

Limitations of Current Robotic Surgery Platforms: Will Robotic be Autonomous?

Erik B. Wilson, MD, FACS

Professor of Surgery

Vice Chair of Surgery

Bariatric Surgery Medical Director Memorial Hermann Hospital

Division Chief, Minimally Invasive and Elective General Surgery

University of Texas Medical School at Houston

Limitations of Current Robotic Surgery Platforms: Will Robotic be Autonomous? YES, Kinda

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Disclosures

Johnson&Johnson-Teaching/Research

Medtronic-Teaching/Research

Intuitive-Teaching/Research

Gore-Teaching

Activ Surgical-Research

Boston Scientific-Teaching/Research

Endogenex-Research

CMR-Research

Distalmotion-Research

GI Windows-Chief Medical Officer

What Is the Goal of Minimally Invasive Surgery?

Better minimally invasive surgery

1. More precise and accurate
2. More reproducible and consistent
3. Easier on the surgeon physically and mentally
4. More efficient--quicker

More minimally invasive surgery

1. Stop open surgery
2. Optimize the procedure to the patient
3. Fewer incisions
4. No incisions

Surgeons want to operate at a high level and talk to patients about operating at a high level and that's it!

Digital is Driving the Process:

Robots, Telesurgery, Endolumenal, AI & Automation

Democratizing Surgery and Bariatric Surgery with Robotic Platforms

Laparoscopic Trends

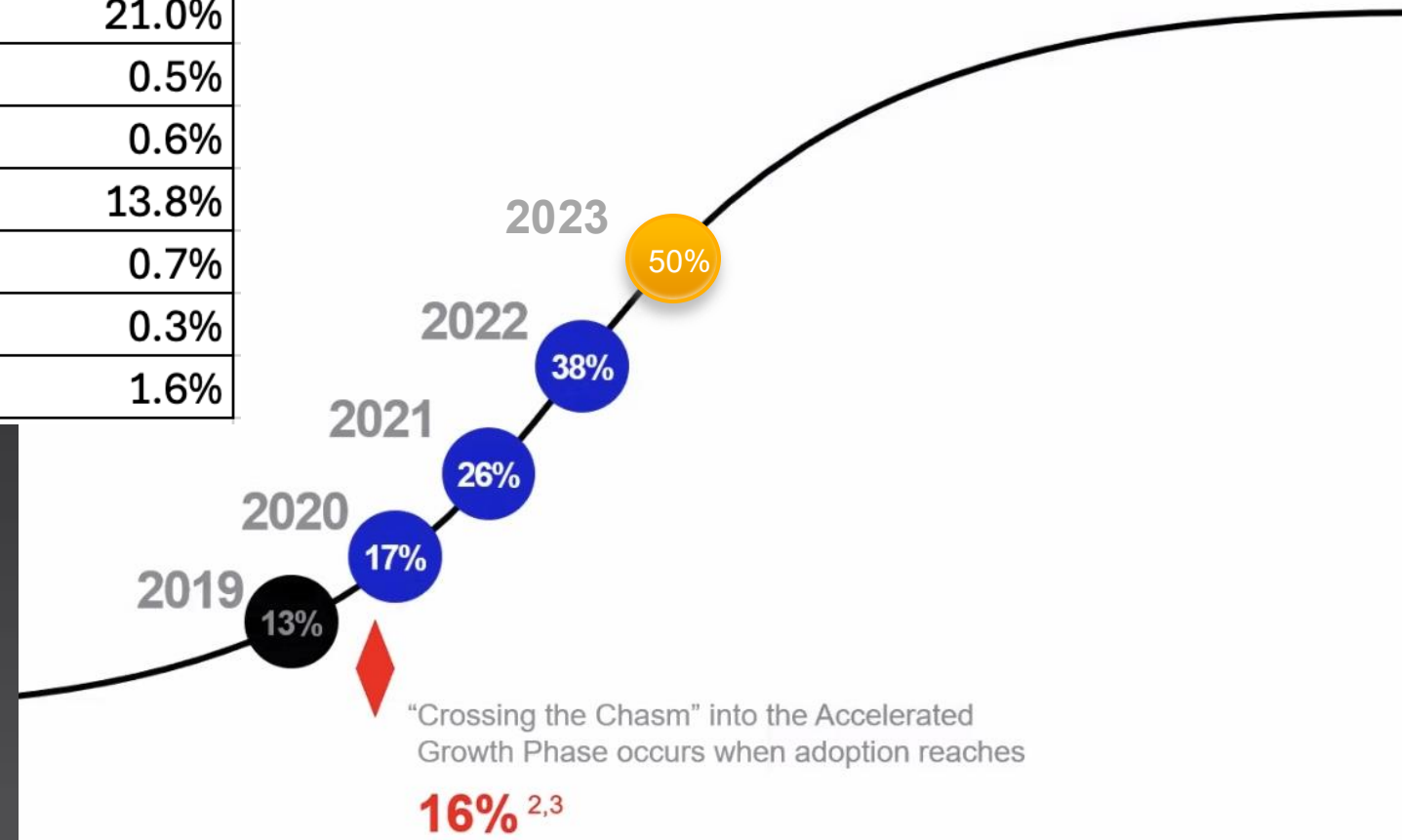
	2020	2021	2022	2023
Sleeve	63.2%	59.2%	59.5%	61.5%
RYGB	19.4%	19.8%	19.9%	21.0%
Band	1.1%	0.5%	1.3%	0.5%
BPD-DS	1.4%	1.7%	1.9%	0.6%
Revision	12.9%	14.0%	13.1%	13.8%
SADI	0.3%	0.5%	0.7%	0.7%
OAGB	0.9%	0.6%	0.5%	0.3%
Other	0.8%	3.8%	3.1%	1.6%

Growing Robotic Bariatric Surgery with Increasing Complexity

Robotic Increasing Anastomotic Cases:

Less sleeves more Bypass and Switch from 2020 to 2025 from Robotic Bari Surgeons

Thank You Intuitive!



