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L'INTELLIGENZA ARTIFICIALE APPLICATA ALLA SALA OPERATORIA

20-22 SETTEMBRE 2023
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Title: Artificial Intelligence in the Operating Room: Transforming Surgery

Introduction

Artificial Intelligence (AI) has made remarkable strides in various industries, including healthcare. In recent years, the integration of AI into the operating room (OR) has been a game-changer, revolutionizing surgical procedures and patient care. This article explores the role of AI in the OR, its applications, and the transformative impact it has on surgery.

AI in Surgical Planning

AI plays a crucial role in the preoperative phase of surgery. Surgeons can harness the power of AI to assist in surgical planning and decision-making. Advanced algorithms analyze patient data, including medical records, imaging scans, and historical surgical data, to create personalized surgical plans. This aids in optimizing surgical approaches, minimizing risks, and enhancing patient outcomes.

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Enhancing Surgical Precision

One of the most significant advantages of AI in the OR is its ability to improve surgical precision. AI-powered surgical robots, such as the da Vinci Surgical System, are at the forefront of this transformation. These robots work in tandem with surgeons, translating their movements into precise, steady, and tremor-free actions. This heightened precision leads to smaller incisions, reduced trauma to surrounding tissues, and faster recovery times for patients.

Real-time Decision Support

During surgery, AI provides real-time decision support to surgeons. Computer vision systems can process live imaging data, assisting surgeons in identifying critical structures and abnormalities within the body. This guidance ensures that surgical instruments are precisely positioned and minimizes the risk of inadvertent damage to healthy tissues.

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Minimally Invasive Procedures

AI has played a pivotal role in advancing minimally invasive surgical techniques. By enhancing the capabilities of surgical robots, AI enables surgeons to perform complex procedures through small incisions. This leads to less pain, reduced scarring, shorter hospital stays, and a quicker return to normal activities for patients.

Continuous Monitoring and Alerts

AI-driven monitoring systems constantly track vital signs and other critical parameters during surgery. In the event of any irregularities or complications, these systems provide immediate alerts to the surgical team. This proactive approach enables swift intervention, potentially preventing adverse outcomes and ensuring patient safety.

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Challenges and Ethical Considerations

While AI in the OR offers immense benefits, it also presents several challenges and ethical considerations. Data privacy is a paramount concern, as AI relies on patient data. Healthcare institutions must uphold rigorous data security measures to protect patient confidentiality. Additionally, regulatory hurdles and the need to establish liability in the event of AI-related complications pose challenges that require careful consideration.

The Future of AI in the Operating Room

The future of AI in the OR holds great promise. As AI algorithms continue to evolve, they will provide more refined guidance to surgeons, enhancing surgical outcomes. Collaborative robots, or "cobots," are expected to become more commonplace, working alongside human surgeons to offer additional support and flexibility.

Personalized medicine will also benefit from AI in the OR. By analyzing each patient's unique medical data, AI can tailor surgical procedures and postoperative care to meet individual needs, further optimizing patient outcomes.

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Conclusion

Artificial Intelligence has become a transformative force in the operating room, elevating surgical precision, patient safety, and recovery outcomes. The integration of AI in surgical planning, real-time decision support, and continuous monitoring has revolutionized the way surgeries are performed. However, addressing challenges related to data privacy, regulation, trust, and equity is essential as AI continues to advance in the medical field.

The future of AI in the OR holds immense potential for further innovation and improved patient care. As AI algorithms become more sophisticated and collaborative robotics become widespread, patients can look forward to safer, more personalized, and less invasive surgical experiences. The partnership between human surgeons and AI in the OR is set to reshape the landscape of surgery, ultimately benefiting patients and healthcare providers alike.

