STS Quality Webinar Series: Minimally Invasive Lobectomy for Lung Cancer

September 2017

Welcome

Bill Burfeind, Jr., MD
St. Luke's Health Network
General Thoracic Surgery

Presented by the STS Task Force on Quality Initiatives

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Thomas Beaver
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Bill Caine
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Judy Tingley
Paul Uhlig
Robert Welsh
Michael Weyant
Jaelene Williams
Dave Wormuth

Presenters

Thomas D'Amico, MD

Todd Demmy, MD

Mark Onaitis, MD

Shari Meyerson, MD

Thoracoscopic Lobectomy: Why?

Thomas A. D'Amico MD

Gary Hock Professor of Surgery
Section Chief, Thoracic Surgery, Duke University Medical Center
Medical Director, Duke Cancer Institute

Disclosures

- None

Thoracoscopic Lobectomy: Past, Present, Future

- Paradigm for surgical innovation against resistance, which would apply across surgical disciplines
- Common problem: Lung Cancer
- Established treatment: Thoracotomy
- Established treatment: Low mortality

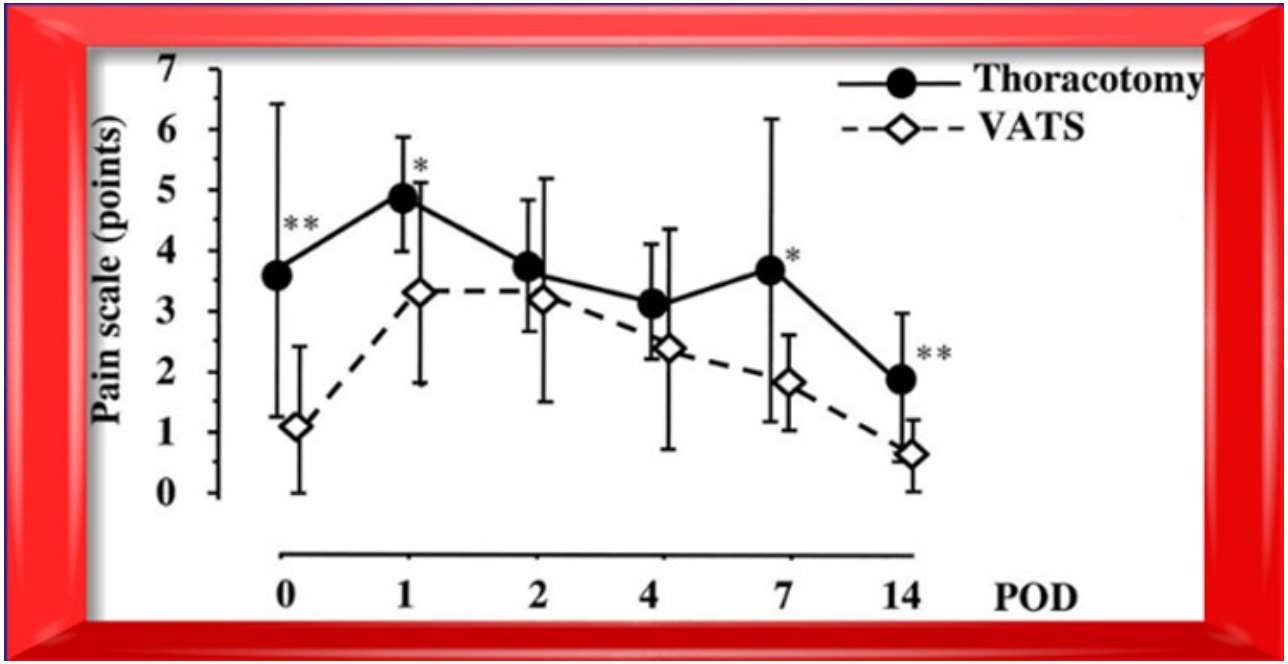
Advantages of Thoracoscopic Lobectomy: 1995-2005

- Less postoperative pain
- Shorter chest tube duration
- Shorter length of stay
- Faster return to full activity
- Preservation of pulmonary function
- Lower inflammatory cytokine response
- Lower cost

Subjective QOL Favoring VATS Lobectomy

- Paradigm for surgical innovation against resistance, which would apply across surgical disciplines
- Pain: 8 Studies
- Functional Health: 3 Studies
- Symptom Control: 3 Studies

Operative Approach for Lobectomy and Postop Pain Measured by 11-Point Pain Scale



Nagahiro I. et al.; Ann Thorac Surg 2001;72:362-365

Objective Studies Favoring VATS Lobectomy

- Functional: 13 Studies
- Respiratory: 7 Studies
- Socioeconomic: 5 Studies
- Mediators: 10 Studies

VATS Lobectomy Reduces Cytokine Responses Compared with Conventional Surgery

Yim APC, et al. Ann Thorac Surg 2000; 70:243-47

- 36 patients with clinical stage I NSCLC
- Randomized to VATS or thoracotomy for lobectomy
- Inflammatory cytokines IL-6 and IL-8 levels significantly lower in VATS group
- ? Preserved humoral immunity

Pulmonary Function, Postoperative Pain, Serum Cytokine Level after Lobectomy: A Comparison of VATS and Conventional Procedure

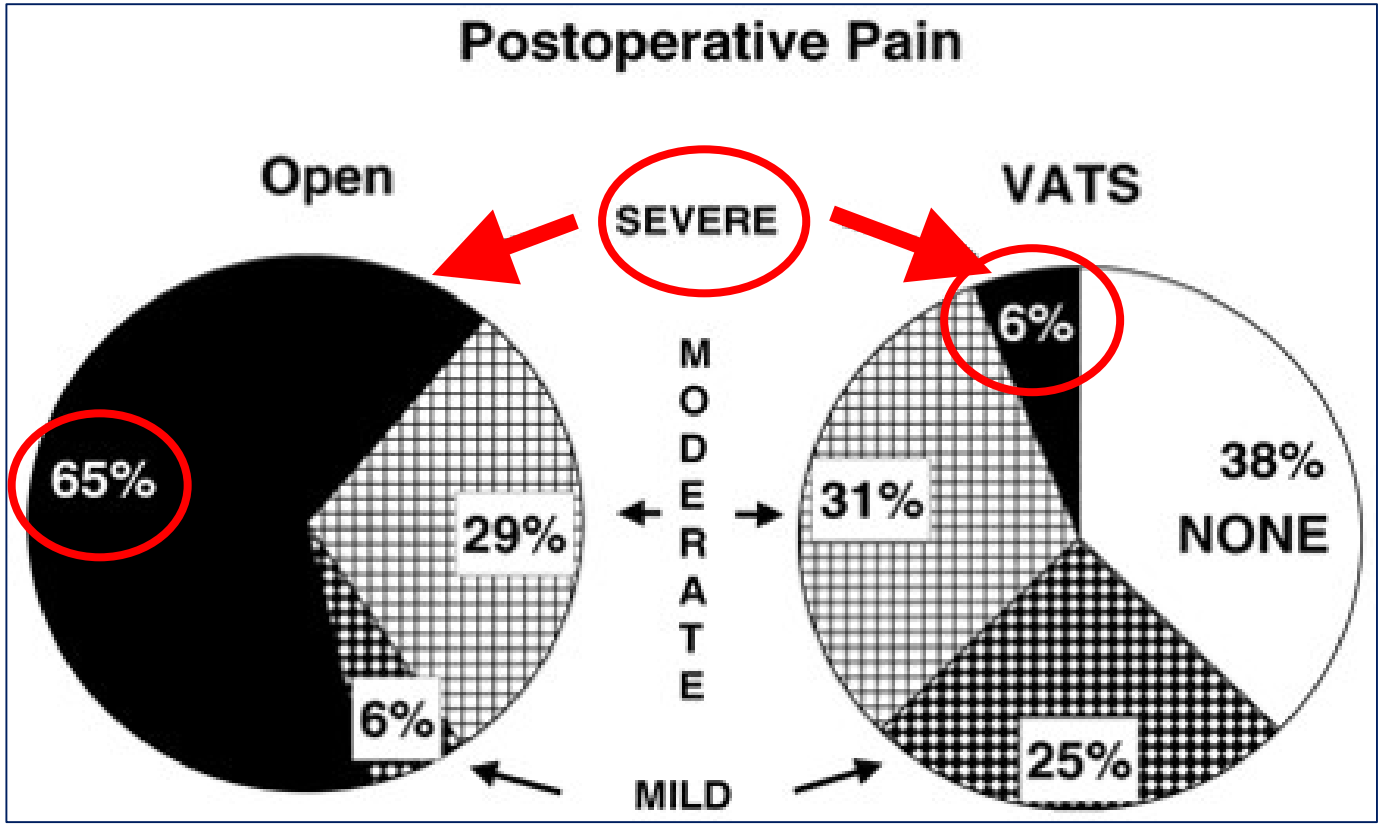
Nagahiro I, et al. Ann Thorac Surg 2001; 72:362-5

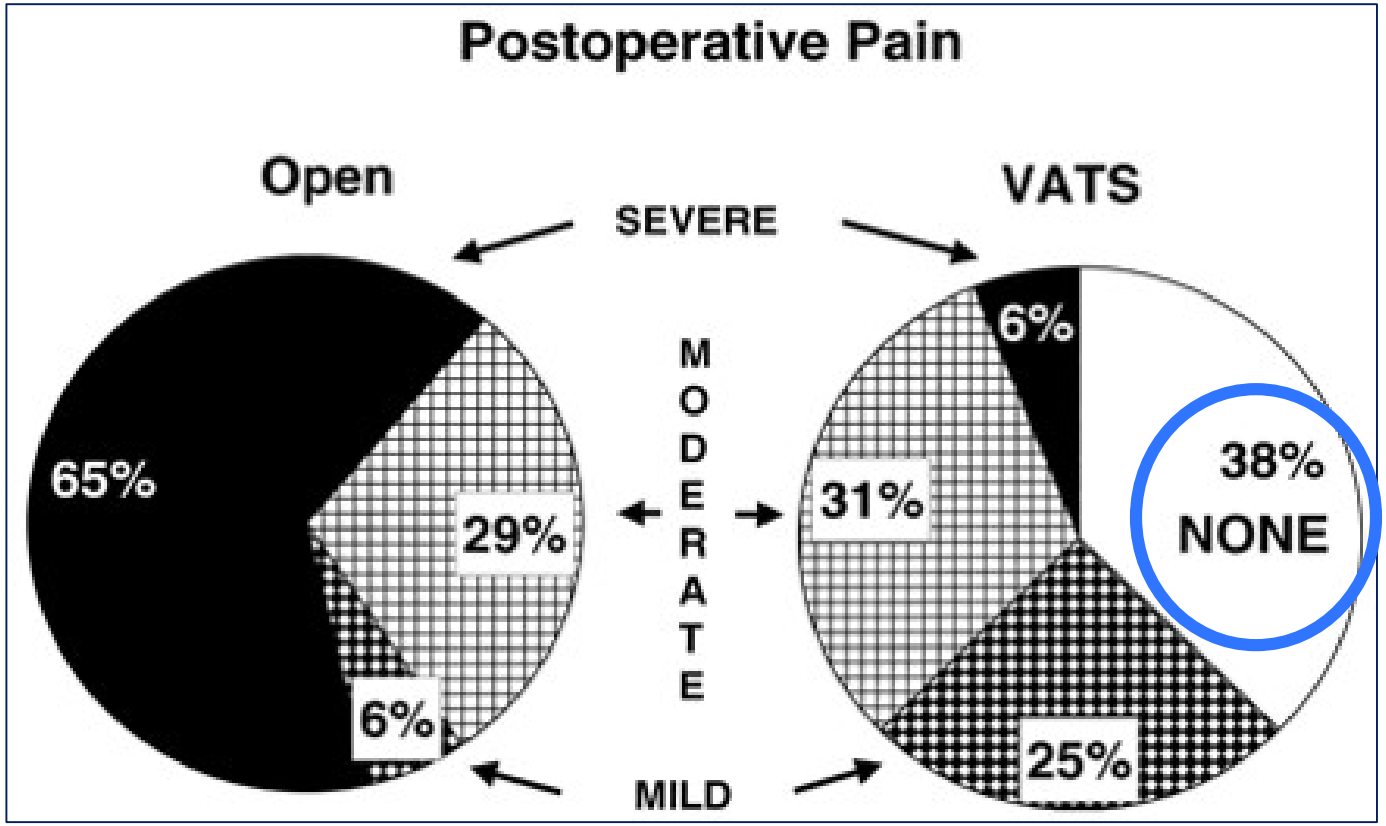
- 22 patients with clinical stage I NSCLC
- 13 VATS, 9 Thoracotomy (non-randomized)
- VATS associated
  - Less postoperative pain
  - Preserved pulmonary function
  - <u>Less inflammatory cytokine production</u>

Minimally Invasive Lobectomy Directed Towards Frail and High-Risk Patients

Demmy TL and Curtis. Ann Thorac Surg 1999; 68:194-200

- 19 VATS cases compared to matched thoracotomy cases for anatomic lobectomy
- Age, sex, side, pulmonary function matched
- VATS associated with
  - Shorter LOS
  - Fewer chest tube days
  - Earlier return to full activity
  - Lower analgesic requirement


Postoperative Pain
Open
VATS
SEVERE
MODERATE
MILD
65%
29%
6%
6%
31%
25%
38%
NONE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Open
VATS
SEVERE
MODERATE
MILD
65%
29%
6%
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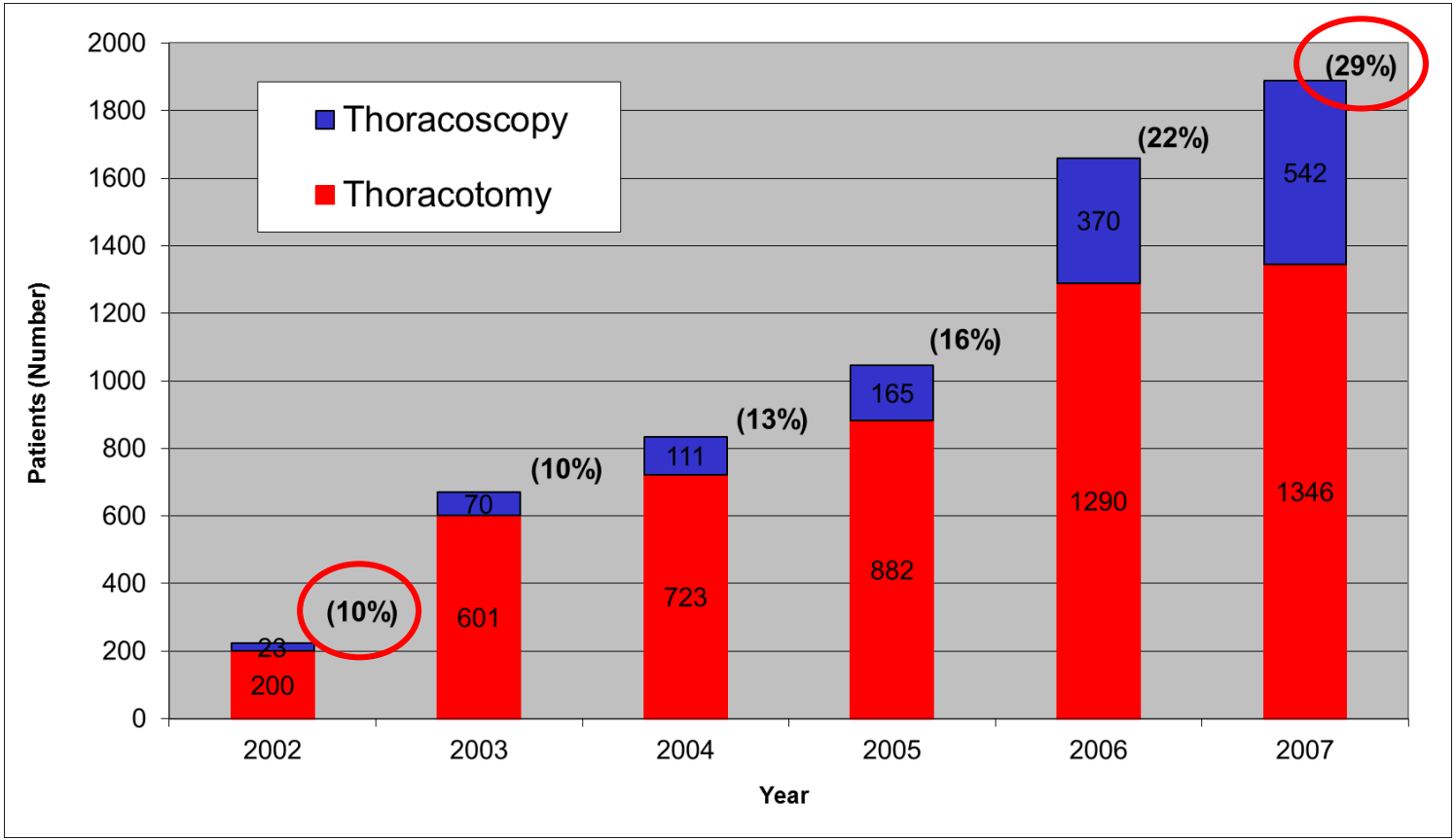
31%
25%
38%
NONE

Advantages of Thoracoscopic Lobectomy: 1995-2005

1. L
2. S
3. S
4. F
5. F
6. L
7. L

Despite these proved advantages, only 30% of lobectomies were performed thoracoscopically by 2007

Lobectomy in STS Database



Proving the Superiority of Thoracoscopic Lobectomy

- Feasibility and quality of life advantages were insufficient to improve adoption against concerns regarding:
  - Safety (case reports of bleeding)
  - Oncologic Efficacy (local and regional recurrence)

Thoracoscopic Lobectomy is Associated with Lower Morbidity Compared to Thoracotomy

Villamizar N, et al. J Thorac Cardiovasc Surg 2009; 138: 419-425

Feature	Thoracotomy (n=284)	VATS (n=284)	P
At least 1 Cx	49%	31%	0.0001
Atrial Fibrillation	21%	13%	0.01
Atelectasis	12%	5%	0.006
Prolonged air leak	19%	13%	0.05
Pneumonia	10%	5%	0.05
Transfusion	13%	4%	0.02
Renal Failure	5%	1%	0.02

Cx = complication

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Thoracoscopic Lobectomy is Associated with Lower Morbidity than Open Lobectomy: A Propensity-matched Analysis from the STS Database

Villamizar N, et al. J Thorac Cardiovasc Surg 2010: 139:366-78

Postoperative Complication	Thoracotomy (n=1281)	Thoracoscopy (n=1281)	P Value*
At least 1 Cx	35%	25%	<0.0001*
All Cardiovascular	13%	8%	0.0002*
Atrial Arrhythmia	12%	7%	0.0004*
All Pulmonary	12%	7%	0.0001*
Reintubation	3%	1%	0.0046*
Transfusion	5%	2%	0.0028*

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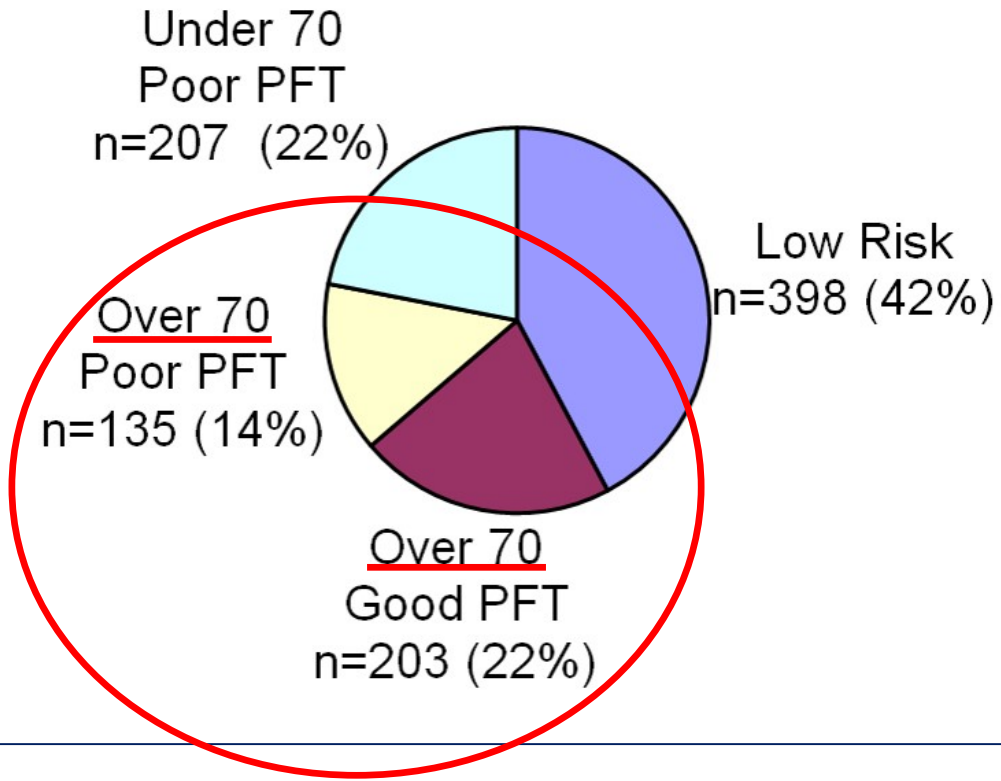
Thoracoscopic Lobectomy Outcomes

- Thoracoscopic lobectomy is safer and superior to thoracotomy: should be considered the standard for all patients with early stage lung cancer
- Is there an incremental advantage in high-risk patients?
  - ↑ Age
  - ↓ Pulmonary function
  - ↑ Extent of procedure

High Risk


Under 70
Poor PFT
n=207 (22%)
Low Risk
n=398 (42%)
Over 70
Poor PFT
n=135 (14%)
Over 70
Good PFT
n=203 (22%)

Risk Factors for Morbidity after Lobectomy for Lung Cancer in Elderly Patients

Berry MF, et al Ann Thorac Surg 2009; 88:1093-99

Morbidity	HR	P Value
Age	1.09	0.01
Thoracotomy	2.21	0.004

	Thoracotomy	VATS	p
At least 1 Cx	64%	39%	0.0001
A-fib	28%	18%	0.04
Respiratory Cx	12%	5%	0.03
Transfusion	16%	7%	0.01
Delirium	13%	5%	0.03