Democratizing Surgery and Bariatric Surgery with Robotic Platforms

Growing Robotic Bariatric Surgery with Increasing Complexity

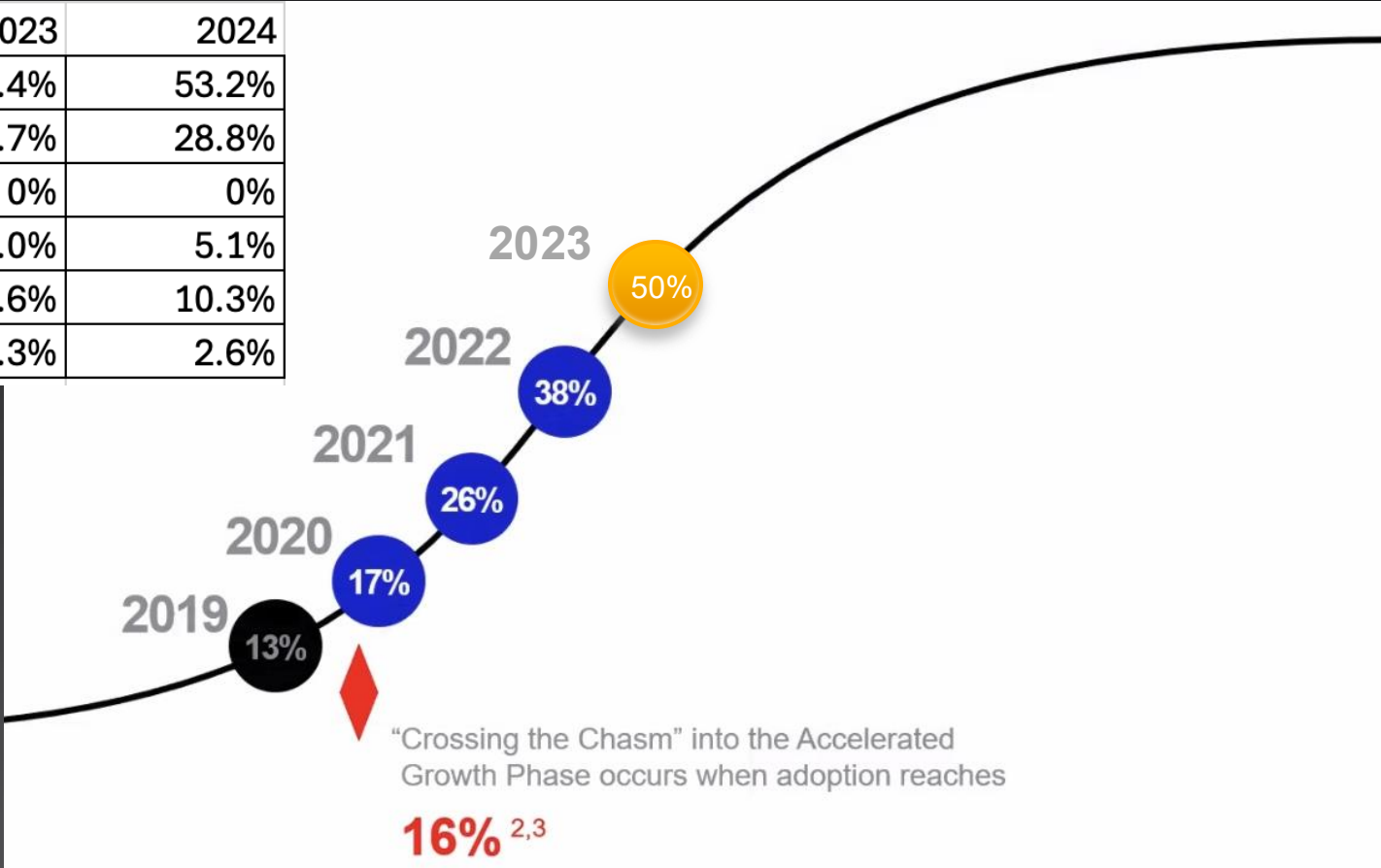
Robotic Trends

	2020	2021	2022	2023	2024
Sleeve	61.0%	60.7%	58.7%	56.4%	53.2%
RYGB	29.0%	29.3%	29.6%	28.7%	28.8%
Band	0%	0%	0%	0%	0%
BPD-DS / SADI	6.5%	6.5%	3.5%	4.0%	5.1%
Revision	3.5%	3.5%	7.9%	9.6%	10.3%
Other	0.0%	0.0%	0.5%	1.3%	2.6%

Robotic Increasing Anastomotic Cases:

Less sleeves more Bypass and Switch from 2020 to 2025 from Robotic Bari Surgeons

Thank You Intuitive!



Democratizing Robotic Platforms with Bariatric Surgical Cases



5 generations of DaVinci and where are we?

A large boom arm system that has marginally changed in function
Stronger instruments, Task autonomous staplers, Advanced energy
Very few changes in scaling and movement and articulation
Few changes in visualization:
Improved stability but questionable need for force feedback/Haptics

Cameras from 12 mm to 8 mm, no articulating cameras except with SP

Instruments from 8 mm to 5 mm and back to 8 mm

Mediocre ergonomics

Very few digital analysis tools

Slower times with basic cases compared to laparoscopy at higher cost



Doesn't the 5 take us to the Next Level??



These decisions are made in an environment of constant risk mitigation to prevent losing what's been gained.

So its more about careful growth than taking risk when in a monopolized space

Haptic Feedback-another recruitment tool? I feel with my vision now.

Improved Ergonomics: Finally but still not enough and way late

More Integrated and Efficient:
Basic level insufflation- no heated
humified, no continuous flow
Entry camera-oh yeah, not integrated.
In console moves- Yay, oh wait I can't practice
them because the simulator modules
aren't out

Modern High Level Processing Power-Great,
and what's that doing now? Little so far

Intuitive: High Performance Robotics?

Intuitive's culture of
converting open surgery to
laparoscopy with robotics

Raising the Floor:
Recruiting surgeons into
robotics

Not Always Raising the
Ceiling: Making good robotic
surgeons better



What are the Problems?

Longer operative times on average

Lots of space issues

Haptics too weak and too strong

Really not much change in laparoscopic capabilities

Digital support is largely a nonexistent currently

Training: It's a tool

Robots don't make the decisions for surgeons

How about really making the surgeon really more comfortable?

Cost, Cost, Cost

And oh yeah Cost



True High Performance Robotics

Eliminate the carts

Truly integrate laparoscopy and robotics

Faster scaling and rotational scaling

Faster instrument exchanges

Right size the tech for the procedure

Flexible cameras

More port position options and arms: true 2 surgeon

More multiuse instruments

Combined endolumenal and laparoscopy at one console

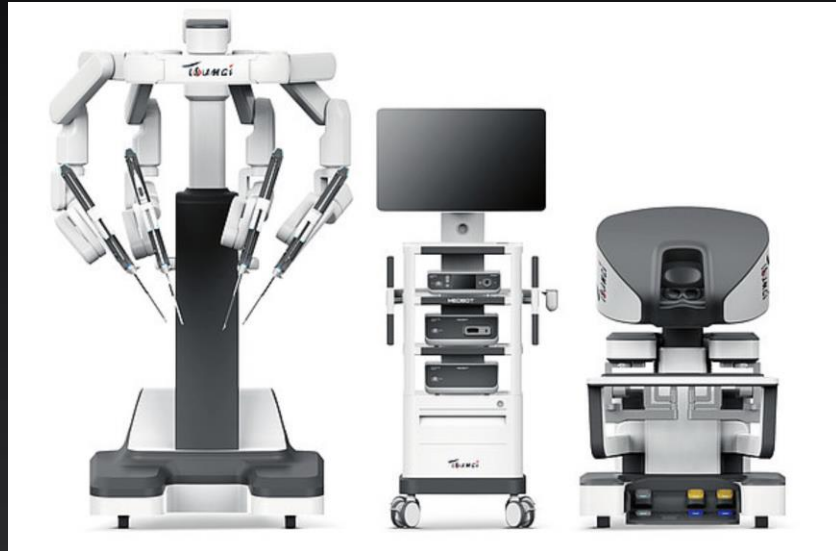
Integrated sealing and stapling that supports the latest best in class devices