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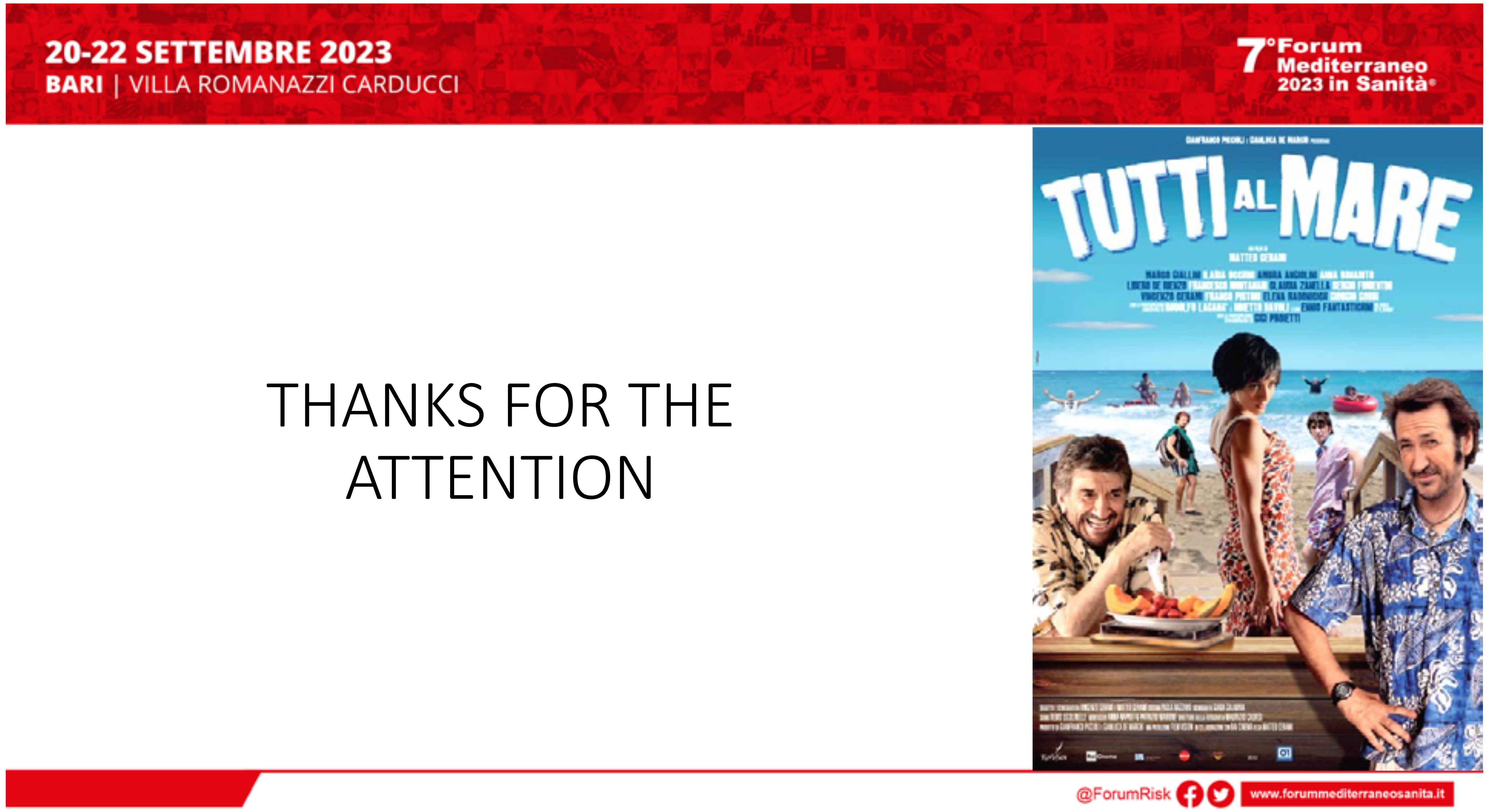
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Write an article of 500 words about artificial intelligence in operating room