Cx = complication; A-fib = atrial fibrillation

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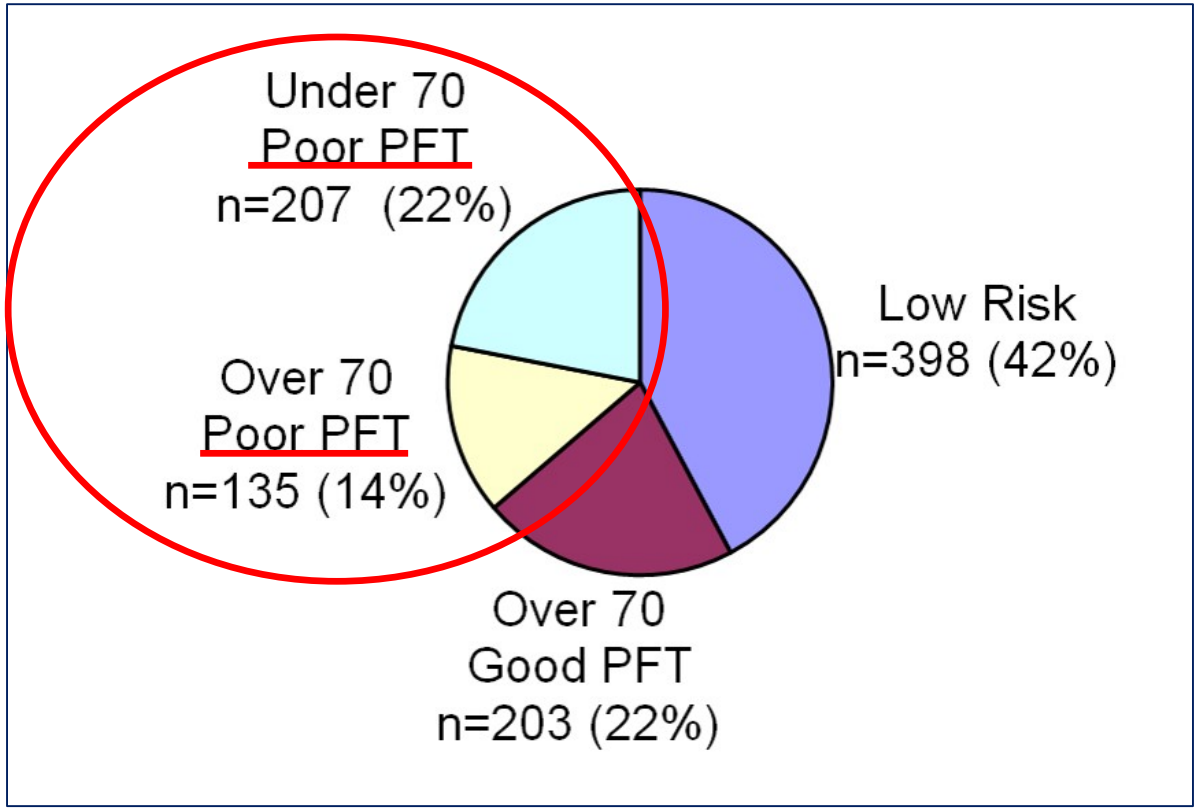
Morbidity	HR		P Value
Age			
Thorac			
At leas			
A-fib			
Respir			
Transfusion	16%	7%	0.01
Delirium	13%	5%	0.03

The use of VATS is twice as important as age in predicting complications

VATS is associated with fewer overall and specific complications in the elderly

Cx = complication; A-fib = atrial fibrillation

High Risk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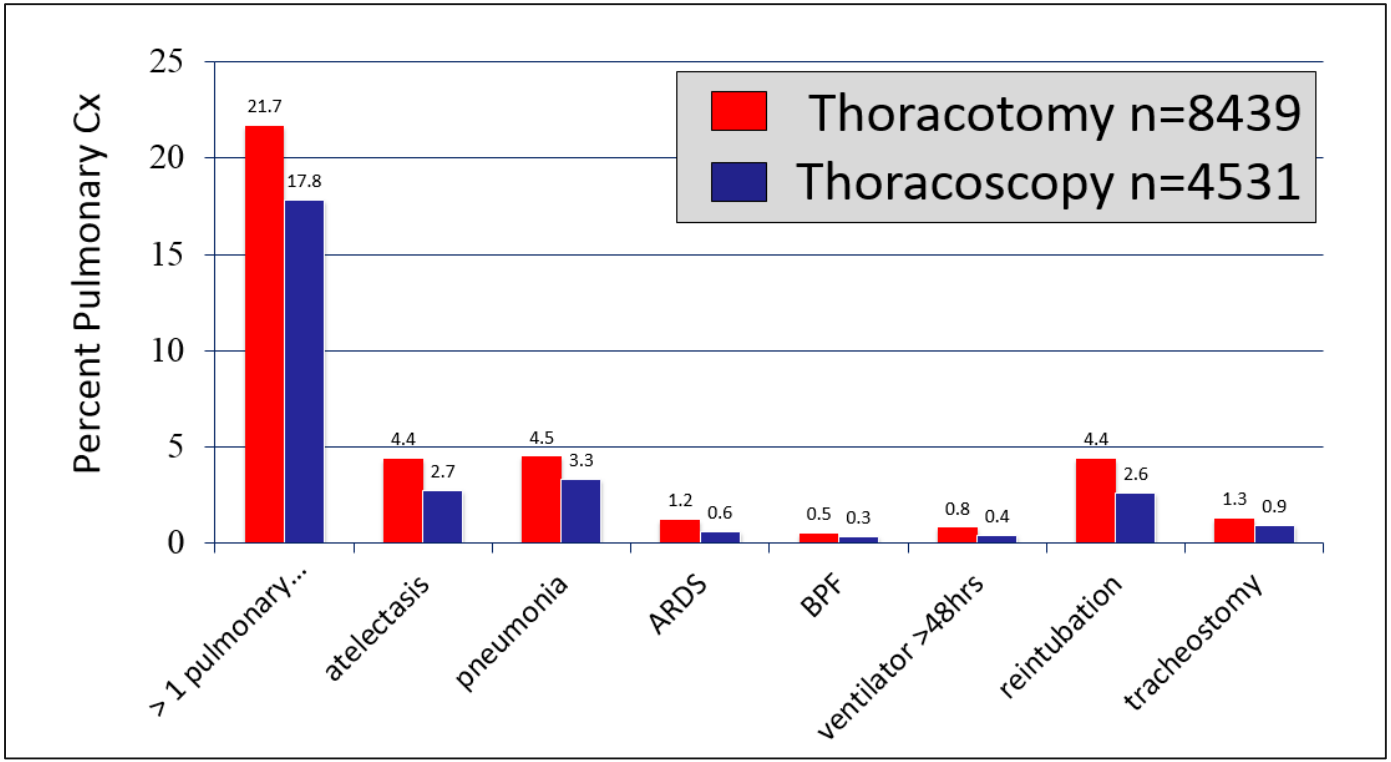
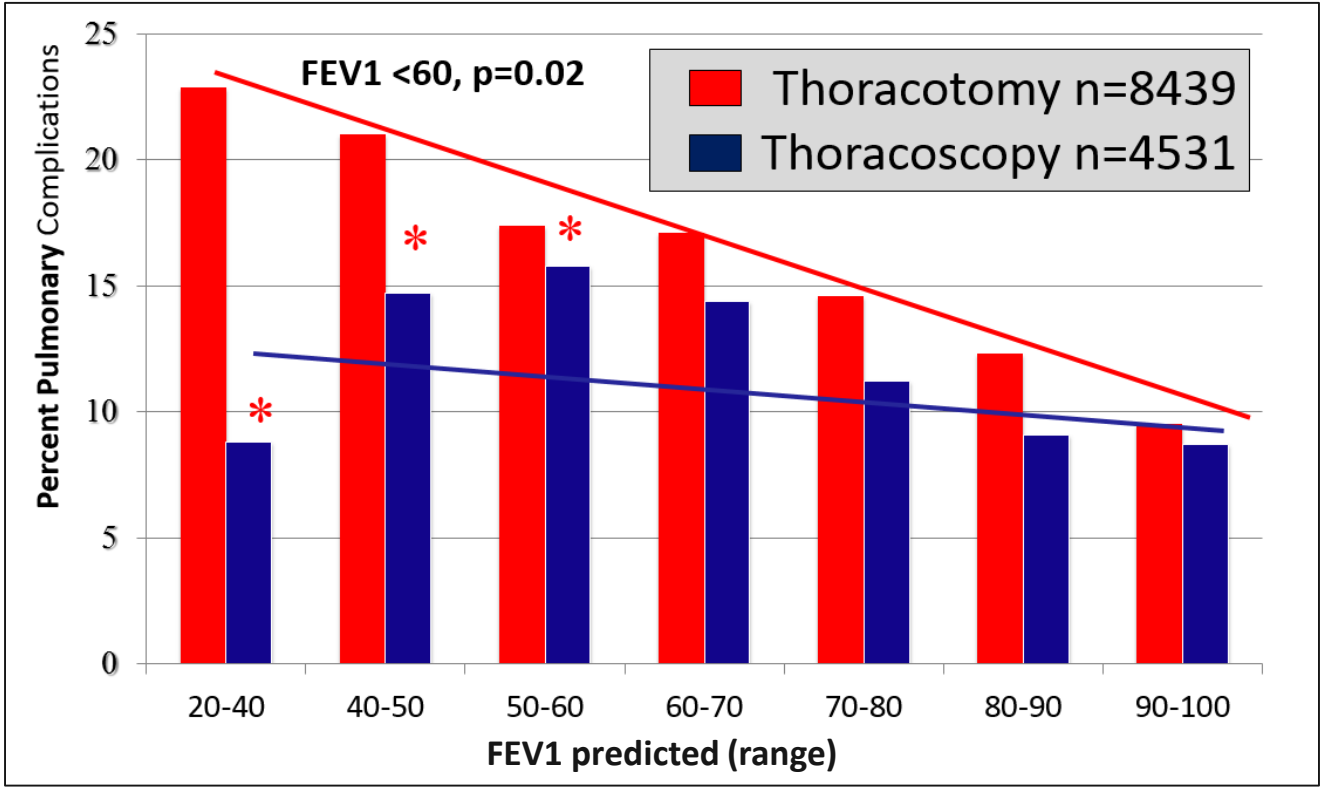
Thoracoscopic Lobectomy Has Increasing Benefit in Patients with Pulmonary Function: A STS Database Analysis

Ceppa DP, et al. Ann Surg 2012;256:487-93



Pulmonary Complications by FEV1



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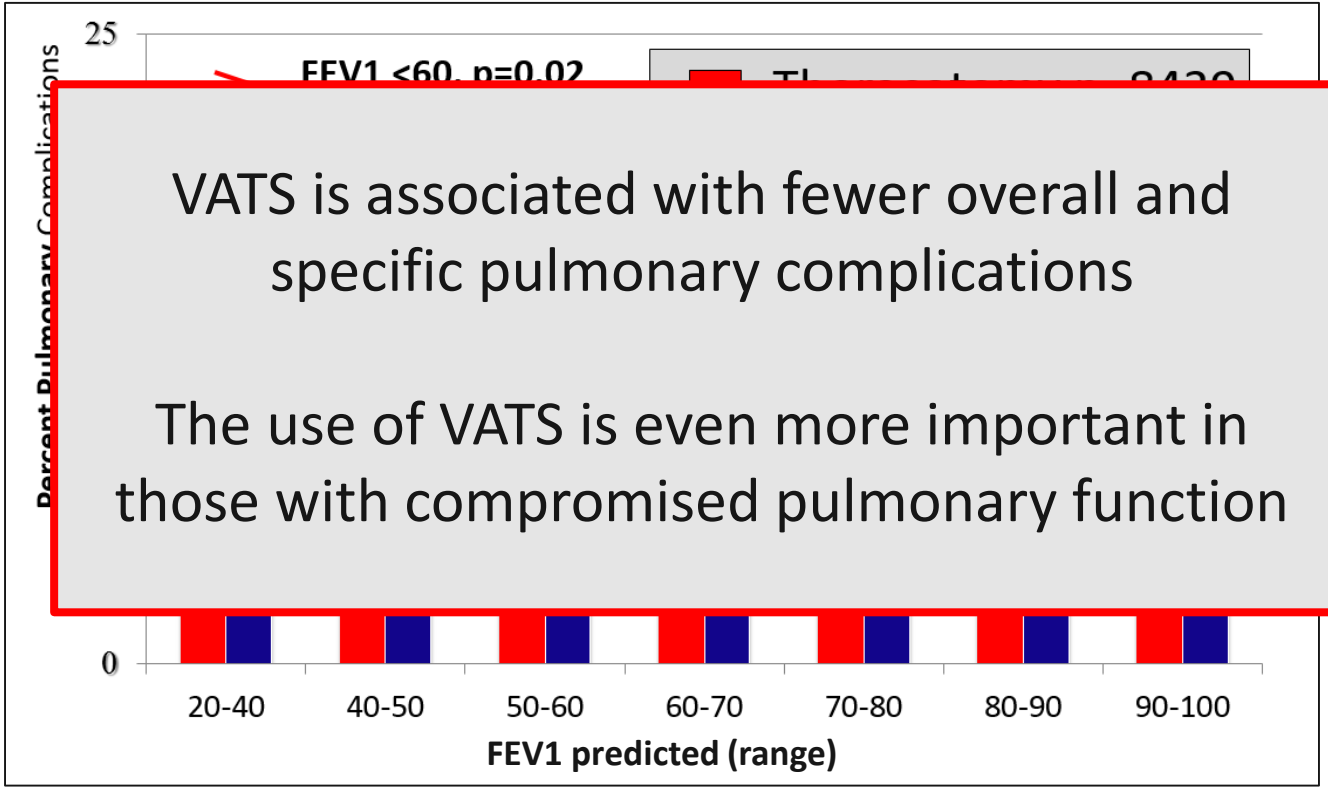


VATS is associated with fewer overall and specific pulmonary complications

The use of VATS is even more important in those with compromised pulmonary function

Thoracoscopic Lobectomy Facilitates the Delivery of Chemotherapy after Resection for Lung Cancer

Peterson R, et al. Ann Thorac Surg 2007; 83: 1245-1250

100 Patients: Lobectomy + Adjuvant Chemo	Thoracotomy N=43	Thoracoscopic N=57	*p*-value
Any delayed chemo doses	58%	18%	<0.001
Any reduced chemo doses	49%	26%	0.02
75% of planned regimen	40%	61%	0.03

JOURNAL OF CLINICAL ONCOLOGY

REVIEW ARTICLE

Systematic Review and Meta-Analysis of Randomized and Nonrandomized Trials on Safety and Efficacy of Video-Assisted Thoracic Surgery Lobectomy for Early-Stage Non–Small-Cell Lung Cancer

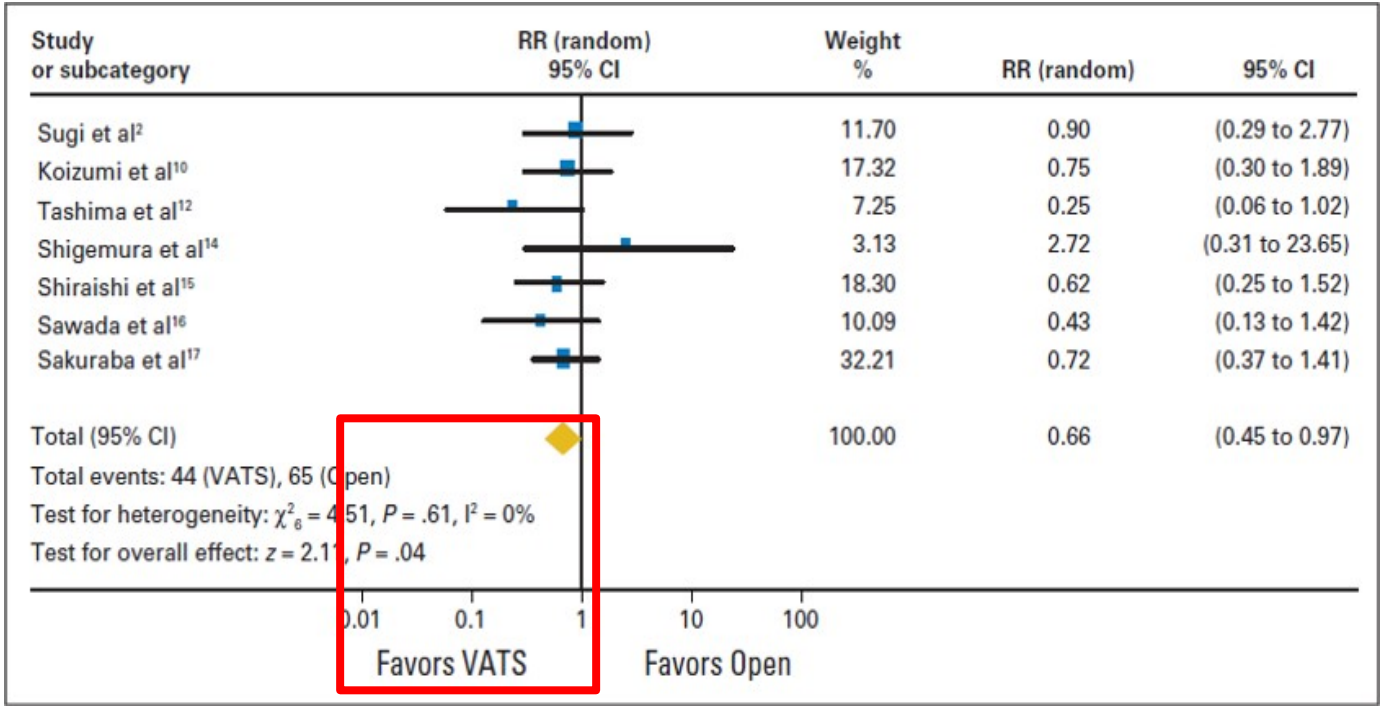
Tristan D. Yan, Deborah Black, Paul G. Bannon, and Brian C. McCaughan

- 21 comparative studies: 2 randomized
- Morbidity, mortality, recurrence, 5-year mortality

Systematic Review and Meta-Analysis of Randomized and Nonrandomized Trials on Safety and Efficacy of VATS Lobectomy

- VATS Lobectomy
  - Reduced systemic recurrence rate (P=0.03)
  - Improved 5-year mortality rate (P =0.04)

All-Cause Mortality



A Meta-analysis of Unmatched and Matched Patients Comparing Video-assisted Thoracoscopic Lobectomy and Conventional Open Lobectomy

Cao C, et al. Ann Cardiothorac Surg 2012: 1: 16-23

- Meta-analysis of 3 studies with propensity matching
- Villamizar N, et al. J Thorac Cardiovasc Surg 2009; 138: 419
- Paul S, et al et al. J Thorac Cardiovasc Surg: 2010; 139: 366
- Ilonen IK et al. Acta Oncologic 2011; 50: 1126

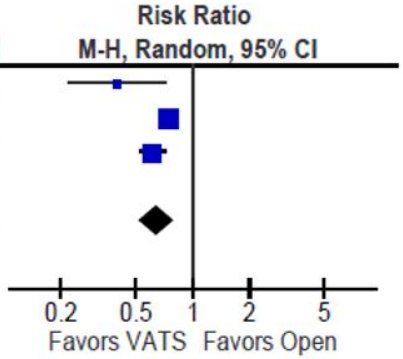
Relative Risk of Perioperative Morbidity

A Un-matched

Study or Subgroup	VATS Events	VATS Total	Thoracotomy Events	Thoracotomy Total	Weight	Risk Ratio M-H, Random, 95% CI
Ilonen 2011	12	116	55	212	10.8%	0.40 [0.22, 0.71]
Paul 2010	336	1281	1788	5042	47.4%	0.74 [0.67, 0.82]
Villamizar 2009	212	697	190	382	41.8%	0.61 [0.53, 0.71]
Total (95% CI)		**2094**		**5636**	**100.0%**	**0.64 [0.52, 0.79]**
Total events	560		2033			

Heterogeneity: Tau² = 0.02; Chi² = 7.78, df = 2 (P = 0.02); I² = 74%

Test for overall effect: Z = 4.09 (P < 0.0001)

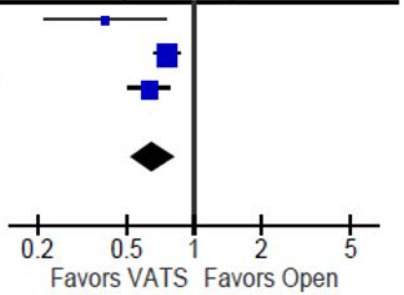


B Matched

Study or Subgroup	VATS Events	VATS Total	Thoracotomy Events	Thoracotomy Total	Weight	Risk Ratio M-H, Random, 95% CI
Ilonen 2011	12	116	30	116	11.4%	0.40 [0.22, 0.74]
Paul 2010	336	1281	444	1281	49.6%	0.76 [0.67, 0.85]
Villamizar 2009	88	284	140	284	39.0%	0.63 [0.51, 0.78]
Total (95% CI)		**1681**		**1681**	**100.0%**	**0.65 [0.52, 0.83]**
Total events	436		614			

Heterogeneity: Tau² = 0.03; Chi² = 5.71, df = 2 (P = 0.06); I² = 65%

Test for overall effect: Z = 3.55 (P = 0.0004)

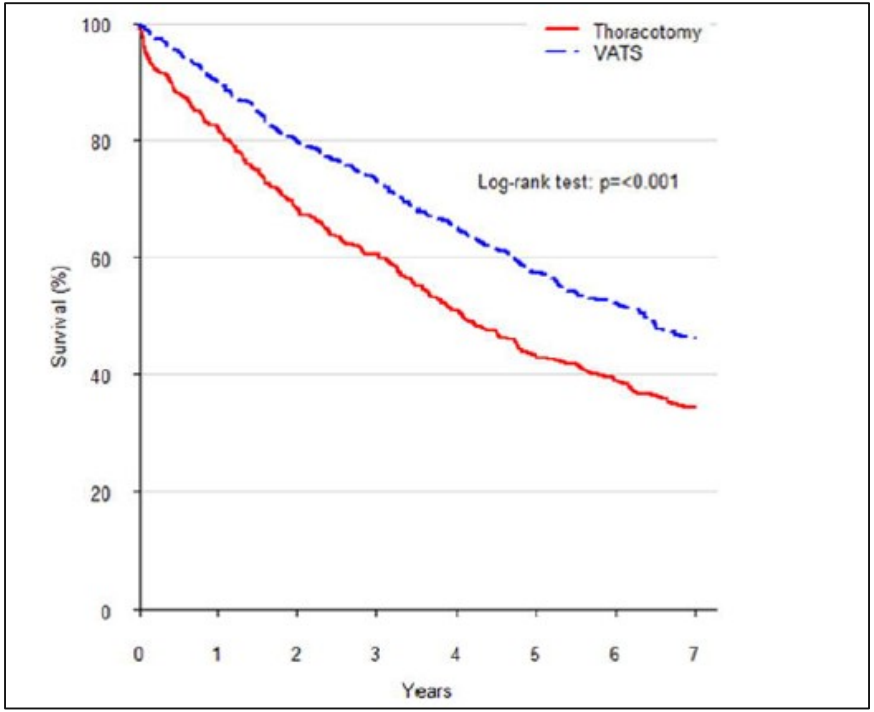


Thoracoscopic Approach to Lobectomy for Lung Cancer Does Not Compromise Oncologic Efficacy

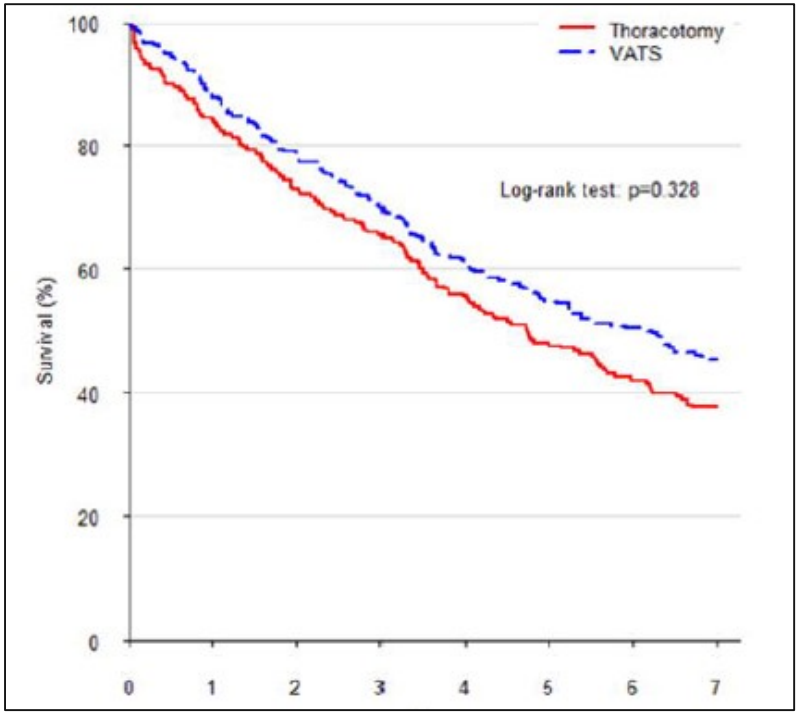
Berry MF, D'Amico TA, et al. Ann Thorac Surg 2014;98:197-202

