# 10-year Review of Robotic Surgery at an Academic Medical Center

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Introduction

History of Robotic Surgery

- AESOP was first surgical robot (1994)

  - Function was to maneuver an endoscope inside the body during surgery, controlled by voice commands by the surgeon or computer

- ZEUS system developed in (2001)
  - Could hold 28 different instruments

A   B

- Intuitive Surgical da Vinci System
  - FDA approved for general laparoscopic surgery in 2000
    - Approved for prostate surgery in 2001

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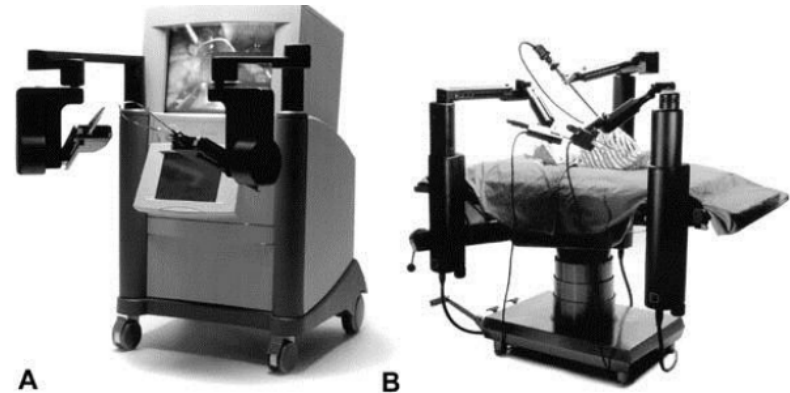
Introduction

Robotic surgery is a rapidly growing field

- Number of procedures nearly tripled from 2007-2010 (80K-205K), in 2013 >500K[1]

  - >3 million cases performed

- Da Vinci systems in US increased 75% from 2007-2009 (800-1400), and international systems doubled (200-400)

  - As of September 2016:[2]

    - 3800 units worldwide

    - 2500 in US

1. Barbash GI, Glied SA. New Technology and Health Care Costs-The Case of Robot-Assisted Surgery. NEJM. 2010;363:8.
2. Intuitive Surgical System, www.intuitivesurgical.com

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Introduction

Benefits

- Shorter length of stay

- Less morbidity

- Improved visualization, dexterity of instruments

- Patients more likely to be offered surgical treatment
  - Prostate cancer surgeries increased 60% from 2005-2008 despite decreased incidence of prostate cancer[1]

Disadvantages

- Longer operating room time

- Learning curve (>150 cases)

- Lack of tactile feedback

- Additional cost of $1600 per procedure plus $1600 for robotic system ($3200 total)
  - High costs of robotic systems ($1M-2.5M)
  - Yearly maintenance ($100K)
  - Robotic disposables

1. Barbash GI, Glied SA. New Technology and Health Care Costs-The Case of Robot-Assisted Surgery. NEJM. 2010;363:8.

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Introduction

Literature on robotic surgery

- Since 1998, over 8500 articles about da Vinci system

- Most studies look at safety or costs for a specific operation

SAGES consensus statement on robotics in GI surgery:[1]

- No increased morbidity or mortality compared to laparoscopic

- Effective, but not superior to laparoscopic surgery. Similar benefits to laparoscopic surgery when compared with open

- More costly, though data assessing the value of robotic surgery does not exist

1. Tsuda S, Oleynikov D, Gould J, Azagury D, Sandler B, et al. SAGES TAVAC safety and effectiveness analysis: da Vinci Surgical System (Intuitive Surgical, Sunnyvale, CA). Surg Endoscopy. 2015;29(10):2873-2884.

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Purpose

- Few studies have examined robotics from a programmatic standpoint
  - How many hospitals evaluate return on investment both clinically and fiscally

- This study examines the 10-year experience of a robotic program at a single academic institution