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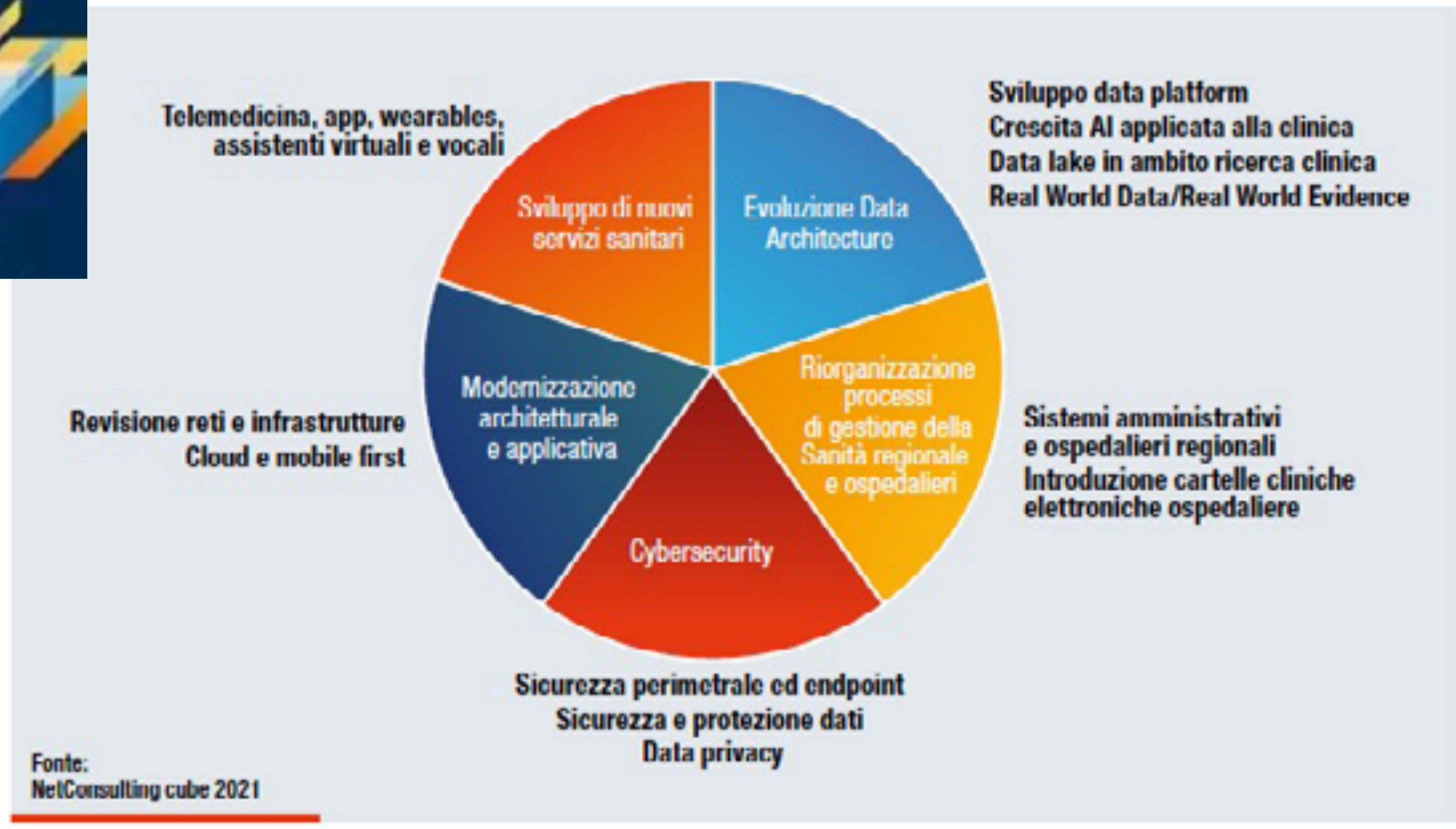

I DRIVER IN SANITÀ

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The world's most valuable resource is no longer oil, but data

The Economist

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The Operating Room of the Future Versus the Future of the Operating Room

Amin B. Kassam, MD*, Richard A. Rovin, MD, Sarika Walia, MD
Srikant Chakravarthi, MD, Juanita Celix, MD,
Jonathan Jennings, MD, Sammy Khalili, MD, Lior Gonen, MD,
Alejandro Monroy-Sosa, MD, Melanie B. Fukui, MD

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Fig. 2. The cockpit. The cockpit of an airplane is juxtaposed to the cockpit of our current OR, highlighting the vast amount of data that are provided in real time simultaneously to both operators and all personnel. This setup ensures that all operators receive the same information to support the critical decision-making process.

