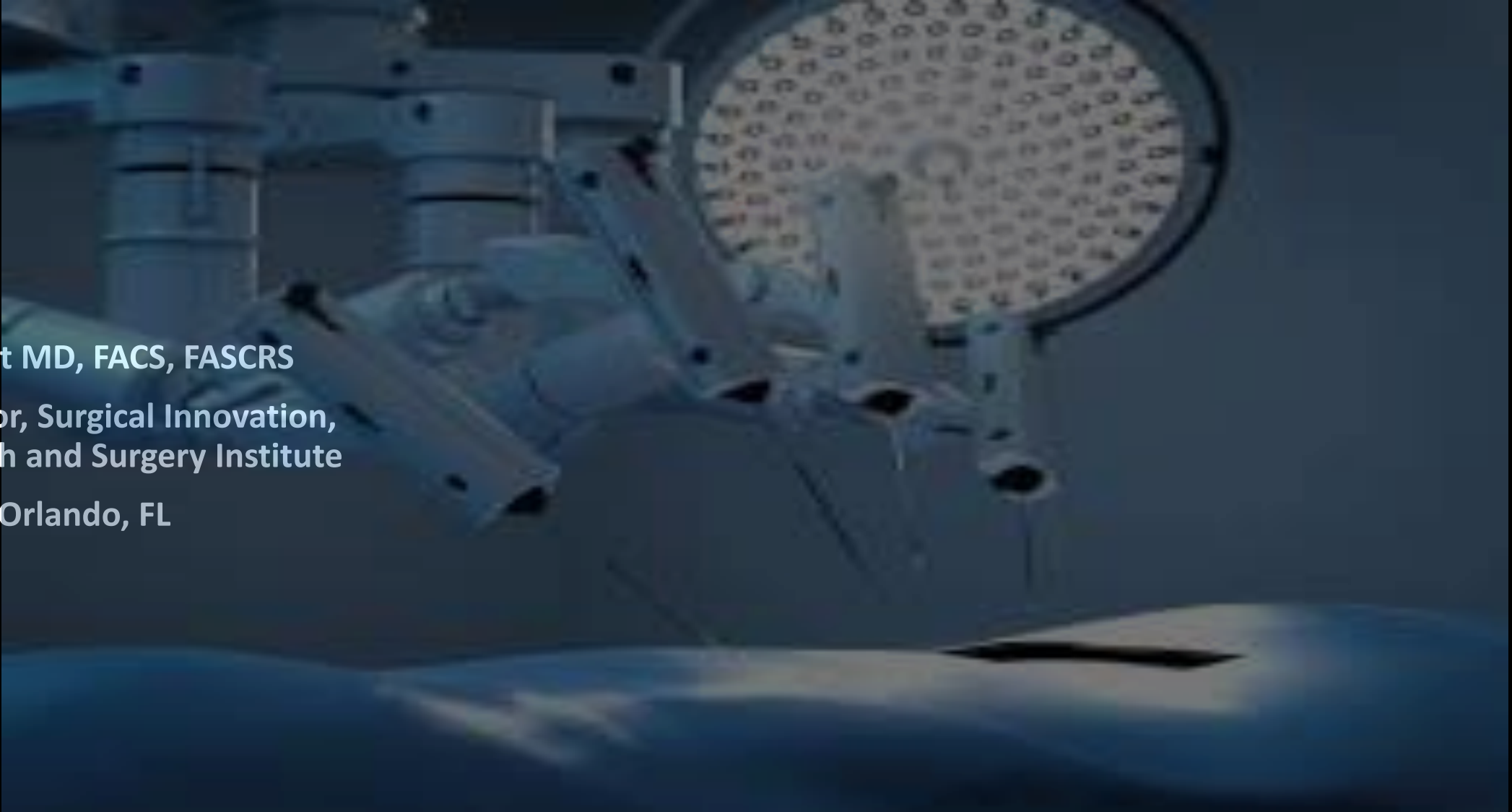


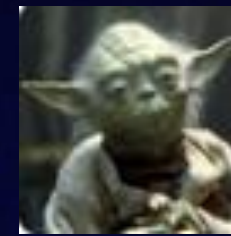
# What's New in MIS?

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**Medical Director, Surgical Innovation,**  
**Digestive Health and Surgery Institute**  
**AdventHealth, Orlando, FL**





# Disclosures



@tamisyoda

- Stryker
- Applied Medical
- Conmed
- Human Extensions
- LivsMed
- Proximie
- Astellas Pharmaceuticals
- Distal Motion
- Endo Quest