- Comprehensive overview of Robotic Surgery program

  - Operative volume and diversity

  - Perioperative data

  - Admissions outcomes

  - Cost
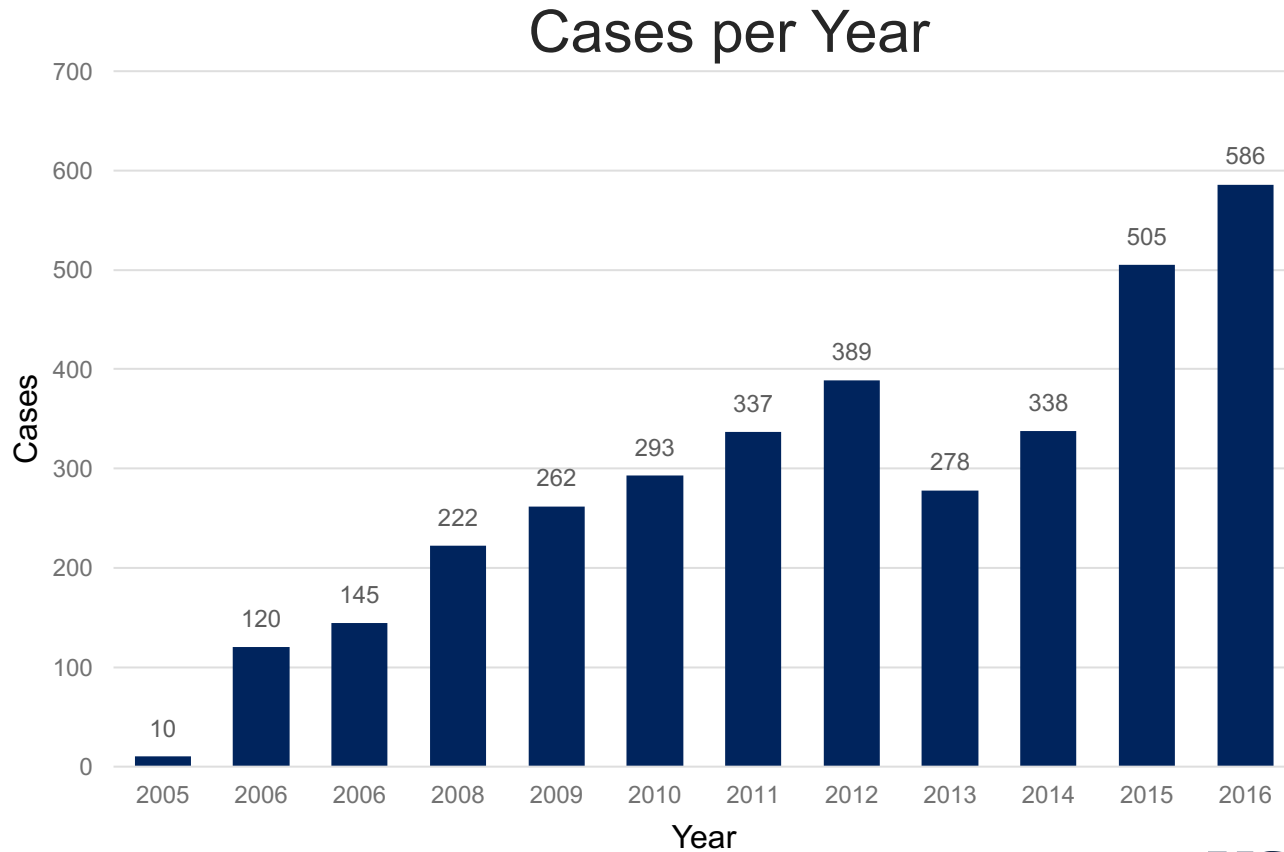
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Methods

- All robotic operations performed at UCSD Medical Center were reviewed
  - August 2005-December 2016