Otolaryngol Clin N Am 50 (2017) 655–671

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As medicine enters an era in which risk is of paramount concern, the same evolution is anticipated to occur. As such, the OR of the future is rapidly transitioning from an exploratory, experiential learning environment (the art of surgery) to an information-driven, iterative learning environment with incremental precision and predictive learning. Explicitly, the authors believe the future OR to be a vital hub of real-time physiologic, anatomic, and pathologic tissue interrogation that is contemporaneously and seamlessly collected in the background, much like the manner in which the e-commerce col-

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Operating room of the future

Rasiah Bharathan, MRCS, MRCOG, Clinical Research Fellow *,
Rajesh Aggarwal, MA, PhD, FRCS, NIHR Clinician Scientist,
Ara Darzi, KBE, FRCS, FACS, Professor of Surgery

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SURGEON ERGONOMY AND COGNITIVE LOAD

The operating room is a high-risk, dynamic and technologically advanced environment in which multidisciplinary teams undertake complex tasks to deliver safe and effective treatment.[7] Optimal preparation of individuals and teams, along with ergonomic operating room environment design and use of effective patient pathways are important elements in maximising productivity and safe delivery of care, while minimising risks. Surgical skills training,[8] team training,[9,10] operating-room ergonomics[11] and World Health Organization checklists[12] have been shown to improve the safety profile. Evidence for cost-effectiveness of these measures is still scarce.[13,14]

Best Practice & Research Clinical Obstetrics and Gynaecology 27 (2013) 311–322

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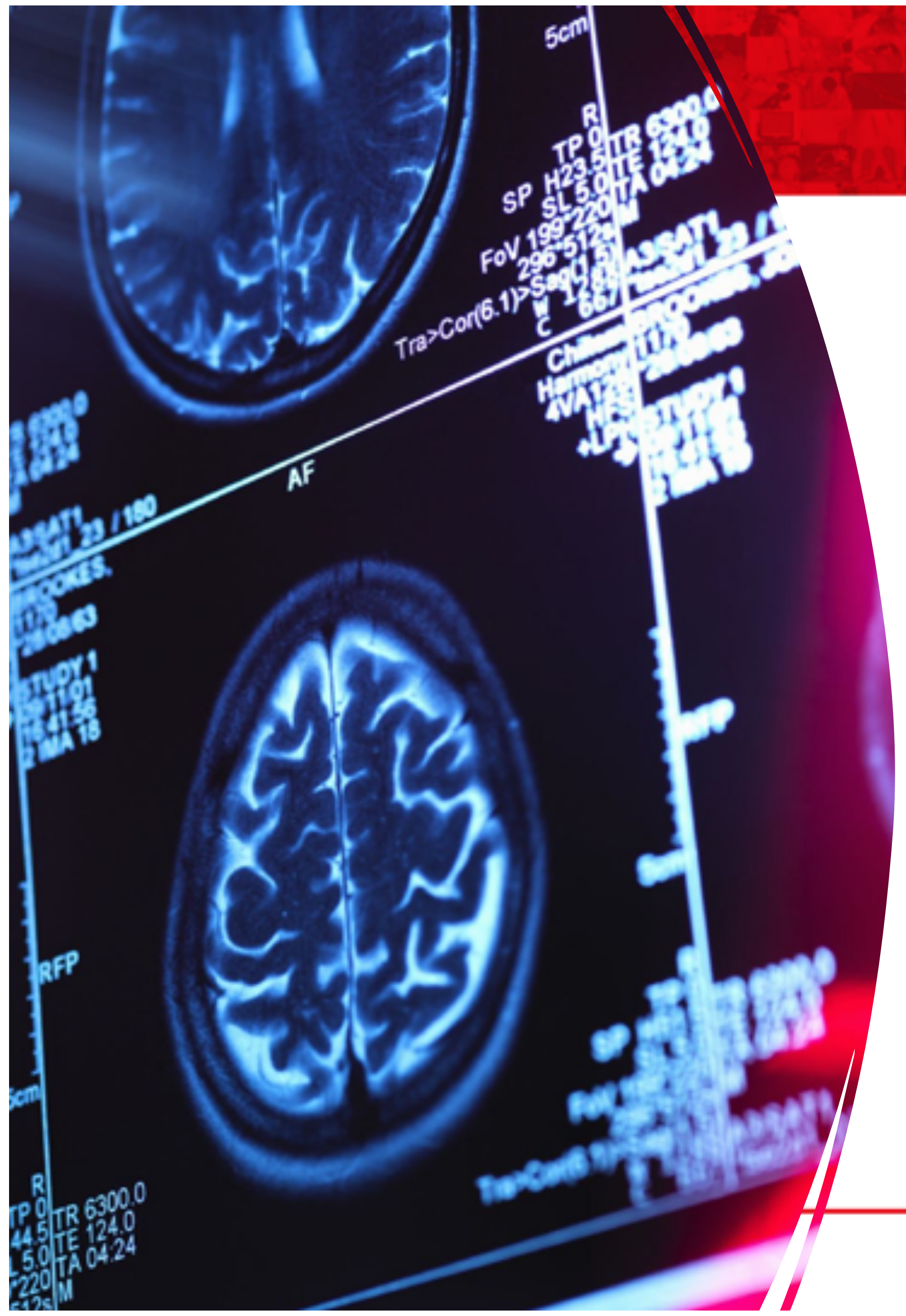
Practice points