# Whats new in MIS?

Surgical Robots

Single Port Robots

Endoluminal robots

Visualization

- Fluorophores

Instrumentation

Computer Technology

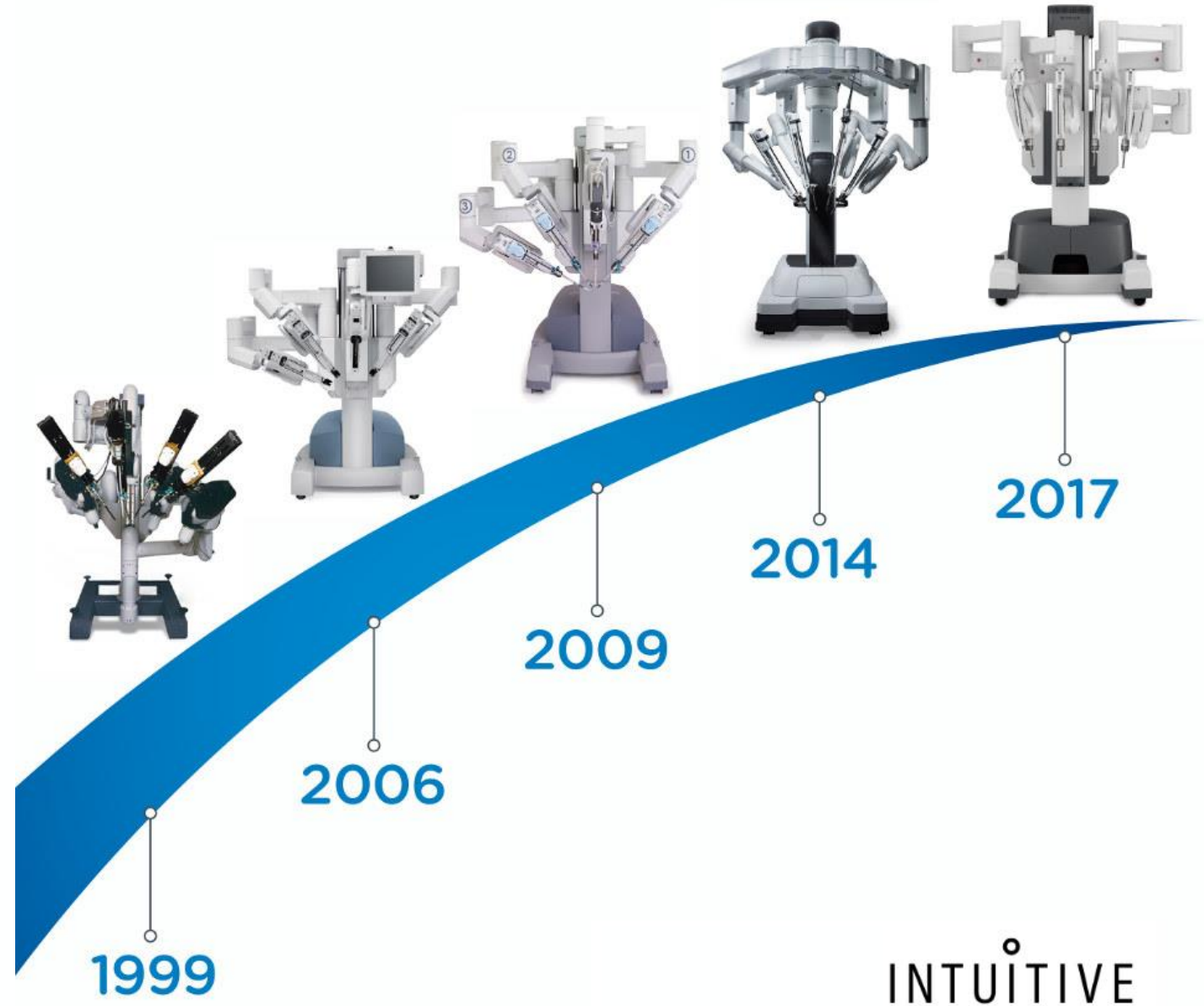


# Surgical Robots: David vs Goliath



# Intuitive Surgical

- Founded 1999
- Computer Vision



# 5 New Surgical Robots by 2025

Medtronic (Hugo)



CMR (Versius)



# 5 Surgical Robots by 2025

Distal Motion (Dexter)



Senhance

Avatera

Bitrack



# Single Port Robots

Intuitive sp

- Not FDA approved for colorectal surgery







# Single Port Robots

## Titan Sport (Enos)

SURGICAL WORKSTATION



PATIENT CART



MULTI-ARTICULATED  
INSTRUMENTS



# Single Port Robots

Virtual Incision (MIRA)














# SinglePort Robots

Hominis (Memic Innovative Surgery Ltd.)

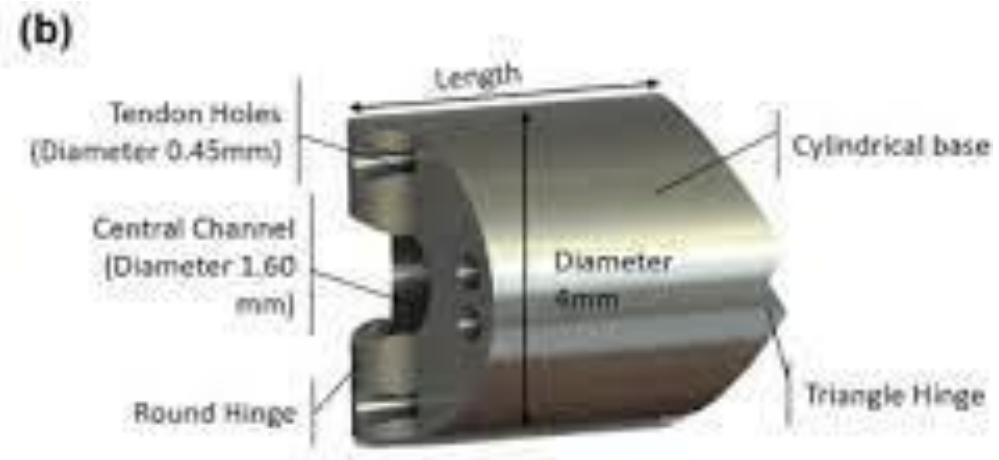
Vicarious

# Endoluminal Robots

|  |   |                                     |   |                                      |          |            |   |
|--|---|-------------------------------------|---|--------------------------------------|----------|------------|---|
| K-FLEX (KAIST) (Image: Permission from KAIST)                  |    | GI surgery and NOTES                | An endoscope (R)/two instruments (R)                        | 17 mm/4                              | 3.7 mm/2 | No         | Double-bending endoscope, payload enhanced instruments, and solo teleoperation/limited triangulation and large bending radius of endoscope                        |
| ColubrisMX ELS system (Colubris MX) (Image [156])              |    | GI surgery                          | A guide tube (R)/a camera (R)/two instruments (R)           | 22 mm/2                              | 6 mm/4   | No         | Articulating camera for angled view, triangulation using elbow joint, and solo teleoperation/large guide tube diameter  |
| Roboflex Avicenna (ELMED) (Image © 2020 ELMED Medical Systems) |    | Renal stone removal                 | A ureteroscope (R)  | Commercial ureteroscope              | NA       | CE         | Compatible with various commercial ureteroscopes and integrated irrigation control/limited ureteroscope translation range and no robotic assistance for basketing |
| MONARCH (Auris Health) (Image © 2022 Auris Health, Inc.)       |    | Lung biopsy and renal stone removal | A bronchoscope (R)/a sheath (R)                             | (Scope) 4.2 mm/2 (Sheath) 6.0 mm/2   | NA       | FDA        | Integrated electromagnetic navigation guidance, enhanced scope steerability, and tension relaxation during withdrawal/risk of electromagnetic interference        |
| ION (Intuitive) (Image © 2022 Intuitive Surgical)              |    | Lung biopsy                         | A catheter (R)  | (Catheter) 3.5 mm/1                  | NA       | FDA        | Optical fiber-based shape-sensing catheter/absence of direct camera vision during the use of biopsy needle  |
| Sensei X (Hansen Medical) (Image [228])                        |    | Endovascular surgery                | A catheter (R)/a sheath (R)                                 | (Catheter) 8 F/2 (Sheath) NA/1       | NA       | FDA        | Highly flexible catheter with small bending radius and tactile vibration/large size and relatively long setup time  |
| Magellan (Hansen Medical) (Image [32])                         |   | Endovascular surgery                | A catheter (R)/a sheath (R)/a guidewire (R)                 | (Catheter) 6 F/2 (Sheath) 9.5 F/1    | NA       | CE and FDA | Enhanced steerable active catheter and detection of excessive driving wire tension/lack of haptic feedback  |
| R-One (RoboCath) (Image © 2018 Robocath, Inc.)                 |  | Endovascular surgery                | A guide wire (R)/a balloon/stent catheter (R)               | Commercial guide wires and catheters | NA       | CE         | Compatible with market leading guidewires and catheters/NA  |
| Corpath (Corindus) (Image © 2022 Corindus, Inc.)               |  | Endovascular surgery                | A catheter (R)/a balloon/stent catheter (R)/a guidewire (R) | Commercial catheters                 | NA       | FDA and CE | Manipulation of all interventional devices, procedural automation, and teleoperation/lack of catheter articulation and loss of tactile feedback                   |

