Robotic Revascularization: When and How?

Robert Poston, MD

Department of Surgery

University of Arizona
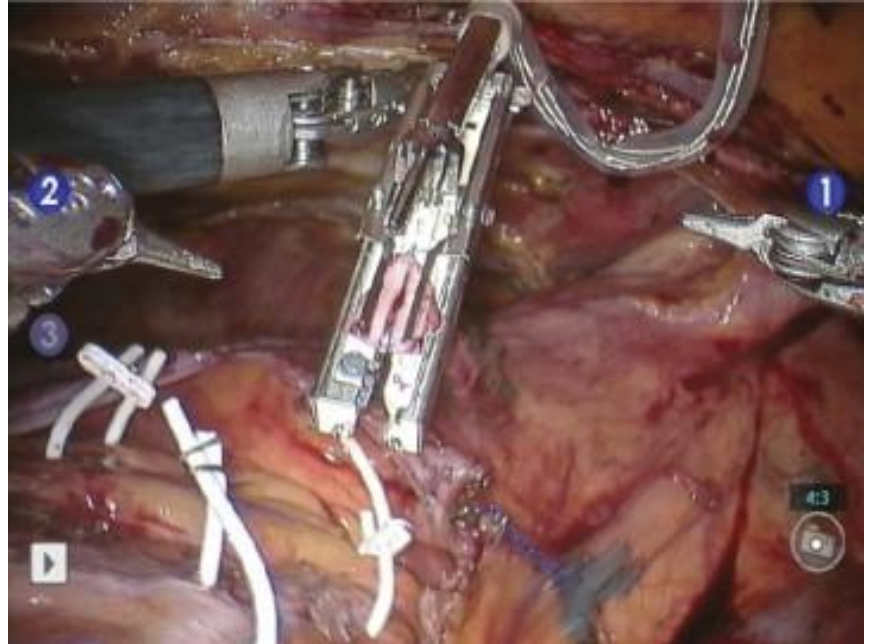
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Disclosure Statement of Financial Interest

I have no conflict of interest related to this presentation.

Minithoracotomy

Totally endoscopic (TECAB)

Robotics in Cardiac Surgery

1400 *da Vinci*® robots

500 surgeons trained

14 active robotic programs[1]

● Active robotic CT programs
   (>50 cases/yr)
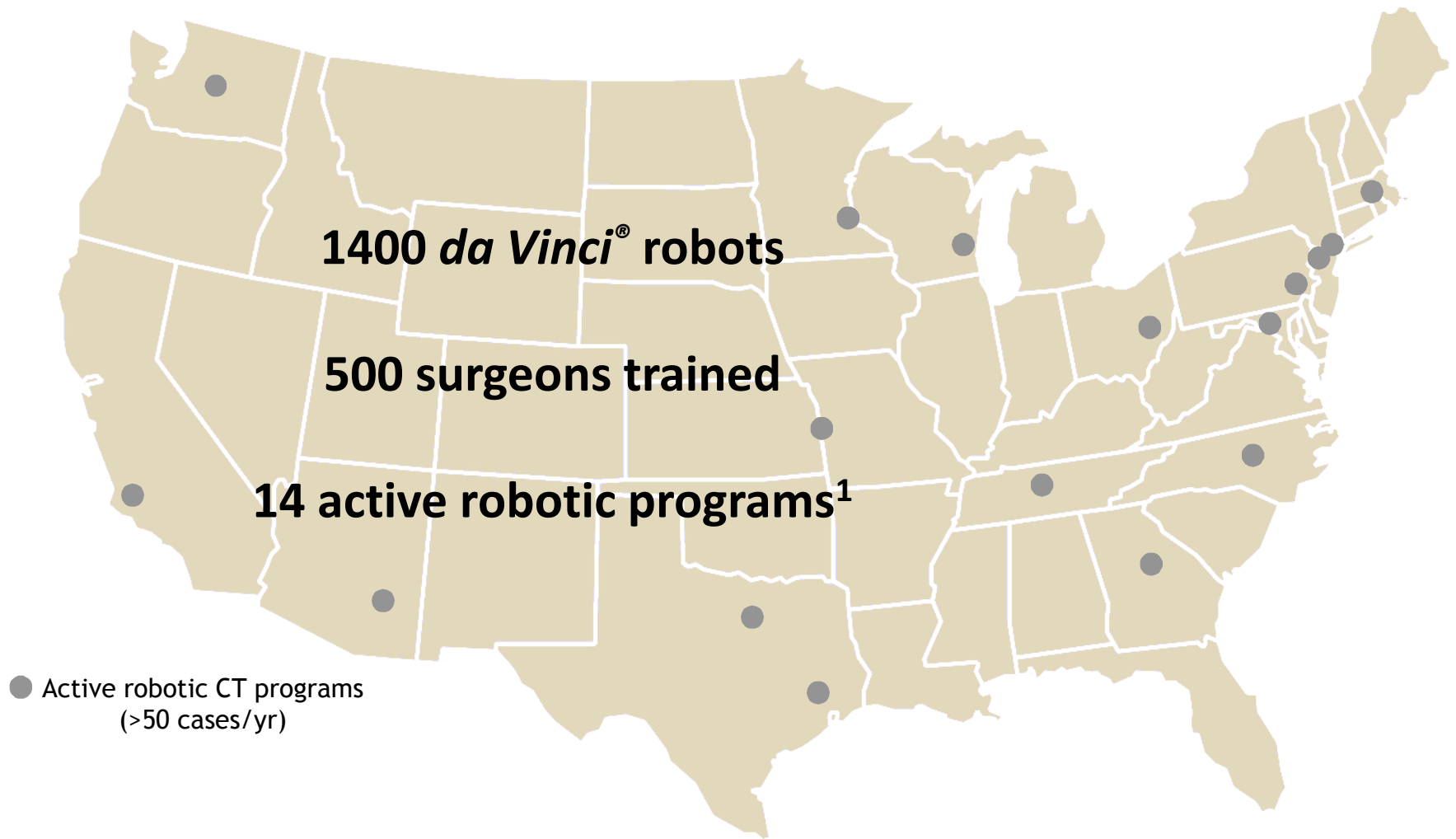
1. Poston, et al., ISMICS abstract presentation, 2013

