryant, MSPH, MD, Douglas J. Minnich, MD, Ben Wei, MD, and Rob… erfolio, MD, MBA

Division of Thoracic Surge… ospitalier de l'Université de Montréal, Montréal, Québec, Canada; and Division of Cardiothoracic Surgery, … of Alabama at Birmingham, Birmingham, Alabama

LESS Expensive than VATS



Swanson SJ et al. J Thorac Cardiovasc Surg. 2014;147(3)
Nasir BS, et al.. *Ann Thorac Surg*. 2014;98(1):203-209
Kaur et al. *Ann Thorac Surg*. 2018;105(4):1050-1057

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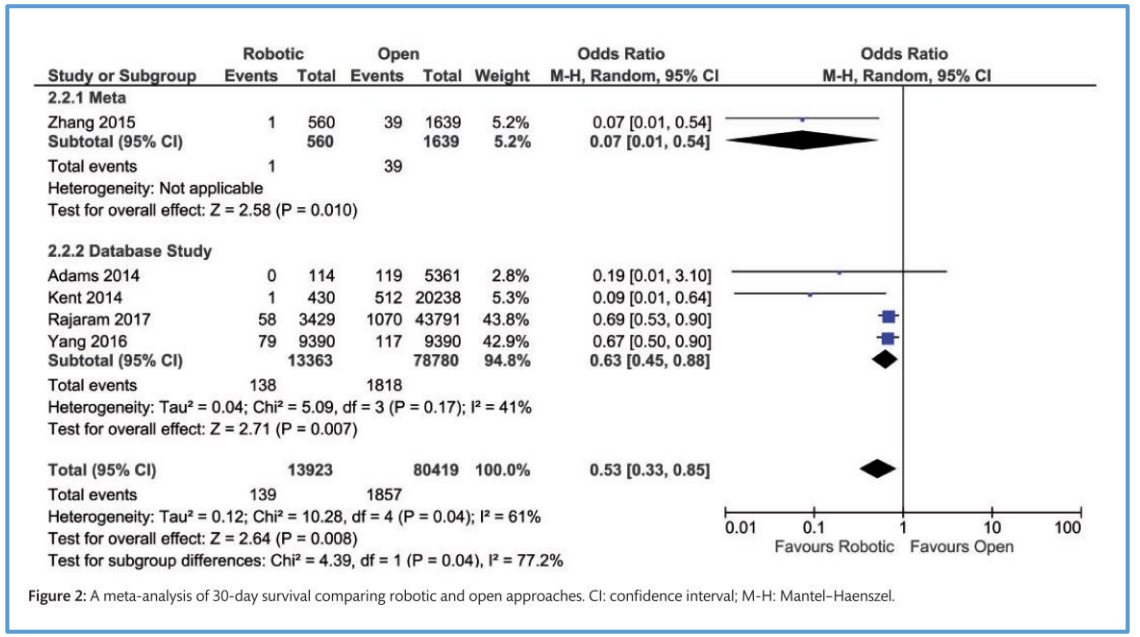
A systematic review and meta-analysis of robotic versus open and video-assisted thoracoscopic surgery approaches for lobectomy

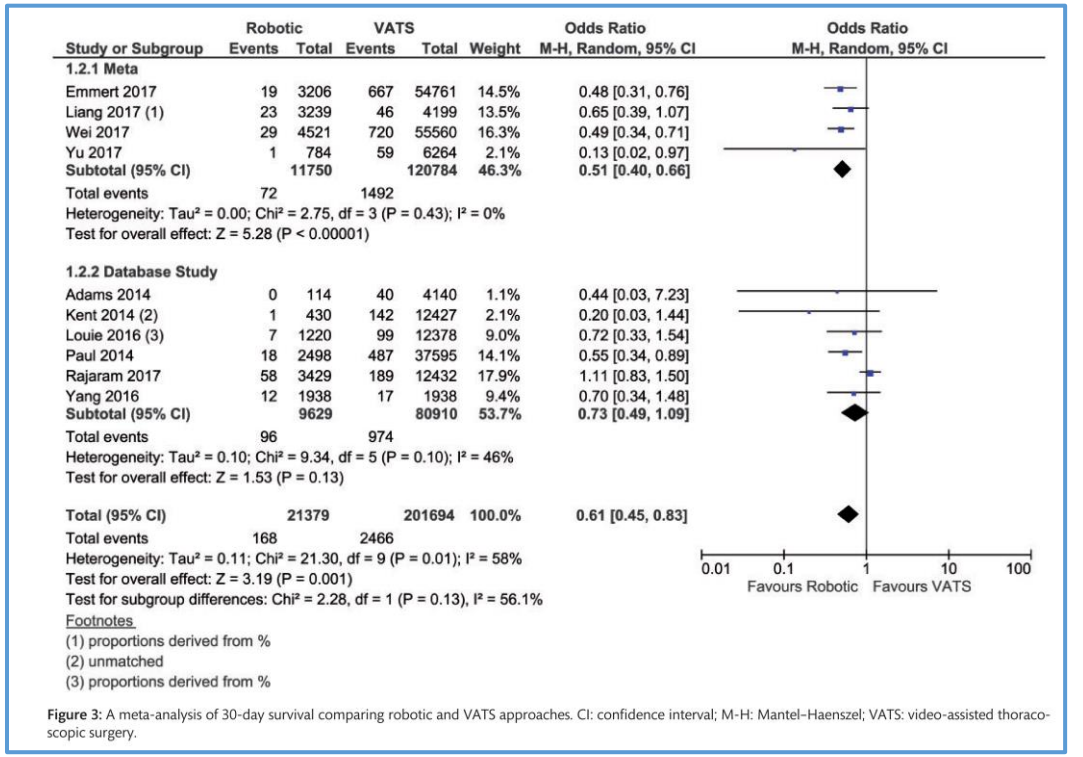
Katie E. O'Sullivan[a,*], Usha S. Kreaden[b], April E. Hebert[b], Donna Eaton[a] and Karen C. Redmond[a]



Study or Subgroup	Robotic Events	Robotic Total	Open Events	Open Total	Weight	Odds Ratio M-H, Random, 95% CI
2.2.1 Meta						
Zhang 2015	1	560	39	1639	5.2%	0.07 [0.01, 0.54]
Subtotal (95% CI)		**560**		**1639**	**5.2%**	**0.07 [0.01, 0.54]**
Total events	1		39			
Heterogeneity: Not applicable						
Test for overall effect: Z = 2.58 (P = 0.010)						
2.2.2 Database Study						
Adams 2014	0	114	119	5361	2.8%	0.19 [0.01, 3.10]
Kent 2014	1	430	512	20238	5.3%	0.09 [0.01, 0.64]
Rajaram 2017	58	3429	1070	43791	43.8%	0.69 [0.53, 0.90]
Yang 2016	79	9390	117	9390	42.9%	0.67 [0.50, 0.90]
Subtotal (95% CI)		**13363**		**78780**	**94.8%**	**0.63 [0.45, 0.88]**
Total events	138		1818			
Heterogeneity: Tau² = 0.04; Chi² = 5.09, df = 3 (P = 0.17); I² = 41%						
Test for overall effect: Z = 2.71 (P = 0.007)						
Total (95% CI)		**13923**		**80419**	**100.0%**	**0.53 [0.33, 0.85]**
Total events	139		1857			
Heterogeneity: Tau² = 0.12; Chi² = 10.28, df = 4 (P = 0.04); I² = 61%						
Test for overall effect: Z = 2.64 (P = 0.008)						
Test for subgroup differences: Chi² = 4.39, df = 1 (P = 0.04), I² = 77.2%						

Figure 2: A meta-analysis of 30-day survival comparing robotic and open approaches. CI: confidence interval; M-H: Mantel–Haenszel.

Open vs Robotic



Study or Subgroup	Robotic Events	Robotic Total	VATS Events	VATS Total	Weight	Odds Ratio M-H, Random, 95% CI
1.2.1 Meta						
Emmert 2017	19	3206	667	54761	14.5%	0.48 [0.31, 0.76]
Liang 2017 (1)	23	3239	46	4199	13.5%	0.65 [0.39, 1.07]
Wei 2017	29	4521	720	55560	16.3%	0.49 [0.34, 0.71]
Yu 2017	1	784	59	6264	2.1%	0.13 [0.02, 0.97]
Subtotal (95% CI)		**11750**		**120784**	**46.3%**	**0.51 [0.40, 0.66]**
Total events	72		1492			
Heterogeneity: Tau² = 0.00; Chi² = 2.75, df = 3 (P = 0.43); I² = 0%						
Test for overall effect: Z = 5.28 (P < 0.00001)						
1.2.2 Database Study						
Adams 2014	0	114	40	4140	1.1%	0.44 [0.03, 7.23]
Kent 2014 (2)	1	430	142	12427	2.1%	0.20 [0.03, 1.44]
Louie 2016 (3)	7	1220	99	12378	9.0%	0.72 [0.33, 1.54]
Paul 2014	18	2498	487	37595	14.1%	0.55 [0.34, 0.89]
Rajaram 2017	58	3429	189	12432	17.9%	1.11 [0.83, 1.50]
Yang 2016	12	1938	17	1938	9.4%	0.70 [0.34, 1.48]
Subtotal (95% CI)		**9629**		**80910**	**53.7%**	**0.73 [0.49, 1.09]**
Total events	96		974			
Heterogeneity: Tau² = 0.10; Chi² = 9.34, df = 5 (P = 0.10); I² = 46%						
Test for overall effect: Z = 1.53 (P = 0.13)						
Total (95% CI)		**21379**		**201694**	**100.0%**	**0.61 [0.45, 0.83]**
Total events	168		2466			
Heterogeneity: Tau² = 0.11; Chi² = 21.30, df = 9 (P = 0.01); I² = 58%						
Test for overall effect: Z = 3.19 (P = 0.001)						
Test for subgroup differences: Chi² = 2.28, df = 1 (P = 0.13), I² = 56.1%						

Footnotes
(1) proportions derived from %
(2) unmatched
(3) proportions derived from %

Figure 3: A meta-analysis of 30-day survival comparing robotic and VATS approaches. CI: confidence interval; M-H: Mantel–Haenszel; VATS: video-assisted thoracoscopic surgery.

VATS vs Robotic

Interactive CardioVascular and Thoracic Surgery 28 (2019) 526–534
doi:10.1093/icvts/ivy315 Advance Access publication 27 November 2018

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Expert Consensus Statement

Optimal Approach to Lobectomy for Non-Small Cell Lung Cancer: Systemic Review and Meta-Analysis

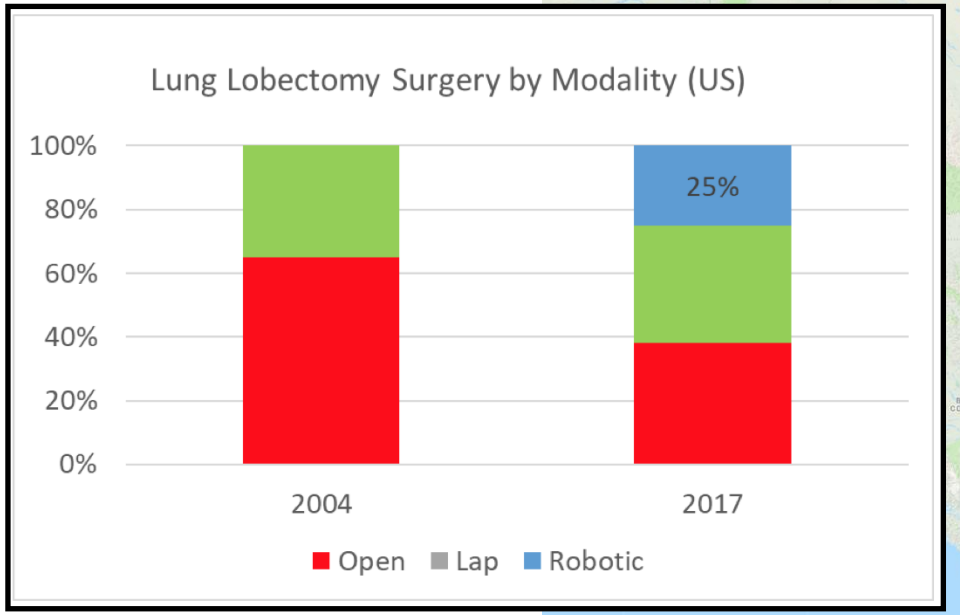
Innovations
14(2) 90–116

DOI: 10.1177/1556984519837027
journals.sagepub.com/home/inv

Calvin S.H. Ng[1], MD, FRCS (CTh), John K. MacDonald[2], BA, MA, Sebastien Gilbert[3], MD, FRCSC, Ali Z. Khan[4], MS, FRCS(CTh), Young T. Kim[5], MD, PhD, Brian E. Louie[6], MD, M. Blair Marshall[7], MD, Ricardo S. Santos[8], MD, PhD, Marco Scarci[9], MD, FRCS(Eng), Yaron Shargall[10], MD, FRCSC, and Hiran C. Fernando[11], MBBS, FRCS

Conclusions: This meta-analysis supports the role of VATS lobectomy for non-small cell lung cancer. Apart from potentially less pain and analgesic requirement with uVATS, different minimally invasive surgical approaches appear to have similar outcomes.