Telesurgery



DaVinci Me Too Boom Mounted Systems

Microport Toumai--No US Plan



Medicaroid: Hinotori—No US Plan



Sagebot Kangduo--
No US Plan



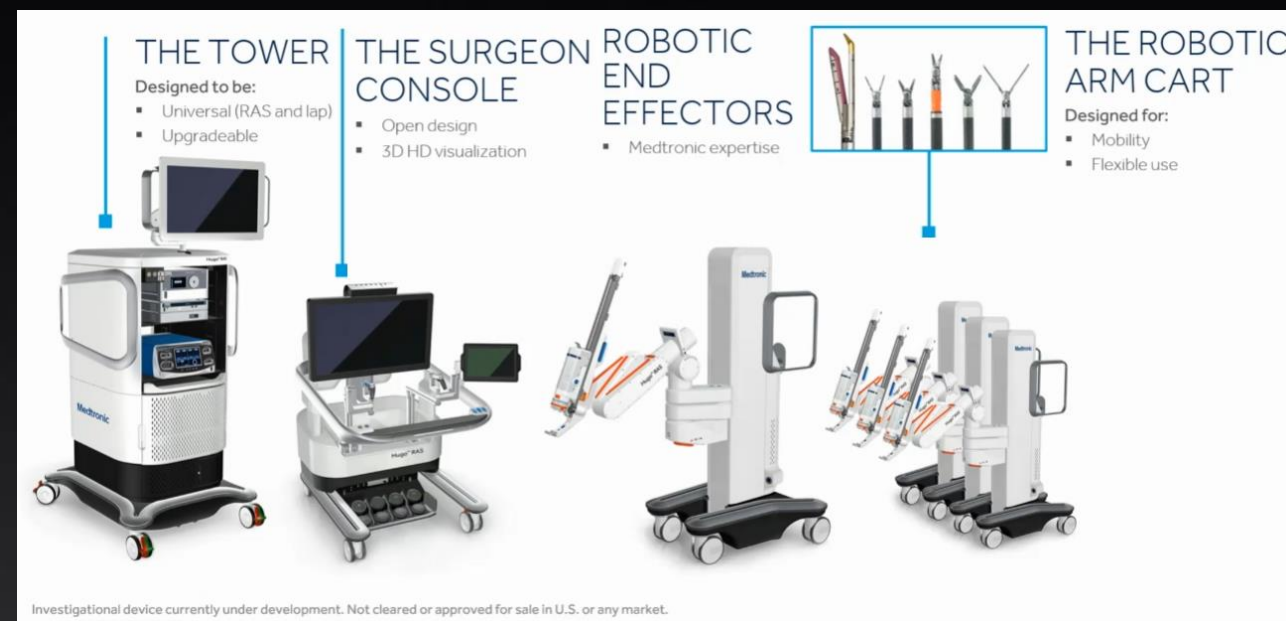
DaVinci Xi
and DV5
10 million
cases



Modular Arms Systems



SSI Mantra—
US 2027-2028



Medtronic Hugo 2026 FDA Cleared—Urology
~20000 cases

Renovo Harmony-No US Plan

This is **Harmony LP**
Simplicity. Precision. Intelligence.

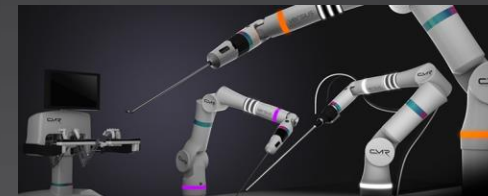


3DHD Laparoscope with
Fluorescence Imaging

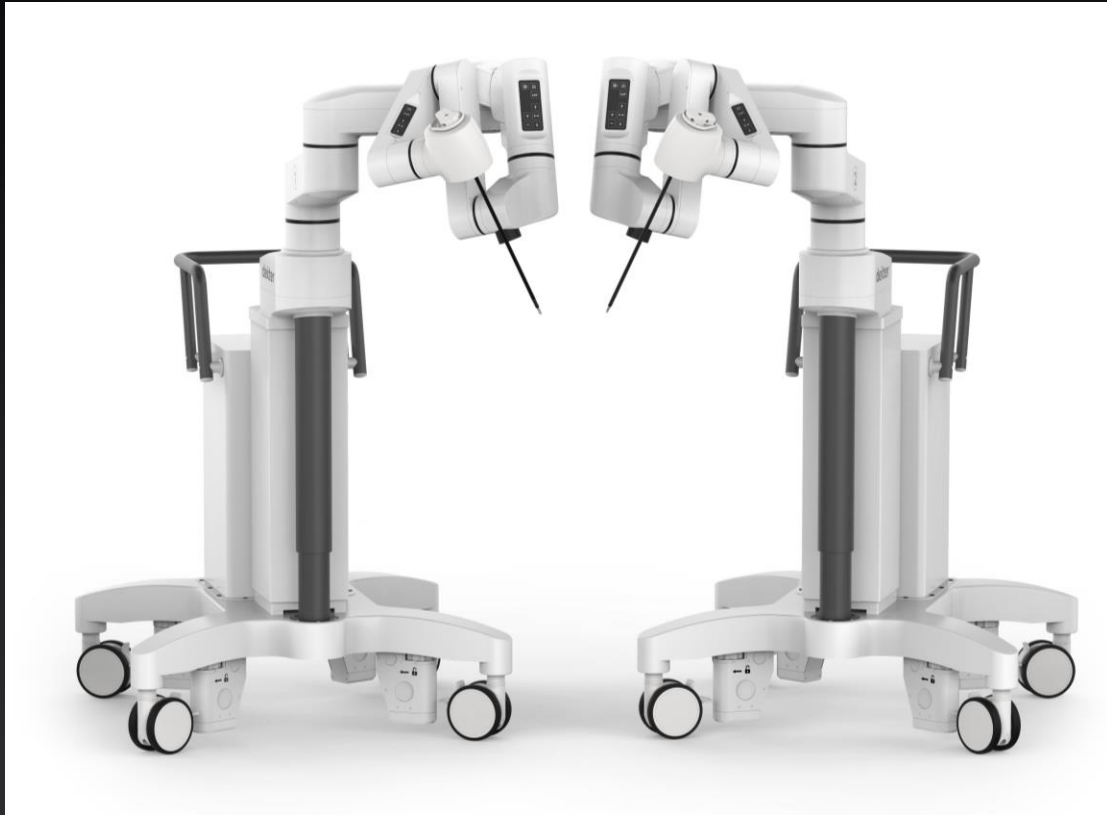
Modular Surgical Robot with
Immersive Surgeon Console

Comprehensive Instrument Offering
Advanced Instrument-Ready

CMR Versius 2026 FDA Cleared—
Cholecystectomy
General Surgery
40,000+ cases



Smaller Module Systems: Make Margin on Simpler Cases



Hospitals need margins

Distalmotion Dexter

FDA Cleared 2025

Basic General Surgery and Gynecology

Uses lap cameras

1/3 cost of DV

Moves from room to room



Smaller Module Systems: Robotic Surgical Assistant



Moon FDA Cleared 2025

All Specialties

AI camera tracking

Uses standard lap instruments and cameras

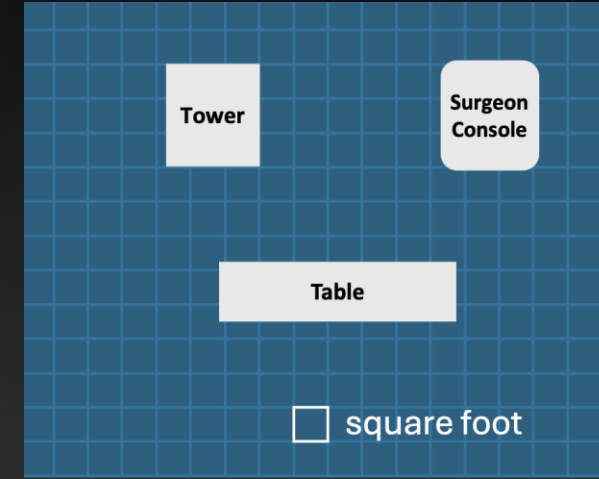
Designed for efficiency in outpatient procedures and driving surgeon autonomy