Variables that influence robotic CABG

- Challenging learning curve
- Technically complex
- Long OR times
- Safety concerns
- Increase hospital revenue
- Cost effectiveness
- Acceptance among stakeholders
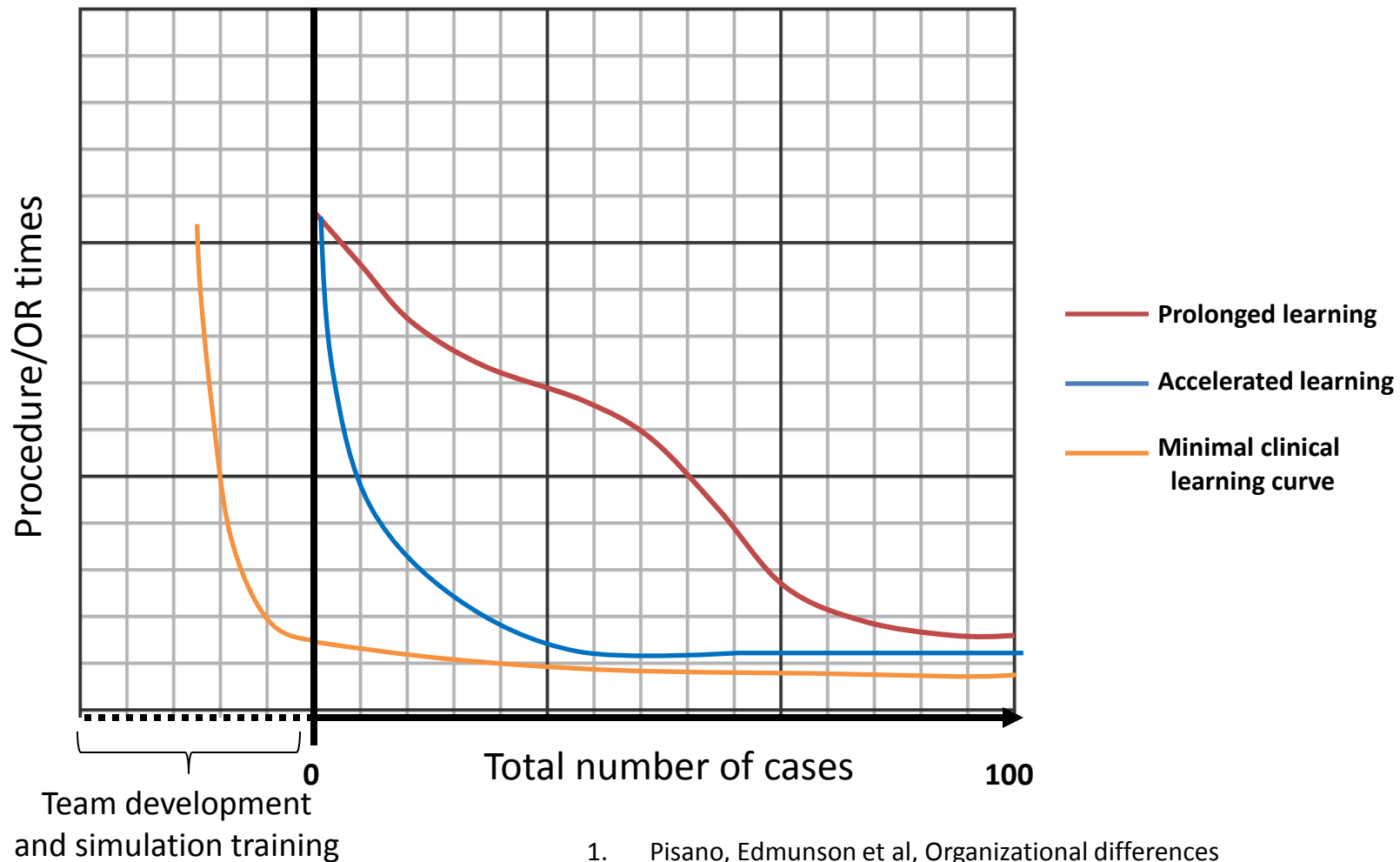- Patient demand/satisfaction