- Data sources:
  - Electronic surgical scheduling system
    - ORSOS (2005-Oct 2013)
    - Epic (Oct 2013-present)
  - Da Vinci console
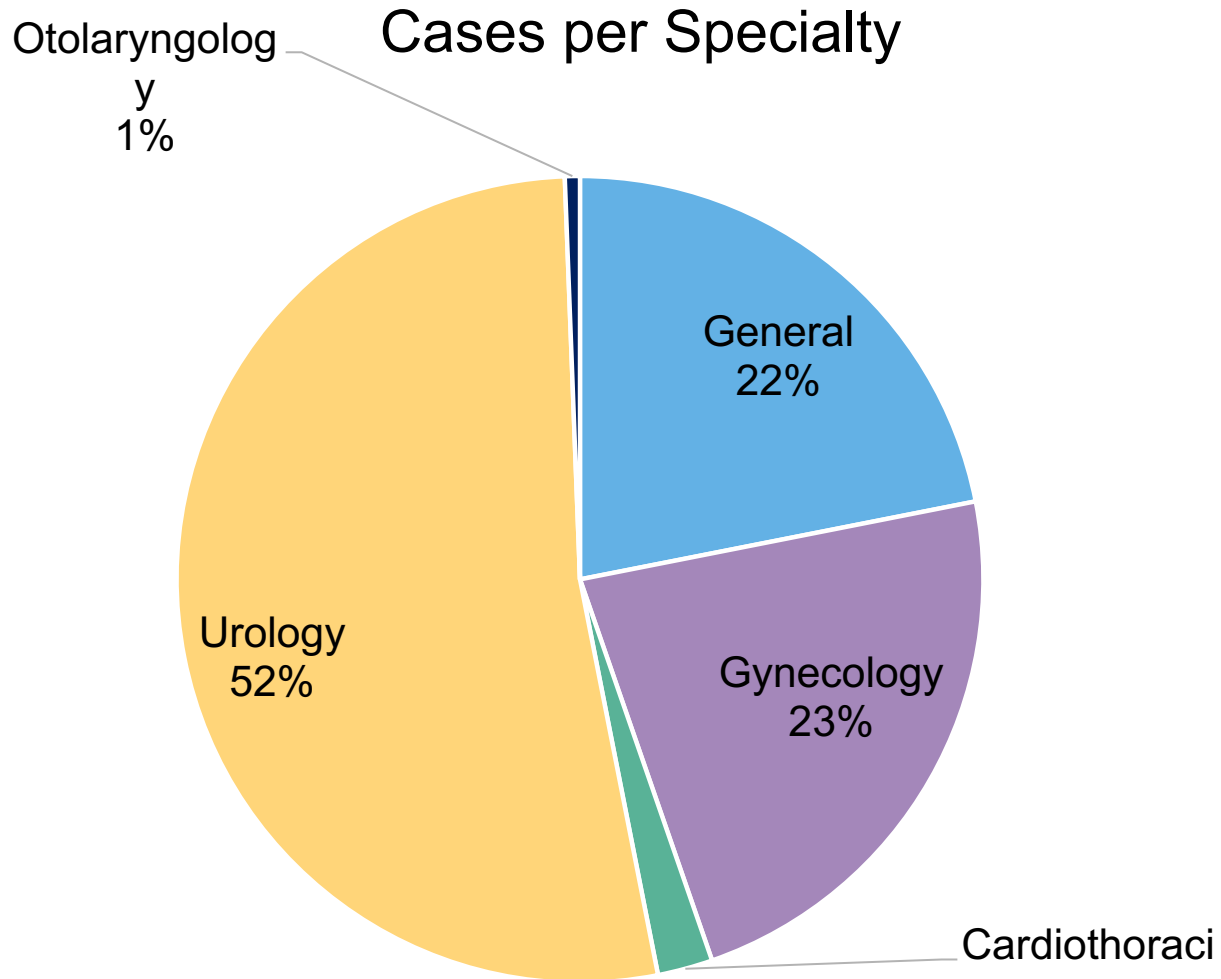 - Hospital administrative databases
  - Robotic Surgery Committee

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Results:
Case volume

- Total cases: 3485

Cases per Year

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Results:
Volume by specialty

Cases per Specialty

Otolaryngology 1%

General 22%

Gynecology 23%

Cardiothoracic 2%

Urology 52%

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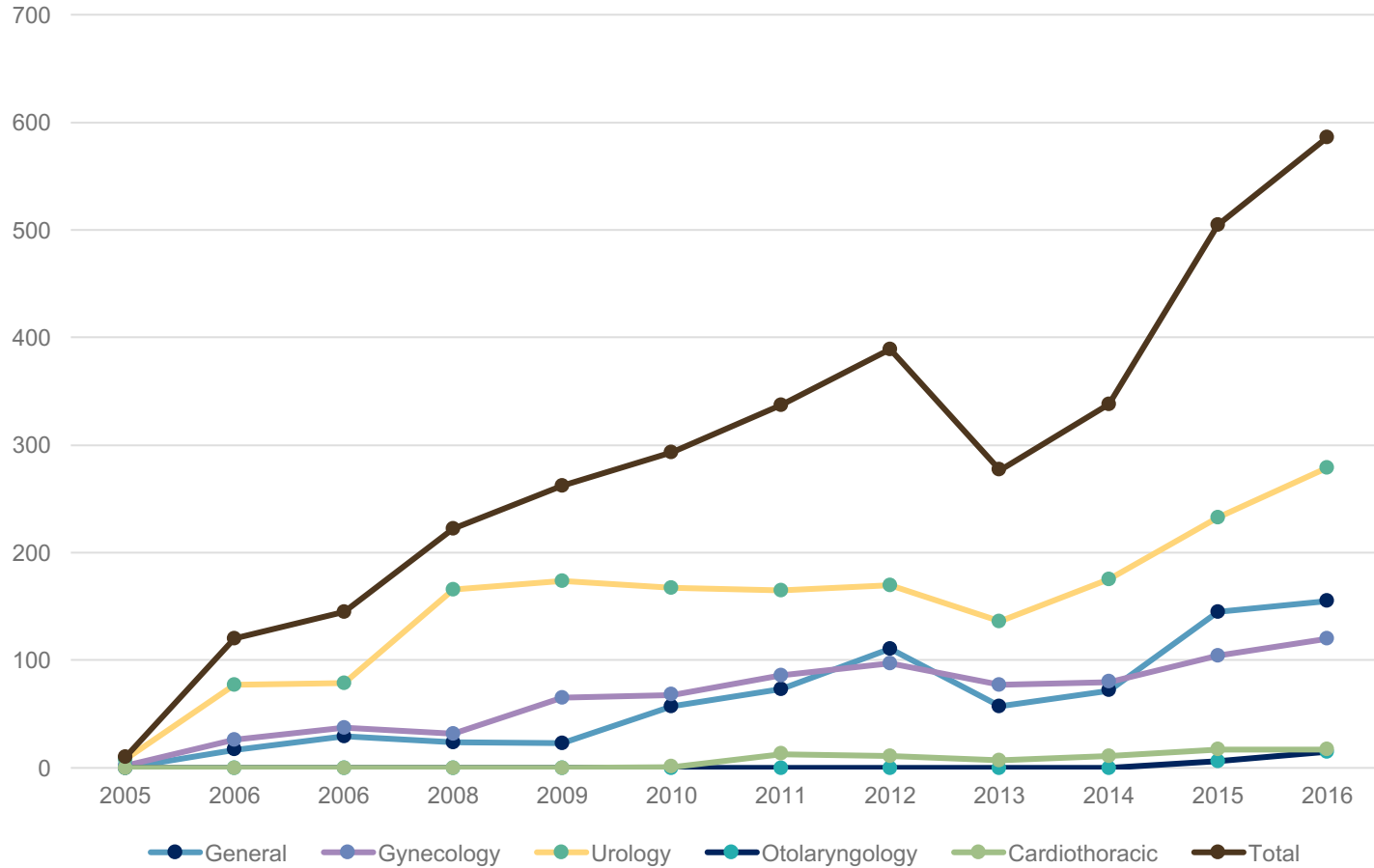
Results:
Volume by specialty