- 1087 patients: 610 VATS, 477 thoracotomy
- Multivariable analysis, worse survival associated:
  1. Increasing age (HR 1.02 per year, $p<0.0001$)
  2. Pathologic stage (HR 1.45/stage, $p<0.0001$)
  3. Thoracotomy approach (HR 1.22, $p=0.01$)

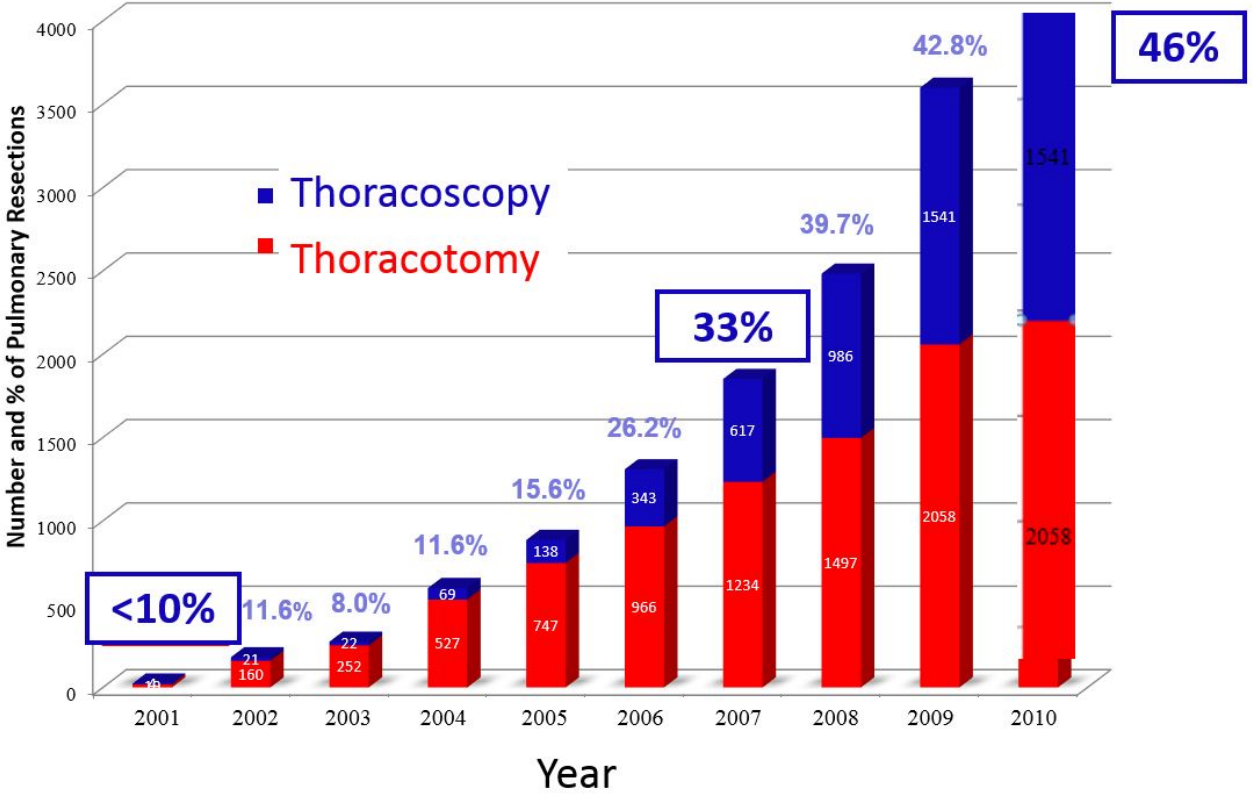
Survival of All Patients by Operative Approach



Survival of Propensity Matched Patients by Operative Approach



STS Database: % Thoracoscopic Lobectomy



Ceppa DP, et al. Ann Surg 2012;256:487-93

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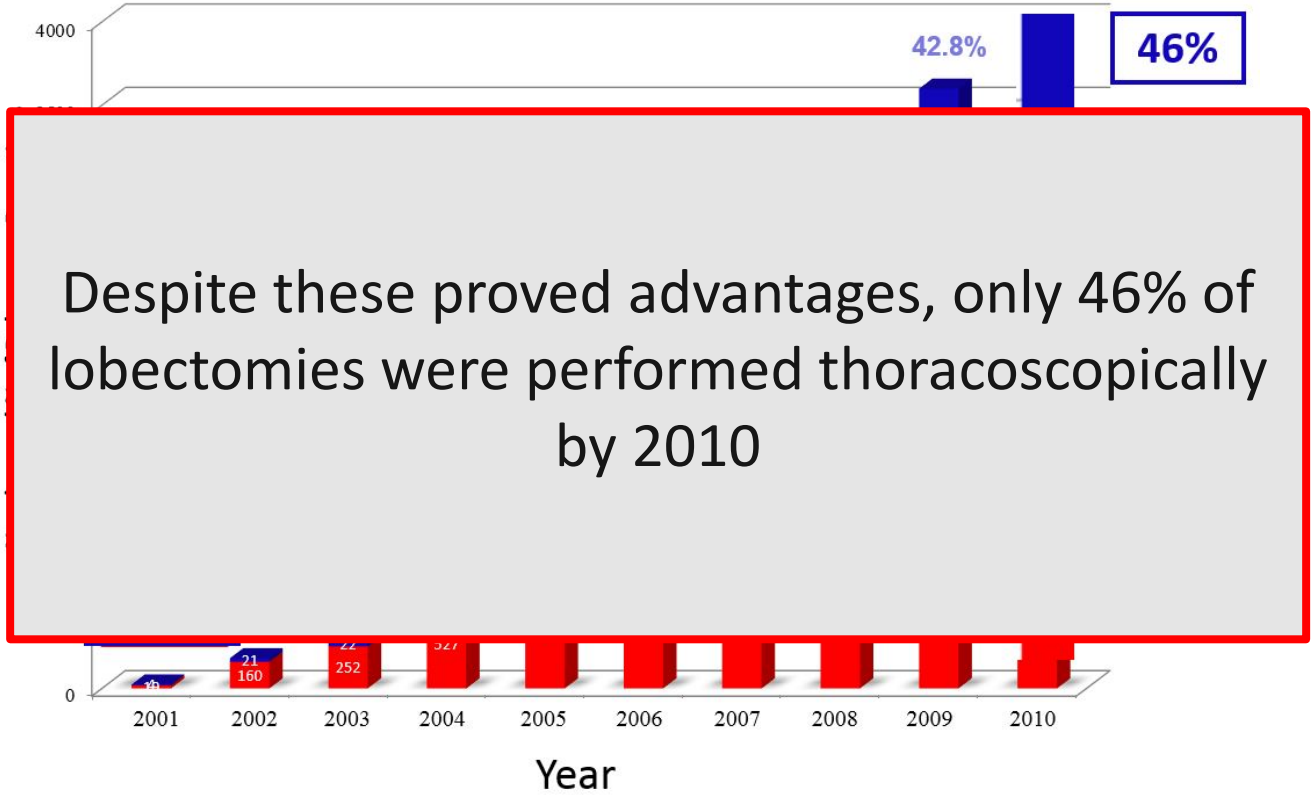
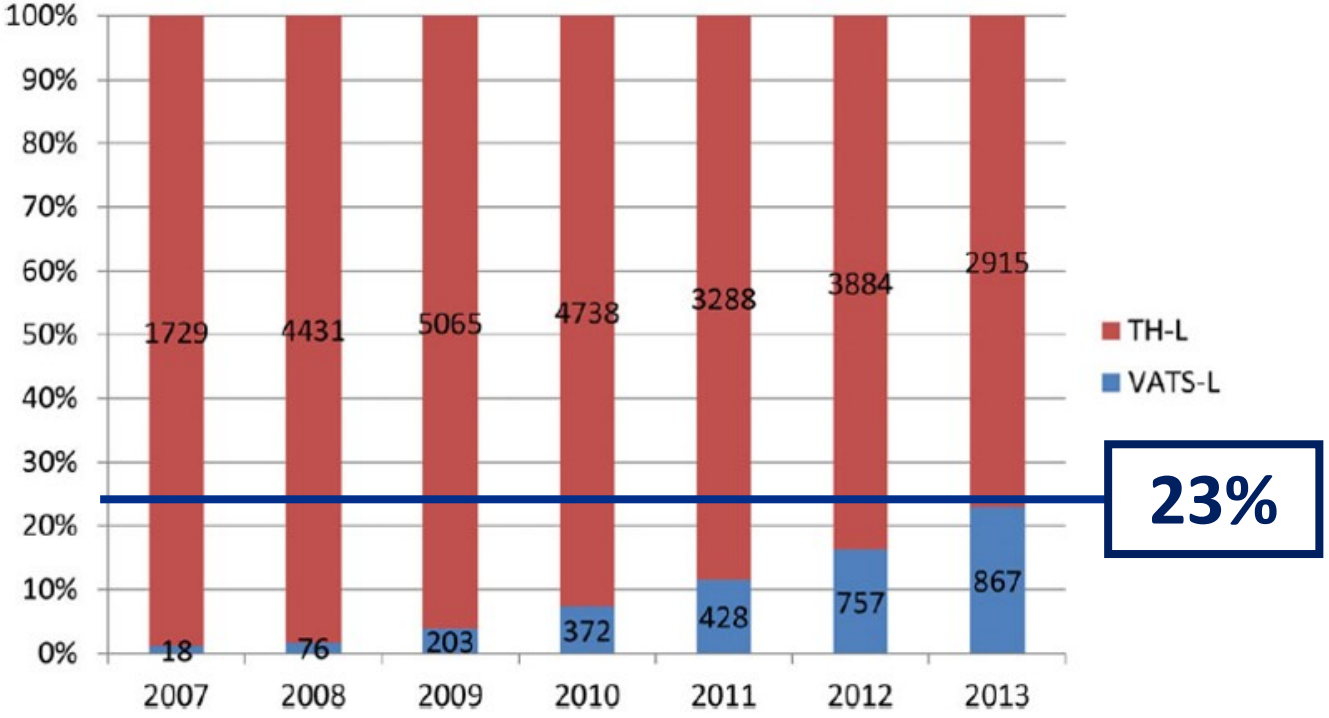


Despite these proved advantages, only 46% of lobectomies were performed thoracoscopically by 2010

Ceppa DP, et al. Ann Surg 2012;256:487-93

Video-assisted Thoracoscopic Surgery versus Open Lobectomy for Non-small-cell Lung Cancer: A Propensity-matched Analysis of Outcome from the ESTS Database

Eur J Cardiothorac Surg. 2016 Feb;49(2):602-9



Thoracoscopic Lobectomy

- Advantages in safety (Cx) and quality of life
- Equal or superior oncologic outcomes and survival
- Superior compliance with adjuvant chemotherapy
- More differentially beneficial than any other minimally invasive procedure vs open alternative
- Even more advantageous for complex patients (high-risk) and complex resections (locally advanced disease)
- Underutilized worldwide

Oncologic Validity of Minimally Invasive Pulmonary Lobectomy

Todd L. Demmy, MD

Professor of Oncology
Department of Thoracic Surgery
Roswell Park Cancer Institute

Disclosures

- Consultant for Medtronic

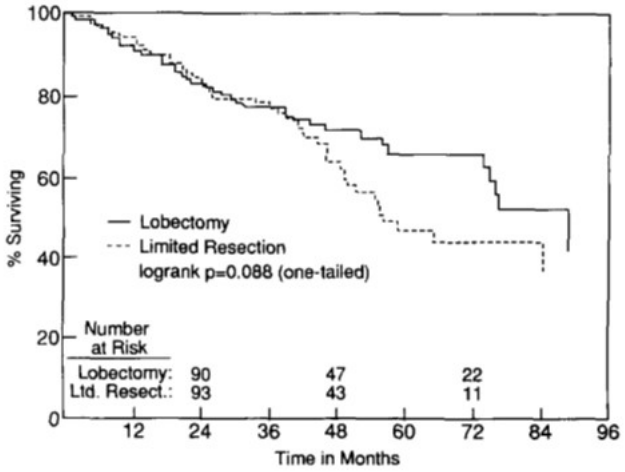
Objectives

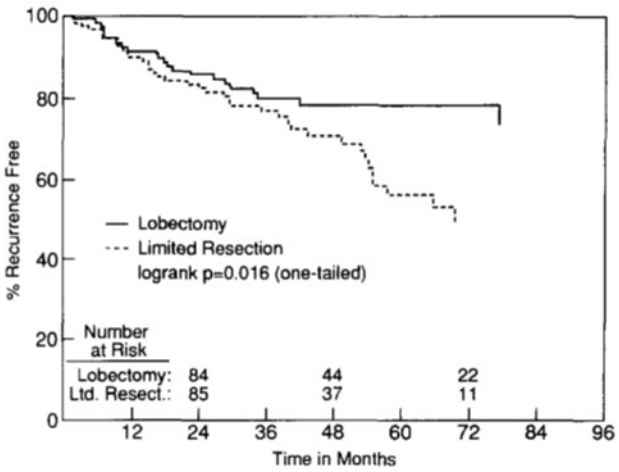
- Randomized Trials
- Retrospective/Large Database
- Correlative Mechanistic (TNM) Considerations

Axillary Thoracotomy Concerns

Randomized Trial of Lobectomy Versus Limited Resection for T1 N0 Non–Small Cell Lung Cancer

Lung Cancer Study Group (Prepared by Robert J. Ginsberg, MD, and Lawrence V. Rubinstein, PhD)

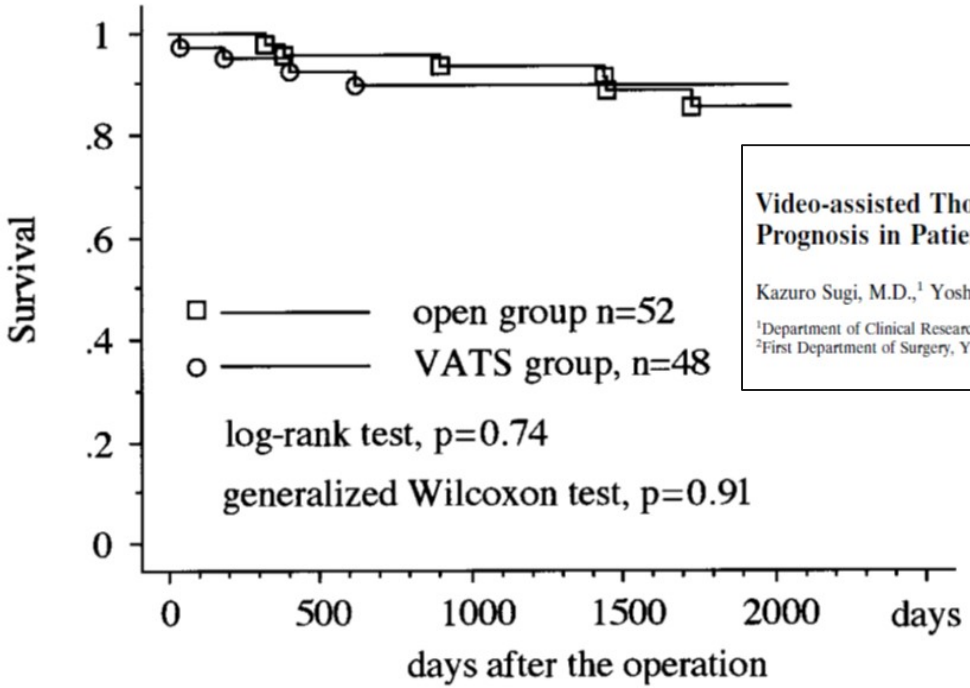




- No Analysis type of approach

Ann Thorac Surg 1995;60:615-23

Sugi, N=100, Randomized



Video-assisted Thoracoscopic Lobectomy Achieves a Satisfactory Long-term Prognosis in Patients with Clinical Stage IA Lung Cancer

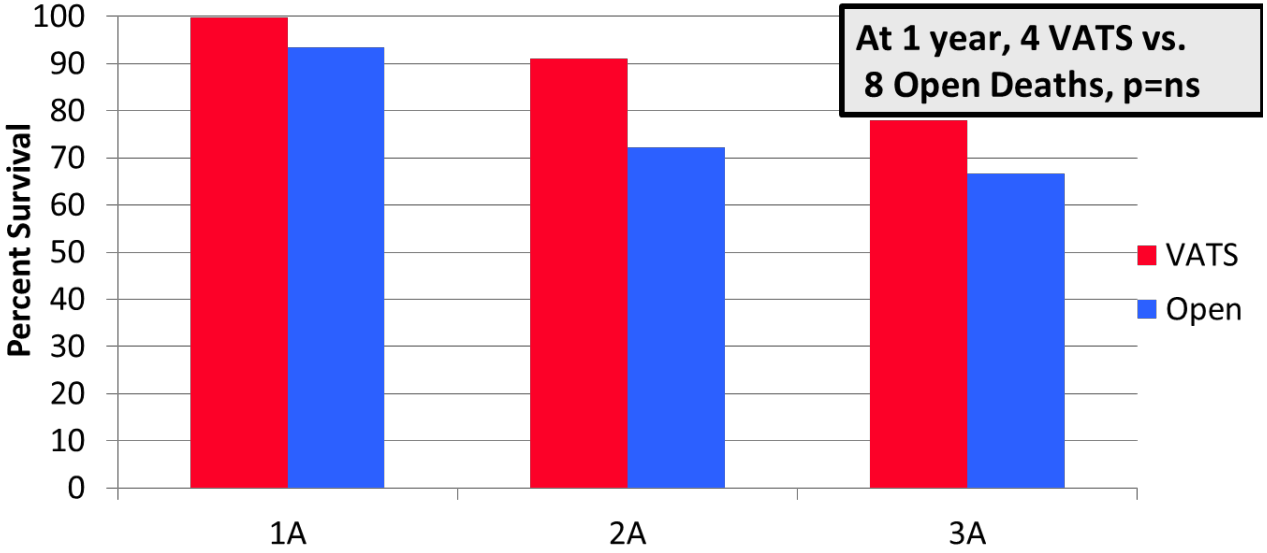
Kazuro Sugi, M.D.,[1] Yoshikazu Kaneda, M.D.,[2] Kensuke Esato, M.D.[2]

[1]Department of Clinical Research, National Sanyo Hospital, Higashikiwa 685, Ube, Yamaguchi, 755-0241 Japan
[2]First Department of Surgery, Yamaguchi University School of Medicine, Kogushi 1144, Ube, Yamaguchi, 755-8505 Japan

Sugi, et al, World J. Surg. 24, 27–31, 2000

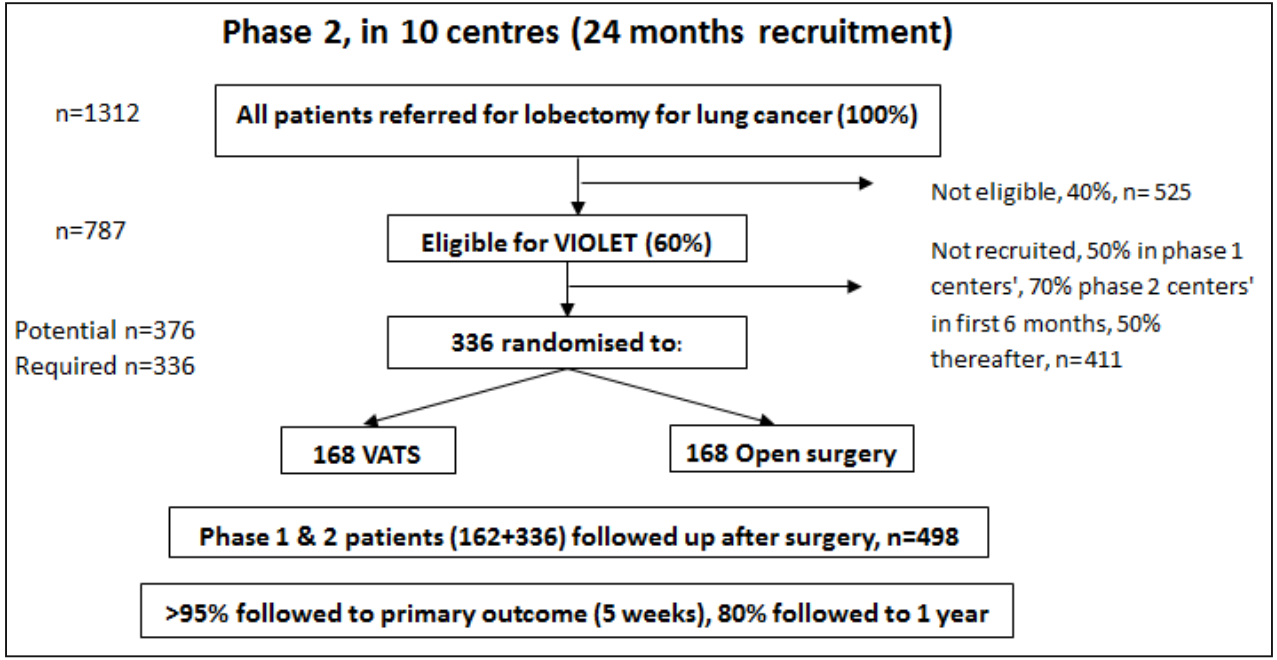
100 Randomized, Ages 62-72, Same One Year Stage Specific Survival

- Significantly fewer complications for VATS



Xue, et al., Cell Biochem Biophys (2015) 73:399–404

VIOLET Trial – NHS Foundation Trust



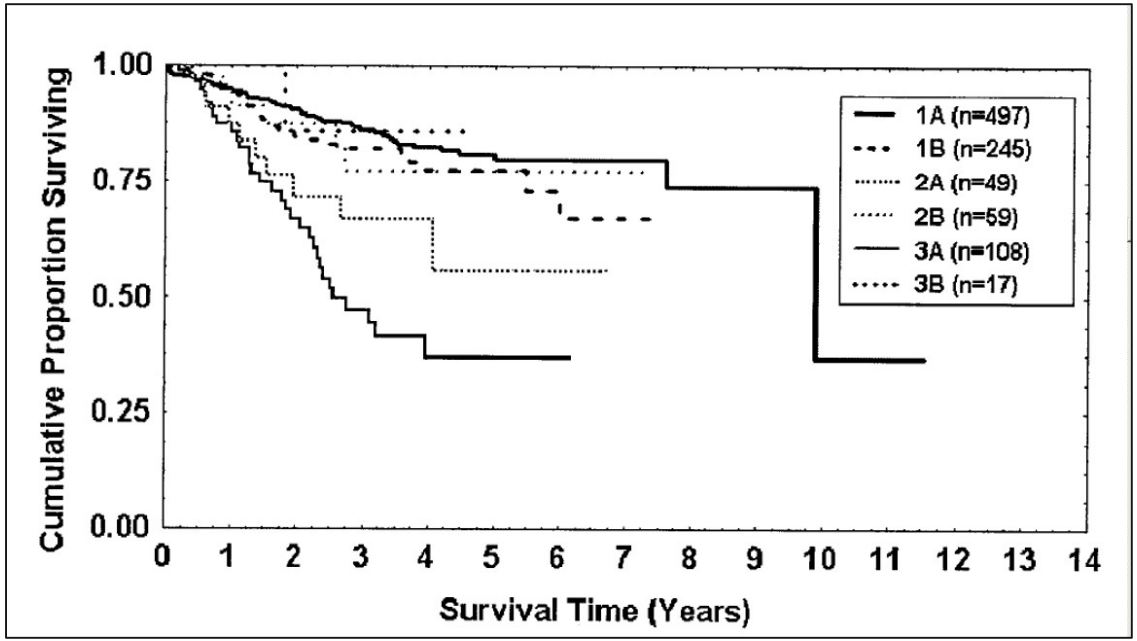
www.nets.nihr.ac.uk/projects/hta/130403

VATS vs. Axillary Thoracotomy N=481 Randomized - China

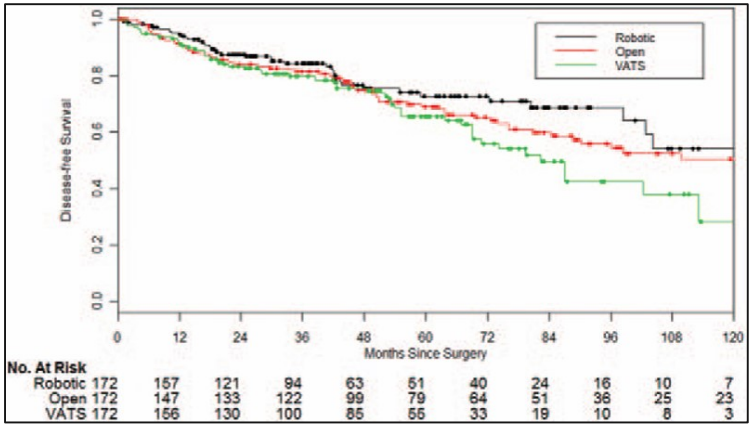
- Multicenter trial – 5 sites, Guangzhou, Chongqing, Shanghai (2), Shenzhen
- 3.72% Conversion
- 16 min faster and less blood loss in VATS (both p=0.001)
- Positive margins 1 VATS and 5 Open
- Lymph nodes 10 vs 12, p=0.389
- Long-term survival pending