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Multicriteria decision analysis[1]

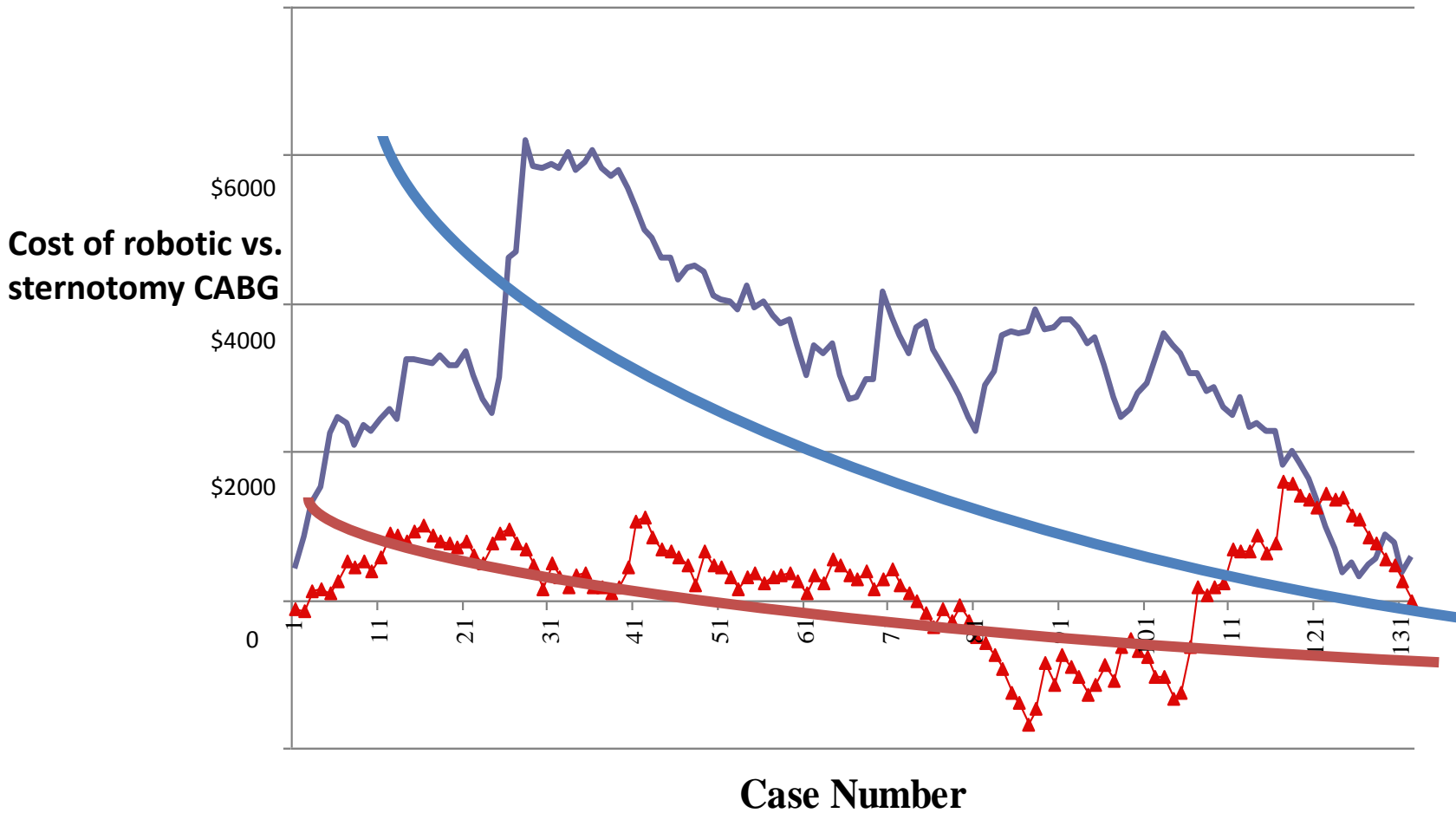1. Rotter, et. Al, Changing economic evaluation of medical technologies, Expert Rev. Pharmaco 2012; 12(6):711-23

Challenging Learning Curve: Variability

Legend:
- Prolonged learning
- Accelerated learning
- Minimal clinical learning curve

Procedure/OR times (y-axis)

Total number of cases (x-axis): 0 to 100

Team development and simulation training

1. Pisano, Edmunson et al, Organizational differences in the rates of learning: Lessons from the adoption of minimally invasive cardiac surgery. Management Science, 2001; 47(6): 752-69.