Cases per Year

Results:
Surgeons

- Total of 43 unique attendings

Surgeons by Specialty

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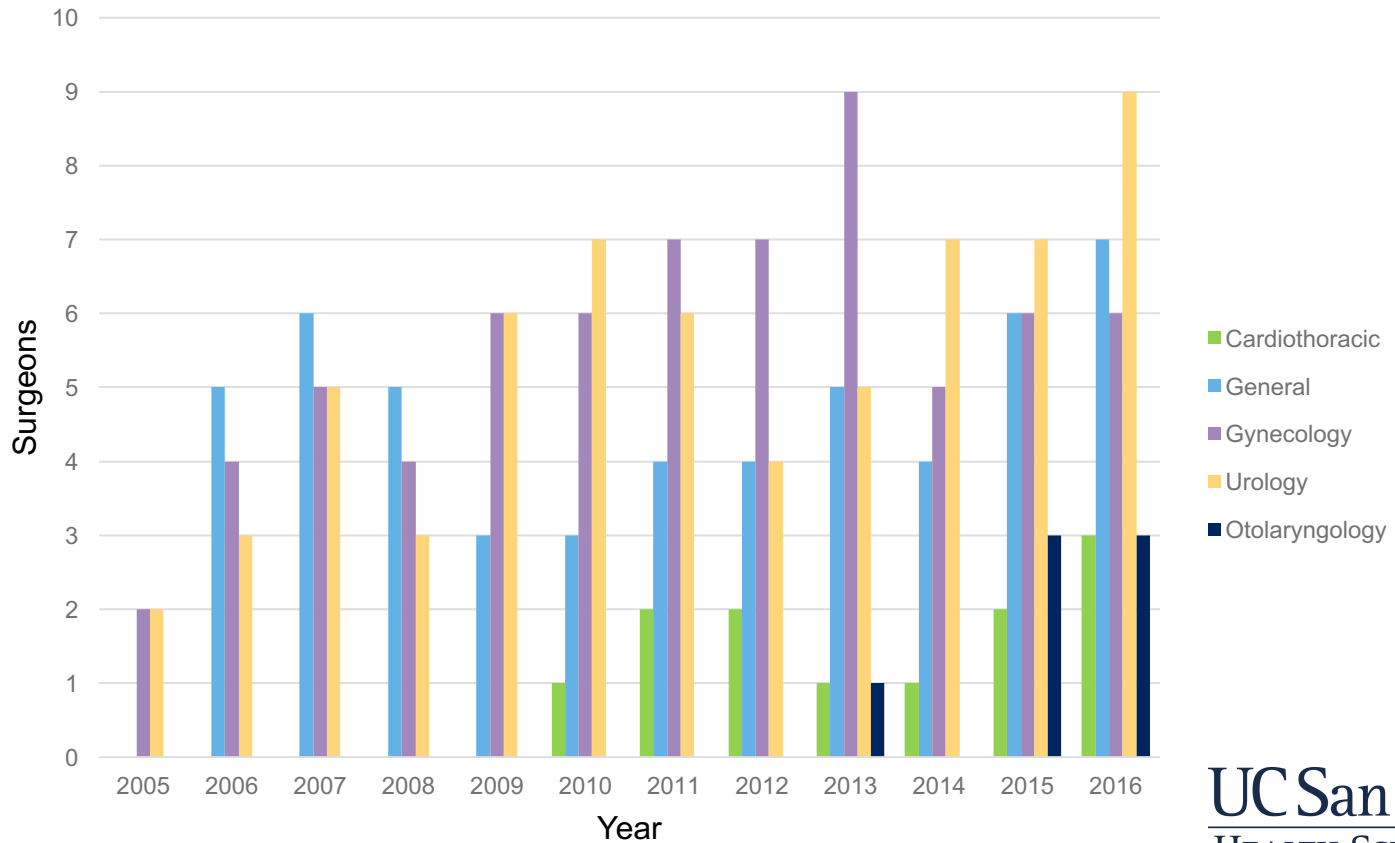
Results:
Types of Cases