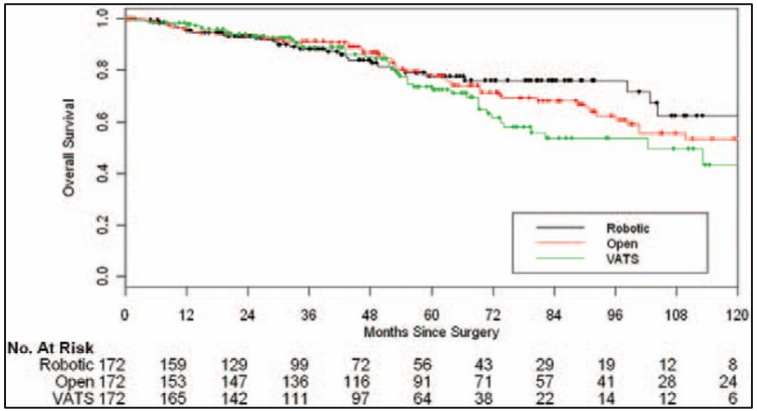
- **Proceedings of STS Annual Meeting 2017, Houston, TX**

High Volume - 1100 VATS Lobes



McKenna, et al, Ann Thorac Surg 2006;81:421– 6



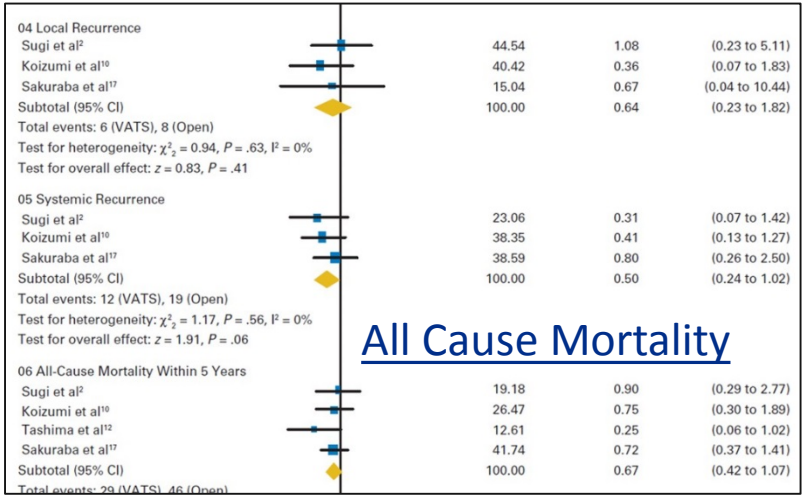


- MSK Data, Stage 1, 2002-2012
- Long-term Lobectomy Survival by Approach for Clinical Stage I NSCLC (516 Matched Cases)
- Minimally invasive shorter LOS
- Robotic (8% of cases), more nodes
- No difference in LT Survival

Yang, Annals of Surgery. 265(2):431-437, February 2017. DOI: 10.1097/SLA.0000000000001708

Meta-Analyses

2009

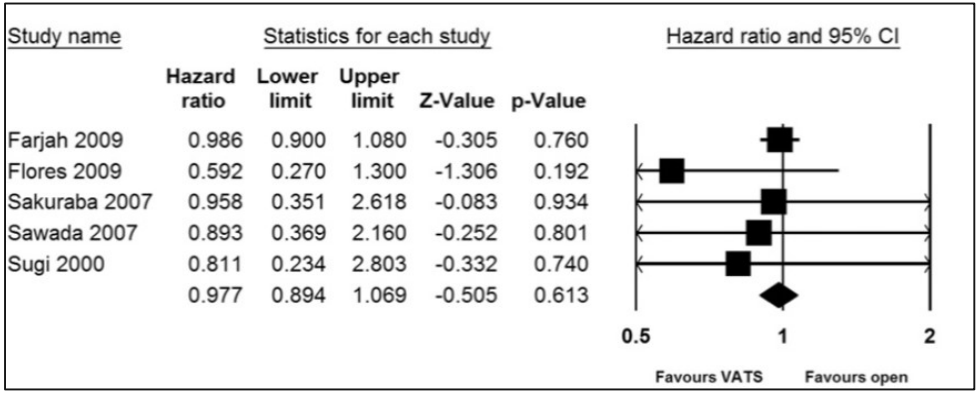


All Cause Mortality

FAVOR VATS

Yan, et al, J Clin Oncol 27:2553-2562

2011

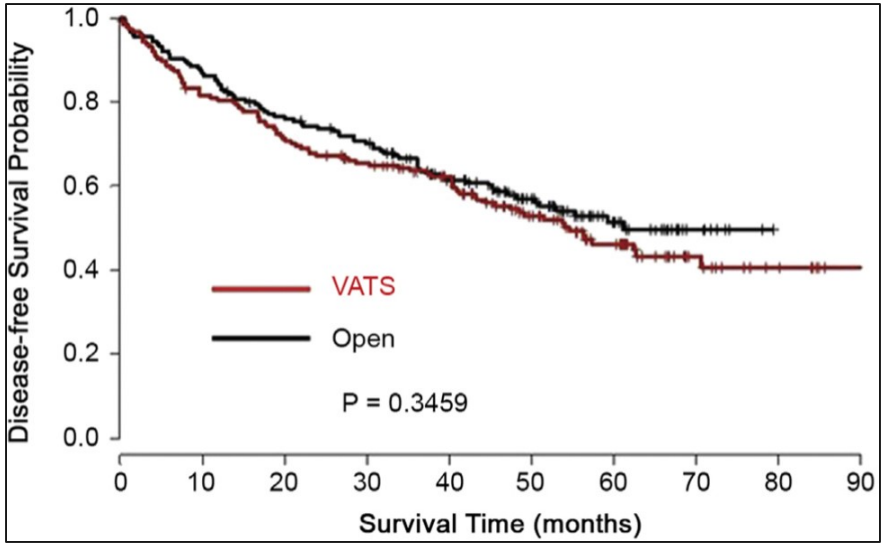


Study name	Hazard ratio	Lower limit	Upper limit	Z-Value	p-Value
Farjah 2009	0.986	0.900	1.080	-0.305	0.760
Flores 2009	0.592	0.270	1.300	-1.306	0.192
Sakuraba 2007	0.958	0.351	2.618	-0.083	0.934
Sawada 2007	0.893	0.369	2.160	-0.252	0.801
Sugi 2000	0.811	0.234	2.803	-0.332	0.740
	0.977	0.894	1.069	-0.505	0.613

FAVOR VATS

Takagi, et al, Ann Thorac Surg 92:403–10

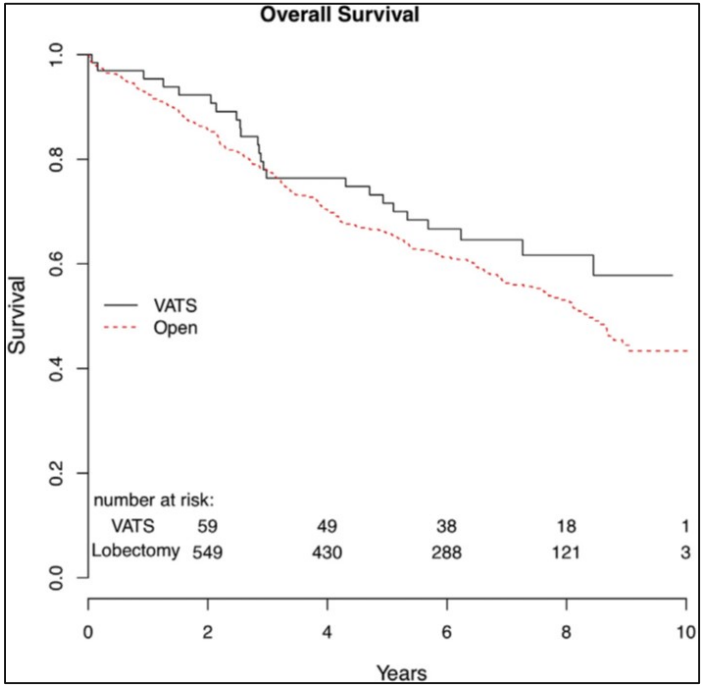
CALGB 31001, an Ancillary Analysis of CALGB 140202 (Alliance)

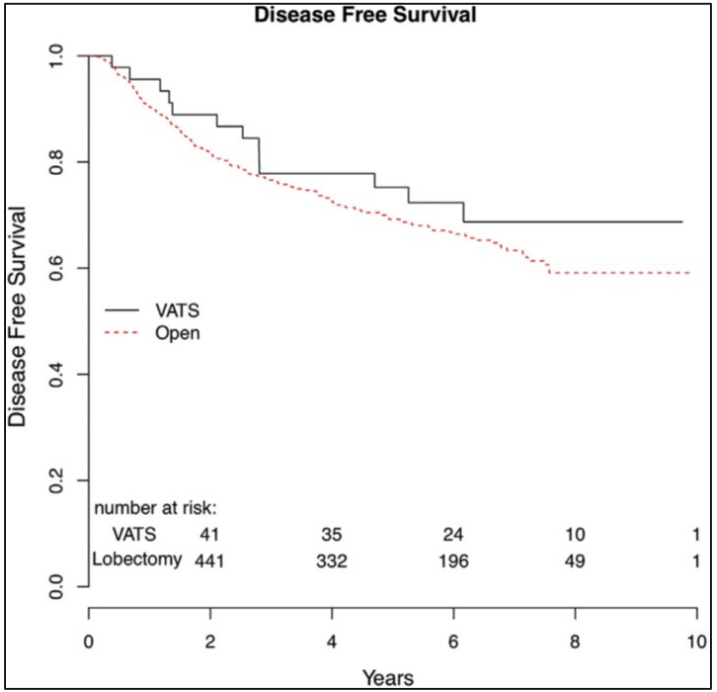


- Patients from Lung Cancer Tumor Bank Stage I+2
- Open (n = 175) vs. VATS (n = 175); matched

Nwogu, et al. Ann Thorac Surg 2015;99:399–405

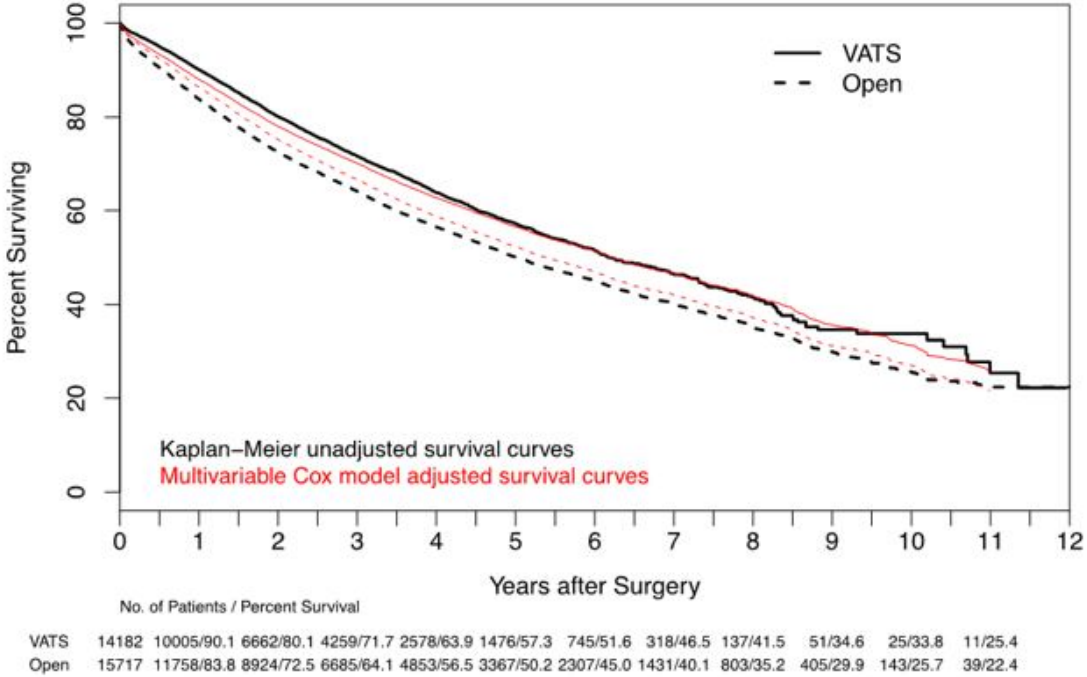
ACOSOG Z0030 Trial Propensity Matched, VATS N=59 vs. Open N=549





Su, et al. J Thorac Cardiovasc Surg 2014;147:747-53

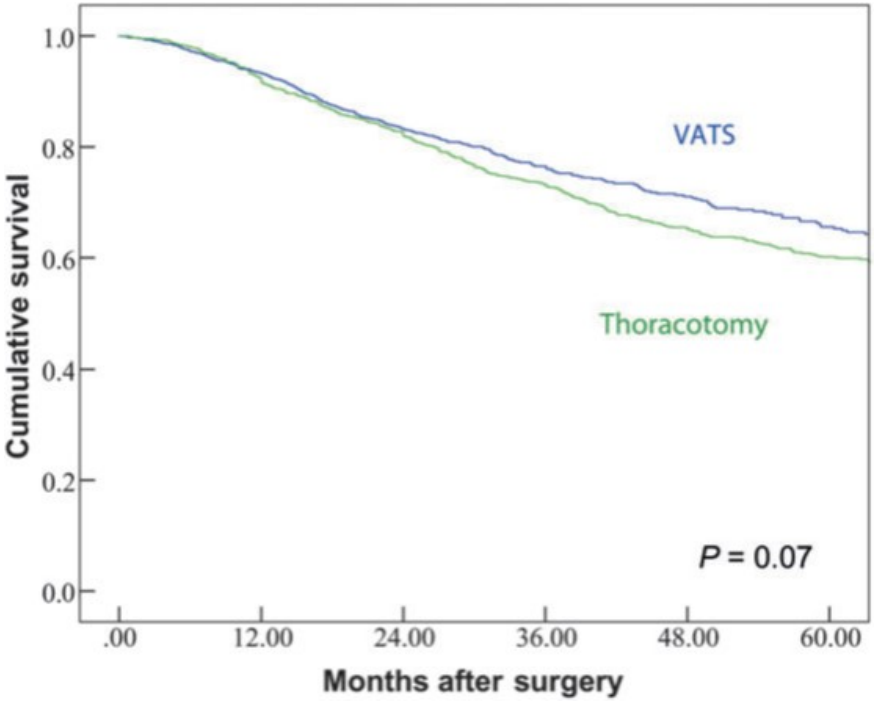
VATS in 29,899 Medicare Patients STS Database Analysis



January 23, 2017
J. Maxwell Chamberlain
Paper

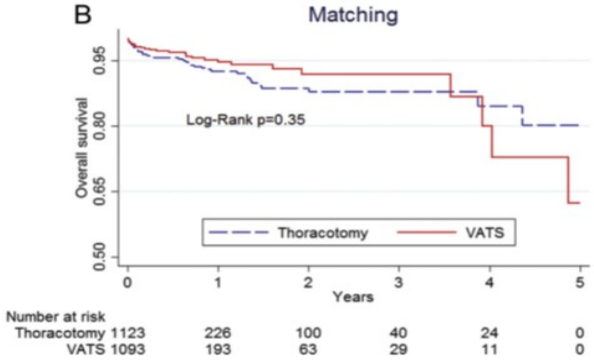
Proceedings of STS Annual Meeting 2017, Houston, TX

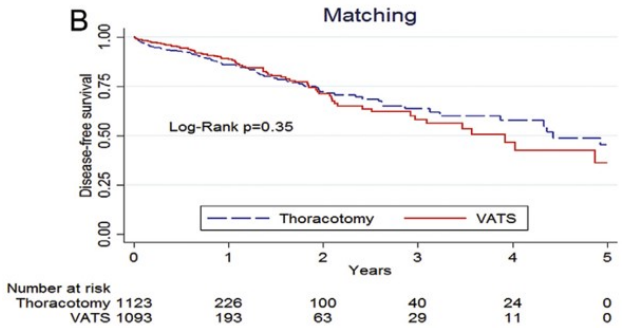
China – Multi-Institutional Registry 2916 Matched Patients

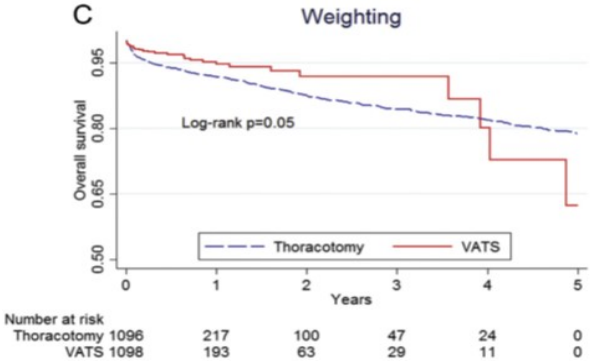


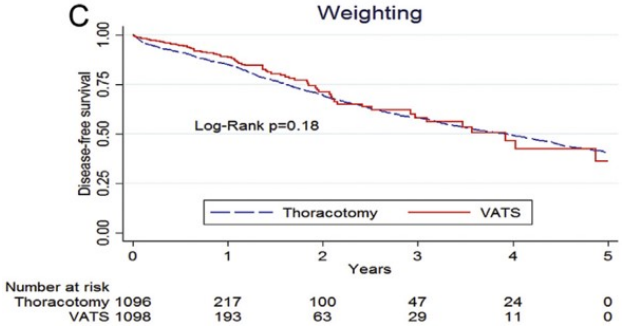
Cao, et al., European Journal of Cardio-Thoracic Surgery 44 (2013) 849–854

France – National Registry EPITHOR 24,811 Open and 1,278 VATS



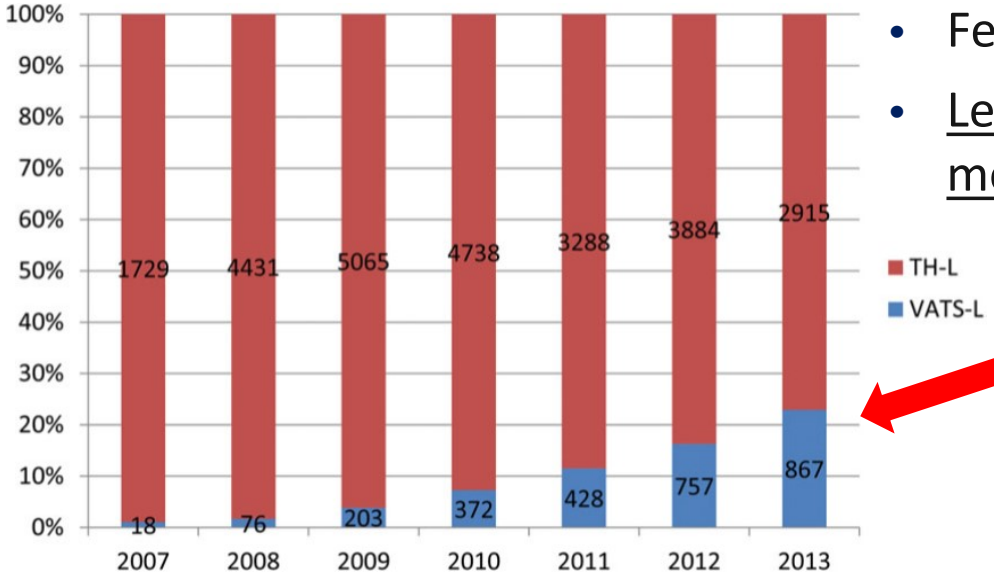






Pagès, et al., Ann Thorac Surg 2016;101:1370–8

European (ESTS) Registry N=28,771
5,442 Propensity Matched



- Fewer VATS complications
- <u>Less VATS perioperative mortality 1.0 vs. 1.9%, p=0.02</u>

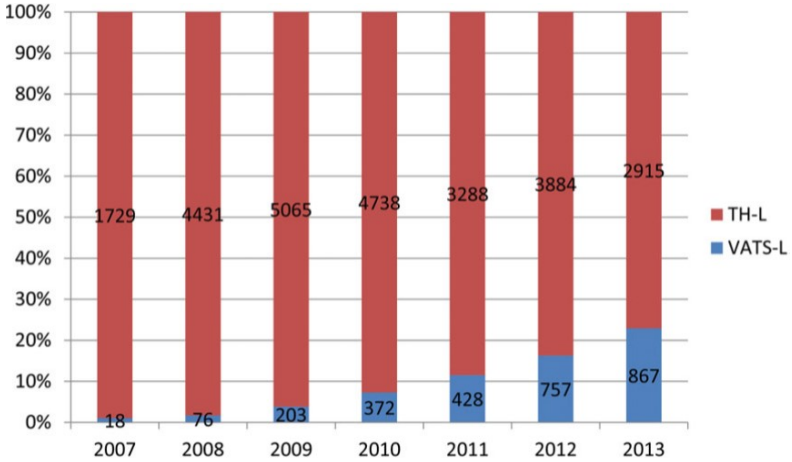
23% VATS

Falcoz, et al, European Journal of Cardio-Thoracic Surgery 49 (2016) 602–609

Commentary

Re: Video-assisted thoracoscopic surgery versus open lobectomy for primary non-small-cell lung cancer: a propensity-matched analysis of outcome from the European Society of Thoracic Surgeon database

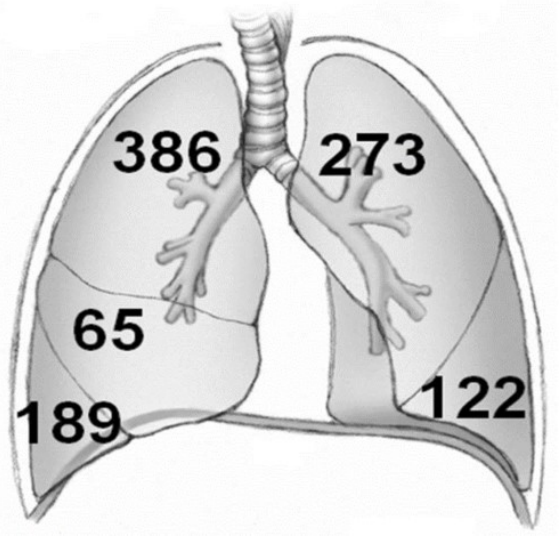
Douglas J. Mathisen*

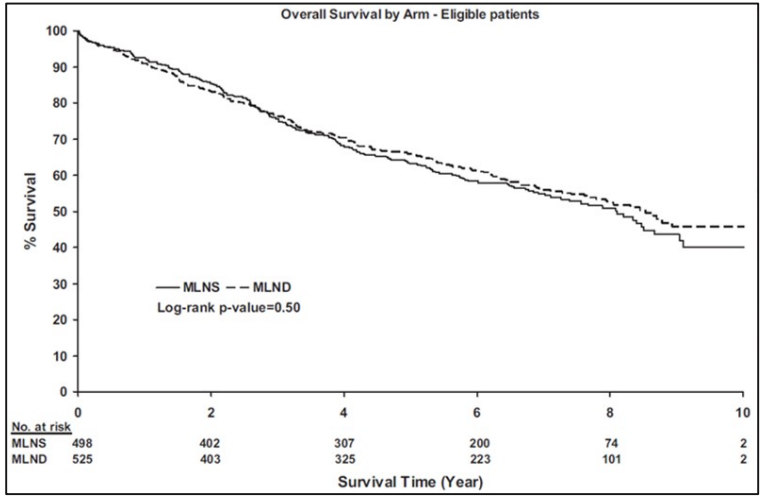


- Selection bias
  - "Procedure done only 10% of time"
- <u>Upstaging Differences (Nodes)</u>
- "Cure remains the goal of surgical therapy and must not be compromised"