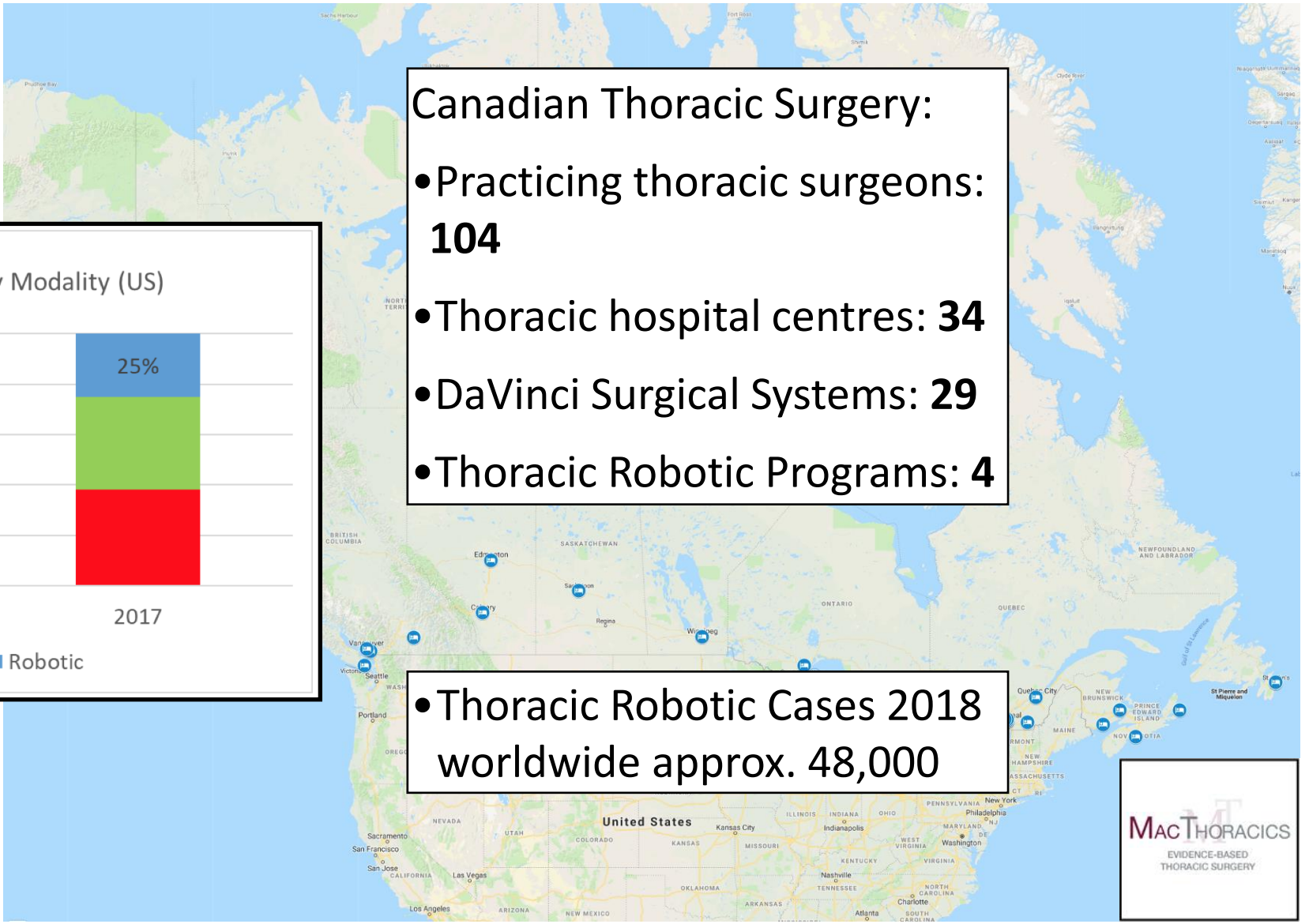
Robotic Thoracic Surgery in Canada and Worldwide: 2019



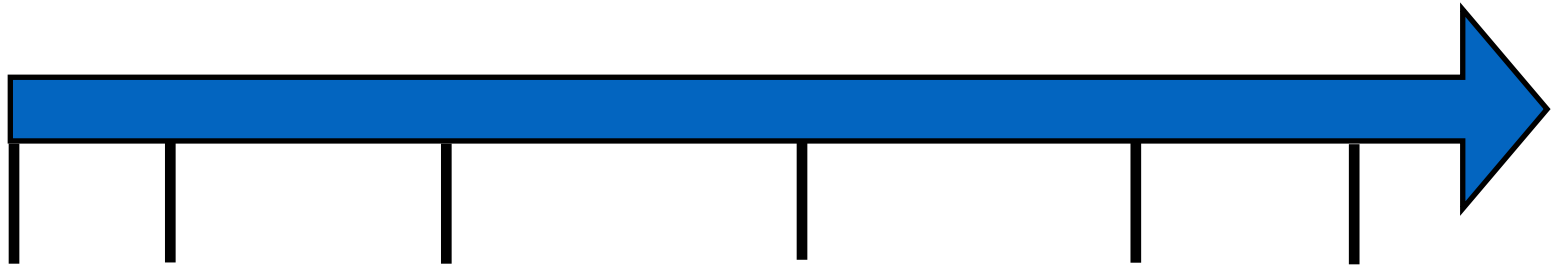
Canadian Thoracic Surgery:

- Practicing thoracic surgeons: **104**
- Thoracic hospital centres: **34**
- DaVinci Surgical Systems: **29**
- Thoracic Robotic Programs: **4**

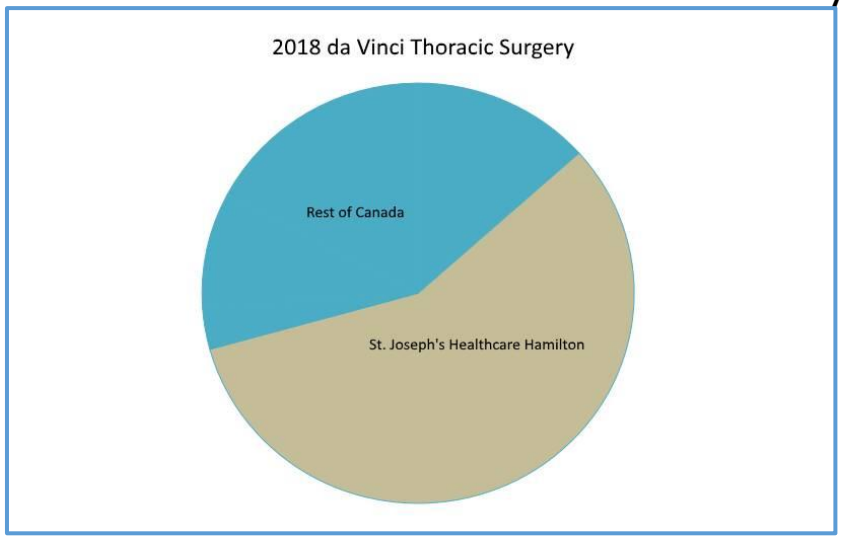
- Thoracic Robotic Cases 2018 worldwide approx. 48,000



Timeline in Canada



2011	2014	2016	2017	2018
UHN	McMaster	Learning Curve Cost Assessment	First Canadian Series	Segmental Resections



2018- McMaster/SJHH performed
63% of Canadian Robotic Lung Resections

Mehta M, et al. *J Thorac Cardiovasc Surg*. 2019;157(5):2029-2035

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REVIEW ARTICLE

Prevention and Early Detection for NSCLC: Advances in Thoracic Oncology 2018

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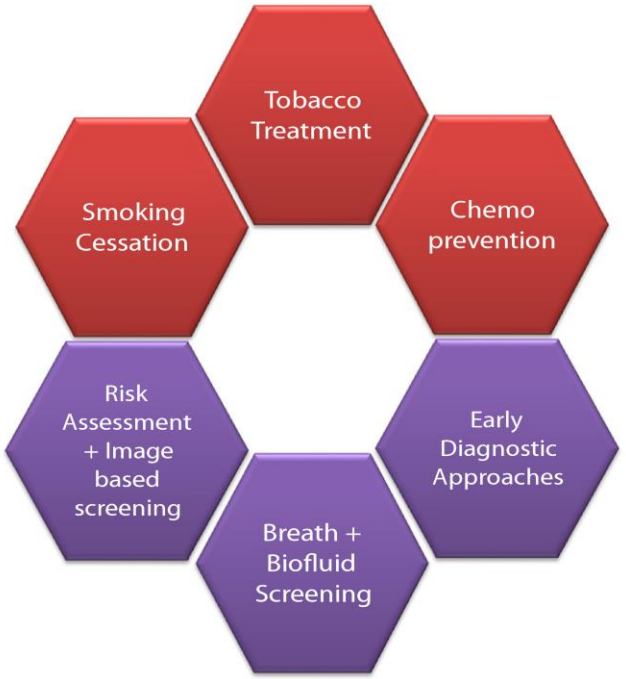
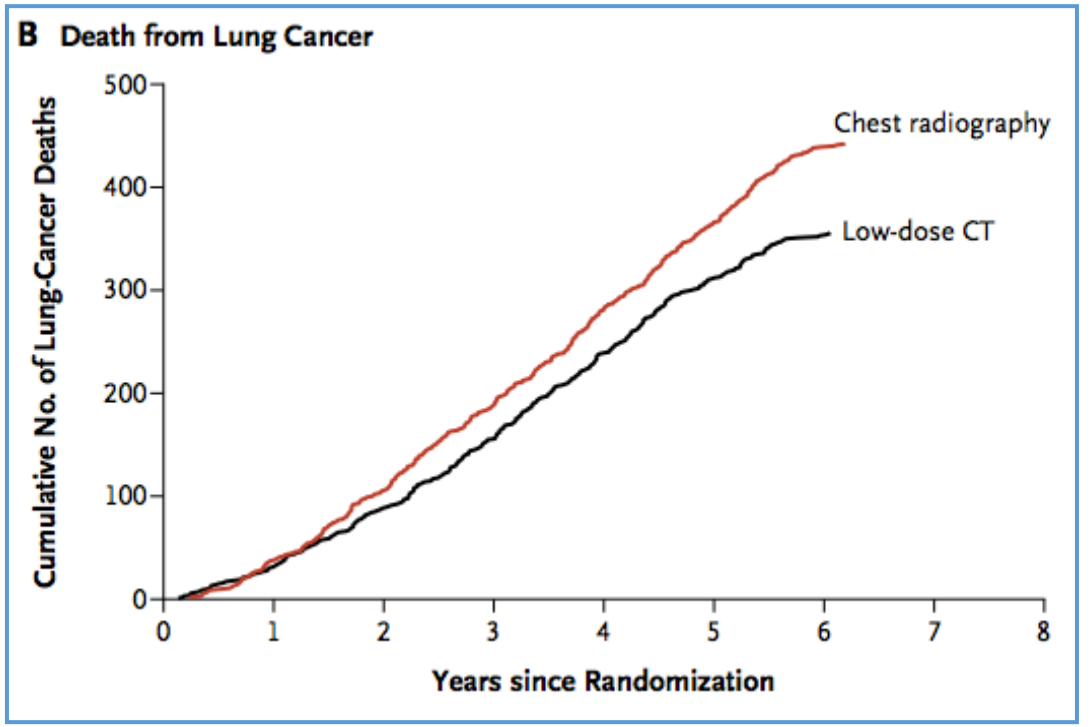


Figure 1. Strategy of prevention (*red*) using smoking cessation, tobacco treatment, and chemoprevention. Early detection approaches (*purple*) involving risk assessment and images- based screening, breath-based and biofluid screening, and early diagnostic approaches.