- Integrated operating-room ecology can improve ergonomics, team performance and staff satisfaction.
- A dashboard-based mechanism for integrating operating-theatre processes is an effective method of improving resource management.
- Improving communication should be a key strategy in minimising the incidence of adverse events within institutions.
- Surgical navigation, through imaging-guided surgery, can play an important role in enhancing the safety and efficacy of operative performance.
- Benefits of computer-assisted surgical platforms include a multitude of benefits, including telesurgery and telehealth education.
- Simulation-based surgical training can contribute to better surgeon preparation.



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THE BEST IS YET TO COME

- Digital Surgery (recording digitale)
- Artificial intelligence
- Automatic Data collection
- Surgical navigation
- Training and telementoring
- Preoperative planning
- Adverse factors analysis
- Intelligent robot
- Alternative visions (NIR camera, functional camera)
- Digital hystology

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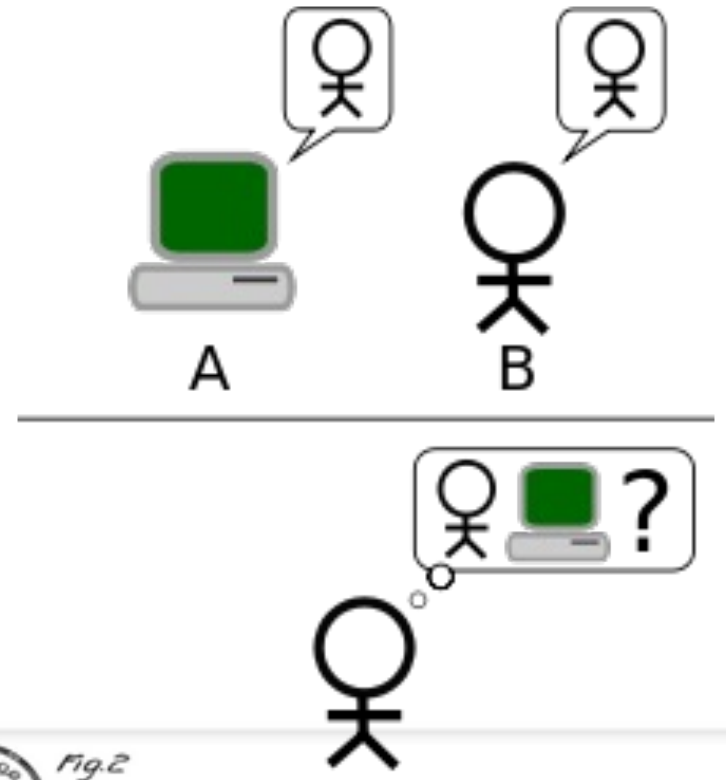
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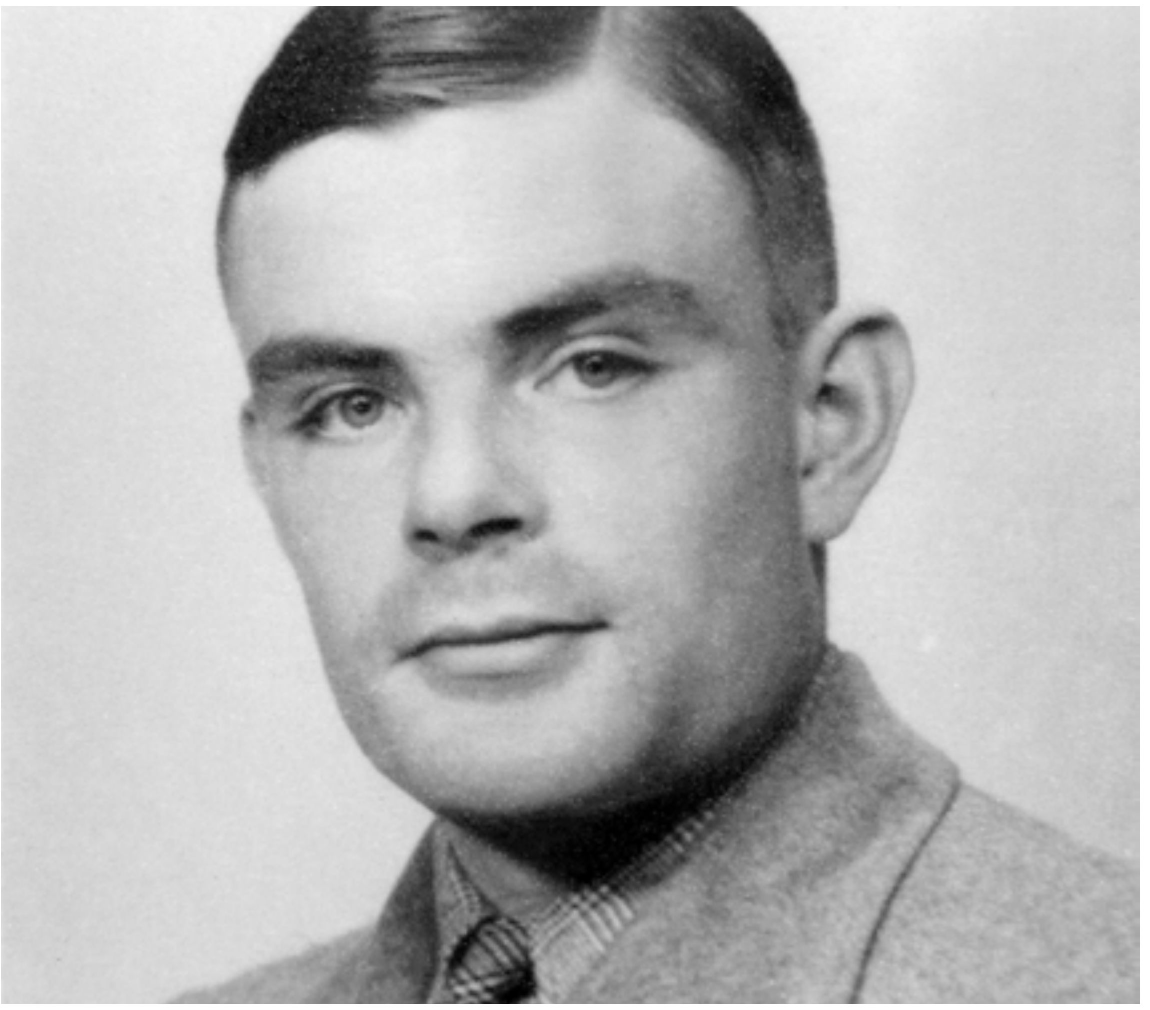