- General Surgery: 763 cases

General: Colorectal	402
LAR	153
APR, Proctectomy	80
Segmental Colectomy	77
Rectopexy	39
Proctocolectomy	42
TAMIS	9

General: Oncology	89
Esophagectomy	70
Gastrectomy	9
Hepatectomy	4
Adrenalectomy	4

General: MIS	272
Donor Kidney, living	109
Myotomy	98
Paraesophageal hernia	46
Cholecystectomy	46
Fundoplication	15
Bariatric surgery	6
Esophageal diverticulum repair	3
Other Hernia	3

Results:
Types of Cases

Urology	1829
Prostatectomy	1269
Partial nephrectomy	211
Cystectomy	153
Radical nephrectomy	98
Pyeloplasty	40
Ureteral reimplantation, resection, or lysis	36
Lymphadenectomy or lymphocele repair	10
Adrenalectomy	5

Gynecology	794
Hysterectomy	467
Salpingooophorectomy	153
Sacrocolpopexy	143
Myomectomy	19
Lymphadenectomy	5
Pelvic mass resection	4

Cardiothoracic	77
Aortic/Mitral Valve	27
CABG	25
Mediastinal Mass excision	10
Repair of septal defect	7
Ablation	4
Other VATS	2

Otolaryngology	21
Transoral Surgery (ENT)	21

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Results:
Types of Cases

53 unique types of cases

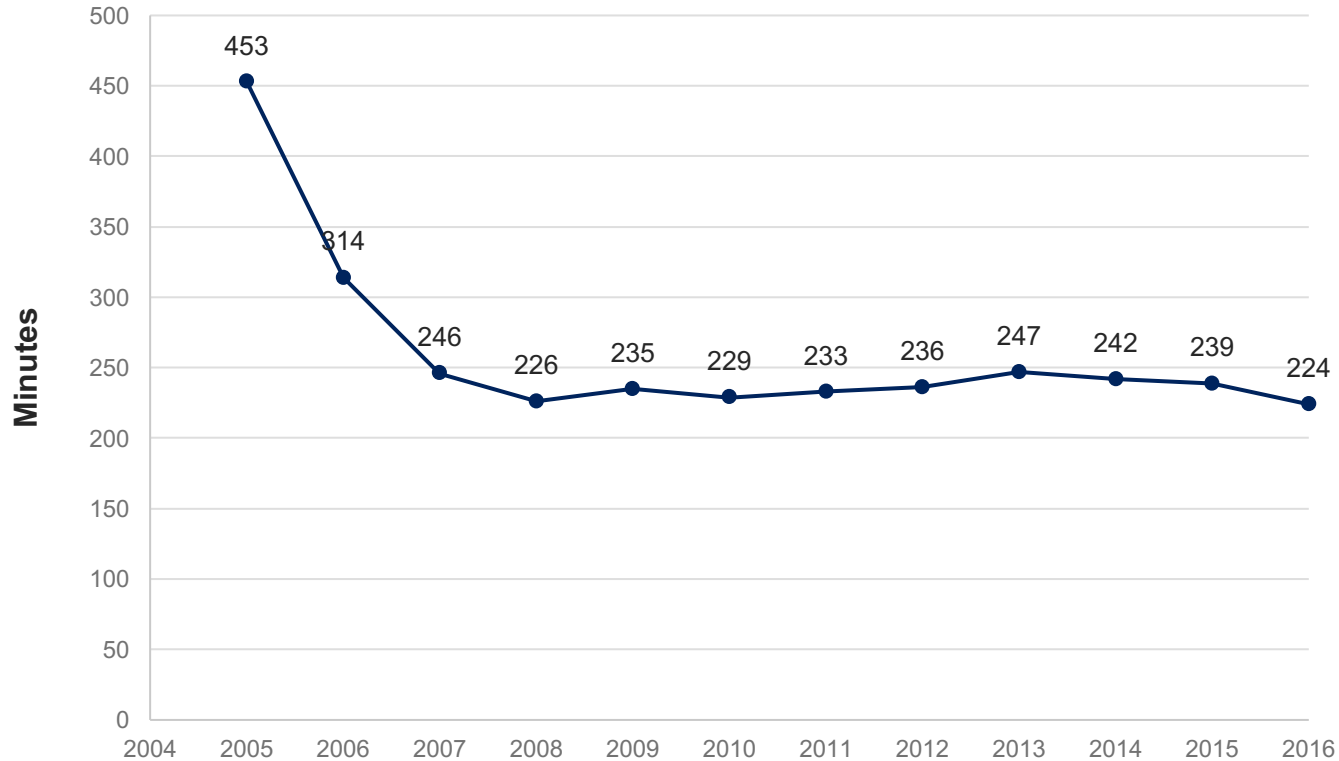- Top 3 cases:

Prostatectomy	1269
Hysterectomy	467
Proctectomy (LAR, APR)	233

- Account for 1969 of 3485 cases (56%)
- Prostatectomy alone accounts for 36% of cases

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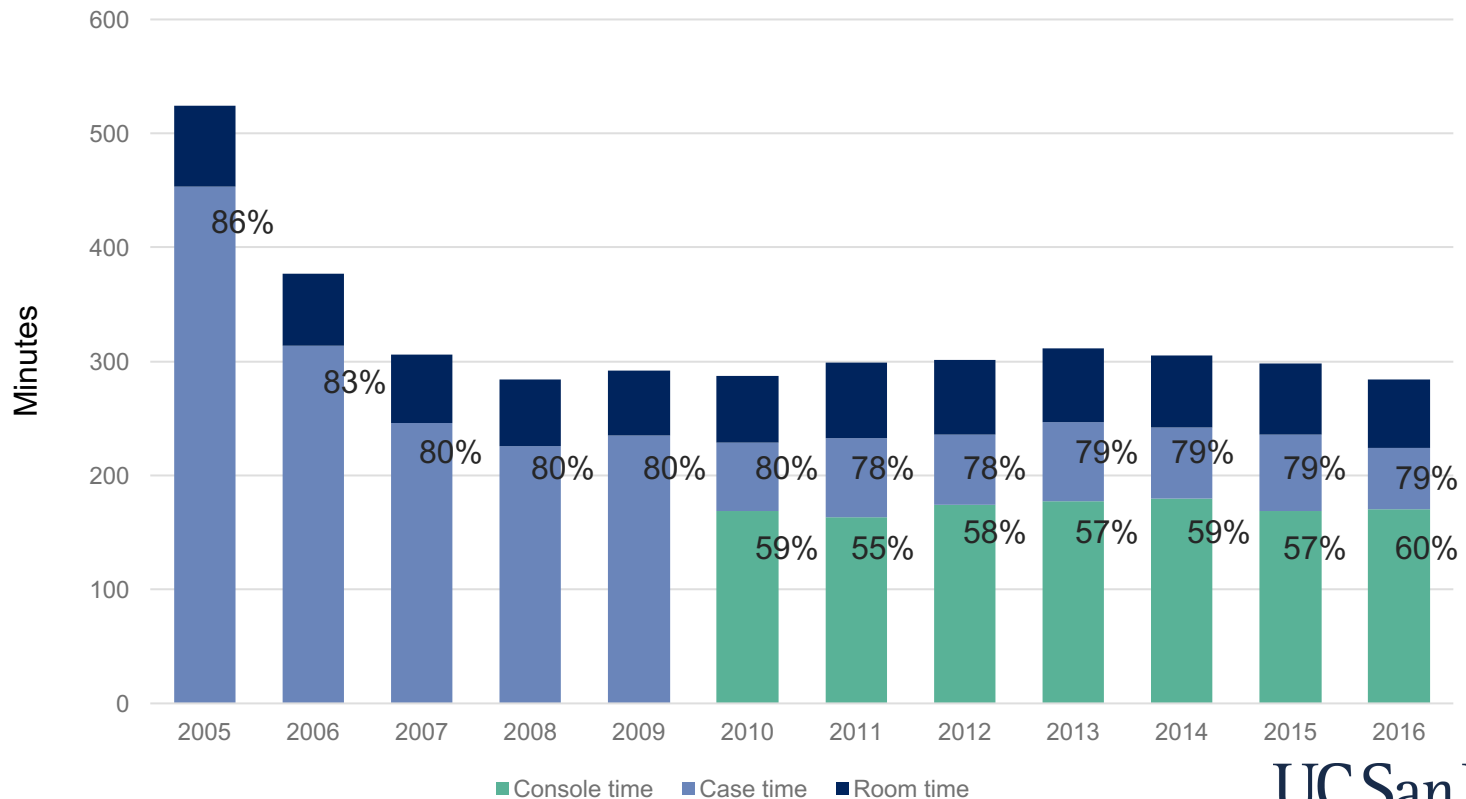# Results:
Case time

Case Time

- 2005-2006 decreased by 31%

- 2006-2007 decreased by 22%

- 2007-2016 average time 236 minutes (range 224-247)