NLST, cancer deaths per arm

Reduced Lung-Cancer Mortality with Low-Dose Computed Tomographic Screening

The National Lung Screening Trial Research Team*



20% mortality reduction in the LDCT group

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Pooled Analysis of 9 RCTs; Lung Cancer Screening with LDCT vs current practice

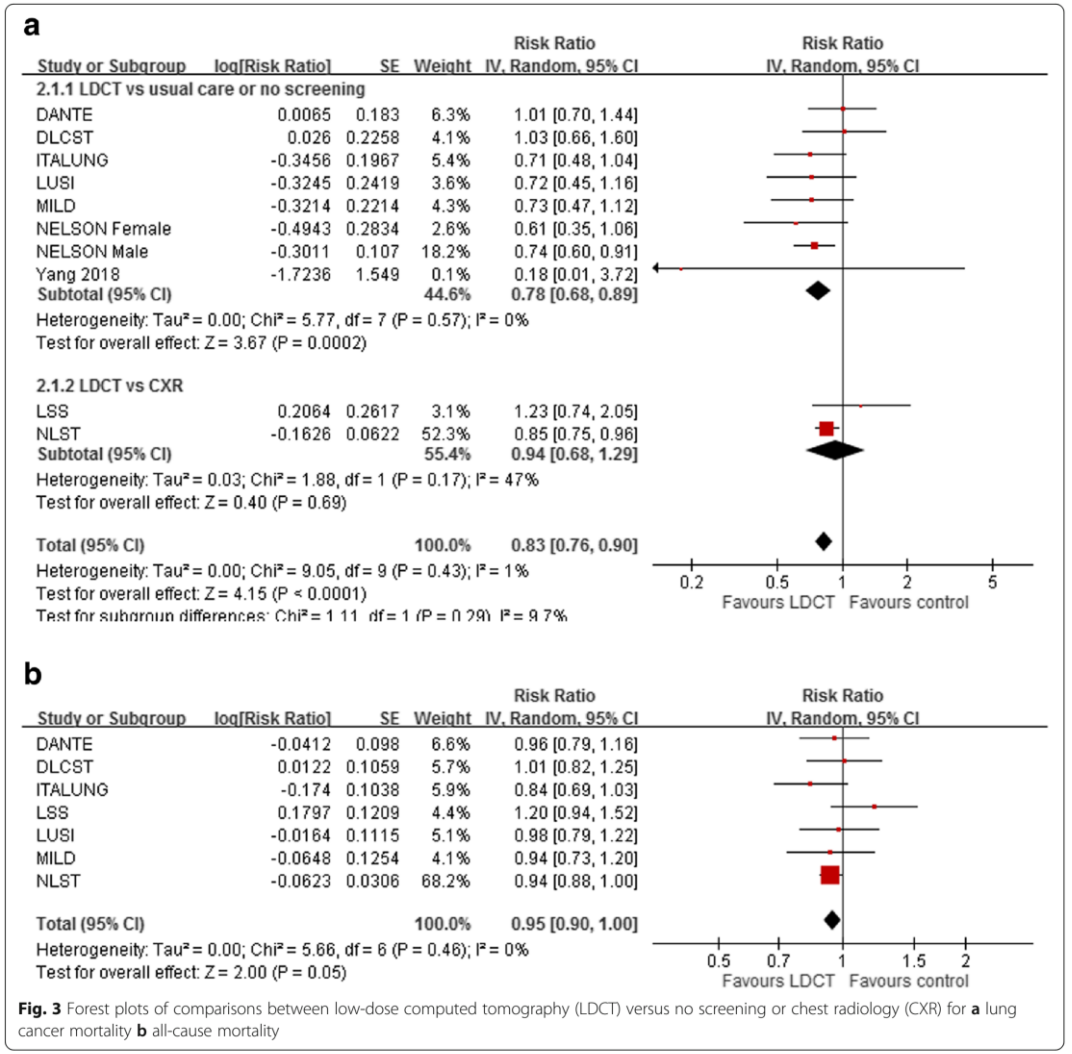
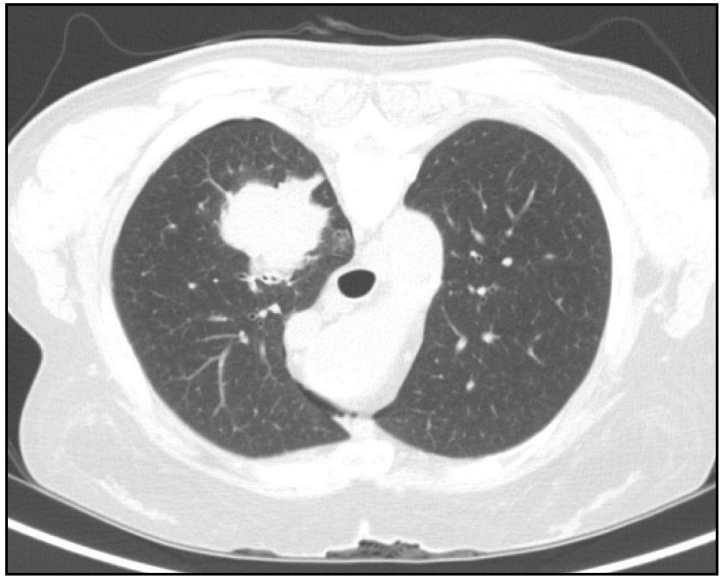


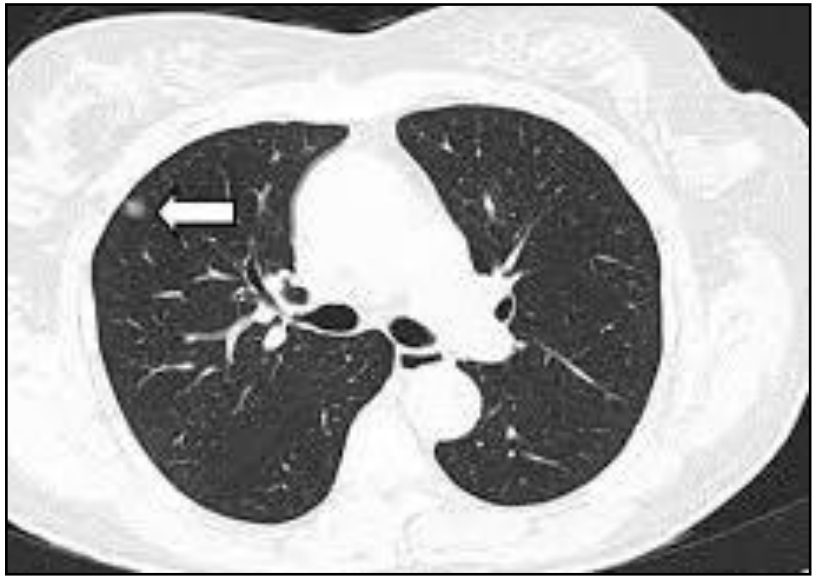
Fig. 3 Forest plots of comparisons between low-dose computed tomography (LDCT) versus no screening or chest radiology (CXR) for **a** lung cancer mortality **b** all-cause mortality

The Era of the Nodule

The Past



The Present



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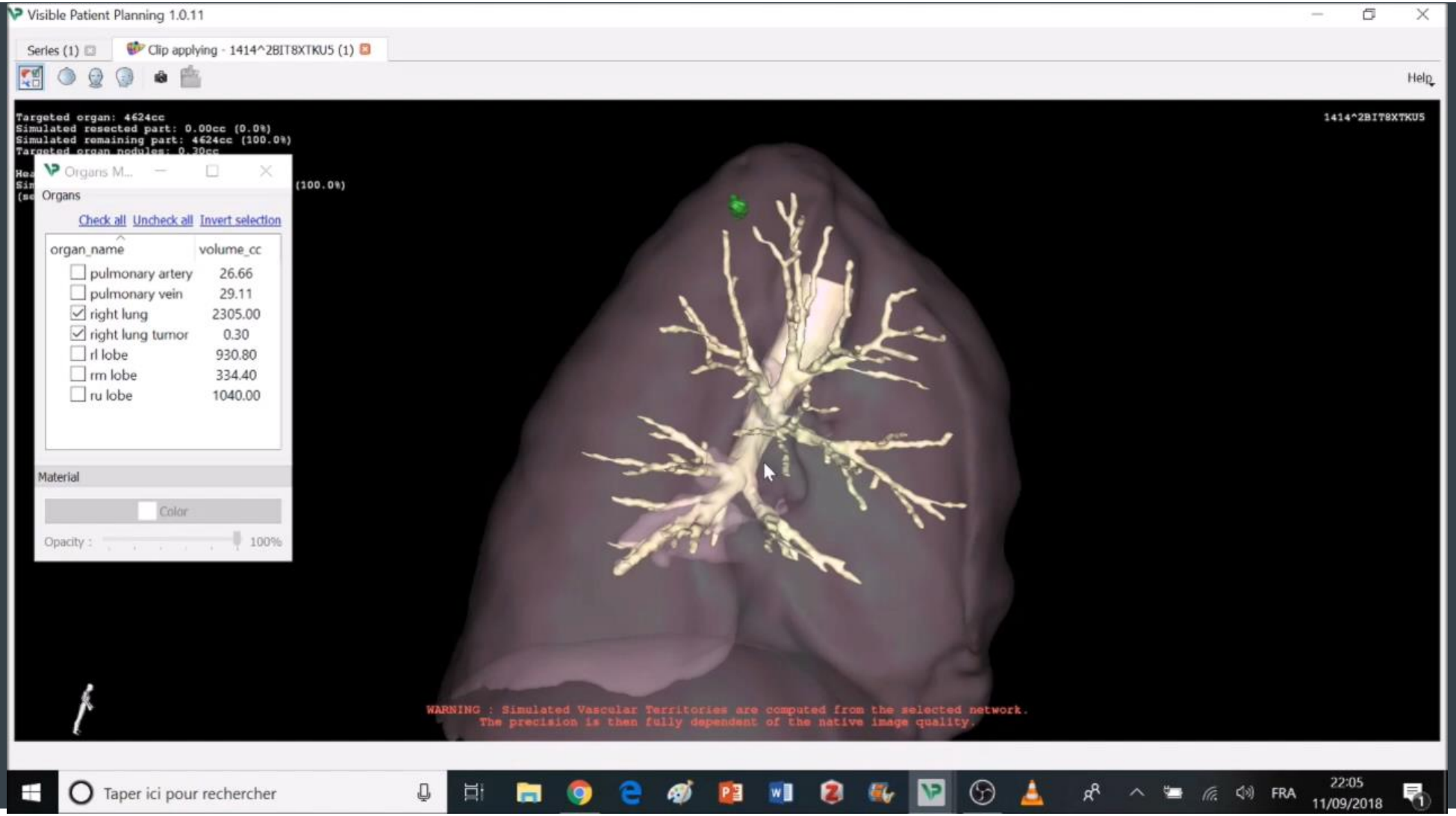
The Era of the Pulmonary Nodule (lesser resections ?)

=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pulmonary vein 29.11
right lung 2305.00
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rl lobe 930.80
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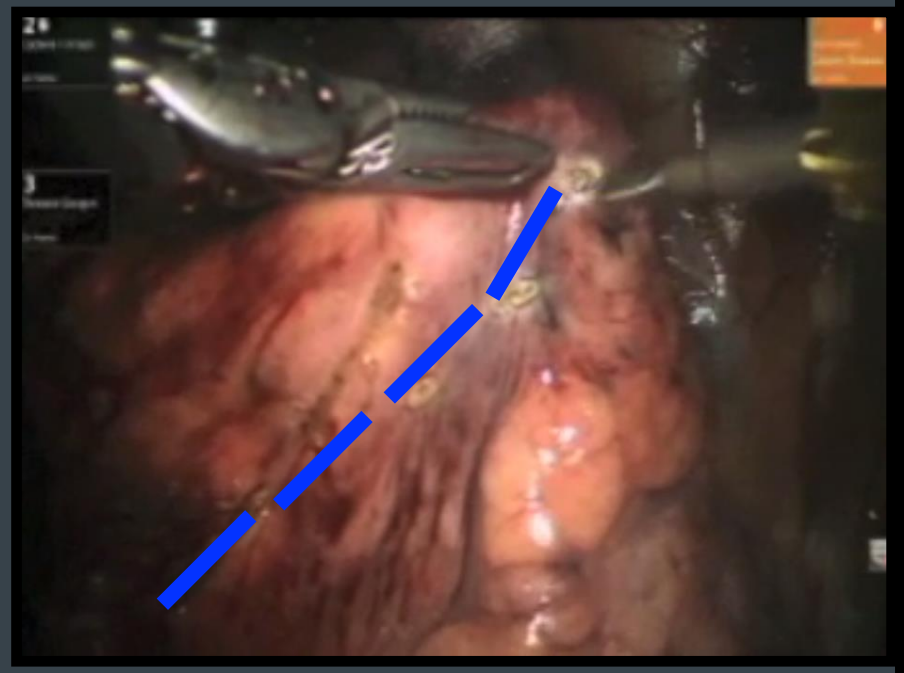
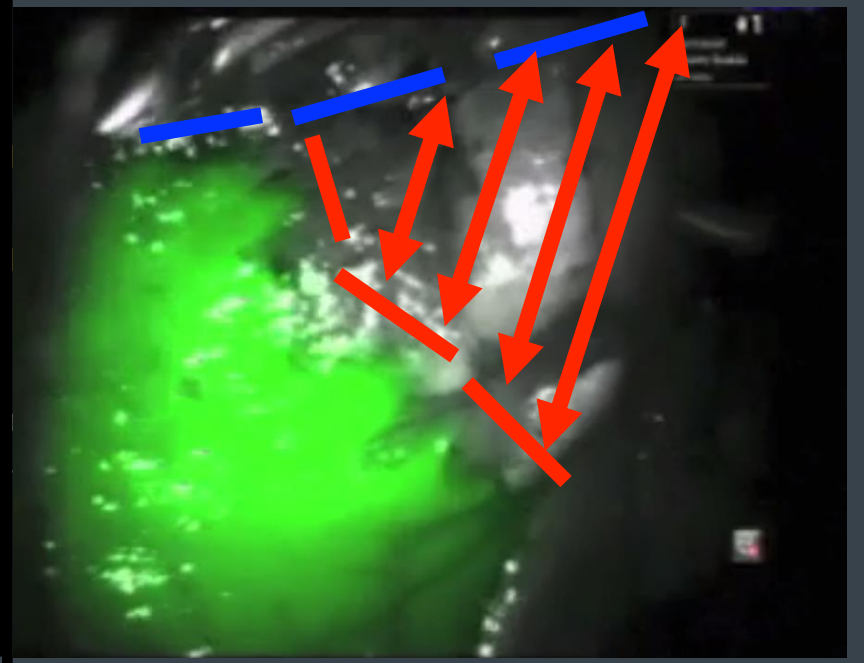
ICG guided sub-lobar resection

Control



ICG



clinicaltrials.gov *NCT0284213*

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Summary points

- Robotic Surgery is an additional platform for MIS lung resection
- It is unknown whether Robotic lobectomy offers any advantages over VATS lobectomy
- It is unknown whether Robotic lobectomy is more expensive than VATS lobectomy
- However, Robotics will likely usher an era of technological progress which will not be possible by VATS/open resections
- With the progression of earlier detection, lesser resections for lung malignancies will likely dominate future TS
- Stay tuned !