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THE FUTURE IS NOW

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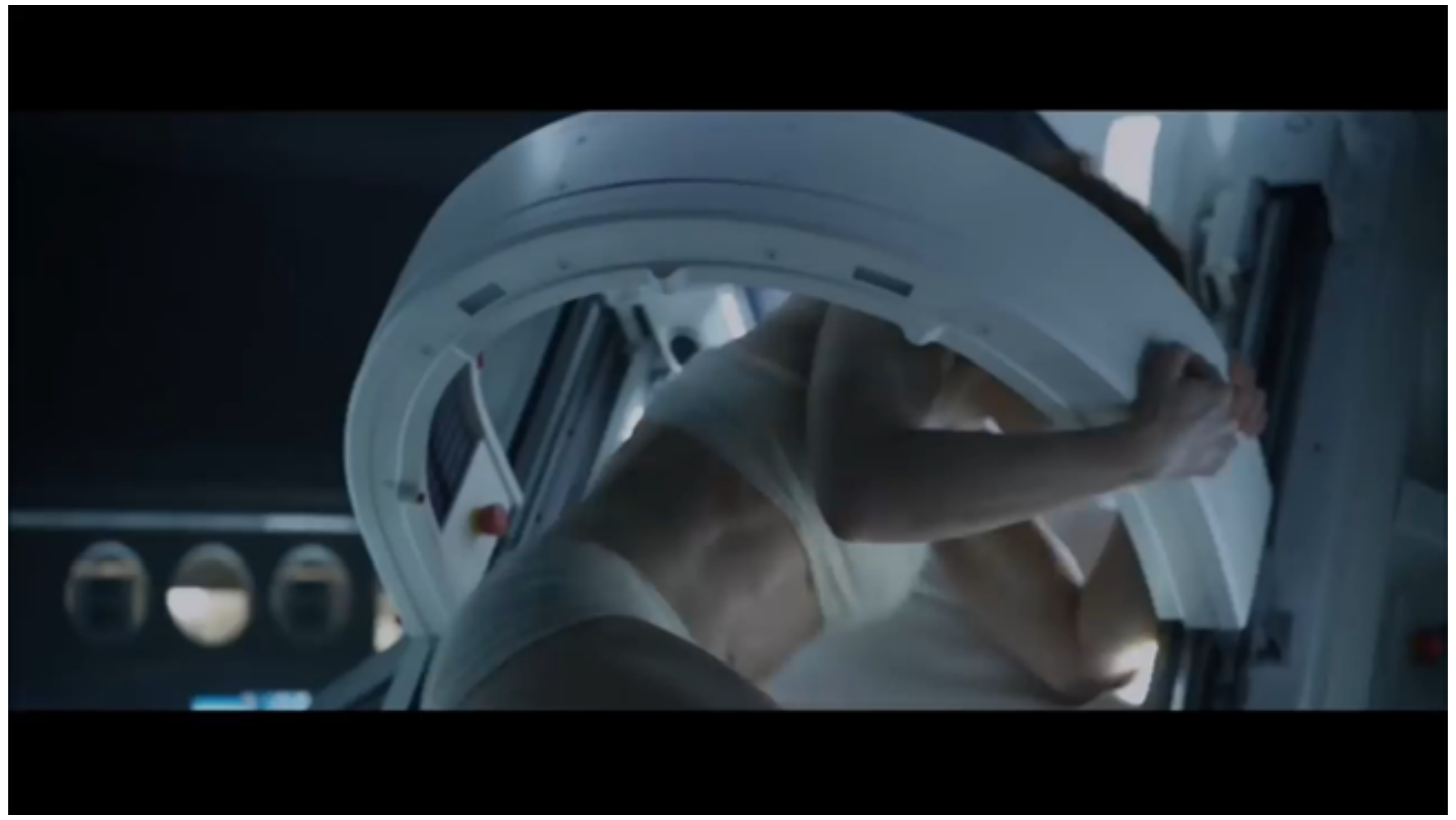