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Results:
Case time

- After 2007, case times 78-80% of OR time

- Console time 55-60% of OR time

Case times

Results:
Case time

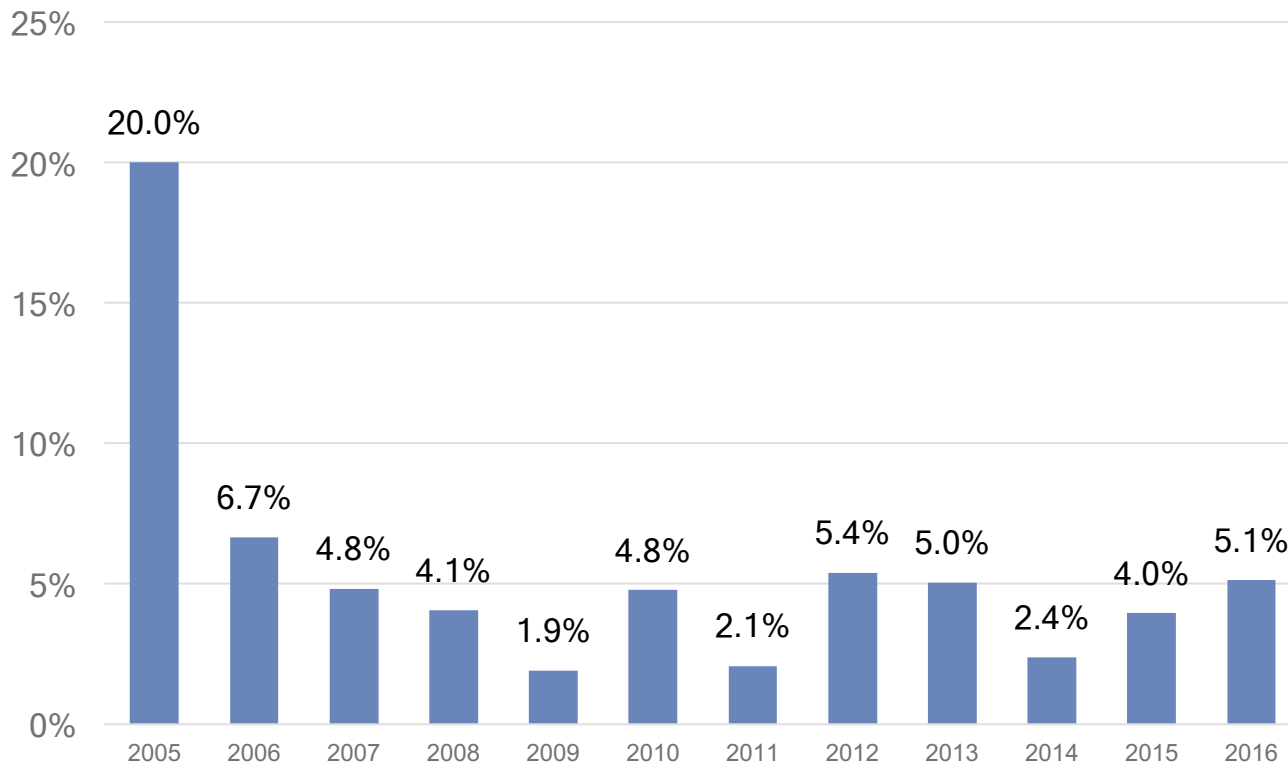
Case times

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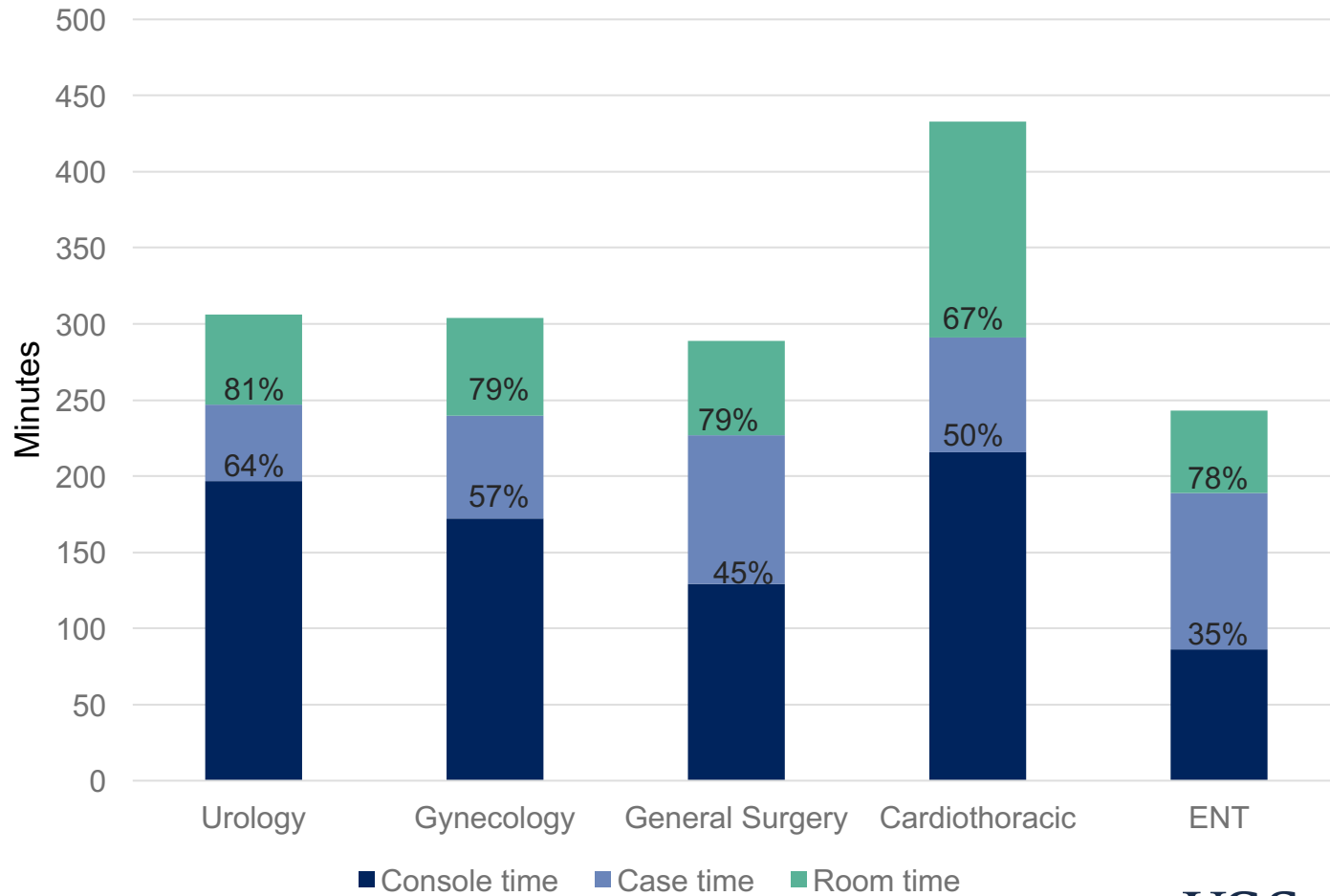
Results:
Conversions to Open

- Overall, 4.2% of cases

Converted to Open

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Results:
Conversions to Open

- Compared conversions to open for robotic vs laparoscopic cases

Operation	Robotic	Laparoscopic
Adrenalectomy	0	**3%**
Cholecystectomy	**9%**	6%
Colectomy	**13%**	9%
Hysterectomy	10%	**15%**
Radical Nephrectomy	4%	**7%**
Sacrocolpopexy	4%	**13%**
Salpingooophorectomy	**8%**	2%
*Overall**	*7.9%*	*6.7%*

*p=0.29

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Results:
Operating Room costs

- Since 2013, average cost for OR supplies is $3540 per case
  - Excluding cardiac cases
  - Low of $1806 (Transoral surgery)
  - High of $5773 (Gastrectomy)

- Average cost for robotic supplies $1555 per case
  - Low of $809 (Transoral surgery)
  - High of $2178 (Low anterior resection)

- On average, robotic disposables account for 44% of supply costs in robotic cases
  - Low of 18% (Esophagectomy)
  - High of 70% (Transanal minimally invasive surgery)

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Results:
Admissions data

- Fiscal Year 2009-2015 admissions data for robotic surgeries and their equivalent open or laparoscopic operations

- 28 types of operations across all specialties, selected by ICD9 code

- Average Length of Stay:
  - Open 7.0 days
  - Laparoscopic 3.3 days
  - Robotic 3.0 days

- Biggest advantage compared to open
  - APR
  - Esophagectomy
  - Regional lymphadenectomy

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Results:
Admissions costs

	Open	Laparoscopic	Robotic
Cases	3340	1026	1528
Cost per Day	x	x	1.7x
ALOS	7.01	3.32	2.97
Cost per admission	2.1y	y	1.5y

- Most cost-effective operations (compared to open):
  - Regional lymphadenectomy
  - APR
  - Esophagectomy
  - Total colectomy
  - Liver resection

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Results:
Readmissions

- Readmissions 2009-2015

	Open	Laparoscopic	Robotic
Cases	2610	959	1411
Readmissions	671	143	214
%	15%	15%	26%

- p<0.0001

Conclusions

- Over 10 years, use of robotic surgery has grown significantly at our institution and continues to grow

- Large increase in number and types of cases, across many specialties

- Operating room costs and equipment costs are high

- Clinical outcomes similar to laparoscopic surgery, but length of stay is lower, readmissions are lower, and admissions costs are lower than open surgery

Thank you

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