1/4 to 1/5 cost of DV

Hospitals need margins



Table Integrated Arms: Modular Access Points without the Carts--Ottava



- I have been part of the OTTAVA program since its inception.
- Table integrated arms—no modules no booms
- What most surgeons will comment on is the architecture – the arms stowed underneath the bed until deployed.
- FDA Clearance NOW—General Surgery
- Performance matching DV

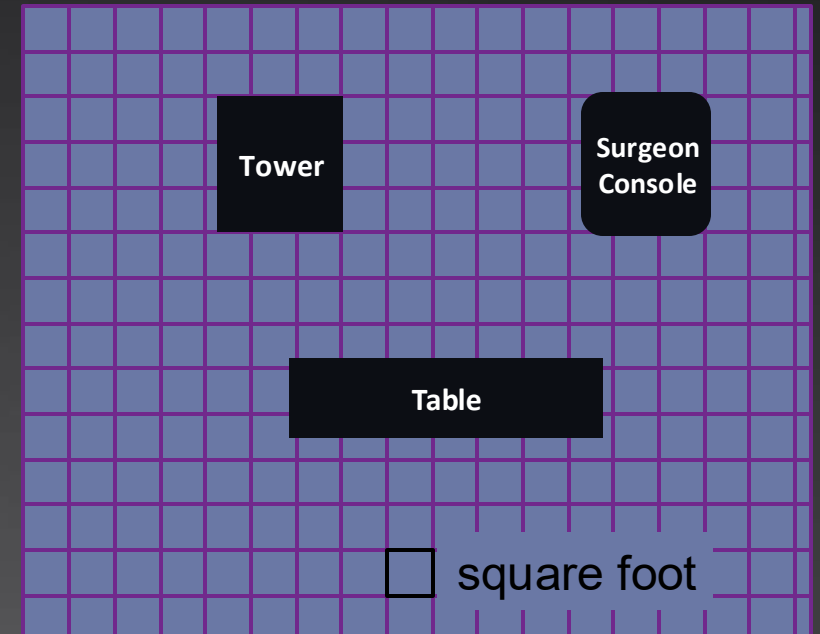
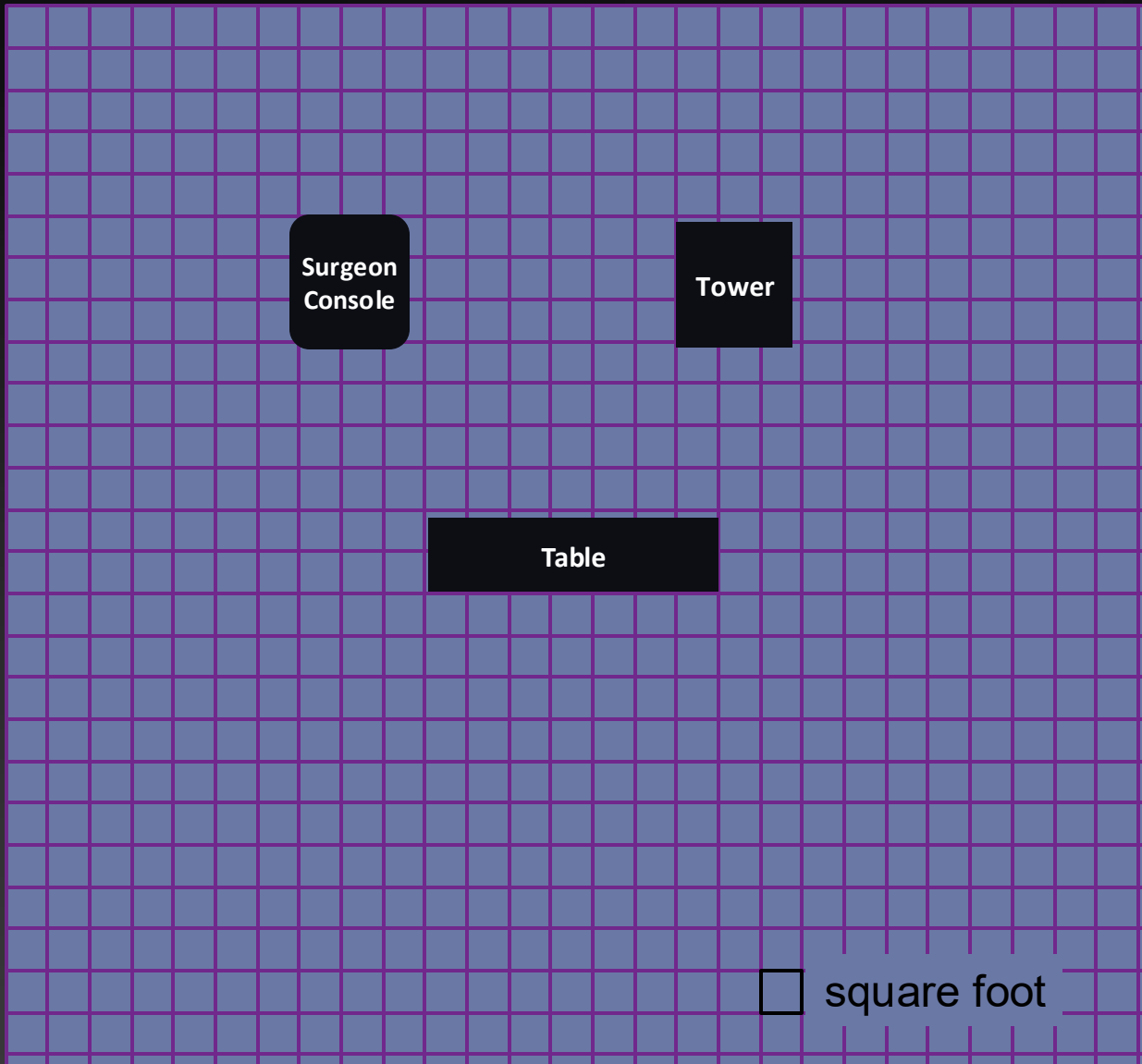
March 2025

Footprint in Operating Room

5 of 6 sites used non-robotic
ORs for study procedures

← Largest OR:
694 sq. ft. (64.5 m²)