Challenging Learning Curve: Variability

Boston experience: minimal team development
AZ experience: comprehensive team training

Cost of robotic vs. sternotomy CABG

$6000
$4000
$2000
0

11 21 31 41 51 61 7 8 1 01 11 121 131

Case Number

Kianni, Poston et al, Abstract presentation, STS 2012

Safety: Outcomes of High Volume Programs

www.sts.org/report-search-hospital-results-2013

Safety: Robotic redo CABG

Redo cardiac surgery
at UAMC over 2 yrs
n=127

Robotic
approach
N=38

Sternotomy
approach
N=99

Propensity matching

Robotic
cases with
a match
N=27

Sternotomy
cases with
a match
N=27
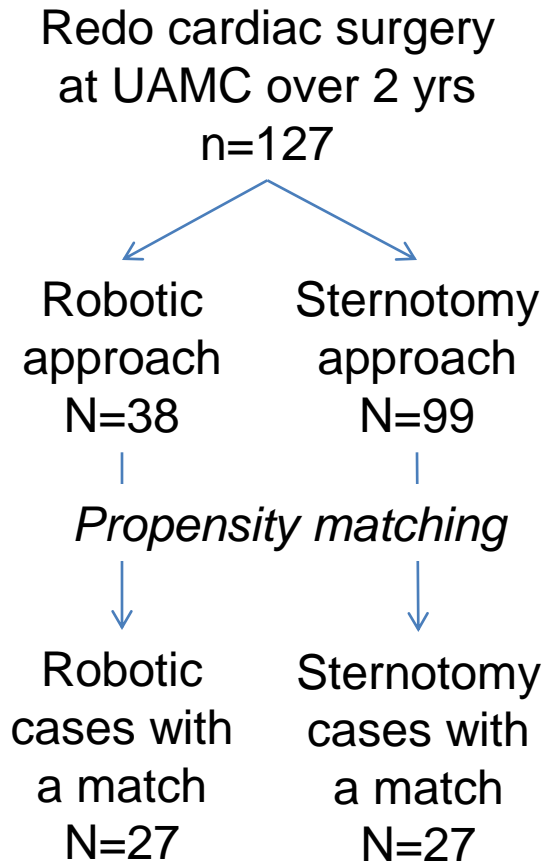
	Robotic redo (n=27)	Sternotomy redo (n=27)	*p* value
Extubated in OR	12(44%)	2 (7%)	0.004
Initial PostOP ventilation [Hrs] {median, range}	1.9 [0-427]	10.7 [0-223]	0.11
Blood transfusion	8 (30%)	23 (85%)	0.003
Surgery time [min]	250 [133-453]	326 [201-772]	0.002
OR time [min]	354 [221-570]	458 [271-865]	0.007
ICU time [hrs]	47 [20-1450]	72 [2-994]	0.57
Postop LOS (median, range}	5 [3-61]	10 [0 – 50]	0.09
Operative Mortality or Morbidity (O/E ratio)	**0.4 (7.1/19.5%)**	**1.1 (27.9/26.2%)**	**0.005**

Poston et al, Abstract presentation, ISMICS 2012
Poston et al. Abstract presentation, SRS 2013