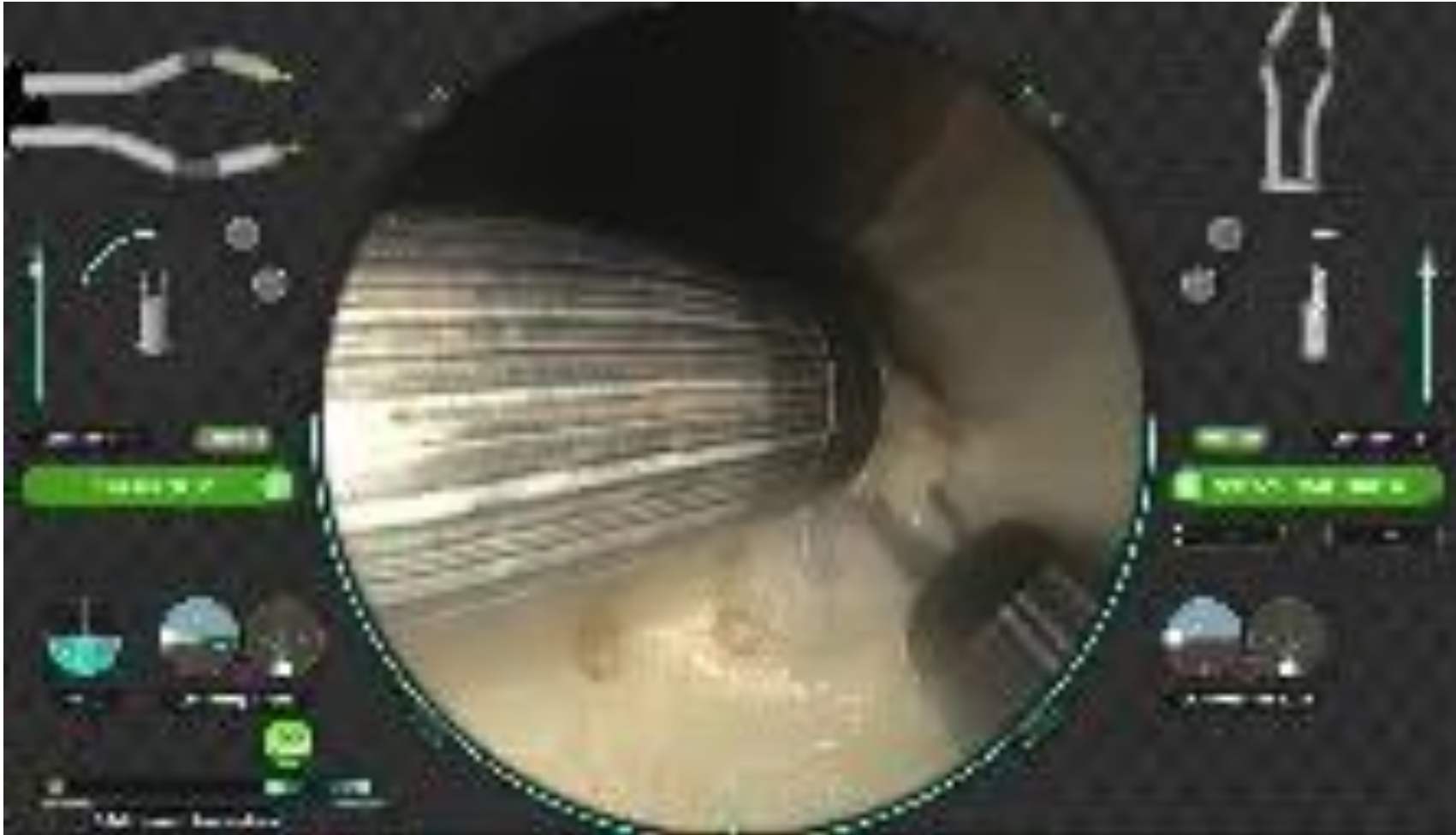
| System   |   | Clinical application                           | Manipulation type (M)/robotic (R))    | Endoscope (Guide tube) diameter/articulation DoF | Instrument diameter/articulation DoF | Approval   | Technical advancement/limitation   |
|--|---|--|---------------------------------------|--|--------------------------------------|------------|--|
| COBRA (USGI Medical) (Image [120])                     |    | NOTES  | A guide tube (M)/two instruments (M)  | NA   | NA                                   | No         | Shape-locking scope and triangulation/imprecise instrument control and impossibility of instrument change  |
| R-Scope (Olympus) (Image [121])                        |    | GI surgery and NOTES                           | An endoscope (M)/two instruments (M)  | 14.3 mm/3  | <2.8 mm/1                            | No         | Instrument channels with vertical and horizontal motion/complex manipulation and poor instrument performance in retroflexion   |
| DDES (Boston Scientific) (Image [123])                 |    | GI surgery and NOTES                           | An endoscope (M)/ two instruments (M) | 16 mm / 2  | 4 mm/2                               | No         | Ergonomic instrument driving handles/impossibility of retroflexion and limited triangulation   |
| EndoSamurai (Olympus) (Image [126])                    |    | GI surgery and NOTES                           | An endoscope (M)/ two instruments (M) | 15 mm/2  | NA/2                                 | No         | Triangulation and driving handles with laparoscopic paradigm/difficulty in bending due to protruded arms and instrument motion delay   |
| Anubiscope (Karl Storz/IRCAD) (Image [129])            |    | GI surgery and NOTES                           | An endoscope (M)/ two instruments (M) | 18 mm/2  | <4.3 mm/1                            | CE         | Distal-end mechanism for triangulation and ergonomic instrument driving handles/limited instrument DoF   |
| Micro Finger (Nagoya University) (Image [227])         |    | GI surgery and NOTES                           | An endoscope (M)/ two instruments (R) | Commercial endoscope                             | 2.6 mm/2                             | No         | The first prototype of a flexible surgical robot and thin instrument inserted through commercial endoscope channels/limited triangulation and force  |
| ViaCath (Endo Medical) (Image [133])                   |    | GI surgery                                     | An endoscope (M)/ two instruments (R) | Commercial endoscope                             | 4.75 mm/4                            | No         | Enhanced instrument articulation with two distal bending segments/difficult insertion into the GI track and insufficient instrument force  |
| EndoMASTER (Image [138])                               |    | GI surgery, NOTES, and Transoral head and neck | An endoscope (M)/ two instruments (R) | 12.6 mm/2 (Commercial endoscope)                 | <3.7 mm/4                            | No         | Triangulation with an elbow joint and thin instrument inserted through commercial endoscope channels/retraction only with left arm, occlusion of instrument tip, and no service channel available during bimanual manipulation |
| FLEX (Medrobotics) (Image [141])                       |    | Transoral head and neck, GI surgery, and NOTES | An endoscope (R)/ two instruments (M) | 15 × 17 and 18 × 28 mm <sup>2</sup> /2           | 3.5-4.0 mm/2                         | CE and FDA | Follow-the-leader mechanism for endoscope insertion, 3D HD vision, and laser instrument/limited endoscope bending angle, instrument torque, and grasping force   |
| STRAS (Univ. Strasbourg) (Image [147])                 |    | GI surgery and NOTES                           | An endoscope (R)/ two instruments (R) | 16 mm/2  | 3.5 mm/1                             | No         | End-tip mechanism for triangulation, solo teleoperation/limited instrument articulation DoF, and endoscope length  |
| RAFE (Kyushu University) (Image [151])                 |   | GI surgery                                     | An endoscope (R)/ two instruments (R) | 9.9 mm/2 (Commercial endoscope)                  | 2.6 mm/2                             | No         | Thin instrument inserted through commercial endoscope channel, solo teleoperation, and small radius of bending/limited triangulation and force   |
| i2 snake robot (Imperial College London) (Image [191]) |  | ENT surgery and GI surgery                     | An endoscope (R)/two instruments (R)  | 16 mm/6  | 3.8/5                                | No         | Endoscope and instrument with high articulation DoFs, integration with industrial robot arm, and solo teleoperation/limited control accuracy and lack of axial rotation and translation of instrument                          |
| ROSE (Korea University) (Image [152])                  |  | GI surgery                                     | An endoscope (M)/an instrument (R)    | Commercial endoscope                             | 16 mm/1                              | No         | Master interface enabling simultaneous instrument control with endoscope/large robot arm, unsmooth roll motion, and protruding instrument during insertion   |
| PETH (KAIST) (Image [154])                             |  | GI surgery                                     | An endoscope (M)/an instrument (R)    | Commercial endoscope                             | 6 × 6 mm <sup>2</sup> /2             | No         | Flexible transmission part without interference to endoscope bending/large robot arm, protruding robot arm during insertion, and assistant for instrument manipulation   |