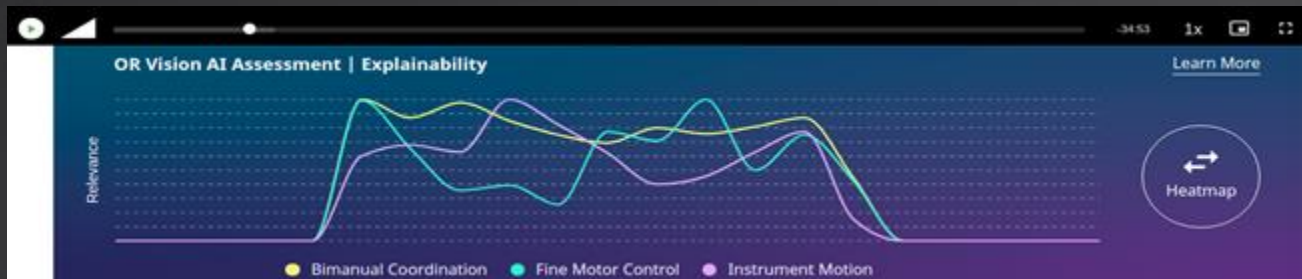
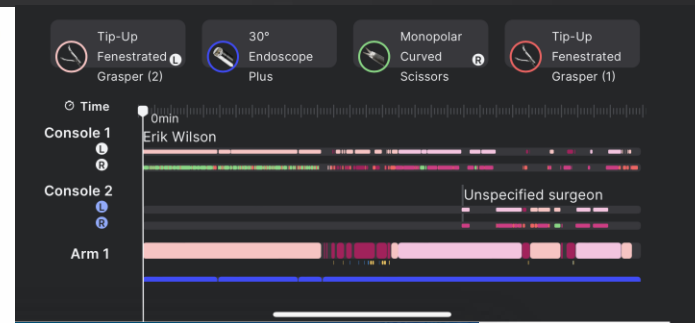
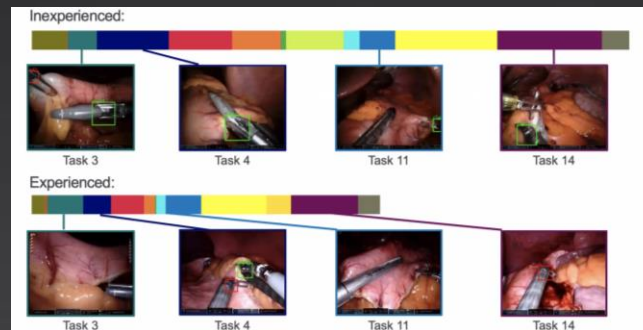
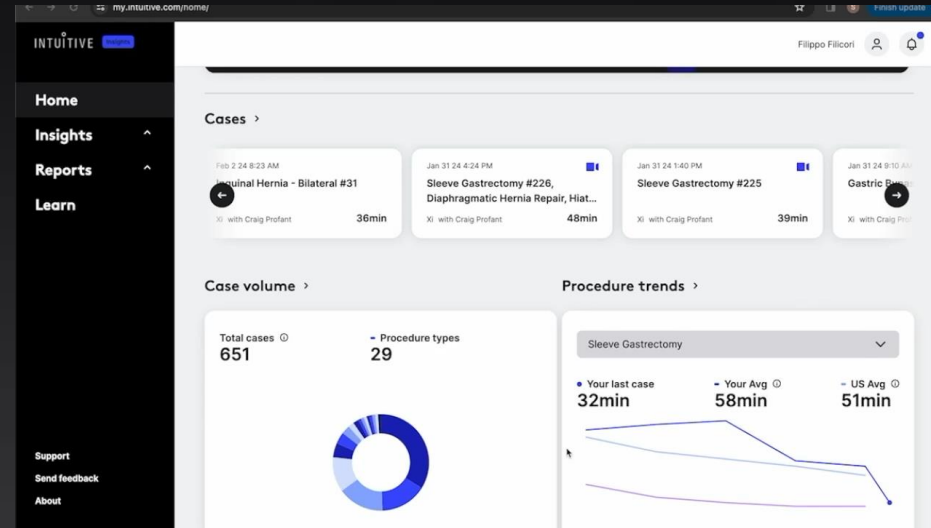
Smallest OR:
243 sq. ft. (22.5 m²)



AI in Bariatric Surgery

Video, Room, Kinematic, Ergonomic and EMR data

OR Black Box-Surgery Video, Room Video, EMR
Proximie-Surgery Video
Theator-Surgery Video, EMR
Touch Surgery-Surgery Video
C-SATS-Surgery Video
Activsight-Surgery Video
Versius-Surgery Video, Kinematic
Orpheus/Hub-Surgery Video, Kinematic
Apella-Room Video
Artisight-Room Video
CareSyntax-EMR
Qventus-EMR
Moon-Field and Surgeon Video



Kinematics: Robotic Objective Performance Indicators

Completion time

Camera activation count

Camera control duration

Camera distance traveled

Instrument distances and trajectories

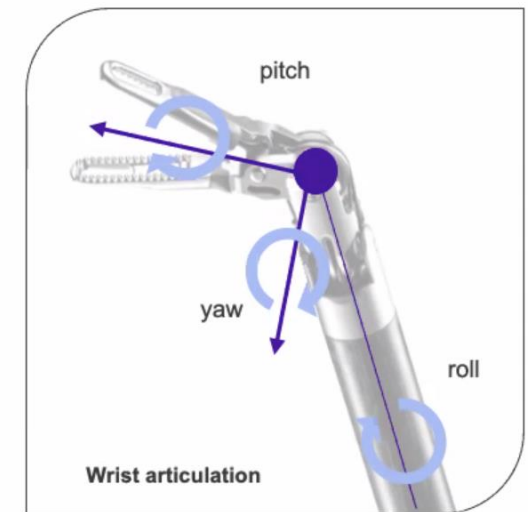
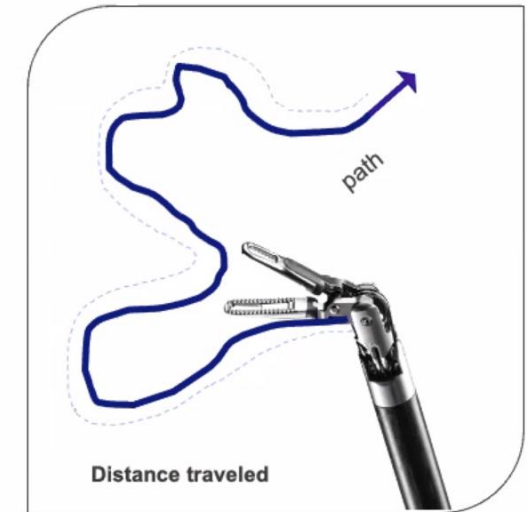
Movement speeds

Third arm swap count

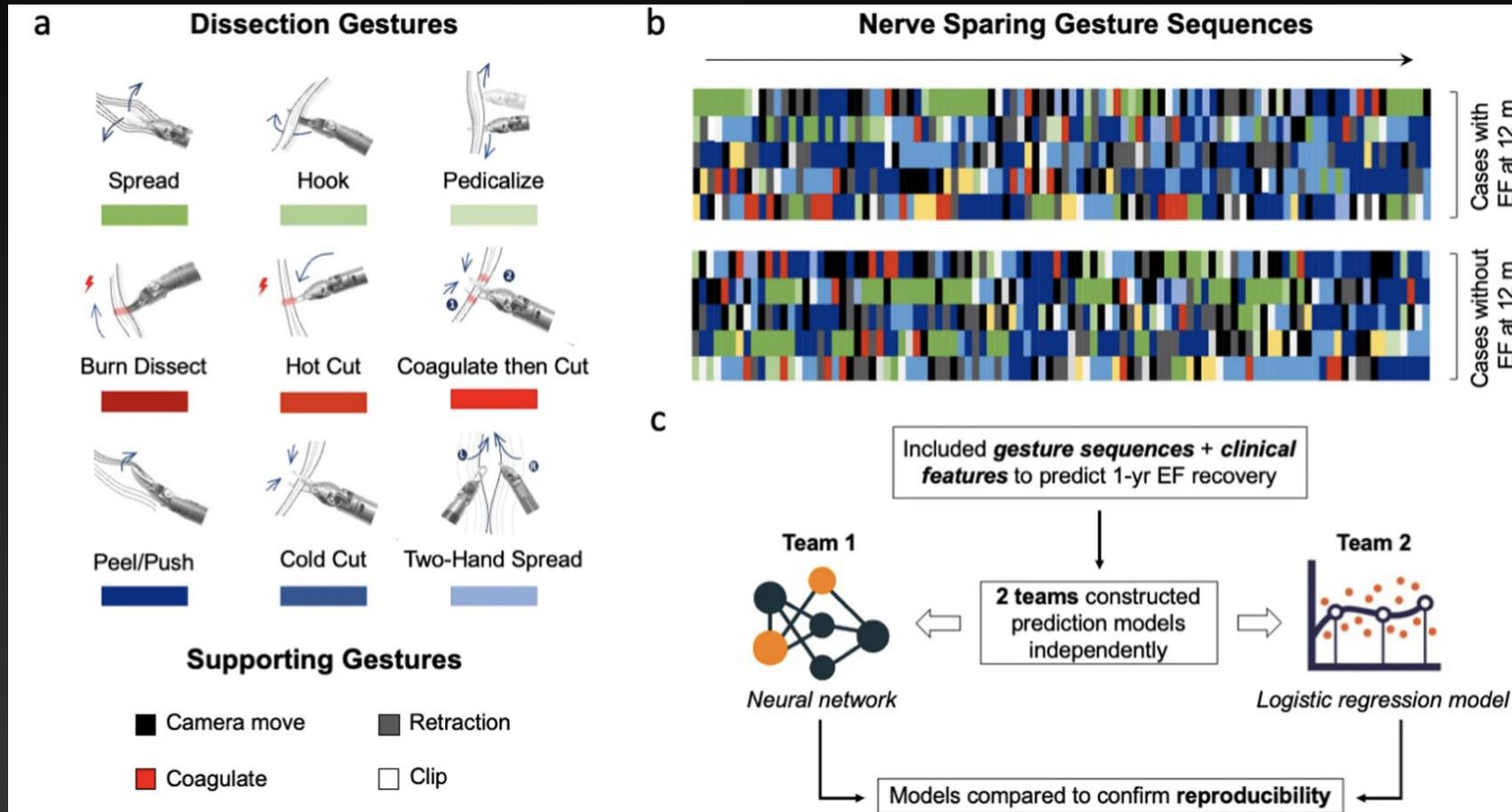
Ratio of dominant / non-dominant arm use