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The evolution of Integrated Care Post- Discharge programs in Thoracic Surgery; Early Experience

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McMaster University

Background

- Readmission after recent hospital discharge
  - Relatively common event
  - Major financial burden to the healthcare system

- About 4.5 million Americans will be readmitted to hospitals annually → Overall estimated cost of $44 billion to the healthcare system (not including physicians services)

- In Canada
  - Estimated $2 billion cost (not including physicians fees)

- Most preventable admissions occur within 1 month
  - Might be an indicator for quality of care
  - *USA Patient Protection and Affordable Care Act (2012)*
    Medicare penalties for hospitals with "higher than expected" readmission rates

- Key research findings:
  - Readmission is associated with increased mortality
  - Readmission into a different hospital – worse outcomes
  - Most readmission risk prediction models perform poorly (*Kansagara, JAMA 2011*)

  Readmission to a different hospital is associated with a higher risk of death ($p<0.001$) (*Staples, CMAJ Open* 2014)

Preventing Early Hospital Readmissions

- Multiple studies, mostly non-surgical
- Meta-analysis of RCT's (1990-2013):
  - 42 trials (GIM, Elderly, COPD), 100-700 pts each
  - Most conducted in academic centres
  - Most interventions: simple discharge planning
  - Some included tele-homecare, telephone follow-up
  - Most studies demonstrated beneficial effect

  (*Leppin, JAMA 2014*)
- TS- no high level data. 60d Readmissions: 8-28%, ER visits- even higher

JAMA Network Open

Invited Commentary | Health Policy

A Decade Later, Lessons Learned From the Hospital Readmissions Reduction Program

Andrew M. Ibrahim, MD, MSc; Justin B. Dimick, MD, MPH

Table. Lessons Learned From the Hospital Readmissions Reduction Program (HRRP) to Guide Future Policy Design and Evaluation

Lesson	Explanation	Implication for Future Policy
Policy design		
Health systems respond to large financial incentives from payers	The financial penalties of the HRRP were enough to motivate large systematic changes to improve quality	Financial incentives tied to outcomes provide an effective mechanism for payers to motivate targeted quality improvement
Large-scale interventions have effects beyond the targeted conditions	Although initially designed for medical conditions, the HRRP had significant spillover to several nontargeted conditions	Focused efforts on key service lines, if chosen correctly, can affect the entire health system and realize broader benefits
Policy evaluation		
Unintended consequences should be anticipated and mitigated	Several studies raised concerns that the HRRP resulted in increased mortality for targeted conditions and enticed health systems to change patterns of coded severity	Screening mechanisms and safeguards should be in place to identify and mitigate unintended consequences of a policy
Planning evaluation of a policy intervention should be considered at the time of policy creation	Because the policy was exposed to nearly all similar hospitals treating these conditions, studies to evaluate the policy were limited by inadequate comparison groups	Future policy interventions should be implemented in a step-wedge fashion so that confounders and secular trends can be accounted for

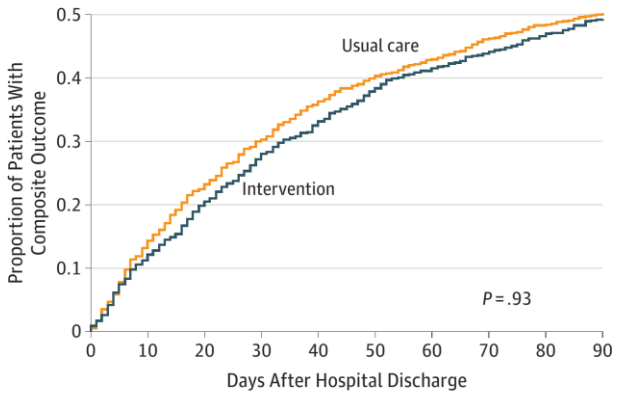
JAMA Network Open. 2019;2(5):e194594. doi:10.1001/jamanetworkopen.2019.4594

JAMA | Original Investigation

Effect of Patient-Centered Transitional Care Services on Clinical Outcomes in Patients Hospitalized for Heart Failure
The PACT-HF Randomized Clinical Trial

Harriette G. C. Van Spall, MD, MPH; Shun Fu Lee, PhD; Feng Xie, PhD; Urun Erbas Oz, PhD; Richard Perez, MSc; Peter R. Mitoff, MD; Manish Maingi, MD; Michael C. Tjandrawidjaja, MD; Michael Heffernan, MD, PhD; Mohammad I. Zia, MD; Liane Porepa, MD; Mohamed Panju, MSc, MD; Lehana Thabane, PhD; Ian D. Graham, MA, PhD; R. Brian Haynes, MD, MSc, PhD; Dilys Haughton, BScN, MHSc; Kim D. Simek, BSc; Dennis T. Ko, MD, MSc; Stuart J. Connolly, MSc, MD

Figure 2. Time to First Composite Readmission, Emergency Department Visit, or Death at 3 Months in the Intervention and Usual Care Groups



Patients at risk										
Intervention	1104	979	884	804	745	686	649	619	589	560
Usual care	1390	1206	1077	973	892	834	795	750	718	695

CONCLUSIONS AND RELEVANCE Among patients with HF in Ontario, Canada, implementation of a patient-centered transitional care model compared with usual care did not improve a composite of clinical outcomes. Whether this type of intervention could be effective in other health care systems or locations would require further research.

JAMA 2019

Summary points:

- Readmissions/ER visits:
  - costly
  - Associated with increased morbidity and mortality
  - Interventions- mixed results
  - *No accountability of care* by index hospitals

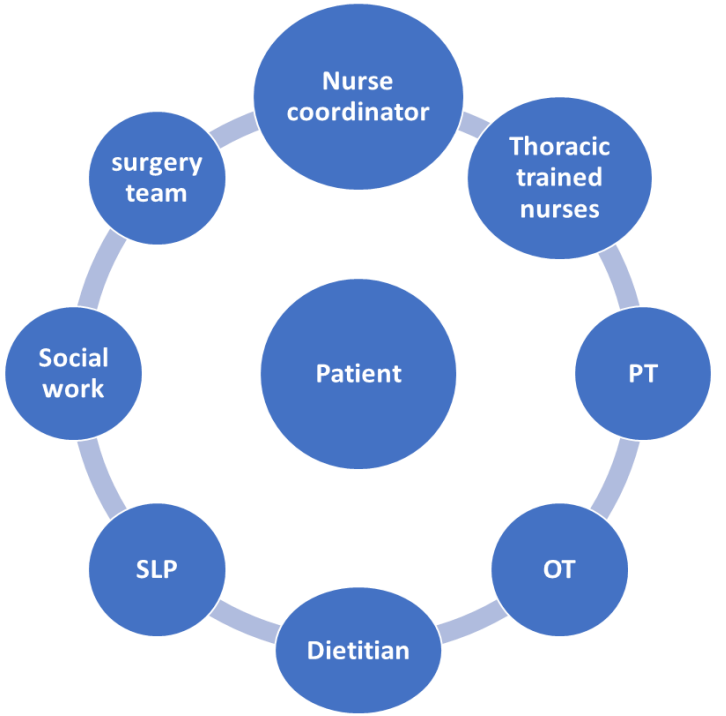
The Integrative Comprehensive Care (ICC) Program

- Hypotheses:
  1. Post-discharge active interventions:
     - Reduce ER visits and hospital readmissions
     - No inferiority in adverse outcomes

  2. "One team-one care" approach is feasible
     - Discharging hospital's accountability will <u>improve overall outcomes</u>
     - Continuity of care post hospital discharge will allow for <u>shorter admission without compromising patients care</u> while maintaining ***accountability of care***

Integrated Comprehensive Care (ICC) program

- Implemented in April 2012
- Eligibility criteria:
  - Reside in LHIN 4; Hamilton-Niagara-Haldimand-Brant (1.8m)
  - Lung resection OR Complex



The Integrative Comprehensive Care Program

- Concept and Structure:
  - Hospital based homecare system, Nurse navigator based
  - Pre prepared care-pathways
  - Post discharge planning starts immediately post-op
  - Post discharge visits by RN's, RPN's, PT's, RT's, others
  - In hospital course stored ***digitally*** and available to all
  - On going communication between homecare team and NN
  - 24/7 contact point to patients and care-givers
  - Immediate action when needed (surgeons involved)
  - External validation

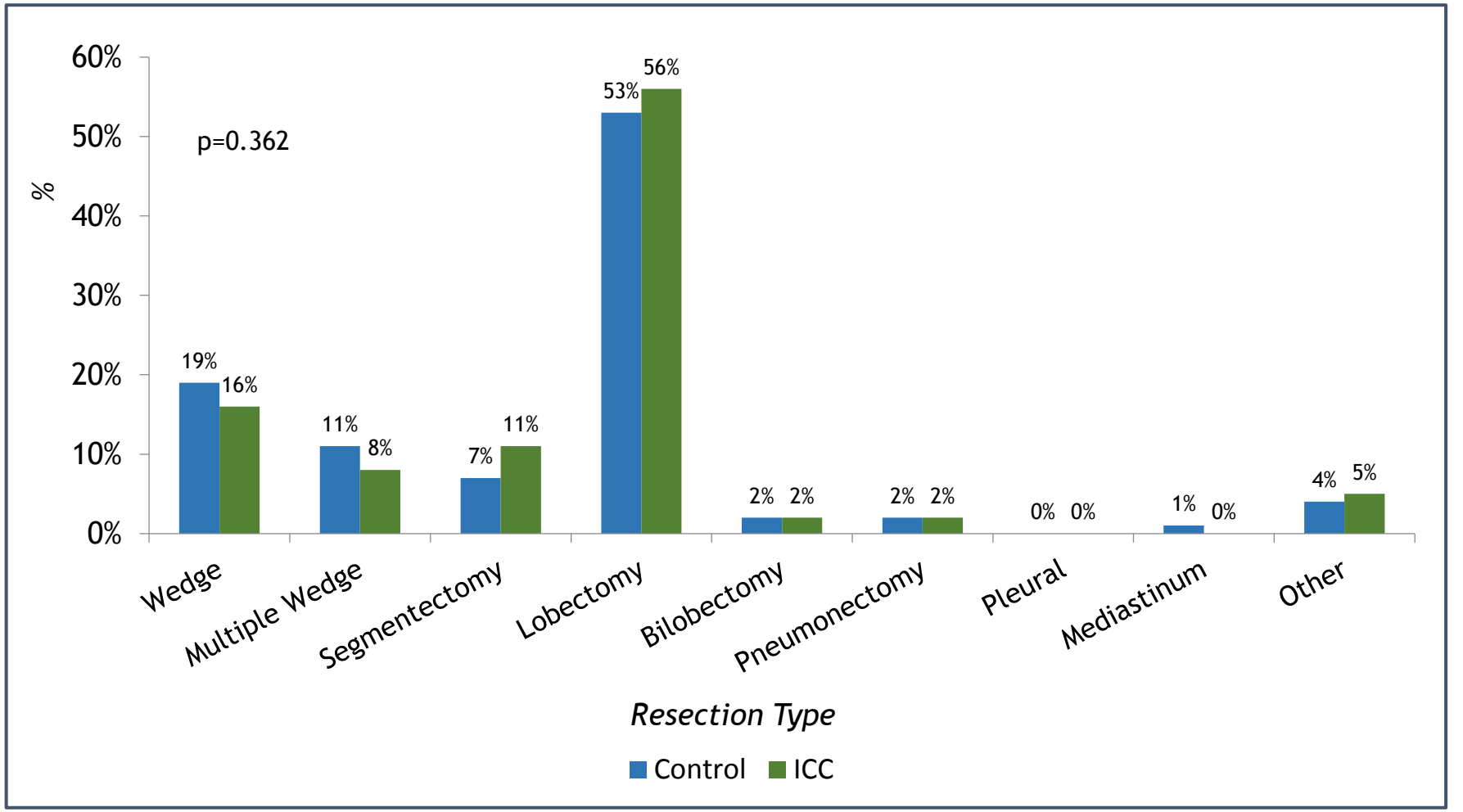
1. Initial Experience

	Control Group (2011-2012)	ICC Group (2012-2013)	p-value
Count	N=355	N=331	--
Gender			0.009
Male	204 (58%)	157 (48%)	
Female	150 (42%)	173 (52%)	
Age (Mean, SE)	63.81 (0.783)	65.57 (0.711)	0.100
CCI (Mean, SE)	1.59 (0.119)	1.39 (0.111)	0.223
FEV1, % predicted (Mean, SE)	84.54 (1.542)	85.32 (1.442)	0.716
DLCO, % predicted (Mean, SE)	74.47 (1.442)	73.46 (1.187)	0.592
Disease Type			0.082
Primary lung cancer	214 (61%)	230 (70%)	
Metastases	48 (14%)	35 (11%)	
Benign	85 (24%)	61 (18%)	
Other	2 (1%)	4 (1%)	