# I2 Snake





# Endo Quest (formerly Colubris)



# Computer tech/software

Content managers

Telementoring

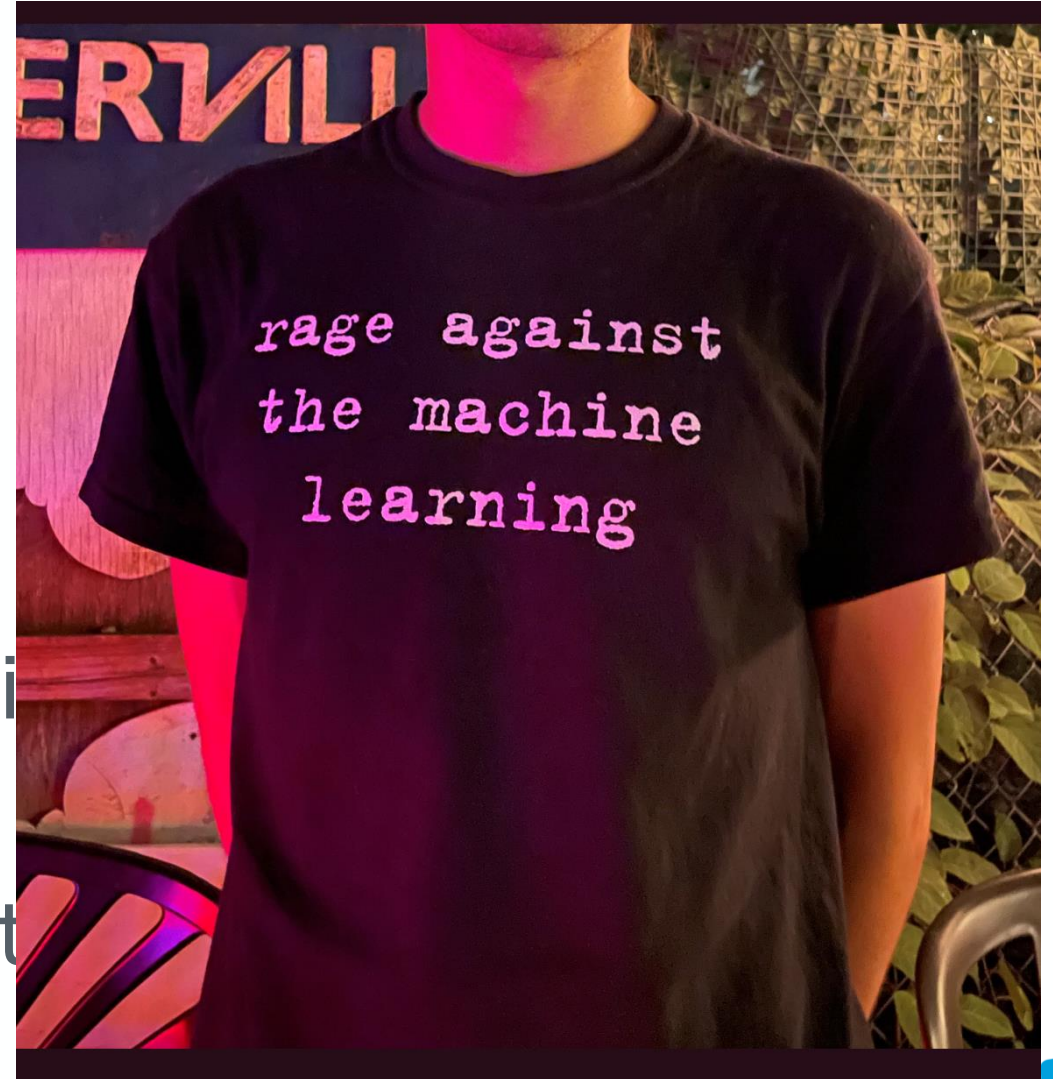
Augmented/virtual reality

Artificial Intelligence

Subjective assessment of technical skills

Navigation

Real time intraoperative support



# SECURE ACCESS TO SURGICAL VIDEOS AND DATA, FROM ANYWHERE



The DS1 computer records as you operate.