European Journal of Cardio-Thoracic Surgery 49 (2016) 609–610

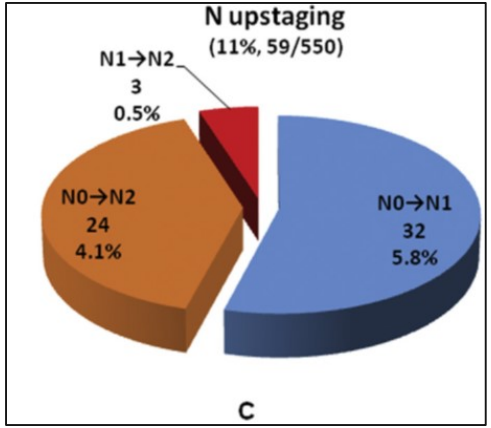
ACOSOG Z0030 Trial Sampling vs. Dissection N=1023

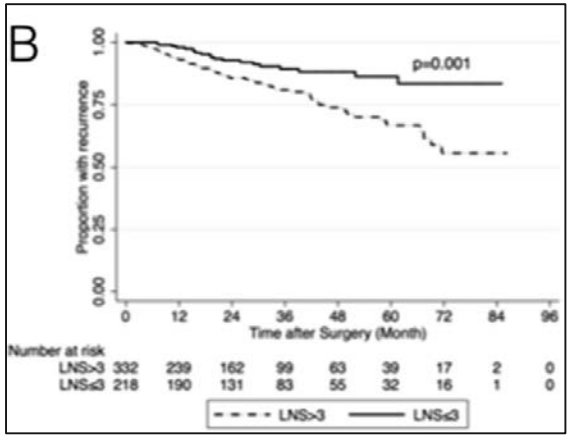




Darling, et al. J Thorac Cardiovasc Surg 2011;141:662-70

MGH Early-stage NSCLC Formal VATS Lobes/Segs N=550

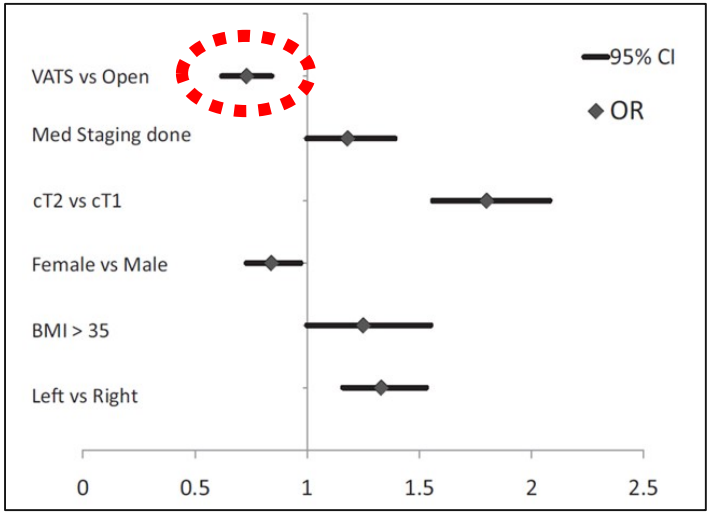


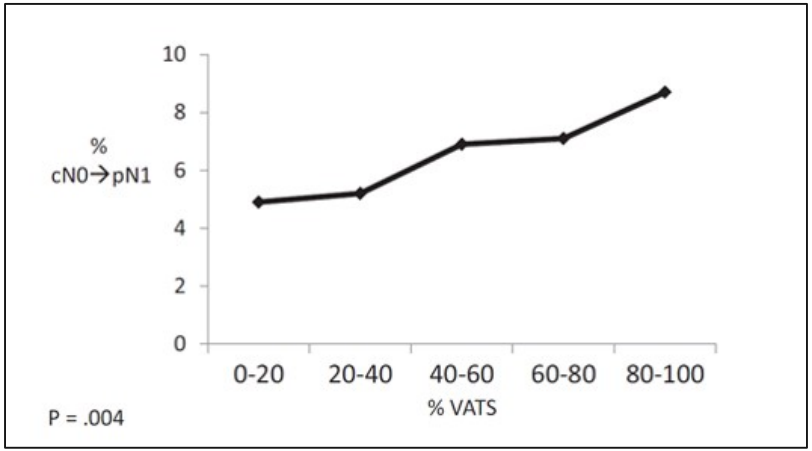


- Sampling > 3 LNS
- ➢ 10 RNs increased nodal upstaging
- ➢ Only LNS > 3 independently predicted lower mortality in VATS lobectomy and segmentectomy

Zhou, et al, Ann Thorac Surg 2015;100:910–7

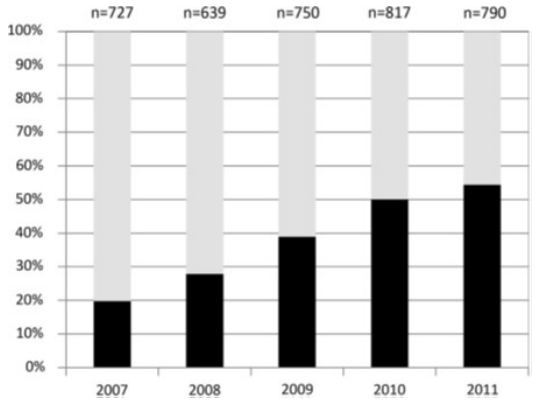
Less Nodal Upstaging VATS STS Database

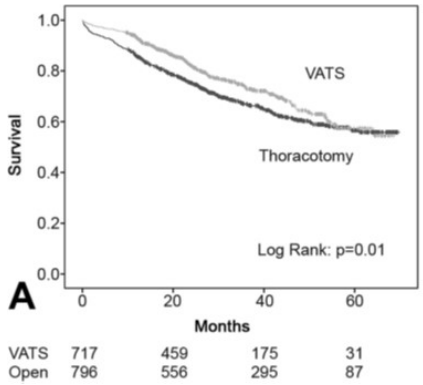


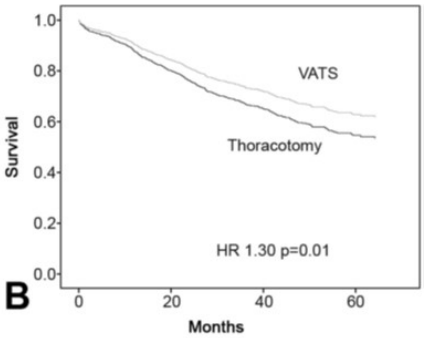


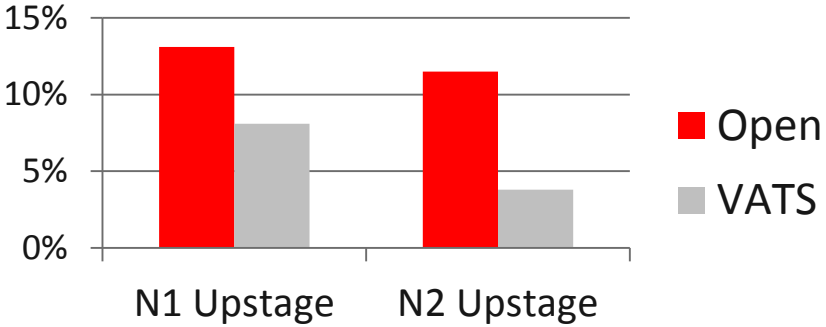
Boffa, et al. Ann Thorac Surg 2012;94:347–53

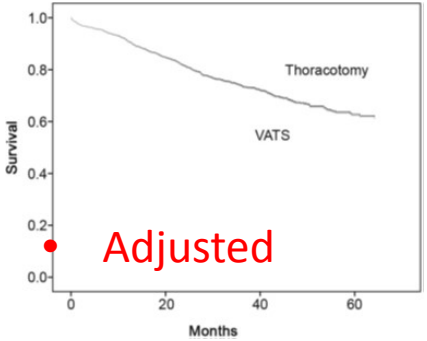
Node Concerns, Danish Registry





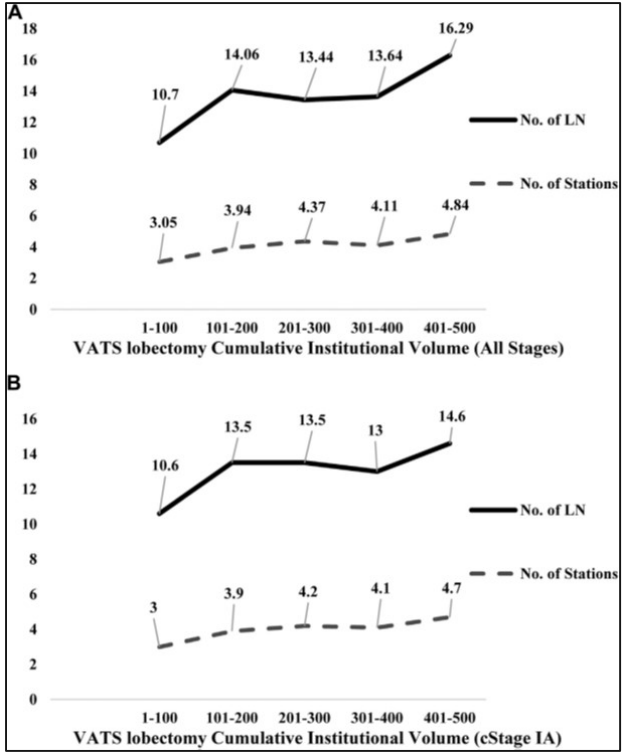






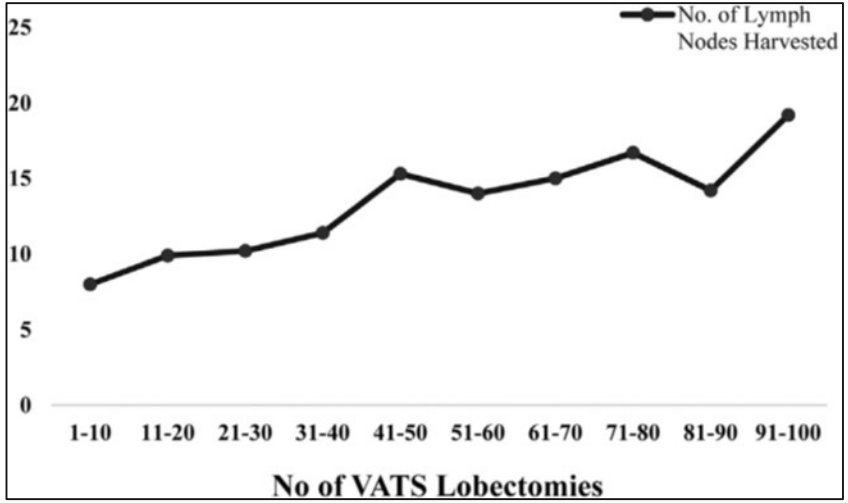
Licht, et al. Ann Thorac Surg 2013;96:943–50

Cornell VATS Reliability



Institutional

Individual

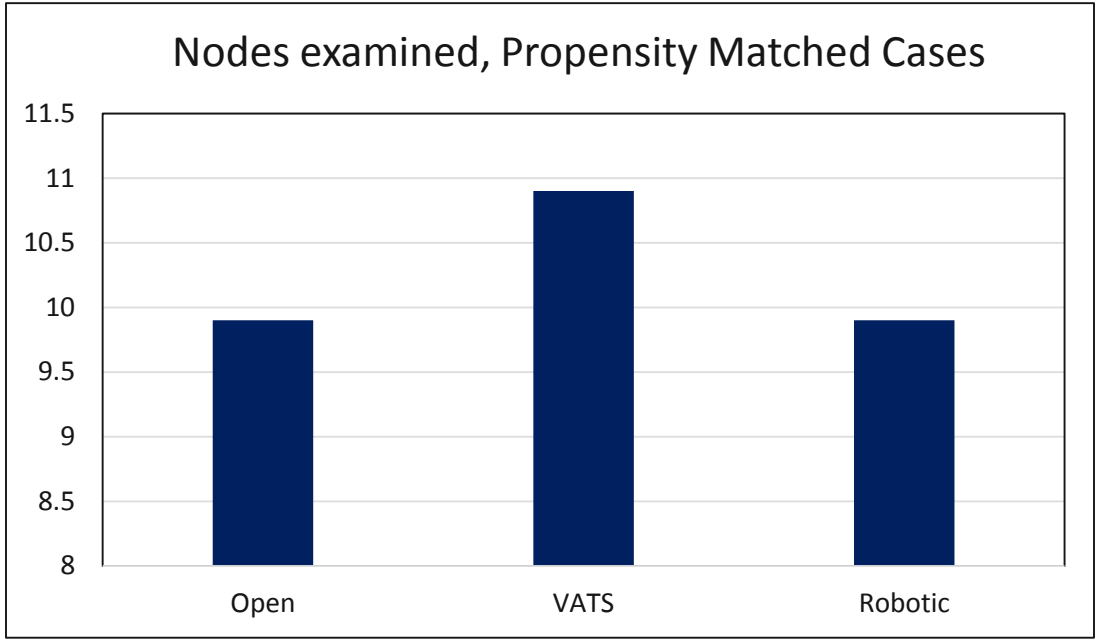


Lee, et al Ann Thorac Surg 2016;101:1116–22

62,206 Lobectomies Performed 2010 - 2012 NCDB Data - Stage I-IIIA, 1215 Hospitals

- More nodes for VATS than Open at academic centers in early stage

Medbery, et al. Journal of Thoracic Oncology (2016) Vol. 11 (2): 222-233



Rajaram, et al. Annals of Thoracic Surgery (2017), Vol. 103:1092-100

VOLUME 25 · NUMBER 31 · NOVEMBER 1 2007

JOURNAL OF CLINICAL ONCOLOGY

ORIGINAL REPORT

Video-Assisted Thoracic Surgery Lobectomy: Report of CALGB 39802—A Prospective, Multi-Institution Feasibility Study

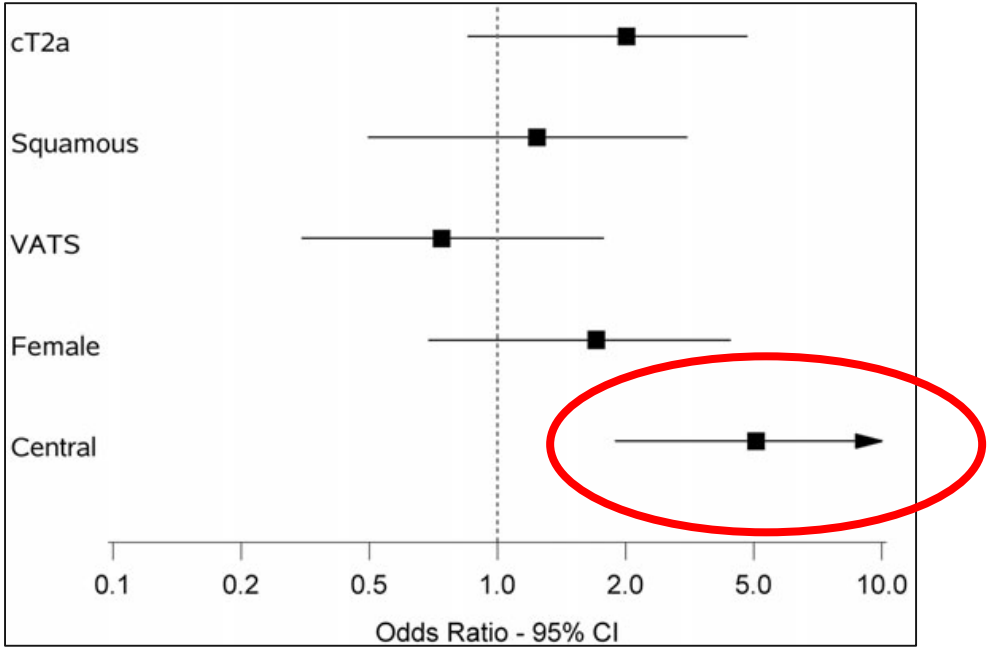
Scott J. Swanson, James E. Herndon II, Thomas A. D'Amico, Todd L. Demmy, Robert J. McKenna Jr, Mark R. Green, and David J. Sugarbaker

Between 1998 and 2001, 128 patients with peripheral lung nodules ≤ 3 cm

- 4-8 cm Access
- Pure Video Guidance
- Hilar Dissection
- No Rib Spreading

J Clin Oncol. 2007 Nov 1;25(31):4993-7

European Registry Data Nodal Upstaging



Decaluwé, et al, Eur J of Cardiothoracic Surgery 50(2016)110–117

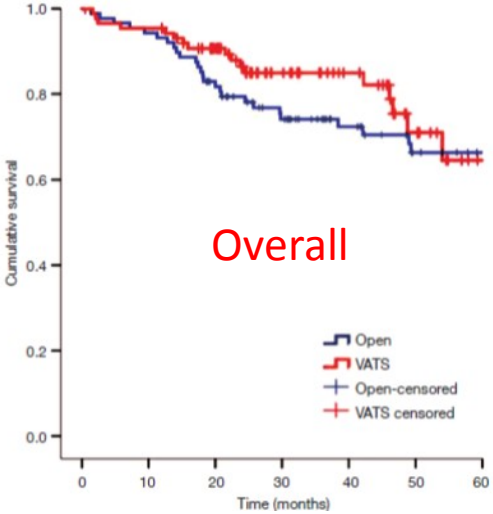
Summary – Node Question

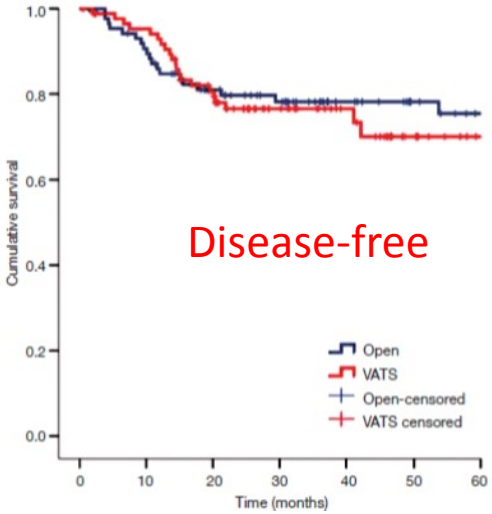
- Plausible mechanisms of VATS oncologic failure
  - Inadequate Nodal Dissection
  - Incomplete Resection of Primary
  - Tumor Dissemination
  - Missing local spread
  - Systemic Effects

- Centrality bias seems to be a more plausible for difference in upstaging seen by VATS in large series
- No strong signal in low or high nodal failure risk populations that inadequate nodal assessment would be a mechanism of VATS survival inferiority

Central Tumors

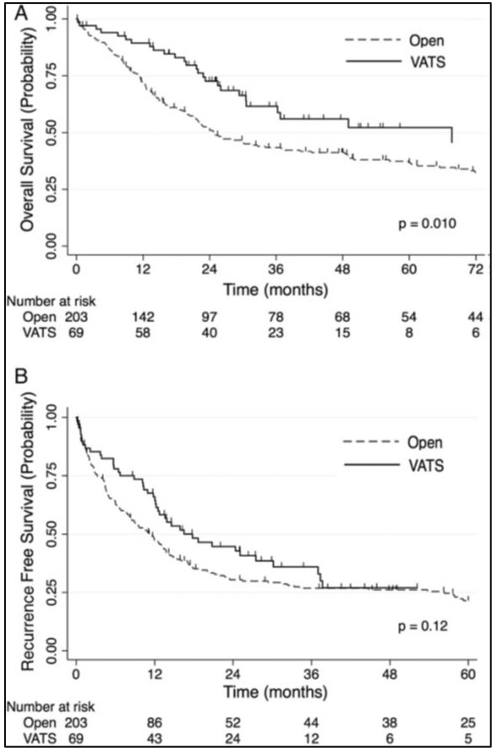
- Bronchial
- Direct tumor invasion
- cN1,N2
- 19% Conversion
- 88 Propensity Matched pairs