Wrist articulation

Instrument idle time



Kinematics: Robotic Gestures



a Gesture classification, including 9 dissection gestures and 4 supporting gestures. **b** Color-coded nerve-sparing gesture sequences (showing only the first 100 gestures). Colors represented corresponding gestures in **a**. **c** One-year EF recovery prediction model construction process. Two teams independently constructed and tested their prediction models to confirm the reproducibility of results.

AI Generated Op Notes: Theator/Activ/Nvidia

Problem

Inefficient surgical documentation workflow cause incomplete and inaccurate notes

Physician Burnout

200% increase in medical errors

Denials

Up to 65% due to insufficient documentation

Solution

Activ Co-Pilot populates image snapshots and a corresponding written description of complex and abnormal anatomy, pathology and physiology observed during a surgical case. This is particularly useful when unforeseen intraoperative complications or delays occur, and the reimbursement opportunity substantially increases (2-3X) for hospitals and physicians.

Use Case 1: Lap Chole

- Visceral and vascular injuries
- Bile duct injury

\$8k increase in reimbursement

Use Case 2: Colorectal

- Bowel injury, obstruction, perforation, ischemia, fistula
- Hemorrhage

\$21k increase in reimbursement

Question: During a cholecystectomy, it is crucial to manage the surrounding organs and structures for a clear view and safe removal of the gallbladder. Given the current stage of preparation, how are the surgical tools being utilized to facilitate this process, and what might be the reasons for the specific actions being performed by the graspers?

Answer: In the image of the cholecystectomy surgery, there are three graspers at work. One grasper is engaged with the gallbladder, likely holding it steady to either move it into a better position for the procedure or to provide tension so that the structures around it can be more easily seen or accessed. This is a common step to expose the cystic duct and artery which need to be clipped and cut during the surgery. Another grasper is retracting the liver; this is done to provide access to the gallbladder underneath it, as the liver can obstruct the surgical field if not retracted. The liver retraction also helps in reducing the risk of liver injury during the surgery. The third grasper does not have a specific verb or target associated with its action, indicating that it may be in transition or its purpose at the moment of the image is not defined. It could be used for a variety of tasks such as moving other tissues out of the way, providing additional tension or counter-tension, or it could be about to engage with another structure.

Solution Prototype



Characteristics of an ideal Surgical Digital Analysis Tool?

- Makes everyone safer
- Makes everyone more efficient
- Doesn't annoy us
- Deploys easily
- Brings financial value
- Doesn't create false incentives

Staple Firing Kinematics with Outcomes-Filicori

Characterizing Advanced Stapling Technique Using Objective Performance Indicators in Robotic-Assisted Sleeve Gastrectomy: A Retrospective Cohort Study

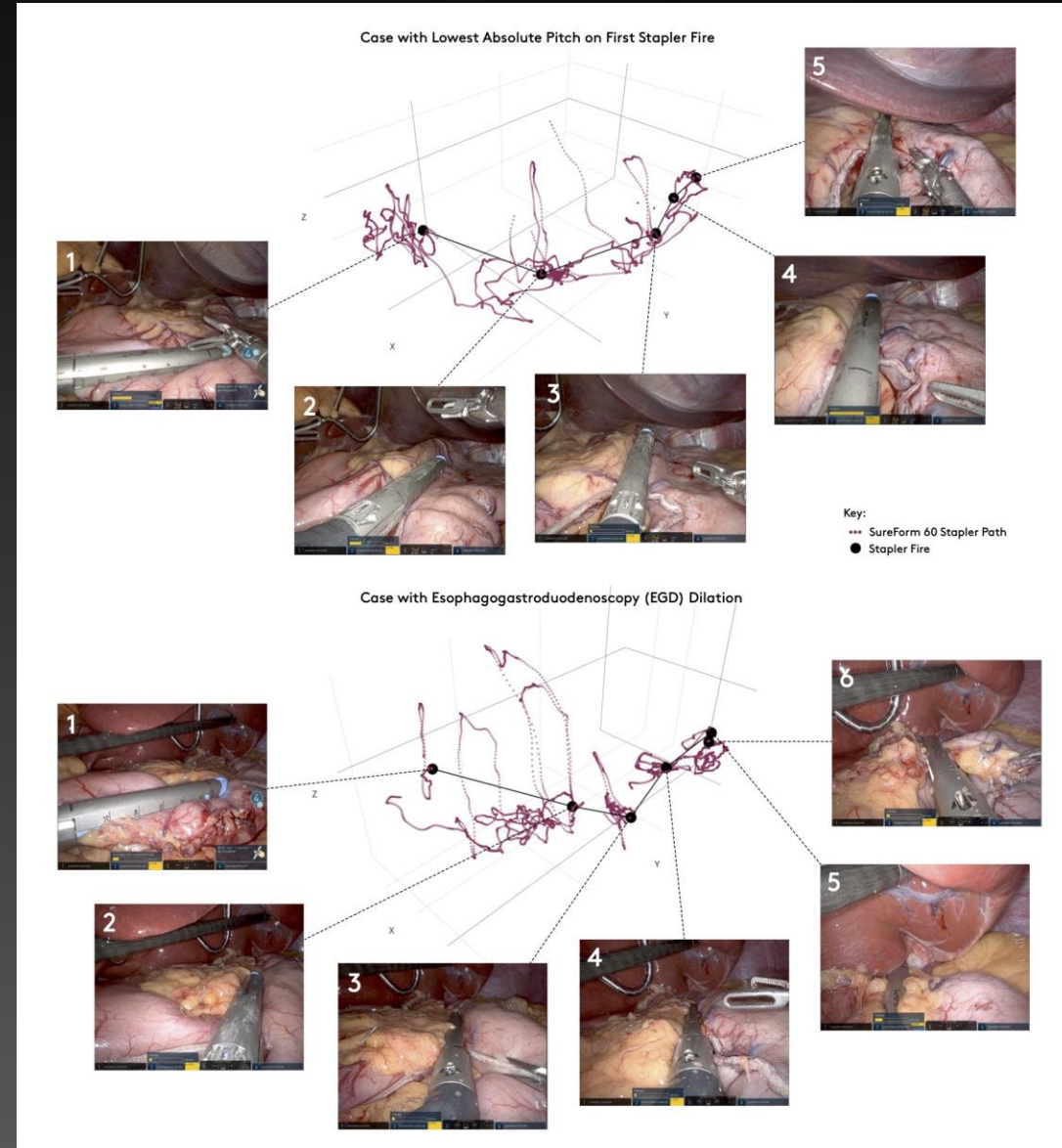
Sarah Choksi, MD^{1,2}, Bishaka Hirachan, BS^{1,2}, Jon Winalski, MD^{1,2}, Kavita Jain, MD^{1,2}, Ruben Salas-Parra, MD¹, Craig Profant, MD^{1,2}, Dimitre Stefanov, PhD^{1,3}, Max Berniker, PhD⁴, Vikrom Dhar, MD^{1,2}, Mitchell Roslin, MD^{1,2}, Andrew Yee, PhD⁴, Filippo Filicori, MD^{1,2}