All out-of-body frames are automatically anonymized by AI, using our proprietary RedactOR™ technology. Tag points-of-interest during the operation for postoperative review.



Videos are seamlessly uploaded to a surgeon's private library - without the need for USB drives, DVDs or encrypted hard drives - and are accessible from anywhere.

Share with permitted colleagues, enabling never before learning or decision-making.



Review actual video of the operation in between cases.

Single-click annotation system allows for the easy addition of contextual information, or feedback.

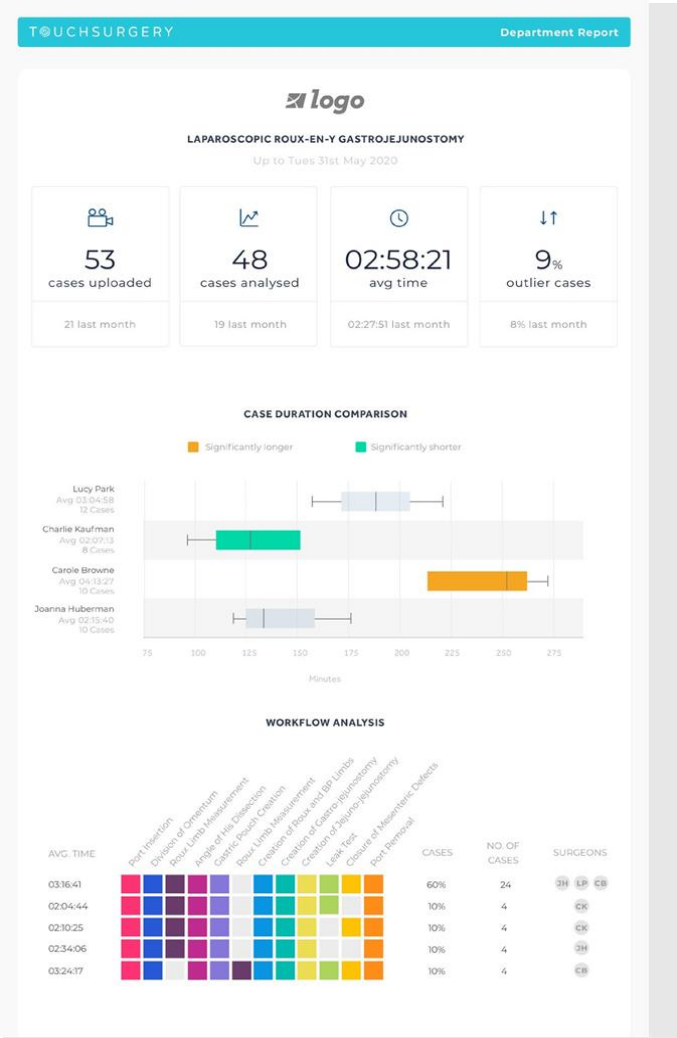


Smart data unlocks easier navigation when reviewing the video and insights.