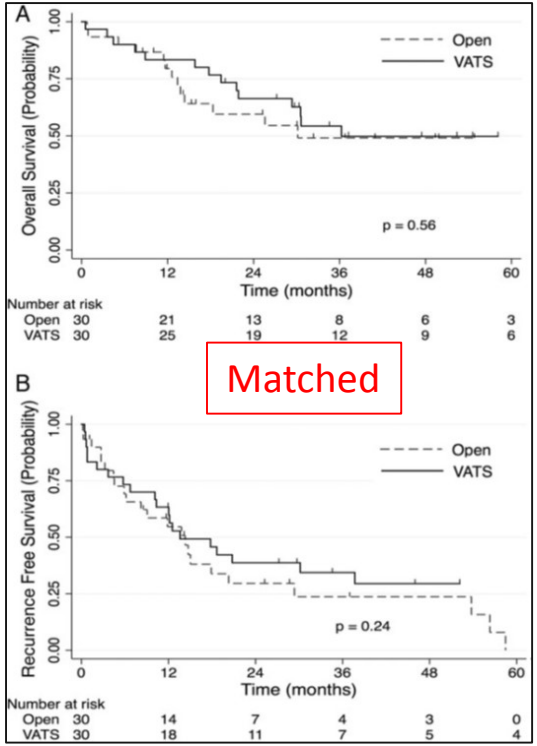




Jung et al, Journal of Thoracic Disease, Vol 7, No 10 October 2015

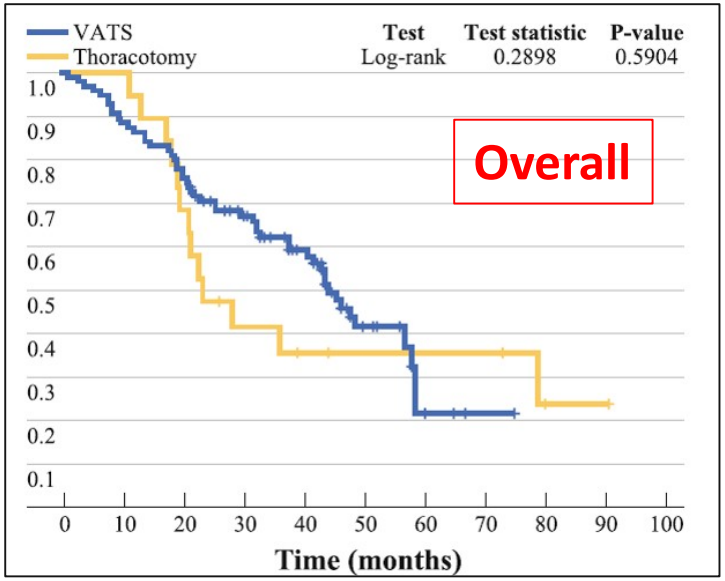
After Induction Therapy: Duke

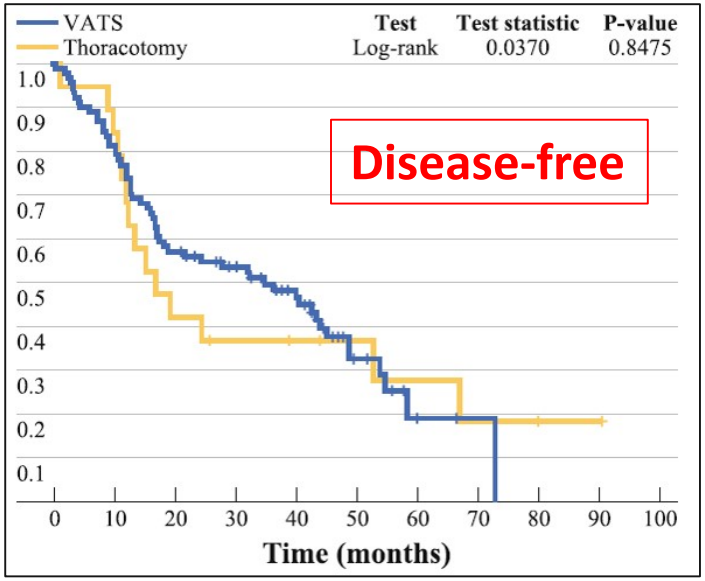




Yang,et al, Eur J CT Surg 49 (2016) 1615–1623

Advanced VATS Resections: Survival N = 125

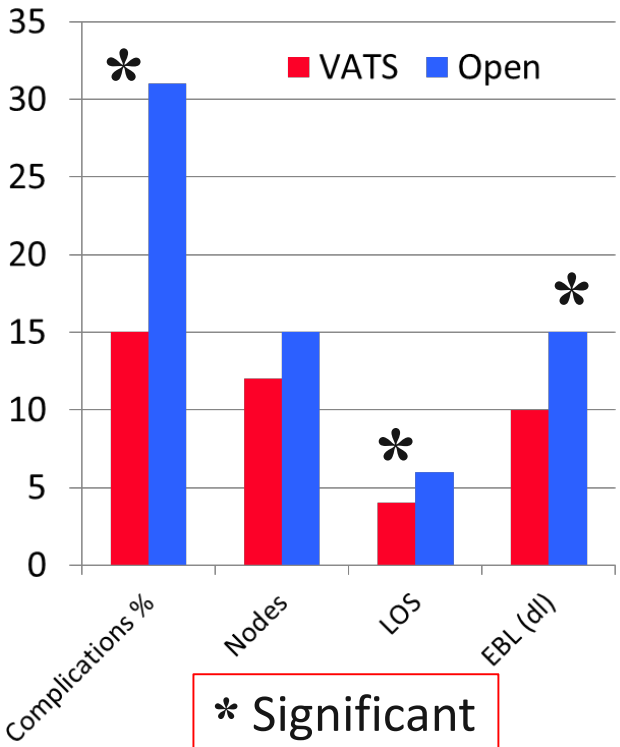




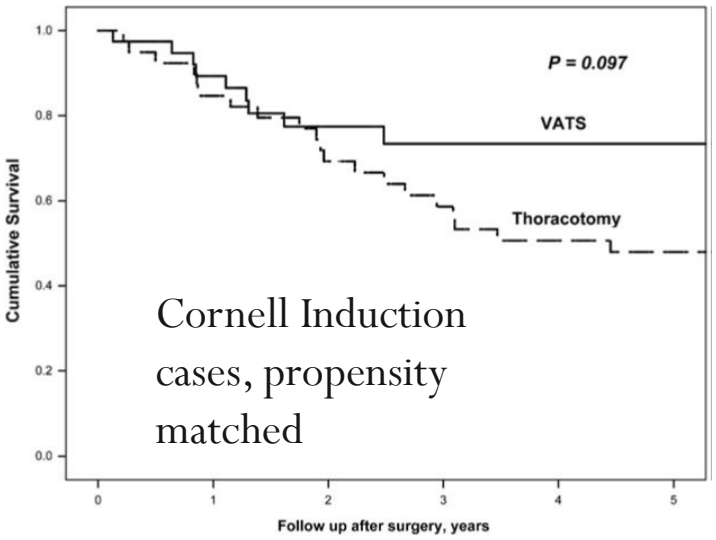
- Tumors ≥ 4cm
- Any T3 or T4 tumor
- Neoadjuvant chemotherapy

Hennon, Ann Surg Oncol (2011) 18:3732–3736

Advanced VATS Resections: Survival N = 125



* Significant



Disease-free Survival

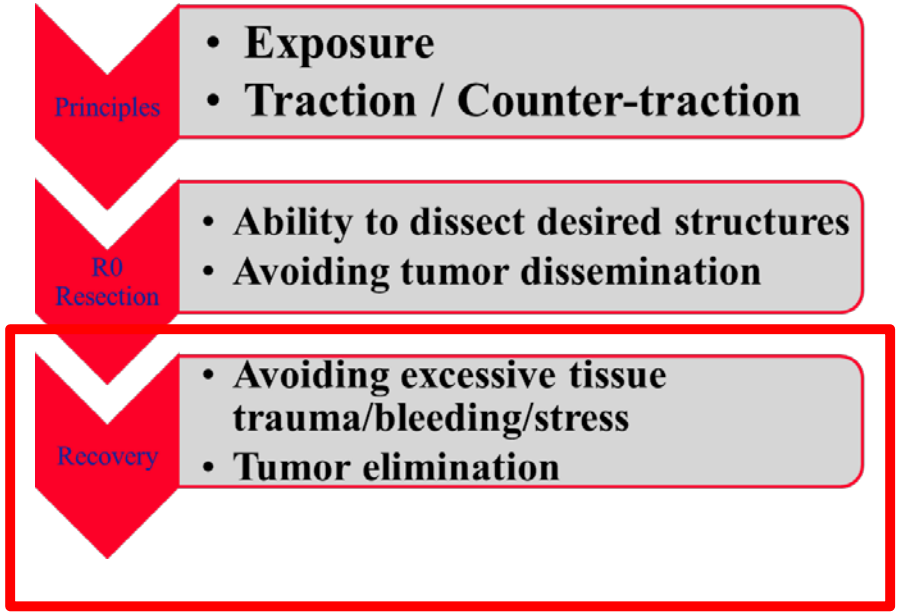
Kamel, et al, Journal Of Laparoendoscopic & Advanced Surgical Techniques, DOI: 10.1089/lap.2016.0540

Summary – Tumor

- Plausible mechanisms of VATS oncologic failure
  - Inadequate Nodal Dissection
  - Incomplete Resection of Primary
  - Tumor Dissemination
  - Missing local spread
  - Systemic Effects

- Despite taking on higher stage (T and N) tumors, centers are not reporting increased local recurrences or worse survivals by VATS
- This combined with lack of signal of impaired local control for early stage tumors reduces the plausibility of this mechanism

Systemic Effect Mechanisms

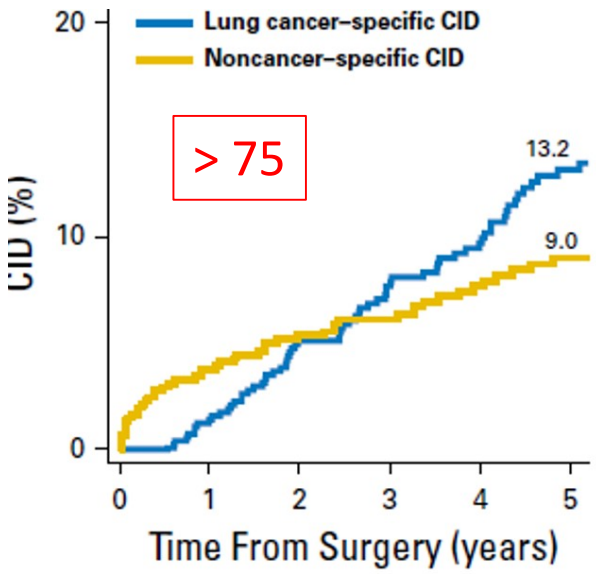


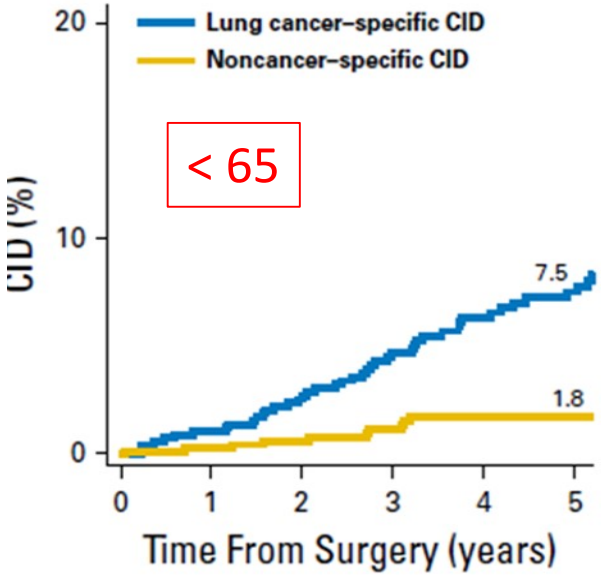
- <u>Negative mechanisms Open compared to VATS</u>
  - Pain
  - Bleeding
  - Cytokines
  - Accentuated in frail populations
- <u>Negative mechanisms VATS compared to Open</u>
  - Prolonged time under anesthesia

Special Populations Amplifying Salutary Effects of VATS

- Pulmonary Compromise
- Cardiac Dysfunction
- Extrathoracic Malignancy
- Poor Physical Performance
- Rheumatologic / Orthopaedic
- Advanced Age
- Vascular Problems
- Recent or Impending Major Operations
- Psychologic / Neurologic
- Immunosuppression / Impaired Wound Healing

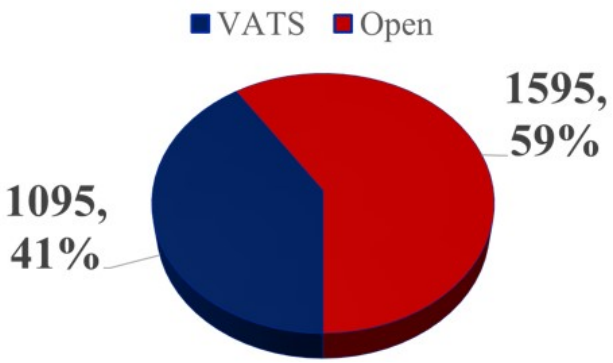
Cause-Specific Mortality and Morbidity in Stage I Lung Cancer by Age





Eguchi, et al, JCO 2017 Jan 20;35(3):281-290

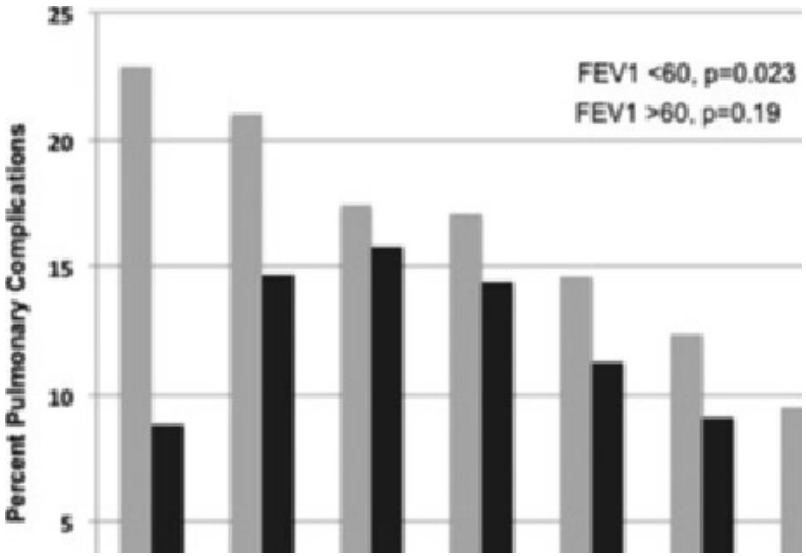
NSQIP Analysis 2005-2012: Mortality by Age Favoring VATS



Age Group	Odds Ratio	95% CI	*p* Value
65–69 years	2.72	1.00–9.46	0.039
70–74 years	4.41	1.28–23.42	0.008
75–80 years	1.60	0.50–5.95	0.450

Bravo-Iñiguez, et al , Ann Thorac Surg 2016;101:541–6

Better Outcome for Poor PFTs – STS



Ceppa, et al, Ann Surg 2012;256: 487–493

"Excisional surgery for cancer cure: therapy at a cost,"

- Coffey, et al, Lancet Oncology, 2003

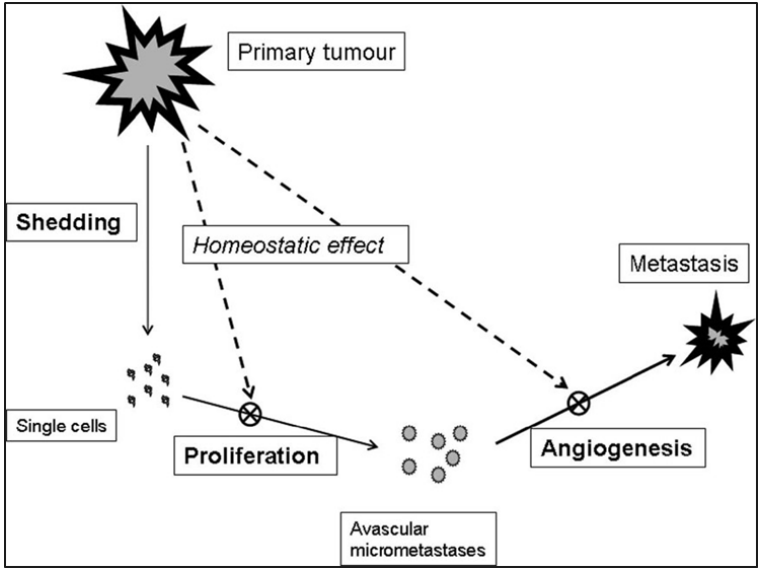
- Circulating tumor cells
- LPS
- Inflammatory cytokines
- Immunosuppression
- Opioids
- Transfusion

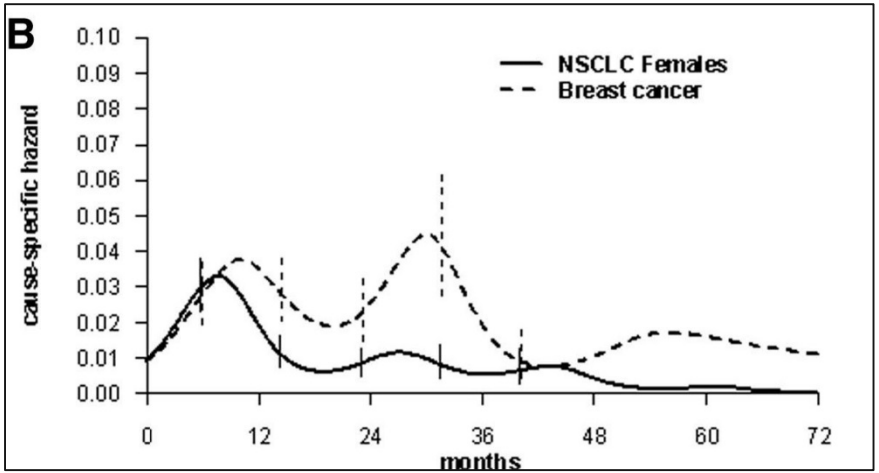
+

Minimal Residual Disease

- Accelerated systemic/local recurrence

Recurrence Dynamics

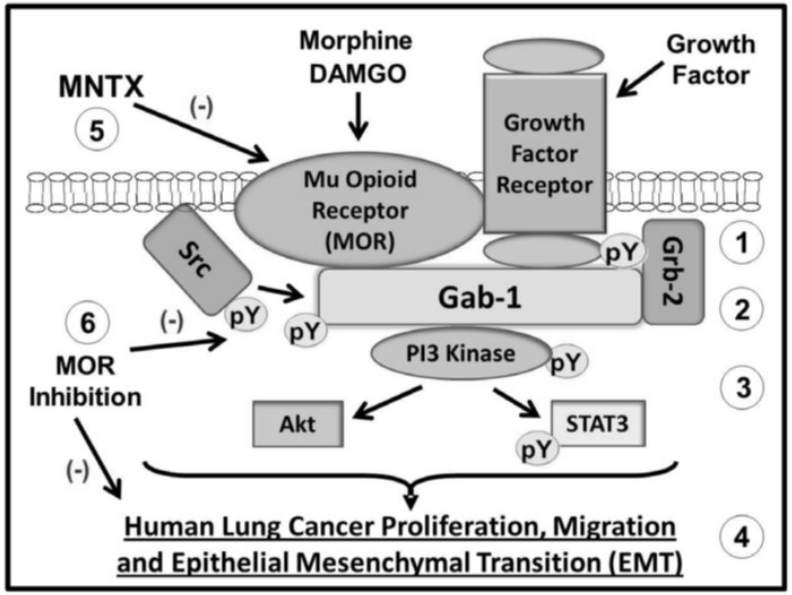


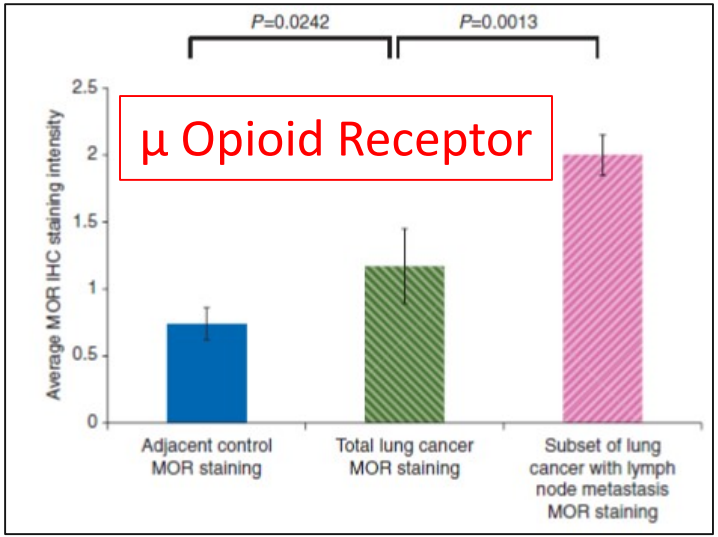


"Air Got to the Tumor"

Demicheli, J Thorac Oncol. 2012;7: 723–730

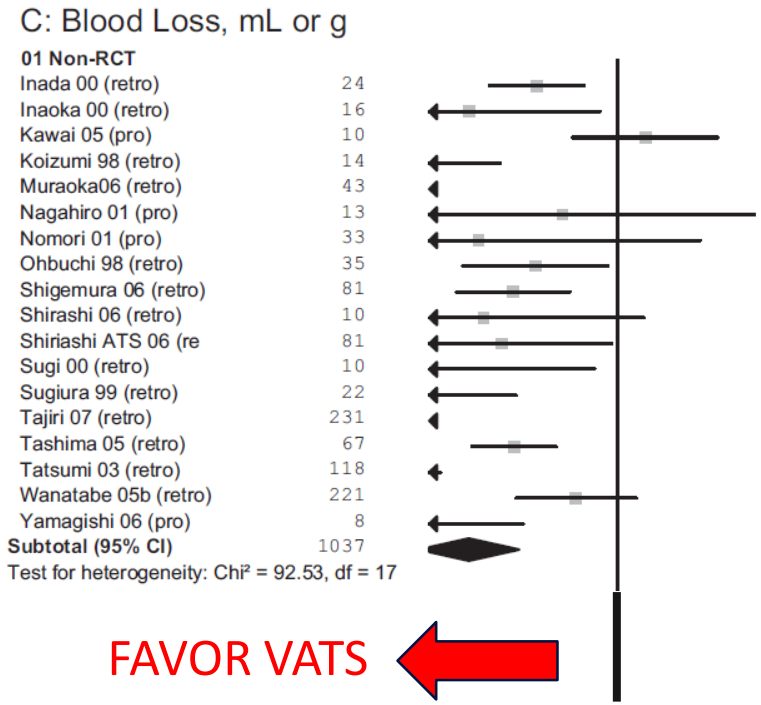
Opioid and Cancer





Lennon, et al, PLoS One. 2014 Mar 24;9(3):e91577
Singleton, et al, Br J Anaesth. 2014 Jul;113 Suppl 1:i103-8

Bad Blood



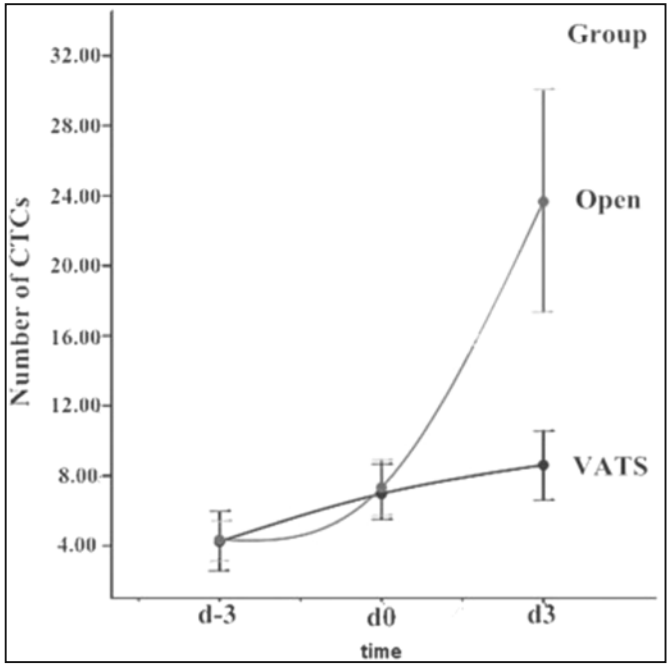
Cheng, Innovations 2007;2: 261–292

Cornell, N=551 VATS Lobectomy

- EBL 250cc (HR: 1.65, 95%CI: 1.04-2.61) independently predicted poor DFS
- EBL was the only modifiable predictor of poor DFS

Rahouma M, et al, J Thorac Oncol. 2016, Nov;11(11S):S297

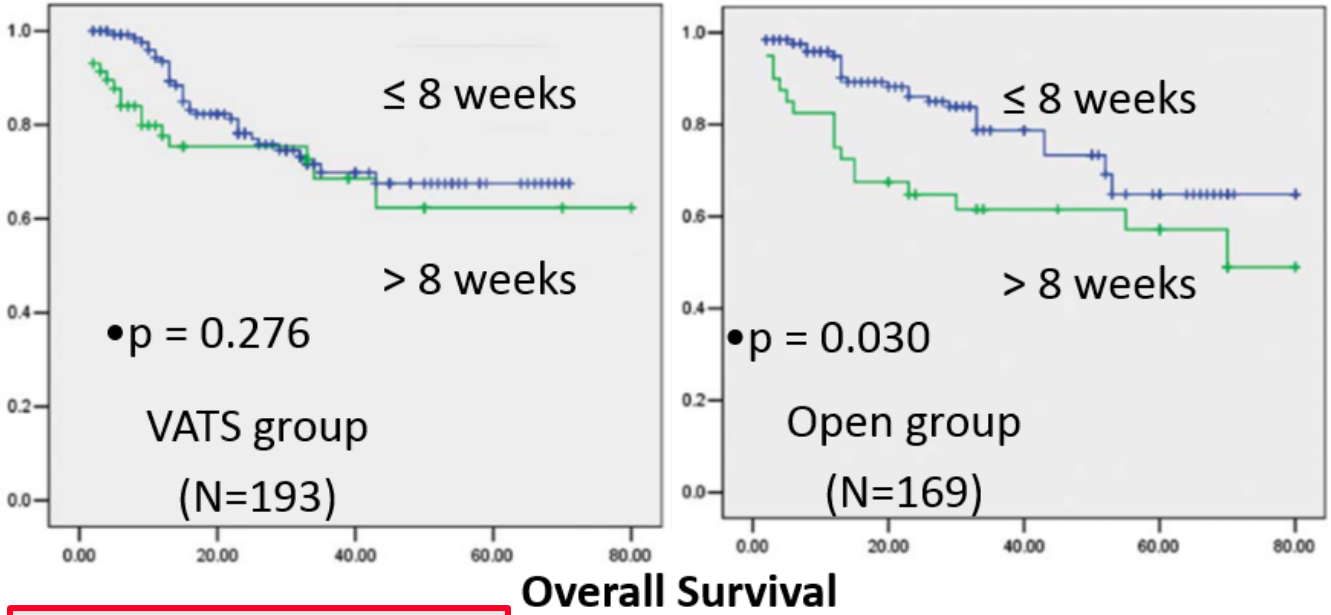
Circulating Tumor Cells



The increase in number of CTCs		
Group	d-3 to d0	d-3 to d3
VATS ($n = 43$)	1.363 ± 2.924	2.181 ± 2.962
Open ($n = 36$)	1.500 ± 2.315	9.666 ± 15.641
t	−0.204	−2.698
p	0.329	0.015

Huang, et al, Thorac Cardiovasc Surg 2016;64:515–519

Delay of Adjuvant Chemotherapy *Path Stage II* or *IIIA NSCLC*



- ***No difference in time to initiation.***

DFS curves similar

Jing, et al. JBUON 2016; 21(6): 1524-1529

Conclusions - 1

- VATS lobectomy has accrued more evidence of oncologic safety than previous approach enhancements accepted by our profession, e.g. Axillary thoracotomy
- Evidence for adoption for this “new” technology is on par used by related specialties such radiation oncology to adopt similar enhancements to their therapies

Conclusions - 2

- Greatest oncologic concern has been in VATS nodal assessment, although this is attributable to early central tumor avoidance the signal has been weak as it pertains to survival
- “Stress testing” plausible mechanisms in patients high risk for failures have not yet generated concerns

Conclusions - 3

- A large proportion of the lung cancer population is older or otherwise frail and it is this group that has higher risk of non-oncologic mortality
- For this group there is a strong signal that VATS is superior largely due to the reduction in complications and mortality.