Hospital Revenue: Opportunity Costs

– Hospital costs of option A vs. option B

- Hospital capacity
- Sternal infections as a "never event"[1]
- Medicare penalties for low patient satisfaction score (i.e. Value Based Purchasing)[2]
- Payer mix
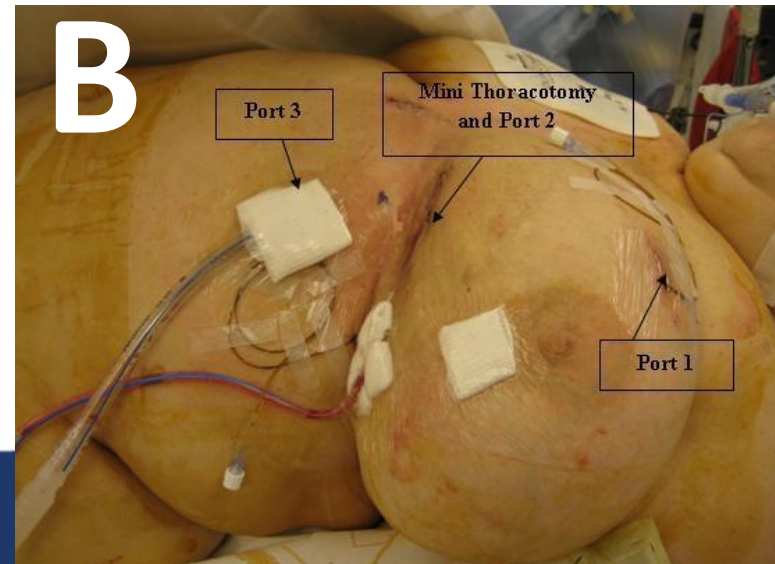
1. Medicare program; payment adjustment for provider-preventable conditions including health care acquired conditions. Final rule. *Centers for Medicare and Medicaid Services (CMS), HHS. Fed Regist. 2011 Jun 6; 76(108):32816-38.*
2. www.cms.gov/Hospital-Value-Based-Purchasing

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Costs: Changes Over Time

Average Cost/Case

Learning Curve (i.e. cases 0-Q_2)**:**
-Physical dexterity, mental confidence

Economies of scale (i.e. cases Q-Q2)**:**
-Renegotiate with suppliers
-Cross-functional staff
-Process standardization