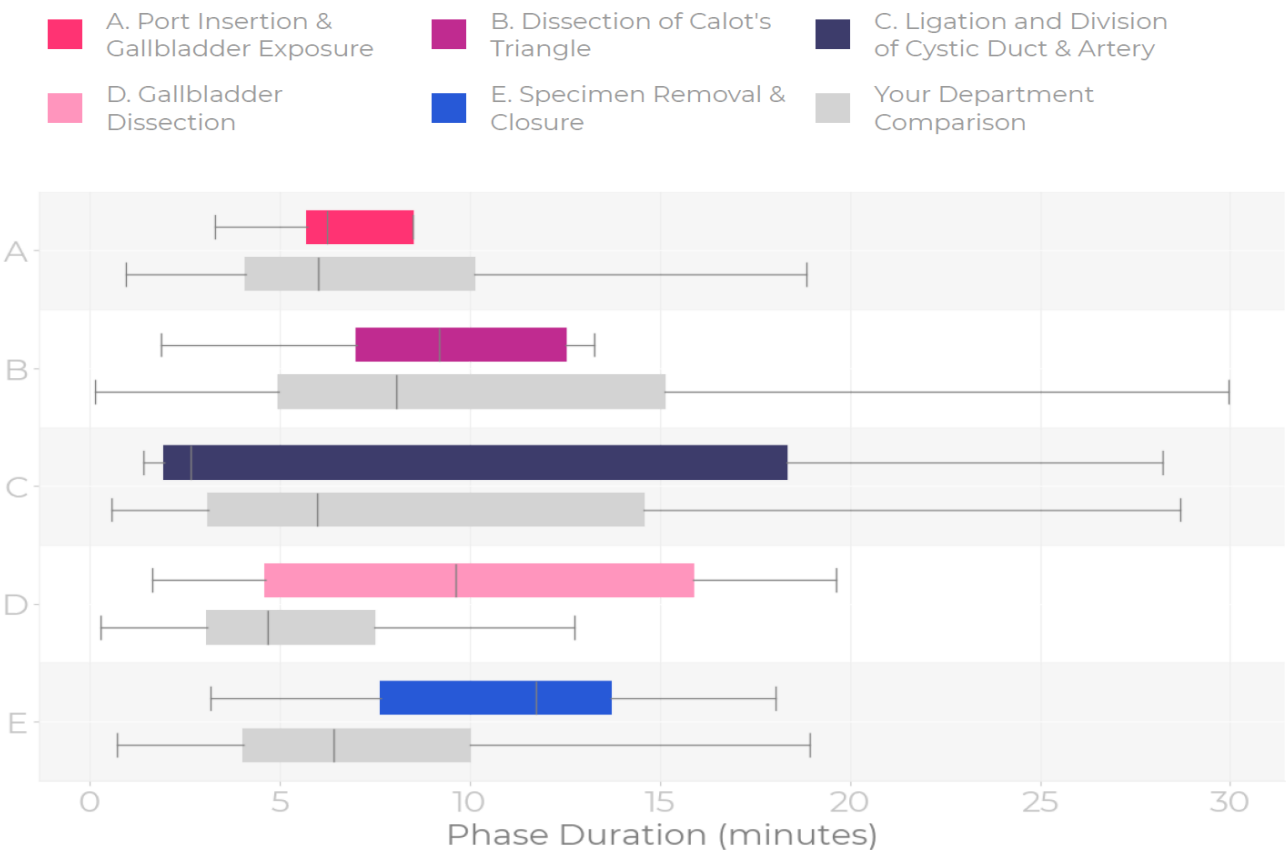


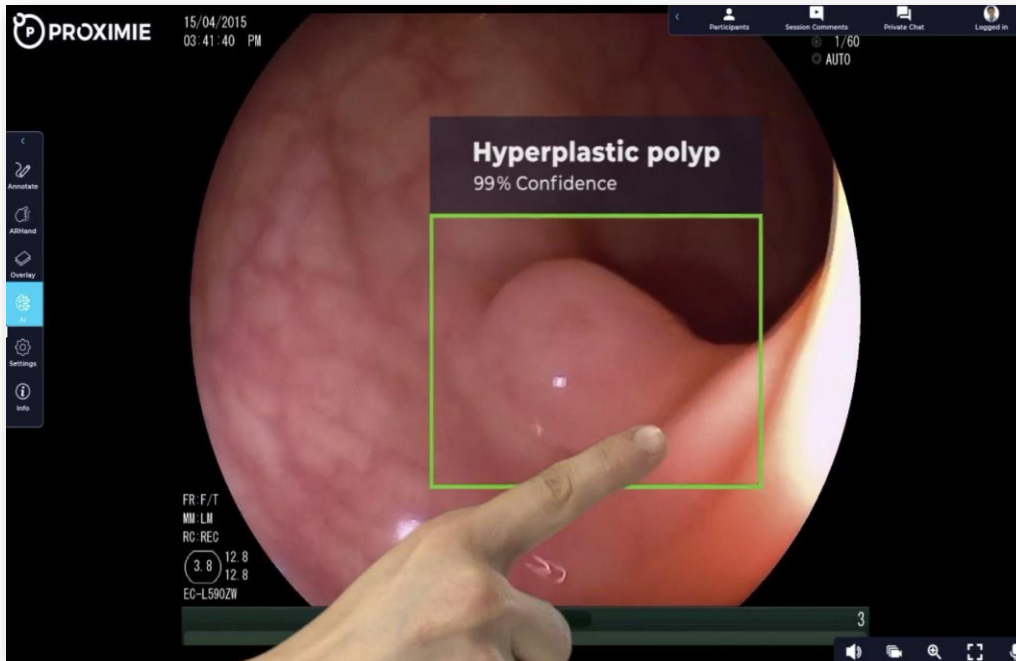
# TOUCH SURGERY ENTERPRISE

## OBJECTIVE INTRAOPERATIVE DATA SET



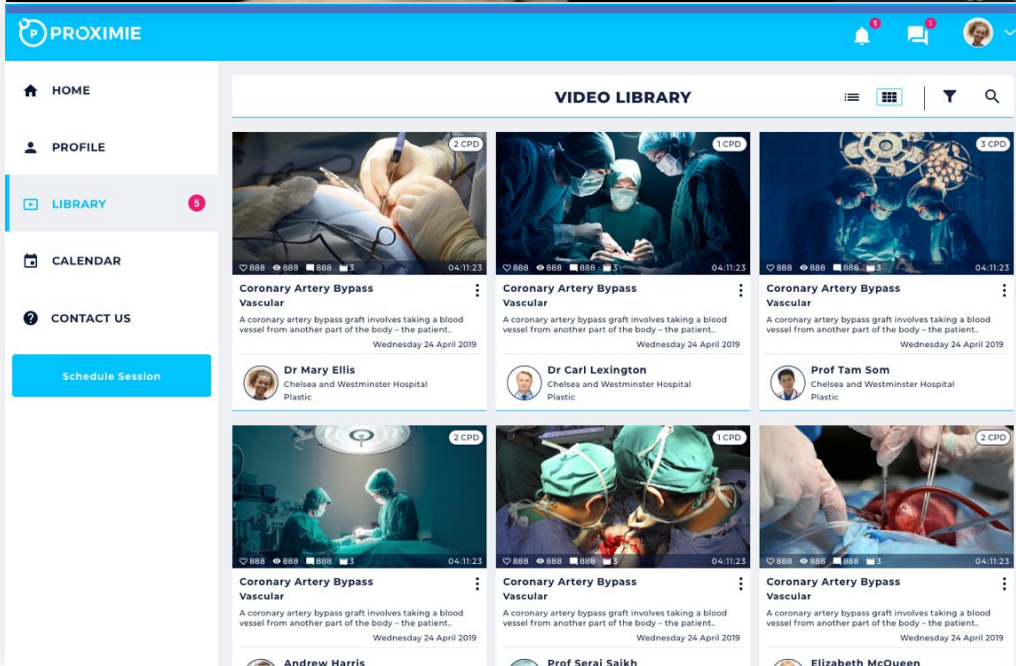
### PHASE DURATION COMPARISON





## LIVE ENVIRONMENT

# PROXIMIE IN ACTION

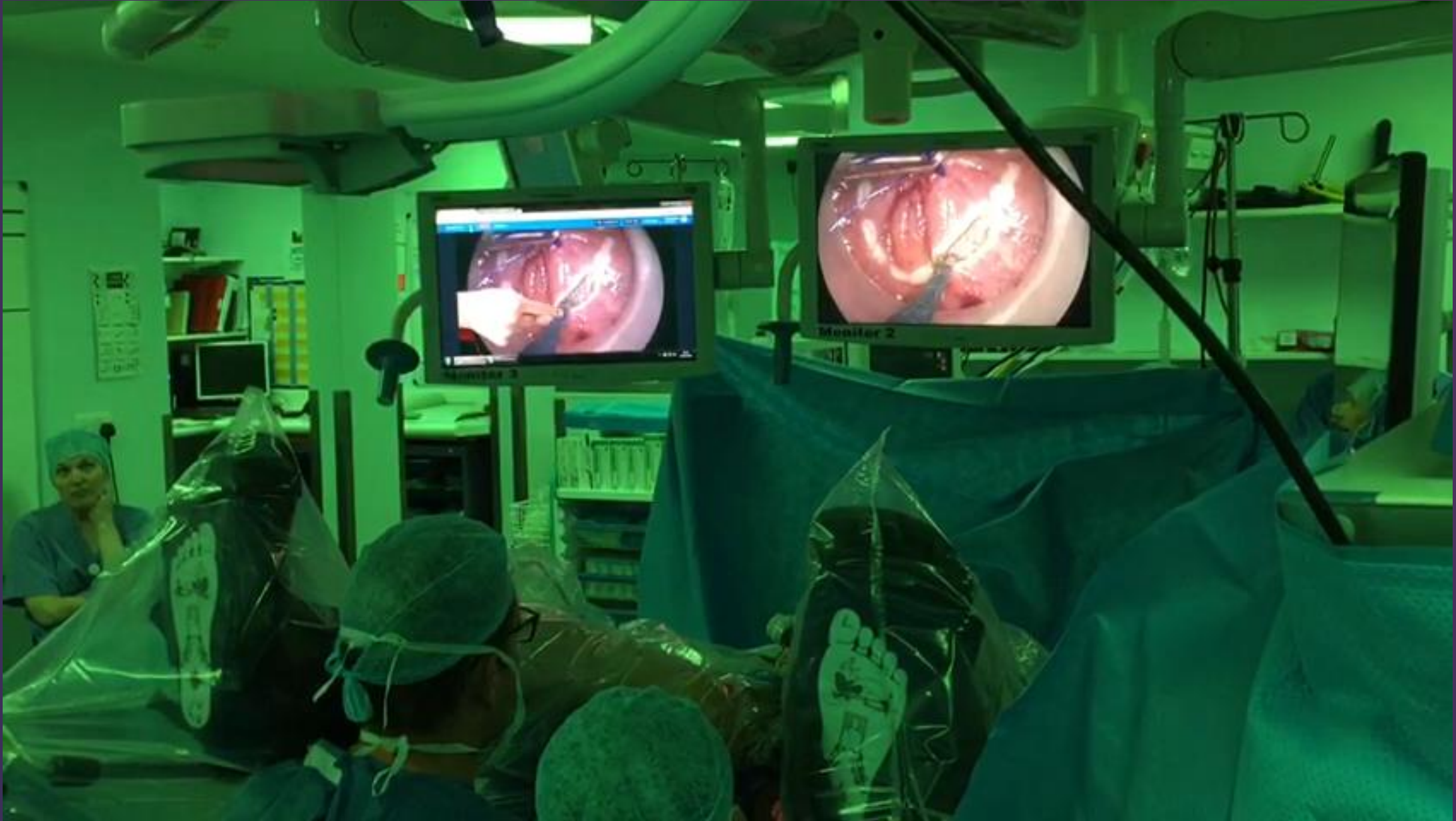


Proximie combines the best human expertise with advanced technologies (AR, AI, ML) to deliver unique insights to clinicians in real-time, before, during and after the procedure.