Conclusions - 4

- Reductions in blood loss, long-term pain, and mediators known to affect tumor dynamics and host immune function are plausible mechanisms that favor less invasive operations
- It is reasonable to accept VATS lobectomy as a generally equivalent oncologic operation and preferable for frail patients until there is evidence to the contrary

Technique of VATS and Robotic Lobectomy

Mark Onaitis, MD

General Thoracic Surgery
University of California, San Diego

Disclosures

- None

VATS/Minimally-invasive Definition

- Absence of rib spreading
- Visualization by camera

Importance of Minimally-invasive Resection

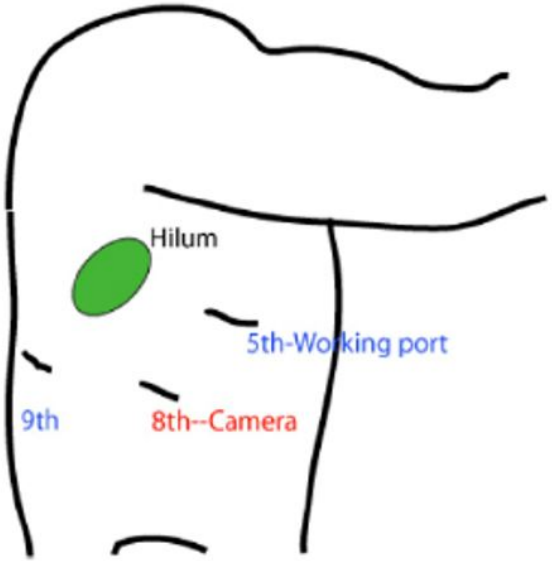
- Less pain
- Decreased LOS
- Earlier return to work
- Better tolerance of adjuvant therapy

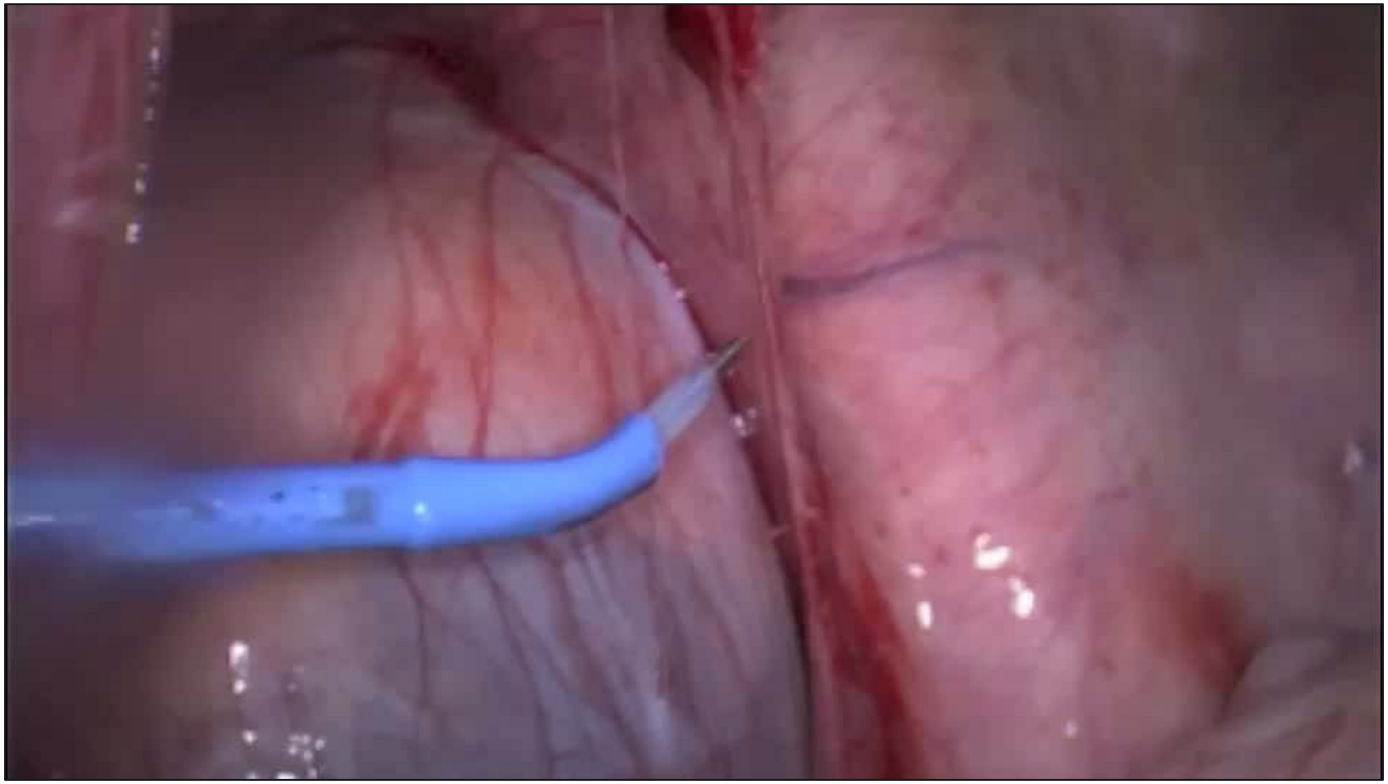
Thoracoscopic (VATS) Lobectomy

- Adoption is less than 50% nationally
  - SEER Database: 8%
  - STS Database: 30-40%
  - Surveys: 50% of recent trainees
- Reasons are multiple
  - Discomfort with bleeding risk
  - Dissatisfaction with lymph node harvest
  - Learning curve, time to complete operation

VATS Pro/Con

- VATS strengths
  - Flexibility
  - Proximity of surgeon to patient
  - Possibly (probably) cheaper
- VATS weaknesses
  - Reliance on help
  - 2D camera/monitors
  - Difficulty of LN dissection?



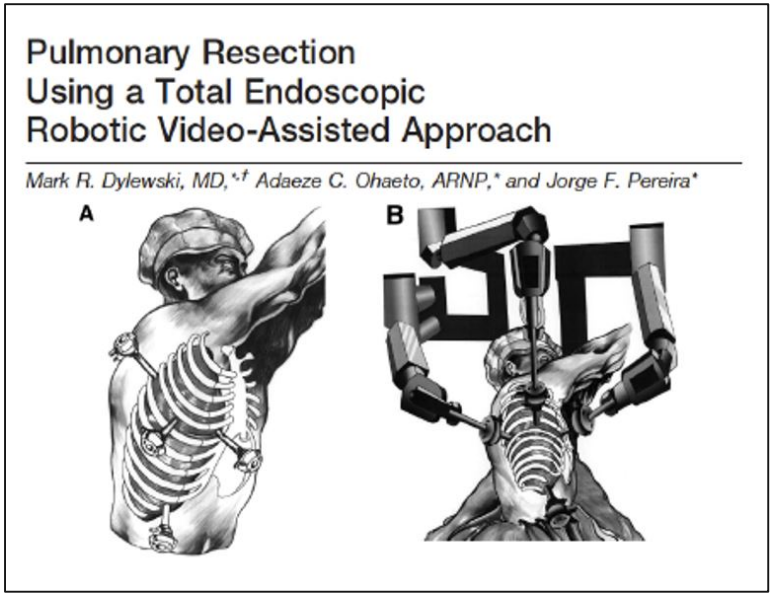


Robot Pro/Con

- Robotic strengths
  - 3D camera with 10x magnification
  - Wristed instruments
- Robotic weaknesses
  - Inflexibility
  - No haptic feedback
  - Reliance on help

Dylewski et al. *Semin Thoracic Surg* 2011. 23:36-42.

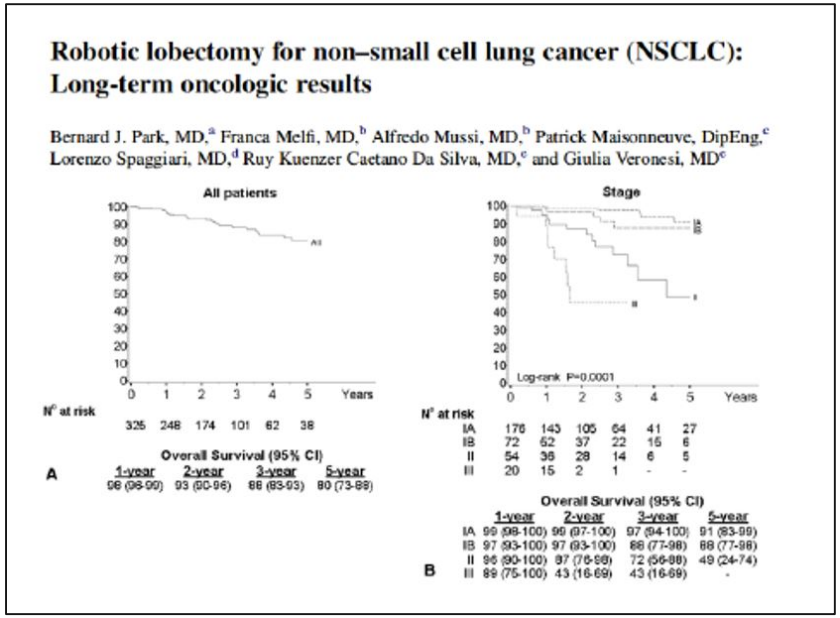
- 200 consecutive lobectomies
- Median operative times 90 minutes
- 3 conversions
- Median LOS 3d


Pulmonary Resection
Using a Total Endoscopic
Robotic Video-Assisted Approach

Mark R. Dylewski, MD,[*,†] Adaeze C. Ohaeto, ARNP,[*] and Jorge F. Pereira[*]

Park et al. *JTCVS* 2012. 143:383-9.

- 325 lobectomies at three institutions with eight conversions
- Median chest tube duration 3d [1,23]
- 1 perioperative mortality (0.3%)

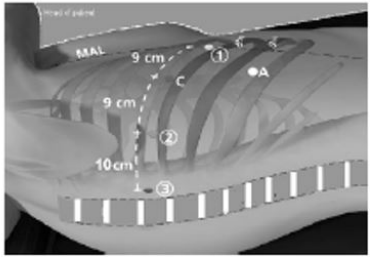


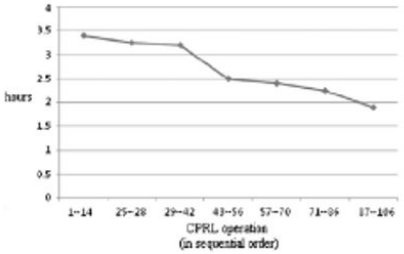
Cerfolio et al. *JTCVS* 2012. 143:383-9.

- 168 consecutive attempted robotic cases (106 successful 4-arm lobectomies)
- Median chest tube duration 1.5d [1,6]
- Median hospital stay 2d [1,7]
- Median no. of N1 nodes resected [5 (4 in 3:1 matched thoracotomy group)]
- 13 conversions (1 in last 106)

Initial consecutive experience of completely portal robotic pulmonary resection with 4 arms

Robert J. Cerfolio, MD, FACS, FCCP, Ayesha S. Bryant, MD, MSPH, Loki Skylizard, MD, and Douglas James Minnich, MD, FACS





Comparison of Video-Assisted Thoracoscopic Surgery and Robotic Approaches for Clinical Stage I and Stage II Non-Small Cell Lung Cancer Using The Society of Thoracic Surgeons Database

Brian E. Louie, MD, Jennifer L. Wilson, MD, Sunghee Kim, PhD, Robert J. Cerfolio, MD, Bernard J. Park, MD, Alexander S. Farivar, MD, Eric Vallières, MD, Ralph W. Aye, MD, William R. Burfeind, Jr, MD, and Mark I. Block, MD

(Ann Thorac Surg 2016;102:917–24)

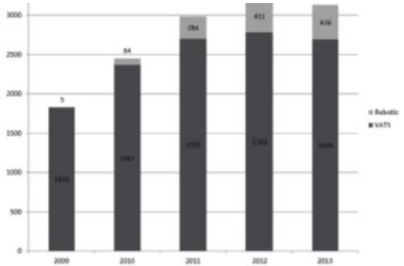


Fig 1. Case volume by surgical approach. (VATS = video-assisted thoracoscopic surgery.)

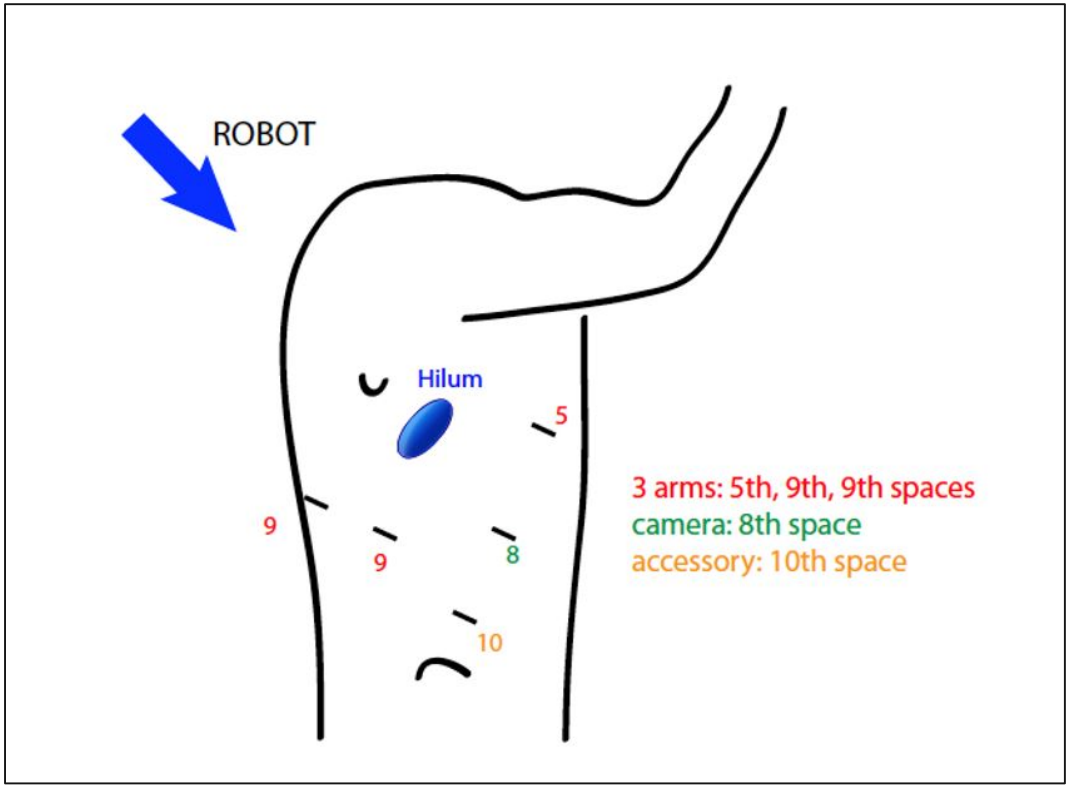
Table 4. Pathologic Nodal Upstaging Overall and Stratified by Clinical Staging

	Proportion of Cases Upstaged to pN1 (Number Upstaged/Total Cases [%])			
Clinical Stage	Overall	Robotic Treatment	VATS	*p* Value
cT1aN0	322/5,412 (5.95)	29/471 (6.16)	293/4,941 (5.93)	0.8422
cT1bN0	257/3,008 (8.54)	19/293 (6.48)	238/2,715 (8.77)	0.1844
cT2aN0	254/2,307 (11.01)	34/244 (13.93)	220/2,063 (10.66)	0.1228
cT2bN0	69/546 (12.64)	7/47 (14.89)	62/499 (12.42)	0.6263
Total	902/11,273 (8.00)	89/1,055 (8.44)	813/10,218 (7.96)	0.5847

VATS = video-assisted thoracoscopic surgery.

- 13,598 patients: No differences in morbidity/mortality
- Robotic lobes had significantly longer OR time

Incisions


ROBOT
Hilum
5
9
9
8
10
3 arms: 5th, 9th, 9th spaces
camera: 8th space
accessory: 10th space


1
2
LASER OFF
1x 30°
3
4

Cost, Effectiveness, Cost-effectiveness?

- Calculating cost of robotic lobectomy is difficult
  - There is no way that the robot is cheaper than VATS
  - If robotic technique can bring a surgeon from open to minimally-invasive lobectomy, there will be cost savings
  - Marketing is intimately related to cost
- Potential effectiveness benefits
  - Better lymph node dissection?
  - Less pain?
  - Fewer conversions?
  - Better teaching (dual console, simulation)

Learning Minimally Invasive Lobectomy

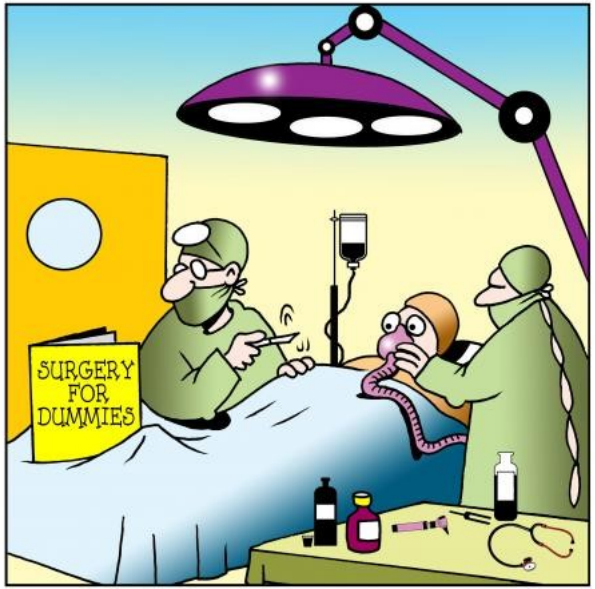
Shari L. Meyerson, M.D.

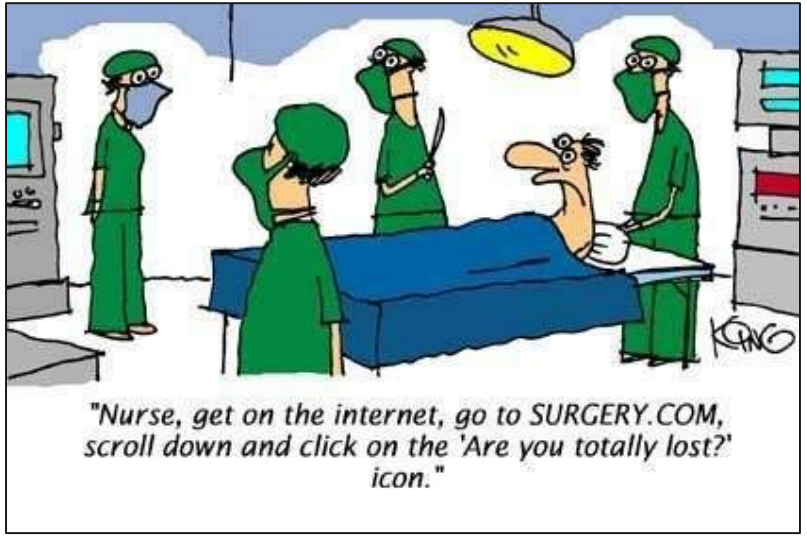
Associate Professor of Surgery
Northwestern University

Disclosures

- None

Learning in Practice

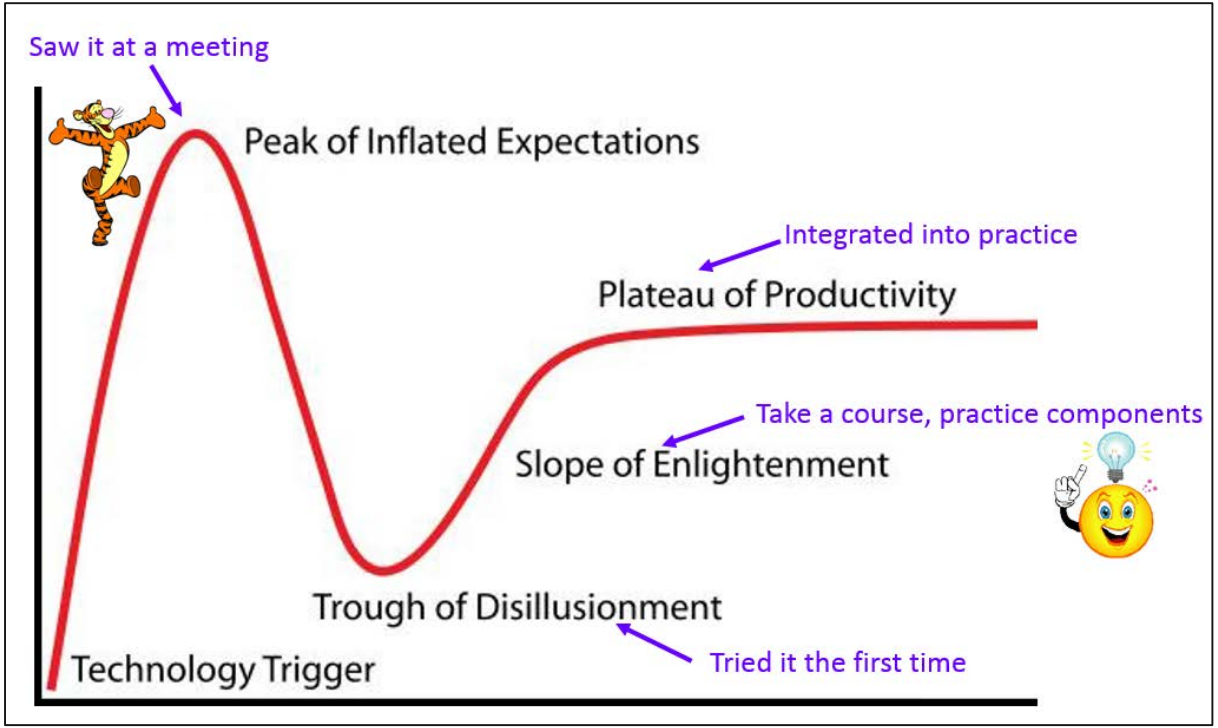




Procedures Developed/Popularized Since I Graduated

- VATS Lobectomy
- Robotic Thymectomy
- Per-Oral Endoscopic Myotomy (POEM)
- Endobronchial Ultrasound

Incorporating New Technology Into Practice



http://www.gartner.com/technology/research/methodologies/hype-cycle.jsp

So, What if I Want to learn:

- VATS Lobectomy

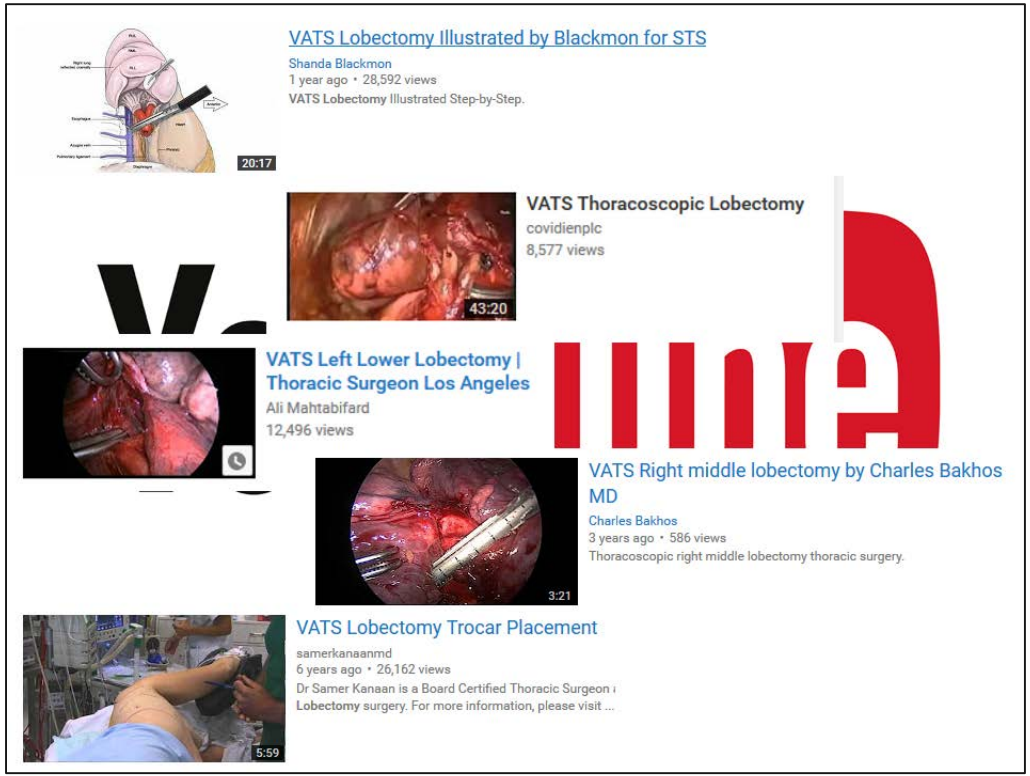
Learning Framework

- What background information do I need to learn?
- What components of this procedure are new skills for me?
- What simulators exist to help me learn?
- Should I take a formal course?