C

C_1

O   Q Q_2

Cumulative Volume
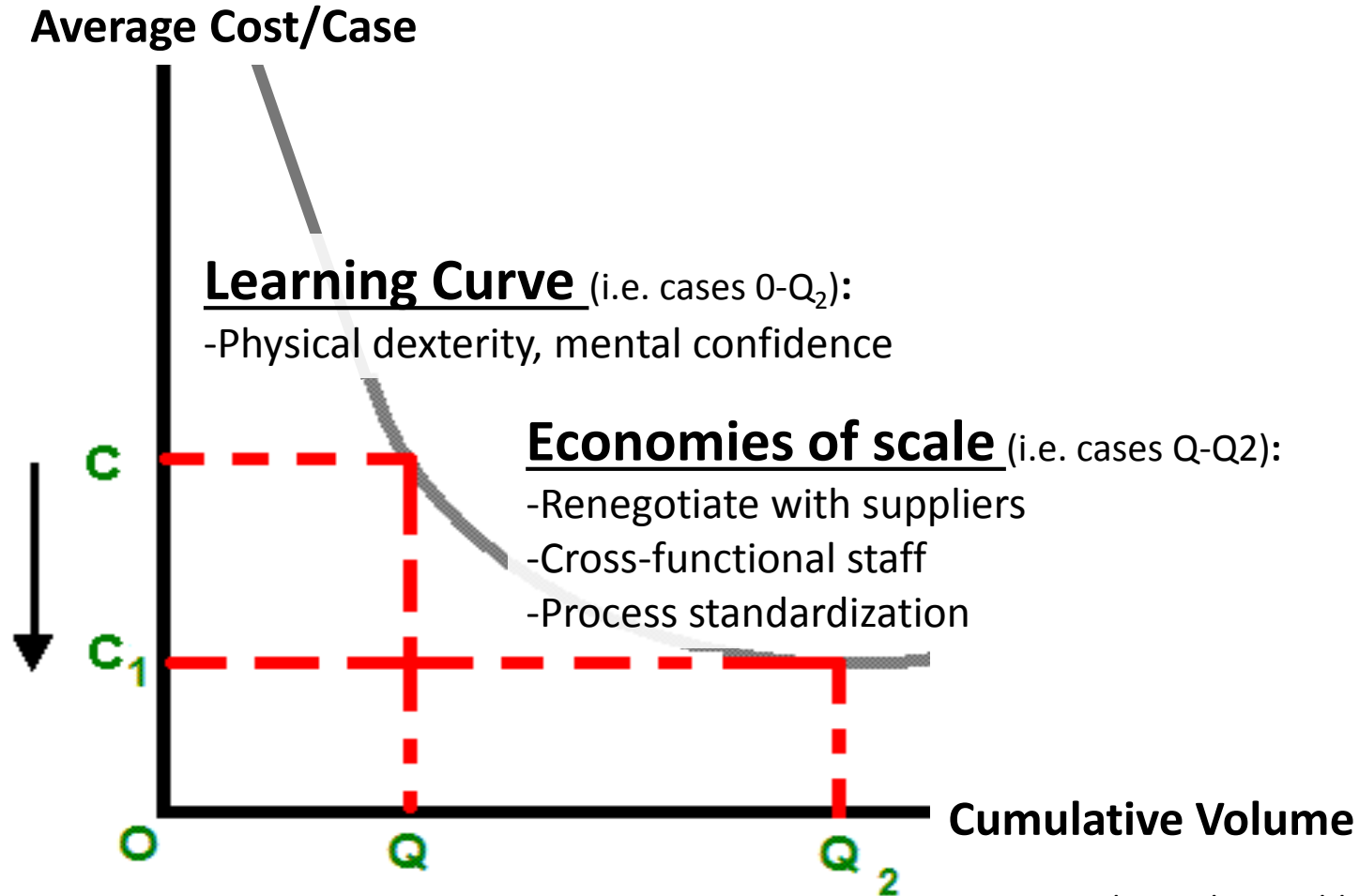
Smith, A., The Wealth of Nations, 1776
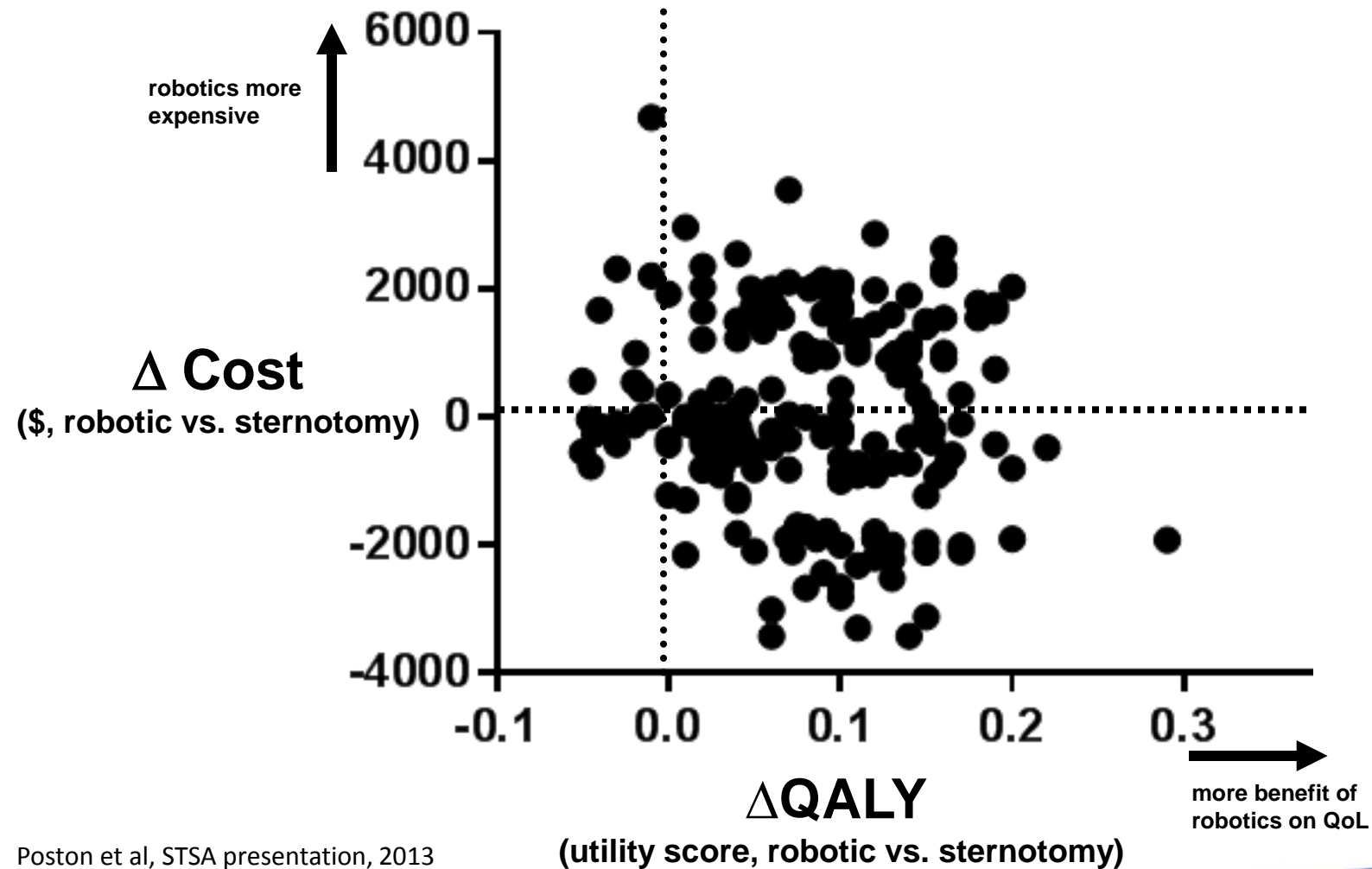
Incremental cost-benefit ratio:
Entire Study Period (Years 1-4)