Median F/U
Control: 20m (0-46)
ICC: 22m (0-35)

Overall 60-day mortality → 1%

Surgical Intervention by Group

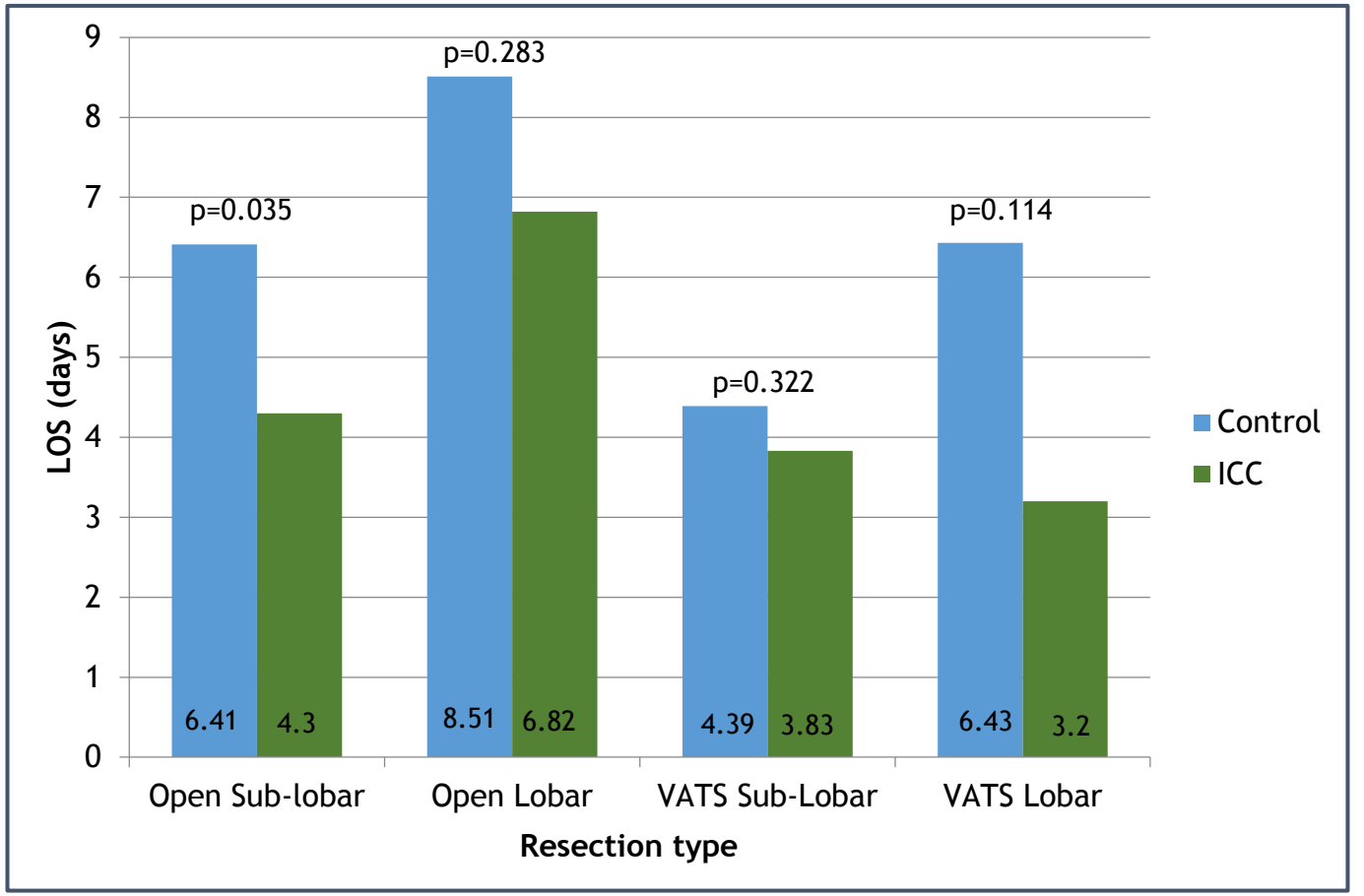


The ICC Team 2013- overall Financial Impact

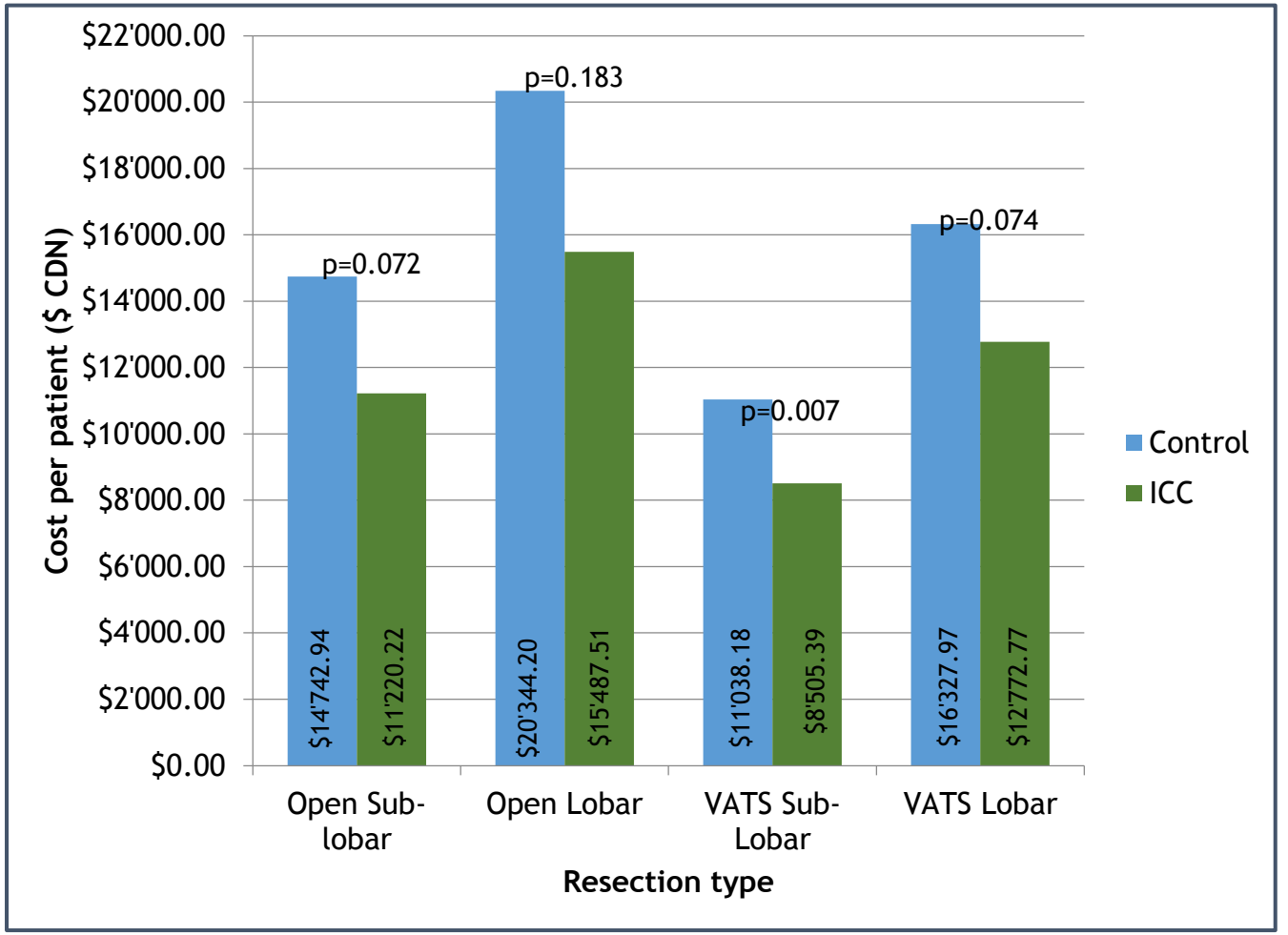
All Thoracic Surgery	% of patients receiving service	# of Visits	Average # of Visits/patient	Total Time (hours)	Average Time per patient (hours)	Total Cost for Service	Average cost per patient receiving service
Physiotherapist (N=6)	76%	553	2.0	410.1	1.5	$49,781.06	$181.02
Registered Practical Nurse (N=4)	75%	970	3.6	572.1	2.1	$44,067.10	$162.61
Registered Nurse (N=4)	63%	838	3.7	532.7	2.3	$49,067.10	$215.79
Respiratory Therapist	13%	167	3.6	170.0	3.7	$21,710.00	$471.96
Personal Support Worker	6%	214	9.3	217.5	9.5	$5,683.84	$247.12
Occupational Therapist	2%	17	2.1	34.0	4.2	$2,145.57	$268.20
Registered Dietitian	1%	5	1.0	3.1	0.6	$696.60	$139.32
Speech Language Pathologist	1%	7	2.3	18.4	6.1	$838.11	$279.37
ICC Coordinator	52% (100%)	255	1.4	137.7	0.7		
Overall	**96%**	**3026**	**8.7**	**2095.7**	**6.0**	**$174,341.69**	**$499.55**

Cost of hospital stay: $1350/day (USA- $1975)