## PROXIMIE LIBRARY

## Colorectal Surgery – Remote Proctoring between Cardiff and Amsterdam

<https://app.aframe.com/links/c9140baf9daab31011bf5268952>





# More....

Intuitive Hub

BrainLab

Stryker

Olympus

Storz

Sony

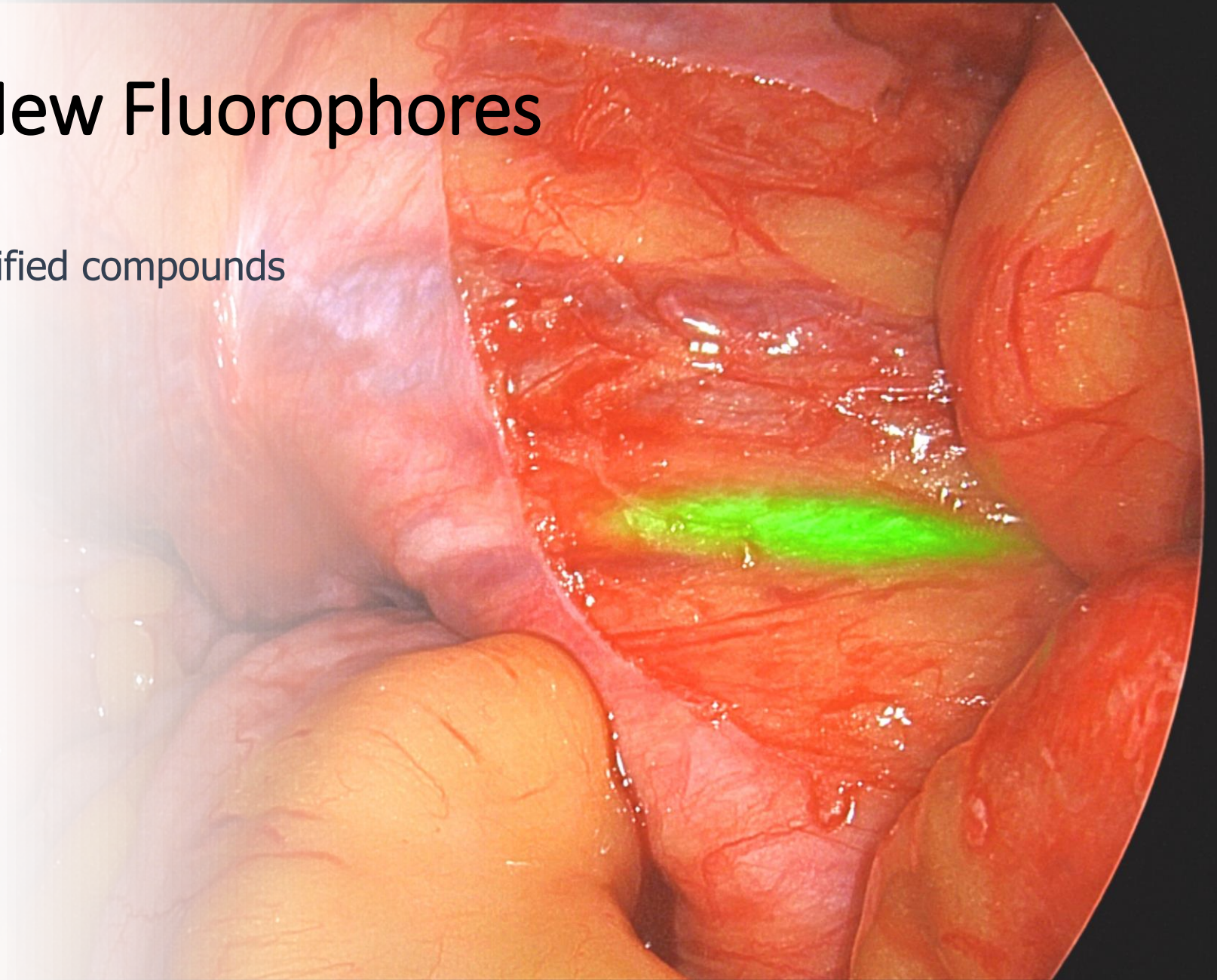
Theator

# Visualization

- Enhanced Icg
- Quantification/Time-flow curves
- 3-D
- Scope holders, visual tracking

# Visualization- New Fluorophores

- Indocyanine green modified compounds
- Intravenous dosing
- Metabolically inert
- Phase 3 trial