Poston et al, STSA presentation, 2013

Incremental cost-benefit ratio:
Entire Study Period (Years 1-4)

robotics more expensive

Δ **Cost**
($, robotic vs. sternotomy)

Robotics dominated sternotomy in 45% of replications

△**QALY**
(utility score, robotic vs. sternotomy)

more benefit of robotics on QoL

Poston et al, STSA presentation, 2013

Incremental cost-benefit ratio:
Excluding Learning Period (Years 2-4)

robotics more expensive

Δ Cost
($, robotic vs. sternotomy)

ΔQALY
(utility score, robotic vs. sternotomy)

more benefit of robotics on QoL

Poston et al, STSA presentation, 2013

Incremental cost-benefit ratio:
Excluding Learning Period (Years 2-4)

robotics more expensive

6000

4000

2000

Δ Cost
($, robotic vs. sternotomy)

0

Robotics dominated
sternotomy in 92%
of replications

-2000

-4000

-0.1   0.0   0.1   0.2   0.3

ΔQALY
(utility score, robotic vs. sternotomy)

more benefit of robotics on QoL

Poston et al, STSA presentation, 2013

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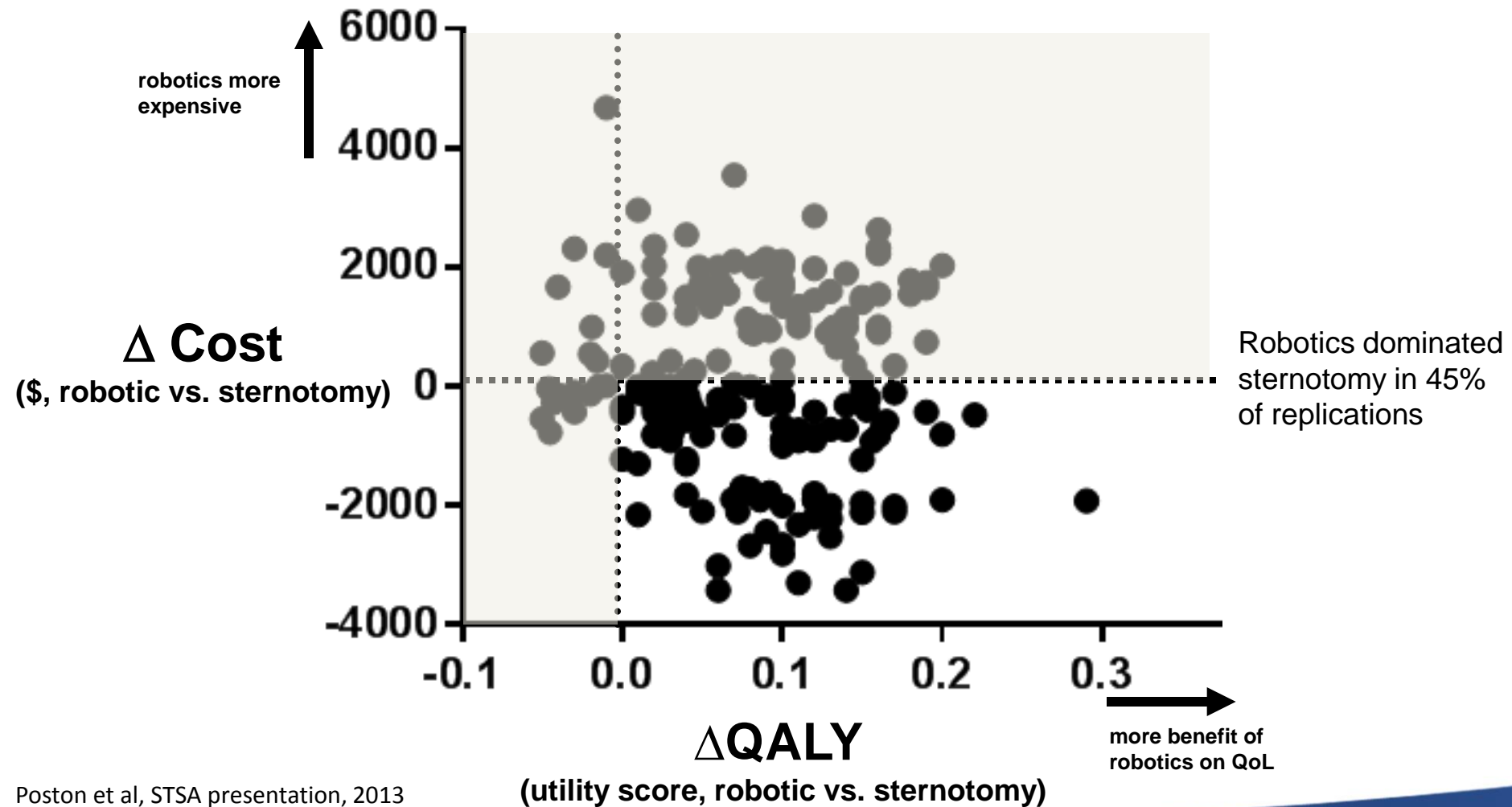
Additional Costs of TECAB
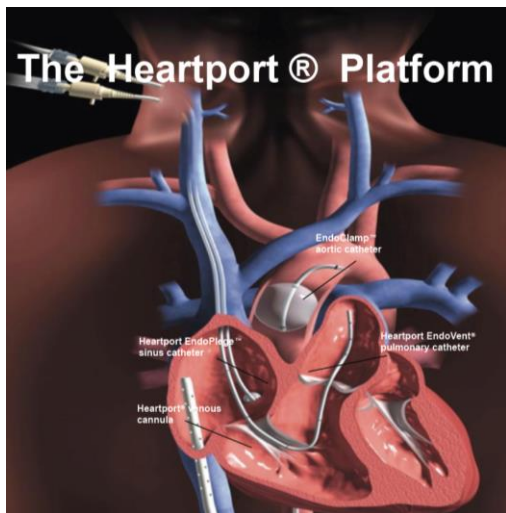
$4500/case