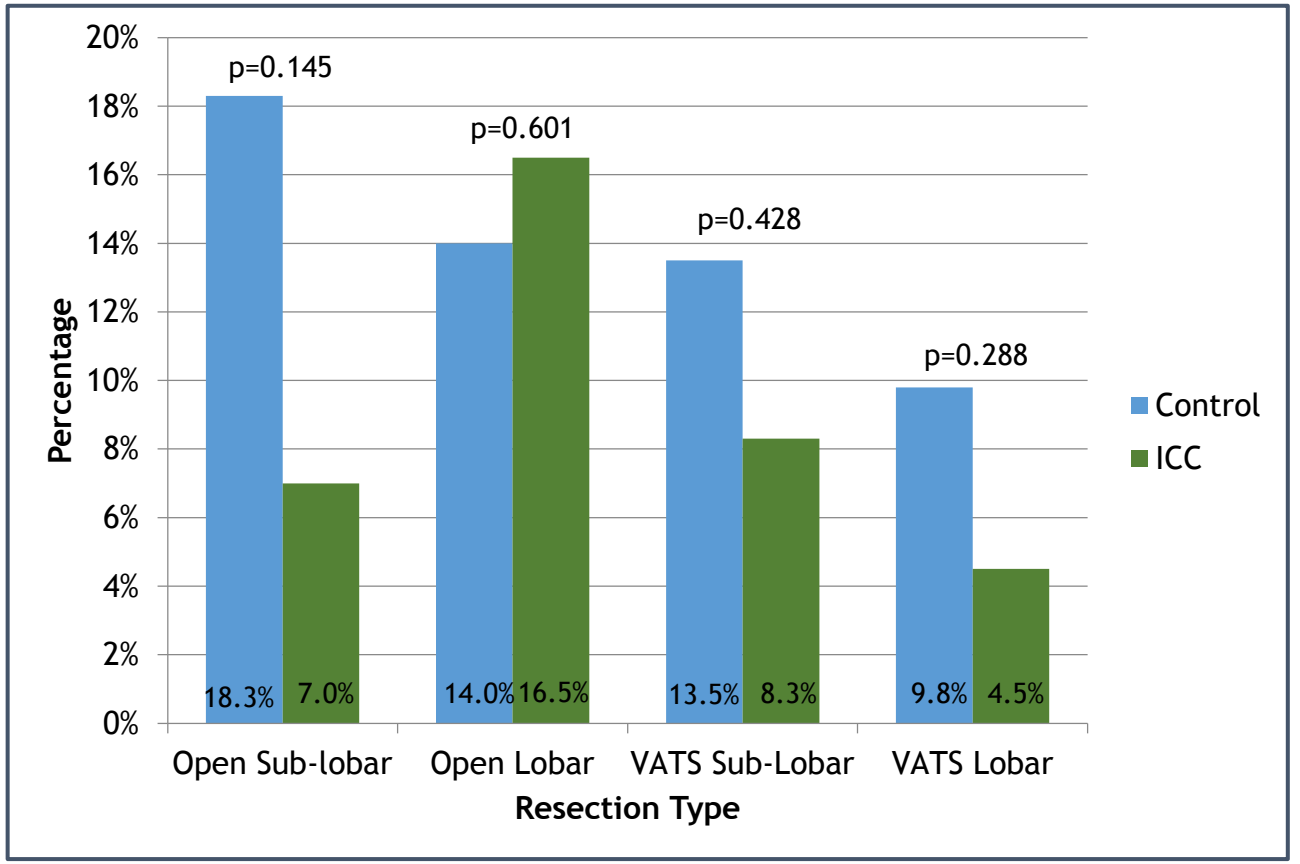
Length of stay by resection type



Total direct in-hospital costs per patient

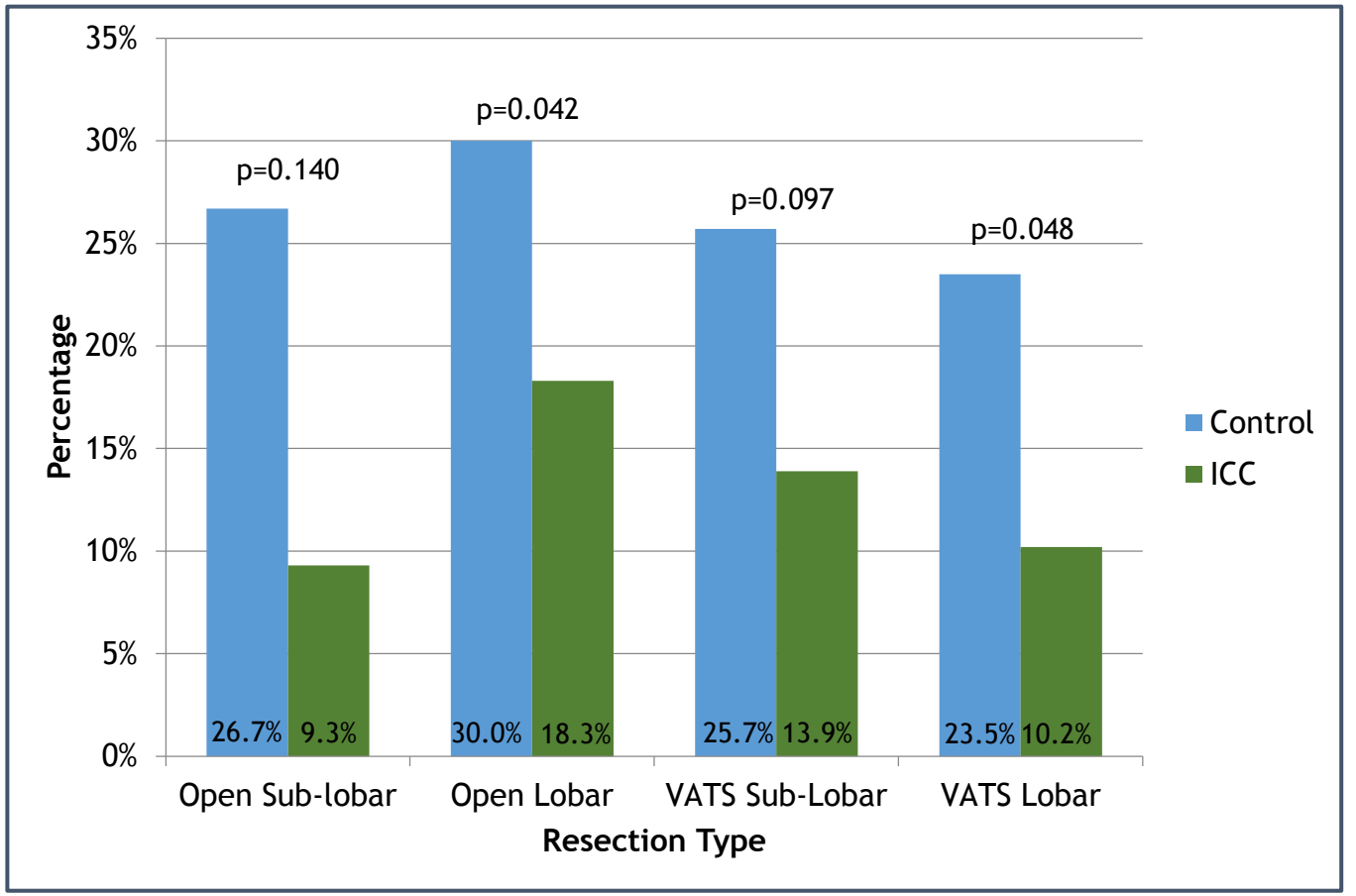


Proportion of patients readmitted to hospital within 60 days of discharge by resection type



- All readmissions included

Proportion of patients visiting ER within 30 days of discharge by resection type

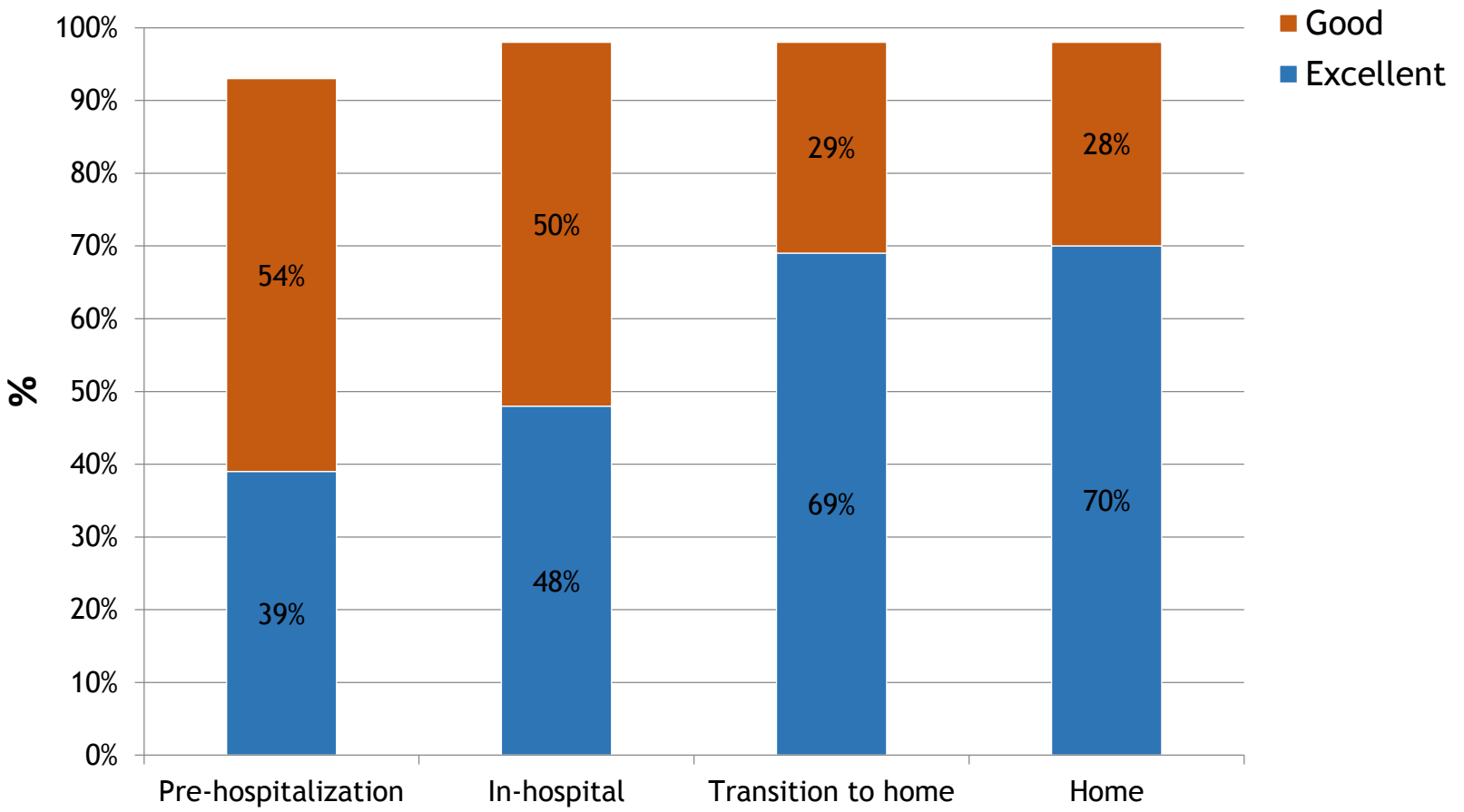


Hospital Readmissions: Control vs. ICC group

	Control Group (2011-2012) n=42	ICC Group (2012-2013) n=27	p=0.891
Pulmonary	11 (26%)	9 (33%)	
VTE	3 (7%)	2 (7%)	
Pain	1 (2%)	1 (4%)	
Cardiac	4 (10%)	4 (15%)	
Other	17 (40%)	8 (30%)	
Empyema	4 (10%)	1 (4%)	
Unknown	2 (5%)	2 (7%)	

- Comparison between admitted to non-admitted groups- no pre-readmission predictors for readmission (both groups)
- 60 day mortality higher for readmitted patients (p=0.012)

Overall patient satisfaction



- Likert 5 points scale

- Initial experience- encouraging
- No inferiority in outcomes
- Implementation is feasible. Simple learning curve
- Future studies needed re- different setups and healthcare systems

Semin Thorac Surg 2016

2. The Addition of a Mobile App to a Post-Discharge Home Care Program Following Lung Resection Reduces the Rate of Emergency Room Visits

Taylor J, Hanna W, Hughes K, Pinkney P, Lopez-Hernandez Y, Coret M, Schneider L, Agzarian J, Finley C, Tran A and Shargall Y

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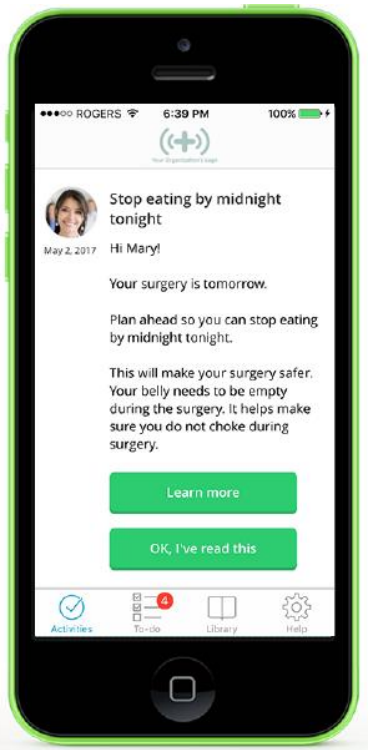
2015: Thoracic Surgery Specific Mobile App

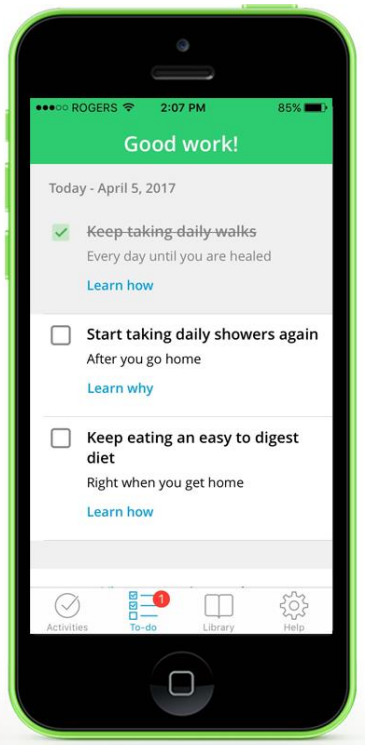
Patient Engagement:

Guide patients through care plans on phone, tablet or computer

Send reminders

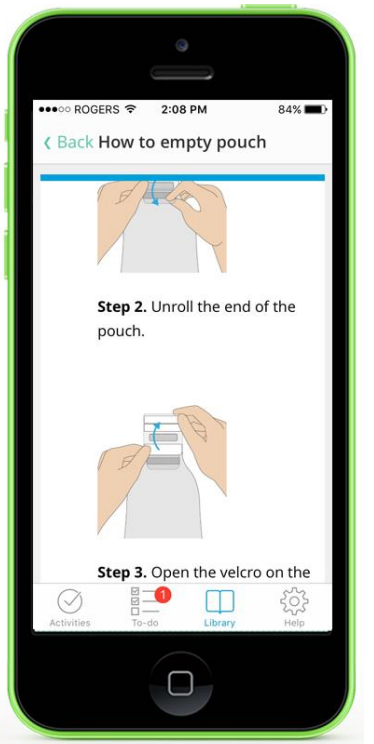


Complete tasks



Collect PROs

Access education



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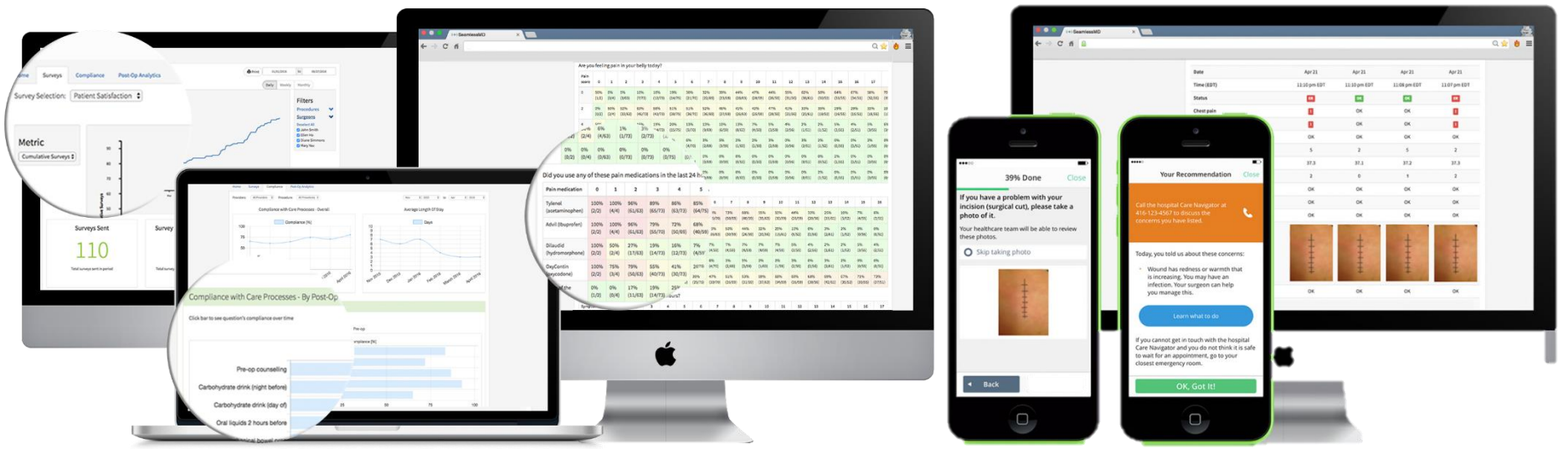
www.seamless.md

2015: Thoracic Surgery Specific Mobile App

Provider Care Management & Analytics:

Alerts and ***real-time*** dashboards to intervene early for patients at-risk



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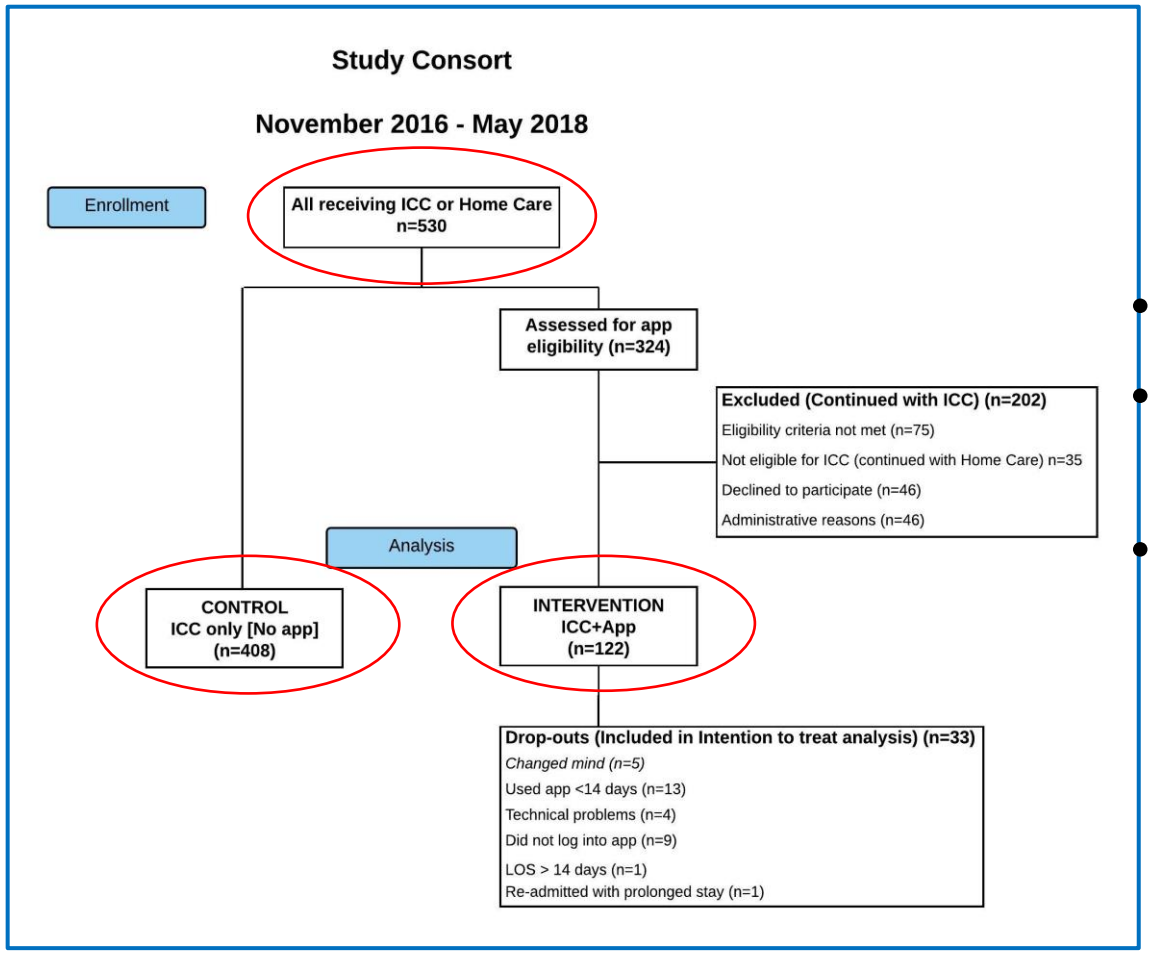
Mobile App for Post-Discharge Care (ICC+APP)



- Overall 530 pts
- **Intervention arm** (ICC+App)- **122**
- **Control** (ICC only)- **408**

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ICC only vs. ICC + APP

	No App (n=408)	App (n=122)	P- Value
	DEMOGRAPHICS		
Age (mean +/- SD)	65.16 +/- 14.20	66.61 +/- 9.35	0.29
Male (%)	50.98	40.98	0.053
Minimally Invasive (%)	66.58	56.56	0.043
Lobectomy	52.00%	66.39%	<0.001
Wedge Resection	31%	17.21%	<0.001
Segmentectomy	8%	13.93%	<0.001
Pneumonectomy	3.25%	2.46%	<0.001
Pleural/Other	5.75%	0.00%	<0.001
Smoker (%)	70.76	77.05	0.358
Diabetes Mellitus (%)	17.86	14.66	0.423
Cardiovascular Disease (%)	4.90	0.82	0.043
Chronic Kidney Disease (%)	2.21	1.64	0.7
FEV1 % predicted	83.83 +/- 19.77	88.47 +/- 21.91	0.0679
DLCO % predicted	71.91 +/- 19.96	78.11 +/-16.42	0.0081
Liver Disease	1.96%	0.00%	0.122
Length Of Stay Median Number of Day (Range)	3(1-21)	3(1-15)	0.095

- Complete F/U
- Similar comorbidities
- Similar LOS (Median- 3d)
- Intervention group (ICC ***and*** App):
  - More open Thoracotomies (p=0.04)
  - More anatomical resections (p<0.001)
- No 30d mortality
- No App related adverse events

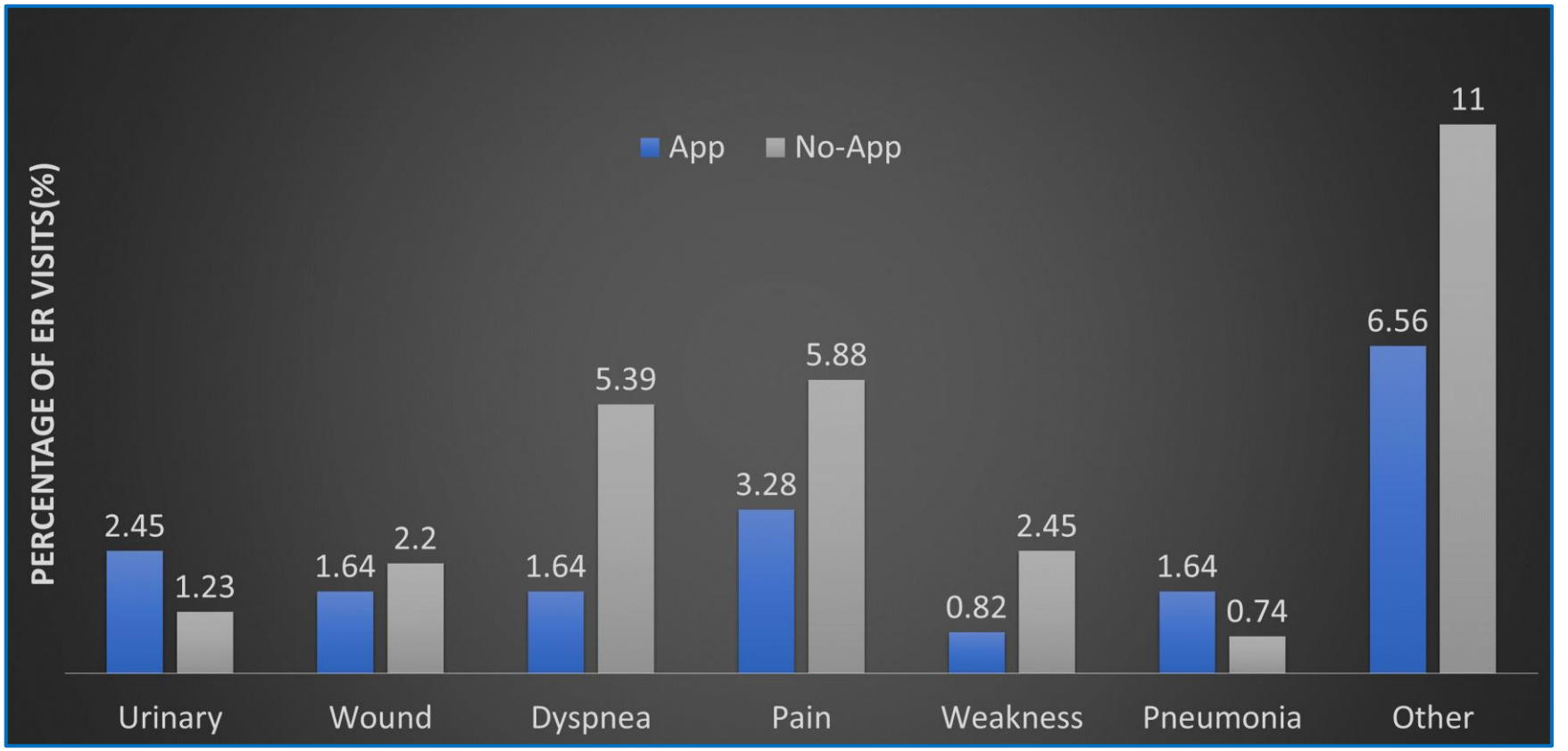
ICC only vs. ICC + APP

	No App (n = 408)	App (n=122)	P-Value
ER Visits (%)	29.41	15.57	0.002
Multiple ER Visits (%)	7.84	2.46	0.032
Readmissions (%)	8.09	6.56	0.59

- QOL similar between the two cohorts
- Multivariate regression analysis:

  The usage of the Mobile App was the only independent predictor for reduced ER visits (OR=0.47, p=0.018)

ICC only vs. ICC + APP



- Reasons for **Readmissions** (Pulmonary, Urinary, others)- similar
- Reasons for **ER visits**- more Dyspnea, Pain, Weakness
  when App *was not used*

3. Impact Of An Integrated Comprehensive Care Program Post Thoracic Surgery: A Propensity Score Matched Study

Negar Ahmadi MD, MSc, MPH; Lawrence Mbuagbaw MD MPH, PhD; Christian Finley MD, MPH; John Agzarian MD, MPH; Waël C. Hanna MD, MBA; Yaron Shargall MD

Division of Thoracic Surgery, McMaster University/St. Joseph's Healthcare Hamilton, Hamilton, ON, Canada

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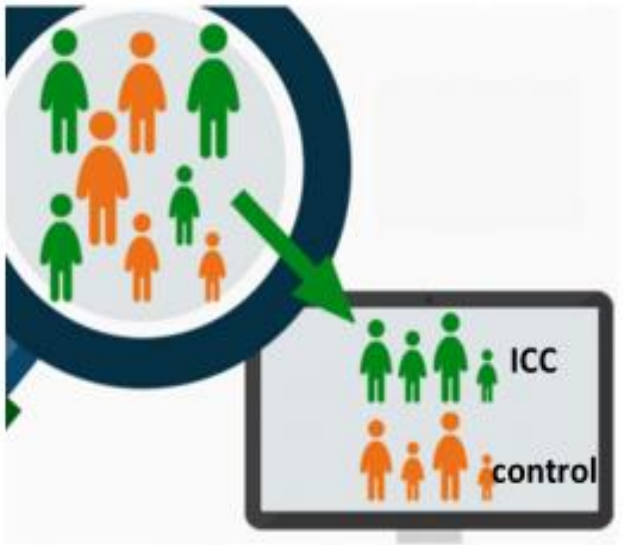
Methods - study design