Objective Performance Indicators

Sureform stapler in 344 robotic sleeve gastrectomies and correlate these measures with postoperative outcomes.

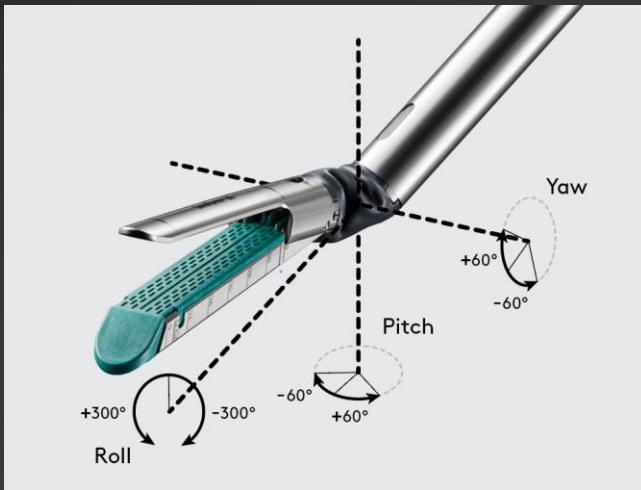
1. Stapling angles correlate with postoperative PO intolerance and staple line leaks

2. Cartridge staple height and peak firing force do not correlate with postoperative bleeding .

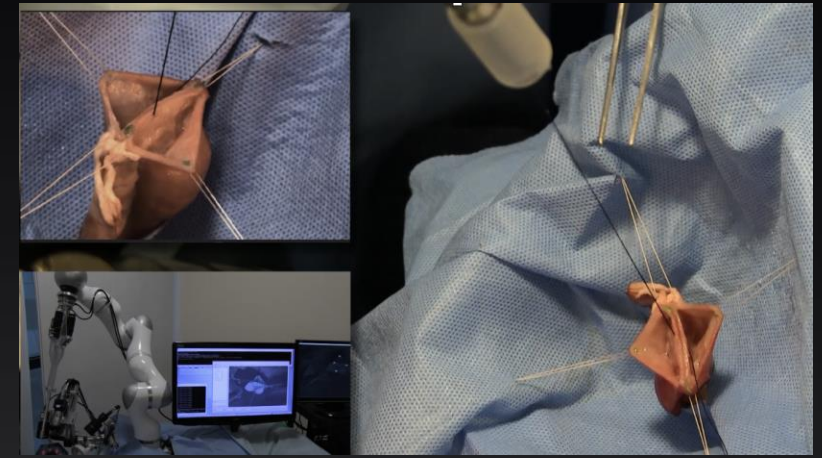


Improving the Algorithm

- * SmartFire can now pause more frequently throughout a fire to allow more time for tissue to compression
- * These changes were made to balance well with good staple line formation
- * Forcefire allows override



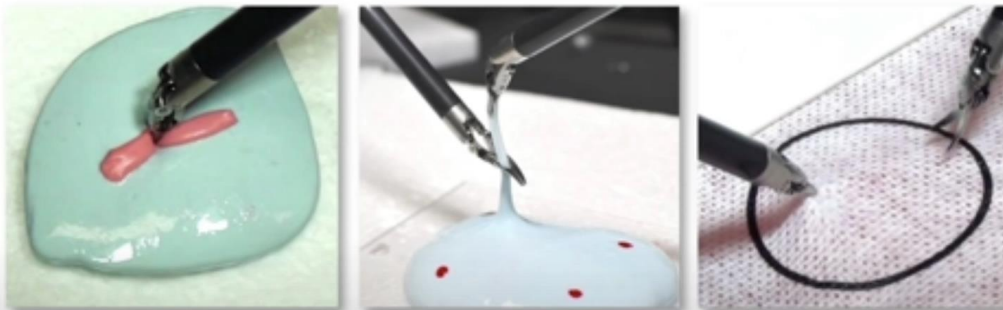
Task Autonomy



Autonomous Robot Surgery

Performing Surgical Subtasks without Human Intervention

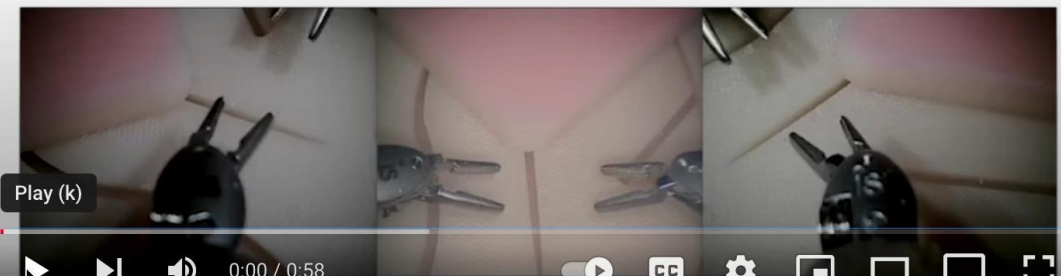
UC Berkeley, October 2014



Adithyavairavan Murali, Siddarth Sen, Ben Kehoe, Animesh Garg,
Seth McFarland, Sachin Patil, W. Douglas Boyd, Susan Lim,
Pieter Abbeel, Ken Goldberg



Surgical Robot Transformer: Imitation Learning for Surgical Tasks



Play (k)

0:00 / 0:58

High Performance Robotics

We are still 20 minutes slower
on average cases

Reduced Latency

Reverse Scaling

Rotational Scaling

Very fast instrument
exchanges

More ports and arms

Multiuse instruments

Combined endolumenal and
laparoscopy at one console



Telesurgery

What Is the Goal of Telesurgery?