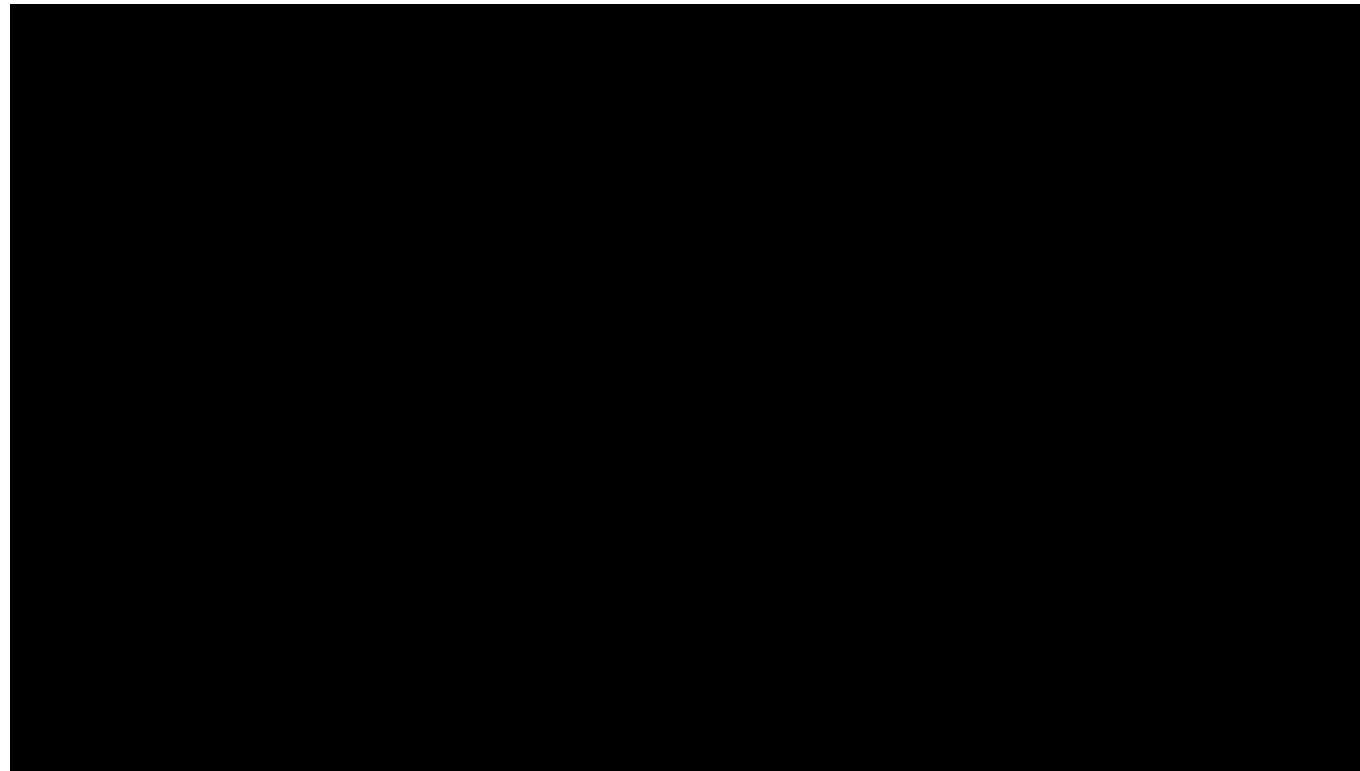
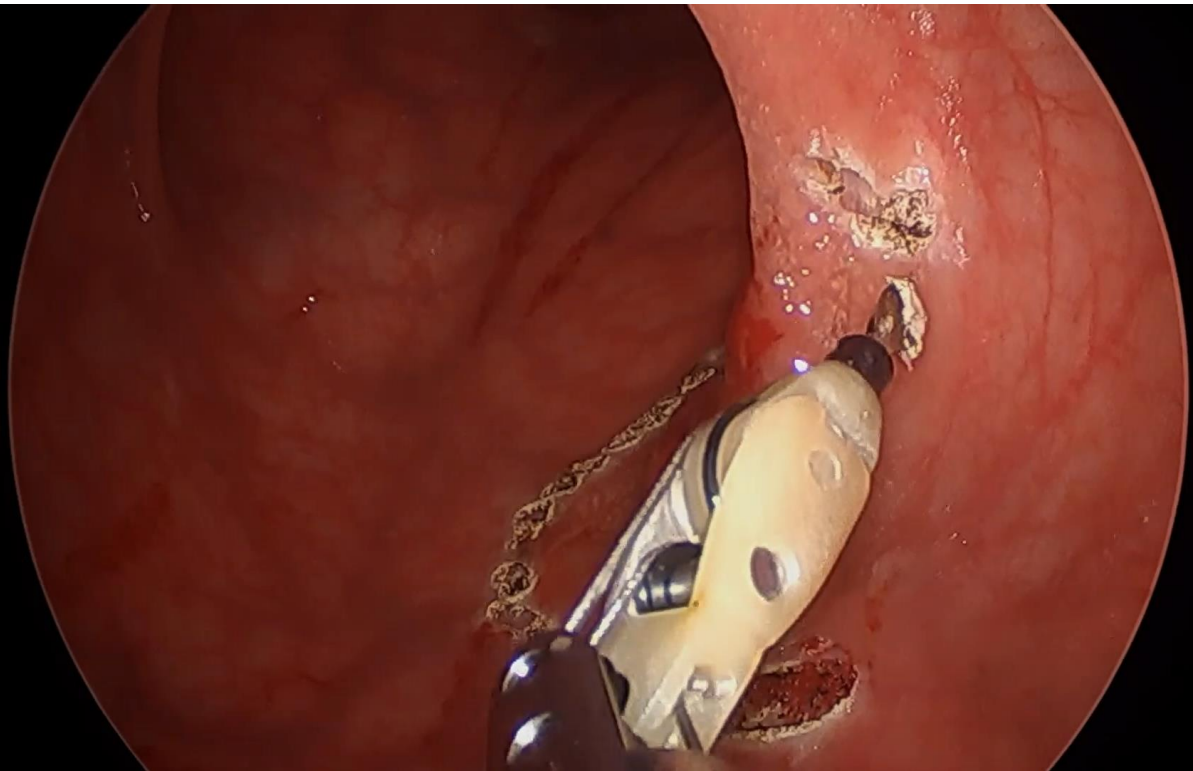
# Instrumentation

Human Extensions  
LivsMed





# Artisential/LivsMed



# Conclusions

Digitalization of operating room

Robotic MIS surgery (endoluminal surgery)

Artificial Intelligence (friend or foe)