Step 1 - Homework

- What background information do I need to learn?
- What components of this procedure are new skills for me?

YouTube


VATS Lobectomy Illustrated by Blackmon for STS
Shanda Blackmon
1 year ago • 28,592 views
VATS Lobectomy Illustrated Step-by-Step.
20:17
VATS Thoracoscopic Lobectomy
covidienplc
8,577 views
43:20
VATS Left Lower Lobectomy | Thoracic Surgeon Los Angeles
Ali Mahtabifard
12,496 views
VATS Right middle lobectomy by Charles Bakhos MD
Charles Bakhos
3 years ago • 586 views
Thoracoscopic right middle lobectomy thoracic surgery.
3:21
VATS Lobectomy Trocar Placement
samerkanaanmd
6 years ago • 26,162 views
Dr Samer Kanaan is a Board Certified Thoracic Surgeon
Lobectomy surgery. For more information, please visit ...
5:59

- Different view of the anatomy
- Unfamiliar instruments
- Done from the hilum up rather than the fissure down

Write out the steps of the operation

List instruments used (do you know/have them)

Next time you're doing a VATS wedge or decort, try to reproduce the retraction, look at the hilum

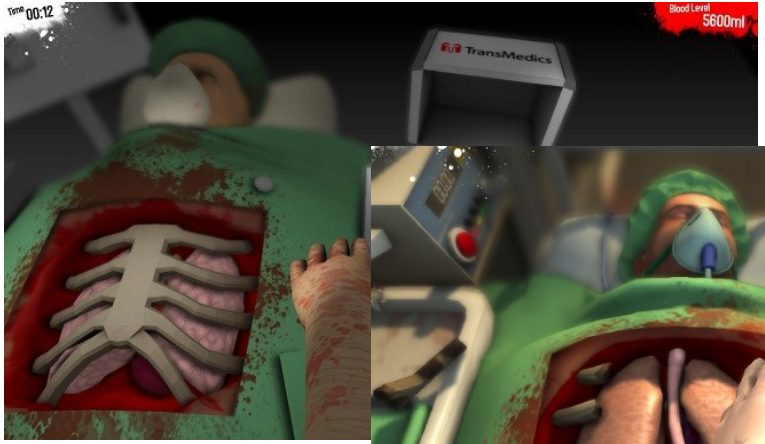
Choosing a Simulator

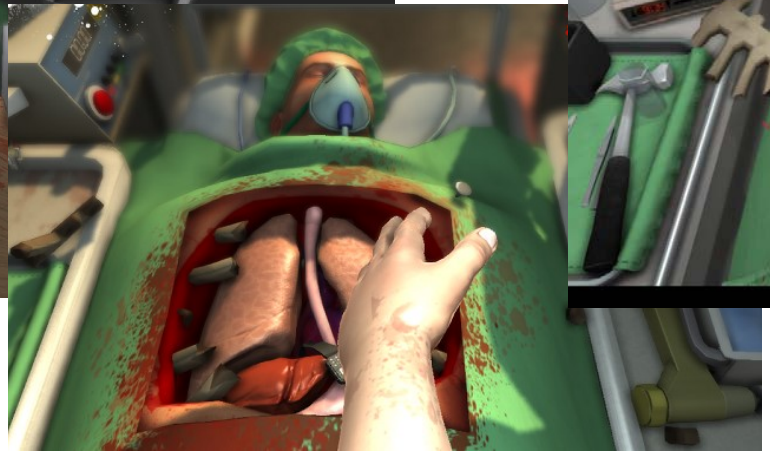
Low Fidelity ⟷ High Fidelity

Component Task ⟷ Full Operation

Tissue-Based ⟷ Inanimate or VR

One Shot ⟷ Reusable





http://www.surgeonsim.com/

Step 2 - Practice

SHORT COMMUNICATION

Off-the-job training for VATS employing anatomically correct lung models

NEW TECHNOLOGY

An Inexpensive, Reproducible Tissue Simulator for Teaching Thoracoscopic Lobectomy

Shari L. Meyerson, MD, Frank LoCascio, BA, Stafford Scott Balderson, PA-C, and Thomas A. D'Amico, MD

Department of Surgery, Section of Cardiovascular and Thoracic Surgery, University of Arizona, Tucson, Arizona; Department of Surgery, Section of Thoracic Surgery, Duke University Medical Center, Durham, North Carolina

A new possibility in thoracoscopic virtual reality simulation training: development and testing of a novel virtual reality simulator for video-assisted thoracoscopic surgery lobectomy

Katrine Jensen[a,b,*], Flemming Bjerrum[c], Henrik Jessen Hansen[a], René Horsleben Petersen[a], Jesper Holst Pedersen[a] and Lars Konge[b]

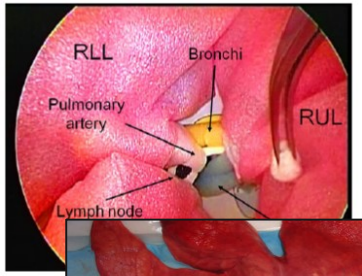


Fig. 1 Thor
model. The
middle lobe.

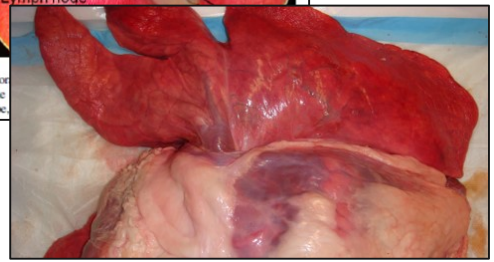
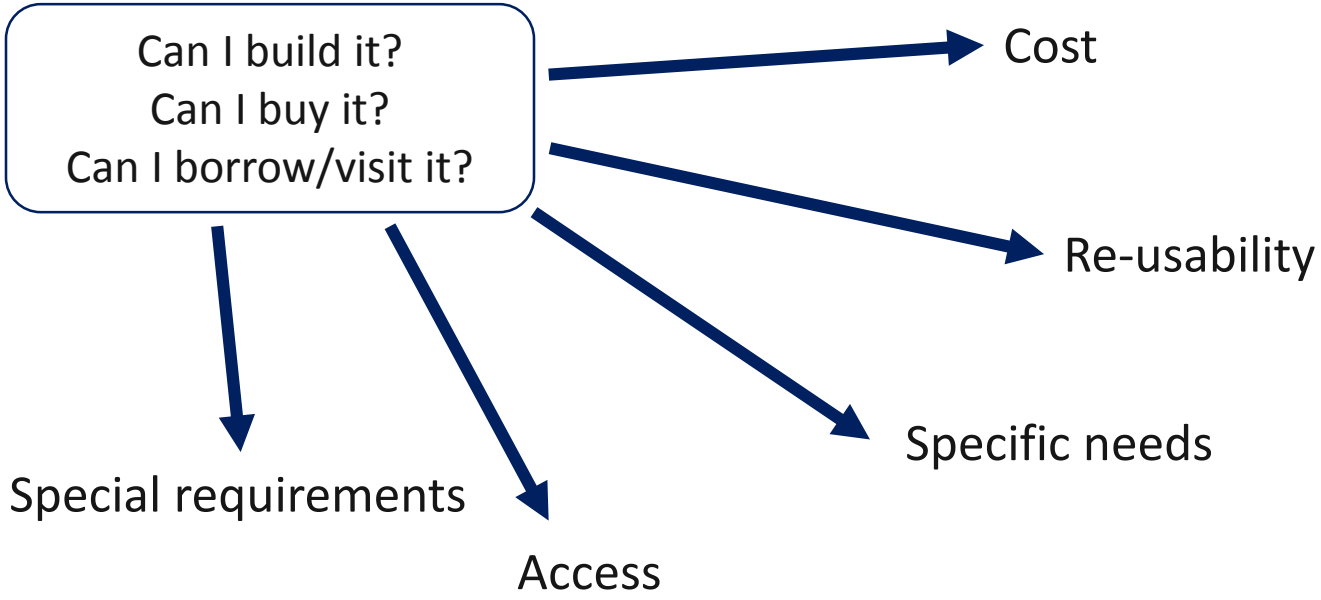


Figure 2: Thoracoscopic forceps behind the artery for the right upper lobe.

- What simulators exist to help me learn?

Trehan K, Kemp CD, Yang SC. JTCVS 2014; 147

Learning in Practice



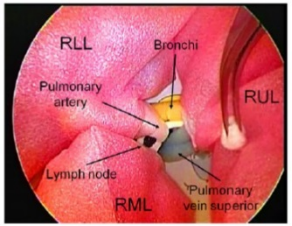
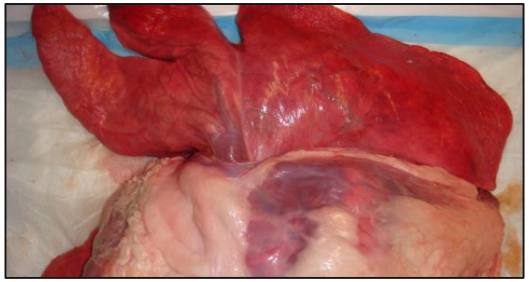


Fig. 1 Thoracoscopic view of the right anatomically correct lung model. The head is to the *right*. *RUL* right upper lobe, *RML* right middle lobe, *RLL* right lower lobe

- Must be bought (cost?)
- Good for learning anatomy/steps
- Not reusable (need more inserts)
- Just put it in a lap trainer

Obuchi T, et al. Surg Today 2012; 42



- Can be built (instructions in paper)
- Good for tissue feel/dissection
- Not reusable (need more inserts)
- Just put it in a lap trainer
- Animal tissue (may need facility)

Meyerson SL, et al. Ann Thorac Surg 2010; 89

Figure 2: Thoracoscopic forceps behind the artery for the right upper lobe.

- Requires VR platform (cost/access?)
- Good for learning anatomy/steps
- Reusable, multiple practices

Jensen K, et al. Interact Cardiovasc Thorac Surg 2015; 21

Step 3 – Try It in a Patient

- Should I take a formal course?
  - If you are not familiar with the equipment - YES
  - If you can’t get access to simulation - YES
  - If you have a friend/local surgeon who can help/proctor – maybe/maybe not

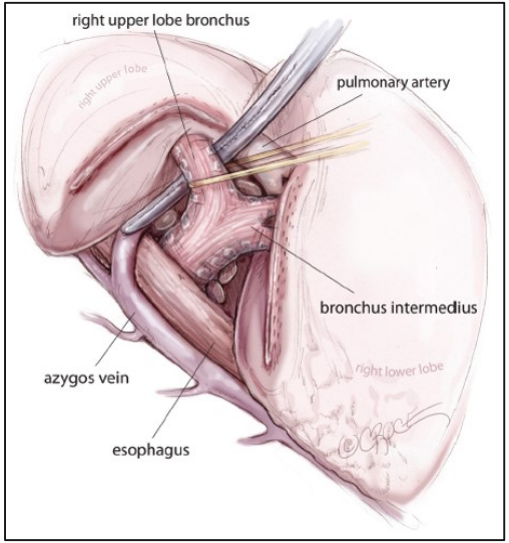
Translation of Skills

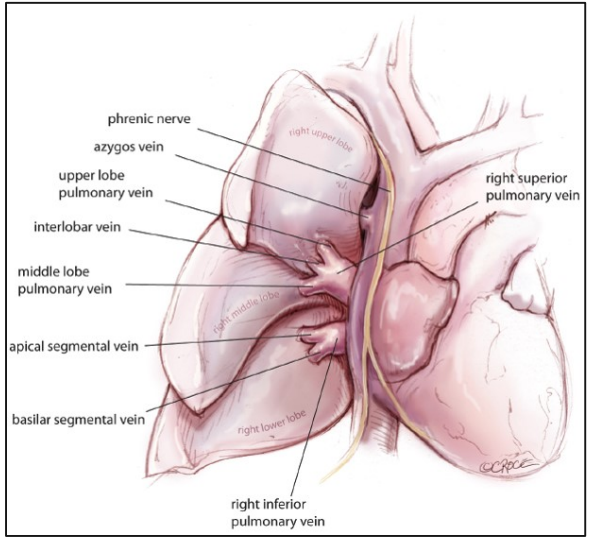
WELCOME TO THE REAL WORLD

- Tissue quality
- Angles of access/incisions
- Time
- Variations in anatomy
- Force required
- Effects of pathology/tumor size

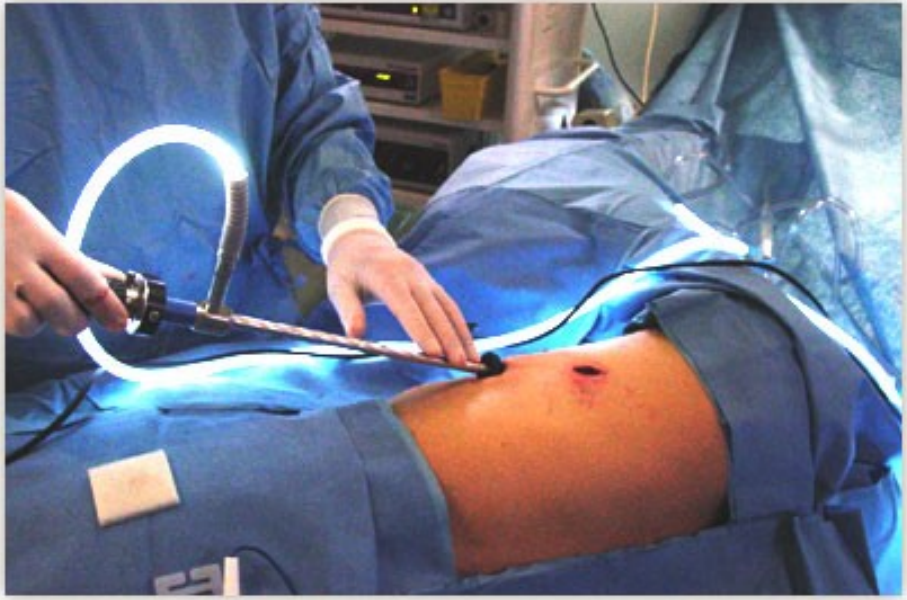
Start with Angle of Approach

- Anterior to posterior rather than down through fissure

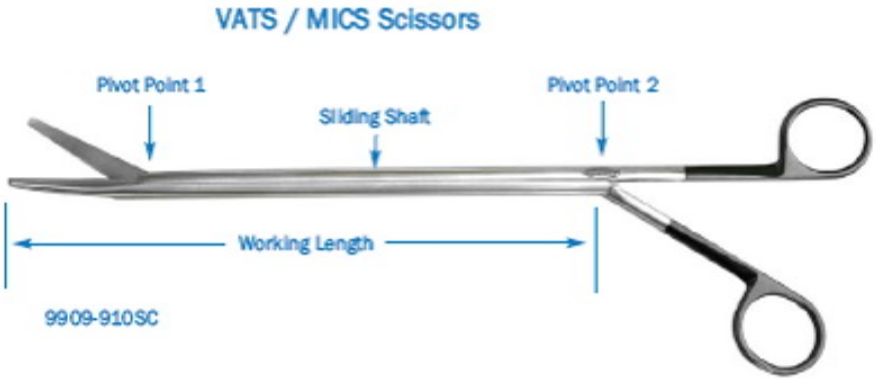




Get Used To the Thoracoscopic View



Get Used To New Instruments



Shrink Incision and Move Anteriorly

Phone a Friend

So, What If instead I Want to Learn:

- Robotic Lobectomy

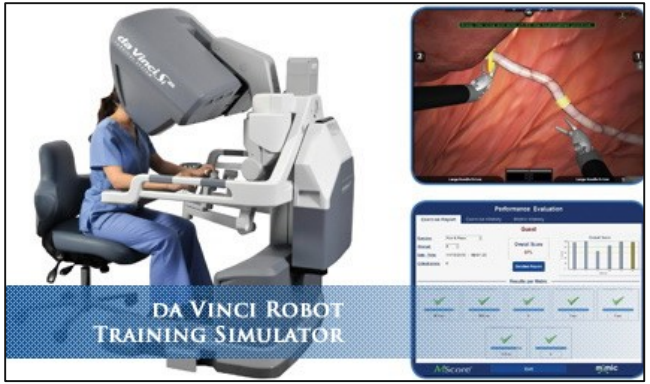
Step 1 - Homework

- What background information do I need to learn?
  - Same as VATS lobectomy
- What components of this procedure are new skills for me?
  - Totally new platform/instruments

Step 2 - Practice

- What simulators exist to help me learn?

- Due to technology there are limited simulator options



- Find an academic center or talk to your rep. If hospital purchasing a robot make sure simulator module included

Step 2 - Practice

- What simulators exist to help me learn?

- Limited options – You can't build this at home

Liss ML, McDougall EM. Cancer J 2013; 19

Step 3 – Try It in a Patient

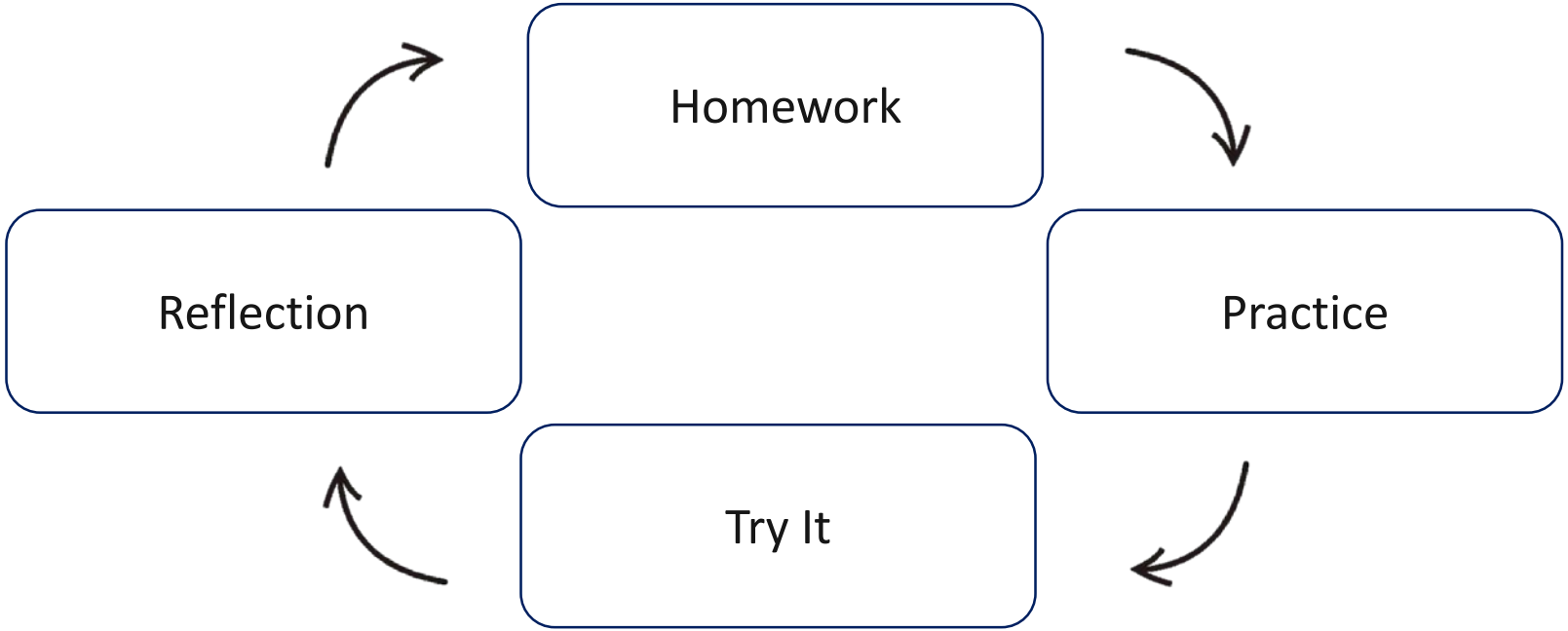
- Should I take a formal course?
  - Absolutely!!!!

- Unfamiliar platform = need help learning
- Utilize company to identify training options and proctor

Tips for Success

- Be honest about your abilities
- Start slowly, one component at a time
- Converting to open means intelligence not failure
- Retake a course if you are struggling

Learning through Simulation



Questions

Please direct questions, comments and feedback to Sydney Clinton, STS Quality Metrics & Initiatives Coordinator, at sclinton@sts.org.

Thank you for viewing the

Lobectomy for Lung Cancer Webinar

Please note that webinar slides and other materials are posted on the STS website