Get the skill set to the patient

Within a hospital-one surgeon available for certain tasks

Within a hospital system-one surgeon for complex case support

Within a region/country/global-surgeon for remote complete surgery

Rural health deserts and emergency interventions

Telesurgery and Task Autonomy Overlay



Endoscopic Sleeve Gastroplasty

Endoscopic sleeve gastroplasty for treatment of class 1 and 2 obesity (MERIT): a prospective, multicentre, randomised trial



Barham K Abu Dayyeh, Fateh Bazerbachi, Eric J Vargas, Reem Z Sharaiha, Christopher C Thompson, Bradley C Thaemert, Andre F Teixeira, Christopher G Chapman, Vivek Kumbhari, Michael B Ujiki, Jeanette Ahrens, Courtney Day, the MERIT Study Group, Manoel Galvao Neto, Natan Zundel, Erik B Wilson

THE LANCET

FDA MARKET AUTHORIZATION

AMA CPT Category 1 Code Jan 2026

USGI POSE, Endomina, Nitinotes



Endolumenal Robotics-Access and Actuation

Neptune-
Digital Flexible shafted transoral or
transanal with robotic driven
camera

Endoquest

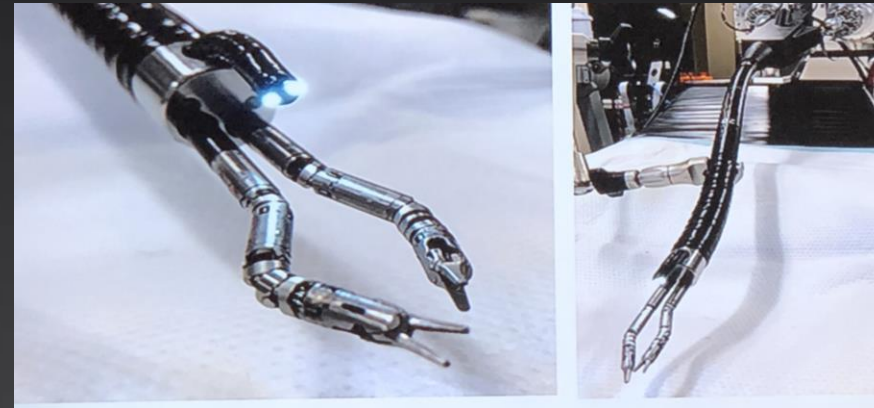
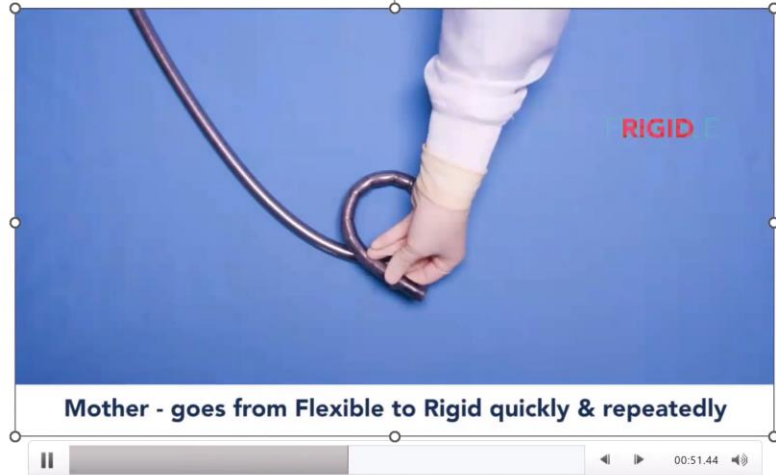
3 arms in 1 flexible port

-Open surgeon console

-Limited excursion of arms

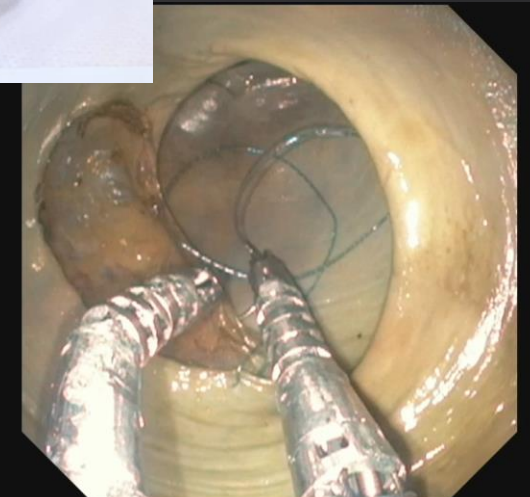
-Goal towards 15mm diameter and
gastric length

FLEXIBLE ROBOTICS – HOW IT WORKS



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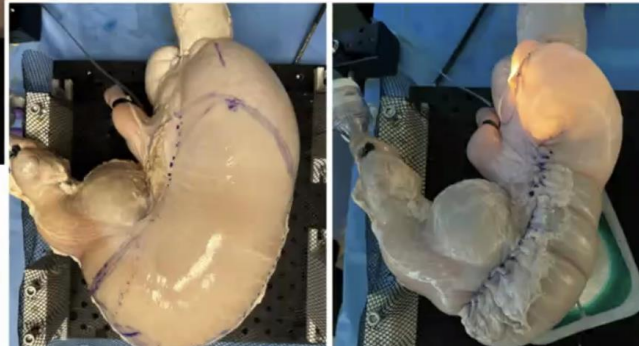
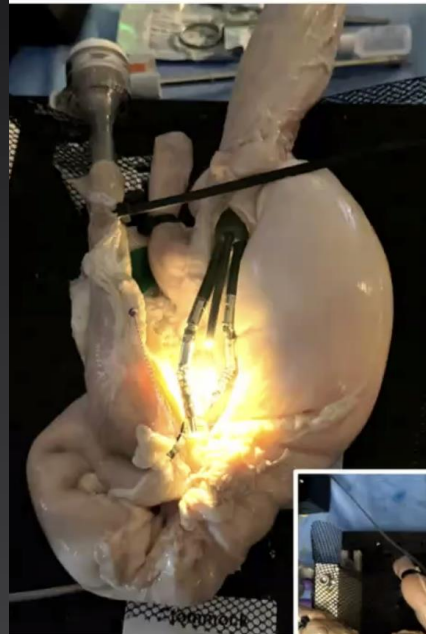
■■■■/----(0/38)
EndoES Cam1



Endoquest Robotics



New Horizons



Surgery vs Endoscopy? No Surgery and Endoscopy

Currently bariatric surgery is uniquely capable of efficient and reliable resectional and anastomotic techniques that aren't manageable exclusively with endoscopy—yet

“Organ sparing” interventions are attractive to patients

Reduced or no incisions are attractive to patients so endoscopic and laparoscopic approaches should progress together

Laparoscopic surgery is not disappearing but will continue to evolve with combined approaches with endoscopic hybridization—ultimately CELRS!

Magnets make sense through multiple access sites and have the potential to make anastomoses safer and more efficient for both surgeons and endoscopists at varying skill levels.

The Big Ideas

The last 25 years robots hasn't changed dramatically in its form and function—Until NOW and everything should start moving much faster

- * Digitization of the OR—engaging visual, kinematic, autonomy, telesurgery
- * Endolumenal growth—just pick up the scope, it will become increasingly important in bariatric surgery and also robotic
- * Combined laparoscopic and endoscopic approaches—surgeons have the advantage
- * Ergonomics—ignoring our own health hurts our patients
- * Higher performance robotic systems with more choices-Raising the ceiling and not just the floor
- * Value based care becomes possible and appropriate in this new world



Erik B. Wilson, MD, FACS
Professor and Vice Chair of
Surgery
Division Chief, Minimally
Invasive Surgeons of Texas
University of Texas Health
Science Center at Houston

The 10th Annual Surgical Disruptive Technology Summit is the preeminent forum for innovation in general minimally invasive surgery bringing together entrepreneurs, venture capitalists, surgeons, and medical device companies all in one place to showcase new ideas, products and procedures. There will be multiple in depth panels in surgical robotics, endolumenal surgery, artificial intelligence, surgical training and many more.

THANK YOU
February 17-21, 2027
Houston Texas