$2300/case

$2100/case

Prolonged OR times[1,2]

- OR cost ($2000/hr)
- Limited OR capacity
- Risk of complications[1]
- Team morale[3]

1. Wiedemann, et al, JTCVS 2012; 143:639-47
2. Dhawan, et al, JTCVS 2012; 143:1056-61
3. Pereira BM, et al, Rev Col Bras Cir 2011;38(5):292-298.

Patient Satisfaction: Robotic vs. Sternotomy

Domain	Robotic CABG percentile (n=60)	Sternotomy CABG percentile (n=98)
Rate hospital 9-10	90th	44th
Recommend the hospital	91st	54th
Comm with nurses	78th	23rd
Pain management	71st	28th
Discharge information	76th	37th
Comm with doctor	99th	57th
Hospital environment	6th	13th

HCAPHS database query at UAMC for FY12, 9/10/13

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Multi-criteria decision analysis

Evaluation Criteria	Minithoracotomy rCABG	TECAB
Acceptable "learning curve"; risk of forgetting	**+**	
Ease of distal anastomoses	**+/−**	**+/−**
Safety (CO_2 insufflation, access)	**+**	
Operative times	**+**	
Increase revenue		**+**
Reduce costs	**+**	
Patient satisfaction		**+**
Broad acceptance among stakeholders	**+**	

Multi-criteria decision analysis

Evaluation Criteria	Minithoracotomy rCABG	TECAB
Acceptable "learning curve"; risk of forgetting	70	30
Ease of distal anastomoses	50	50
Safety (CO_2 insufflation, emergent access, conversion risk)	70	30
Operative times	80	20
Increase revenue	35	65
Reduce costs	80	20
Patient satisfaction	10	90
Broad acceptance among stakeholders	60	40
TOTAL	57%	43%

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Multi-criteria decision analysis

Evaluation Criteria	Rank	Weight	Minithoracotomy rCABG	TECAB
Acceptable "learning curve"; risk of forgetting	1	30	70	30
Ease of distal anastomoses	2	20	50	50
Safety (CO_2 insufflation, access)	3	15	70	30
Operative times	4	15	80	20
Increase revenue	5	5	35	65
Reduce costs	6	5	80	20
Patient satisfaction	7	5	10	90
Broad acceptance among stakeholders	8	5	60	40
TOTAL	-	100	57%	43%

Multi-criteria decision analysis

Evaluation Criteria	Rank	Weight	Minithoracotomy rCABG	TECAB
Acceptable "learning curve"; risk of forgetting	1	30	70% = 21	30% = 9
Ease of distal anastomoses	2	20	50% = 10	50% = 10
Safety (CO_2 insufflation, access)	3	15	70% = 10.5	30% = 4.5
Operative times	4	15	80% = 12	20% = 3
Increase revenue	5	5	35% = 1.75	65% = 3.25
Reduce costs	6	5	80% = 4	20% = 1
Patient satisfaction	7	5	10% = 0.5	90% = 4.5
Broad acceptance among stakeholders	8	5	60% = 3	40% = 2
TOTAL	*-*	*100*	*57% = 62.75*	*43% = 37.25*

Conclusions on Robotic CABG

- Robotic revascularization
  - Safe
  - Financially viable
  - Strong patient demand

- No measurable advantage of TECAB over minithoracotomy.

- Robotic CABG should be done according to the technique favored by the surgeon