- **Propensity score matched cohorts**
  - 1:1 ratio, with replacement

Age | Gender | BMI | Smoking
PMH | CCI | DLCO | FEV1
PSH | ASA | Surgical approach
stage | pathology | Adjuvant therapy

- **Intervention effect assessed by comparing intervention group to controls**
  - T test and chi-square test
  - SMD (standardized mean difference post matching)

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Evidence-based Thoracic Surgery

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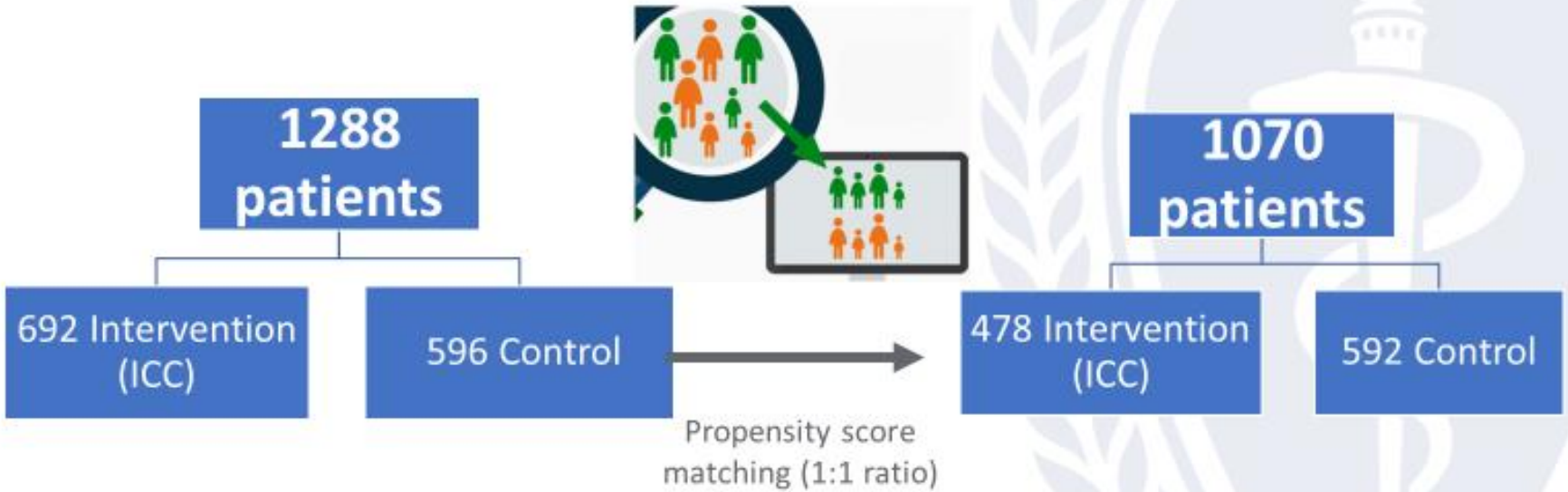
Results



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Results

Outcomes	Control (Pre-ICC) cohort	Intervention (ICC) cohort	Total	P value
Length of stay (days): median (IQR)	5 (4-7)	4 (3-6)	4 (3-6)	0.001
60-days readmissions (yes): n (%)	51 (8.6)	33 (6.9)	84 (7.9)	<0.001
60-days ED visit (yes): n (%)	168 (28.4)	47 (9.8)	215 (20.1)	<0.001
60-days #2 ED visit (yes): n (%)	38 (6.4)	6 (1.3)	44 (4.1)	<0.001
60-days #3 ED visit (yes): n (%)	12 (2.0)	2 (0.4)	14 (1.3)	<0.001
60-day mortality: n (%)	5 (0.8)	3 (0.6)	8 (0.7)	<0.001

2019 ICC team members

- **Multidisciplinary team:**
  - 1 nurse coordinator
  - 8 nurses with thoracic training
  - 6 PTs
  - 1 OTs
  - 1 dietitians
  - 1 SLP
  - 1 social worker

Current Data 2018-9

- ICC average length of stay 3.30 days (VATS anatomical median LOS- 2)
- ICC all-cause ED visit rate at 60 days 29.7%

- ICC all-cause readmission rate 60 days - 7.0% - (decrease of 2.9% from FY15/16 (9.9%)

- ICC 60 day bundle (index & readmit) average Total combined LOS - 3.53 days - decrease of 0.57 days from FY 15/16 (4.10 days)

2019- current numbers

- 455 patients, 1799 nursing visits average (3.95 nursing visits per patient), 247 PT visits in (0.54 visits per patient)

- Complex pleural space patients tend to have higher usage of nursing and less of the others since these patients are usually the empyema (with or without surgery) and Pneumothorax patients without surgery

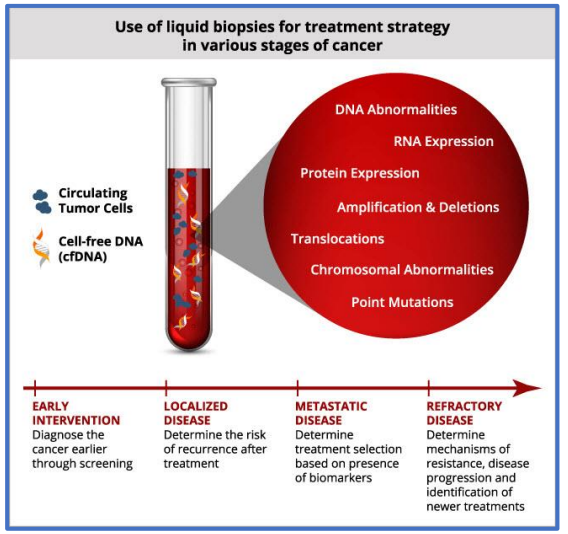
Summary and discussion points

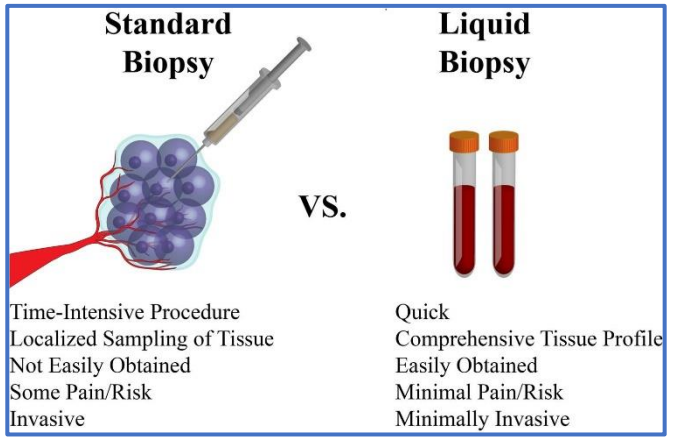
- Integrated care- a valid concept with potential for substantial ramifications
- Our own experience- positive, both from patients and team perspectives. Moderate level data supports superiority
- Readmissions and ER visits cannot be totally eliminated
- Challenges and opportunities:
    1. Integration with pre existing homecare systems and primary care physicians/clinicians (NPs ? PAs ?)
    2. Integration of internet based solutions
    3. Prediction models, pre admissions support systems/frailty
    4. Applicable for other healthcare systems ? Other countries ?

The Future

- Early detection of malignancies, less invasive approaches

1. Liquid Biopsies





1. Detection, localization
2. Spread
3. Suitability for specific treatment
4. Genetic changes
5. Treatment effect
6. Surveillance

2. Volatile Organic Compounds (Breathomics)

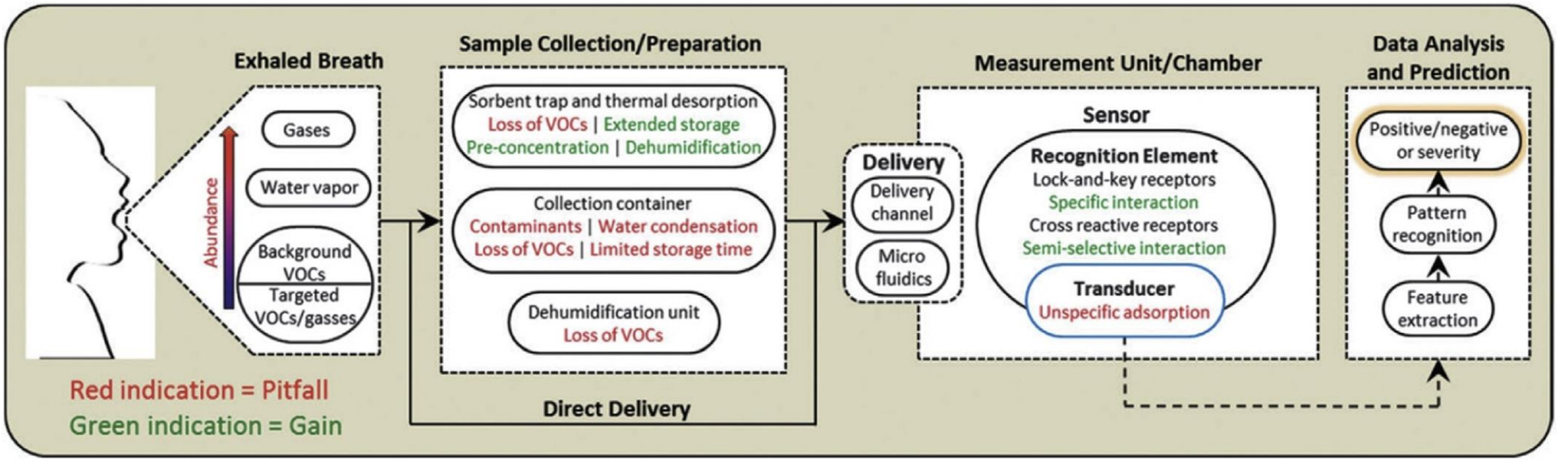
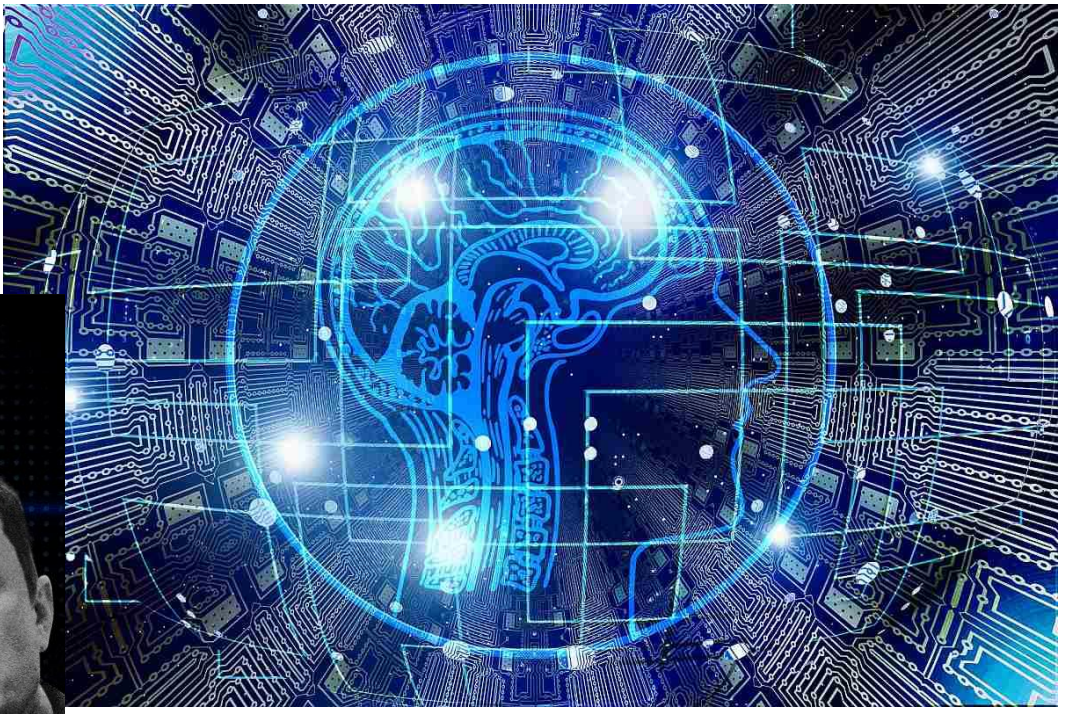


Figure 3. The stepwise process leading to breath analysis. The modalities of breath sample collection, preparation, measurement and evaluation through predictive models are illustrated (see text). Reproduced from Haick et al.[9] with permission. VOC, volatile organic compound.

A.I.



MacThoracics

EVIDENCE-BASED
THORACIC SURGERY