Prometheus, 2012 science fiction film directed by Ridley Scott

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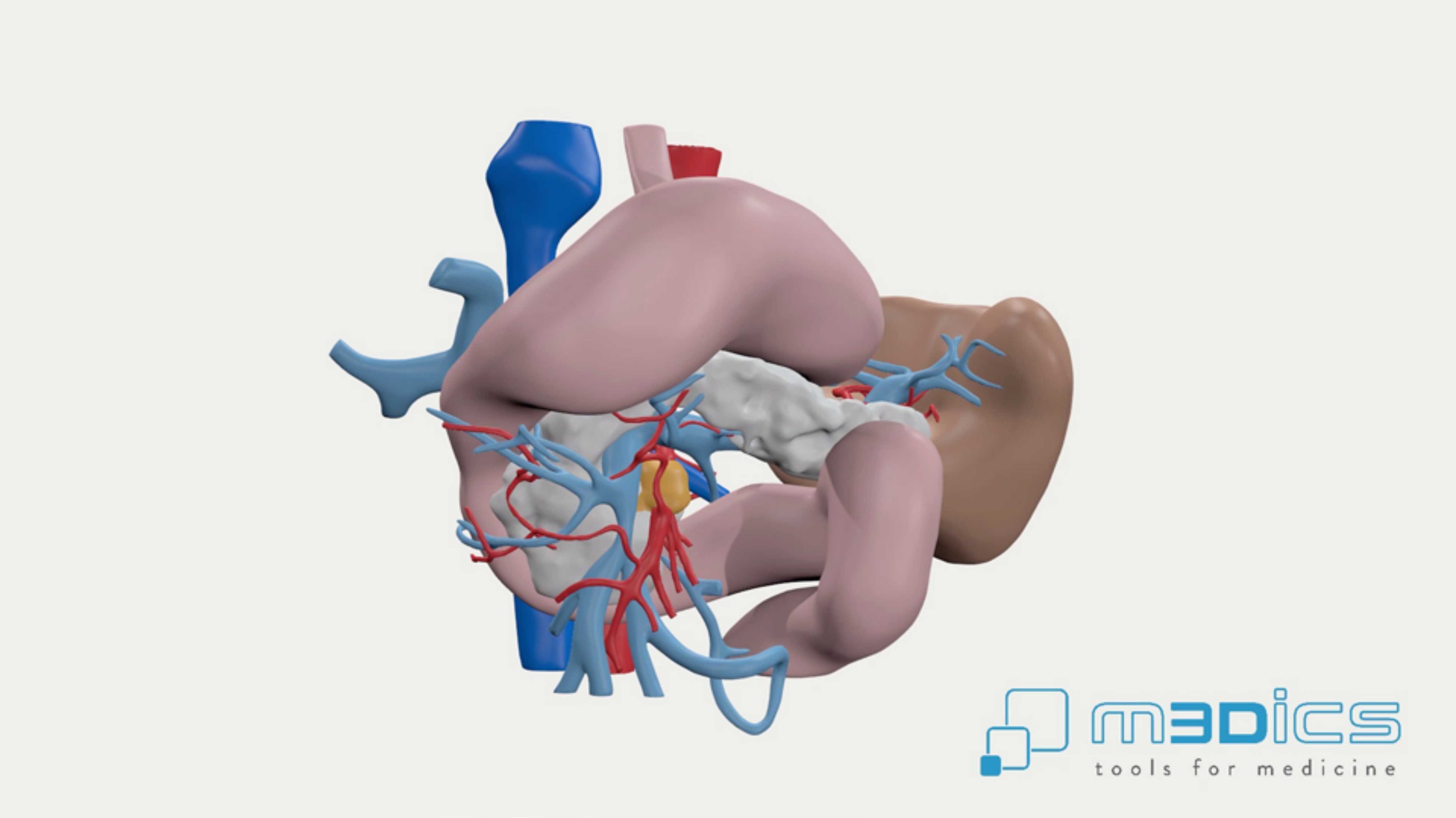
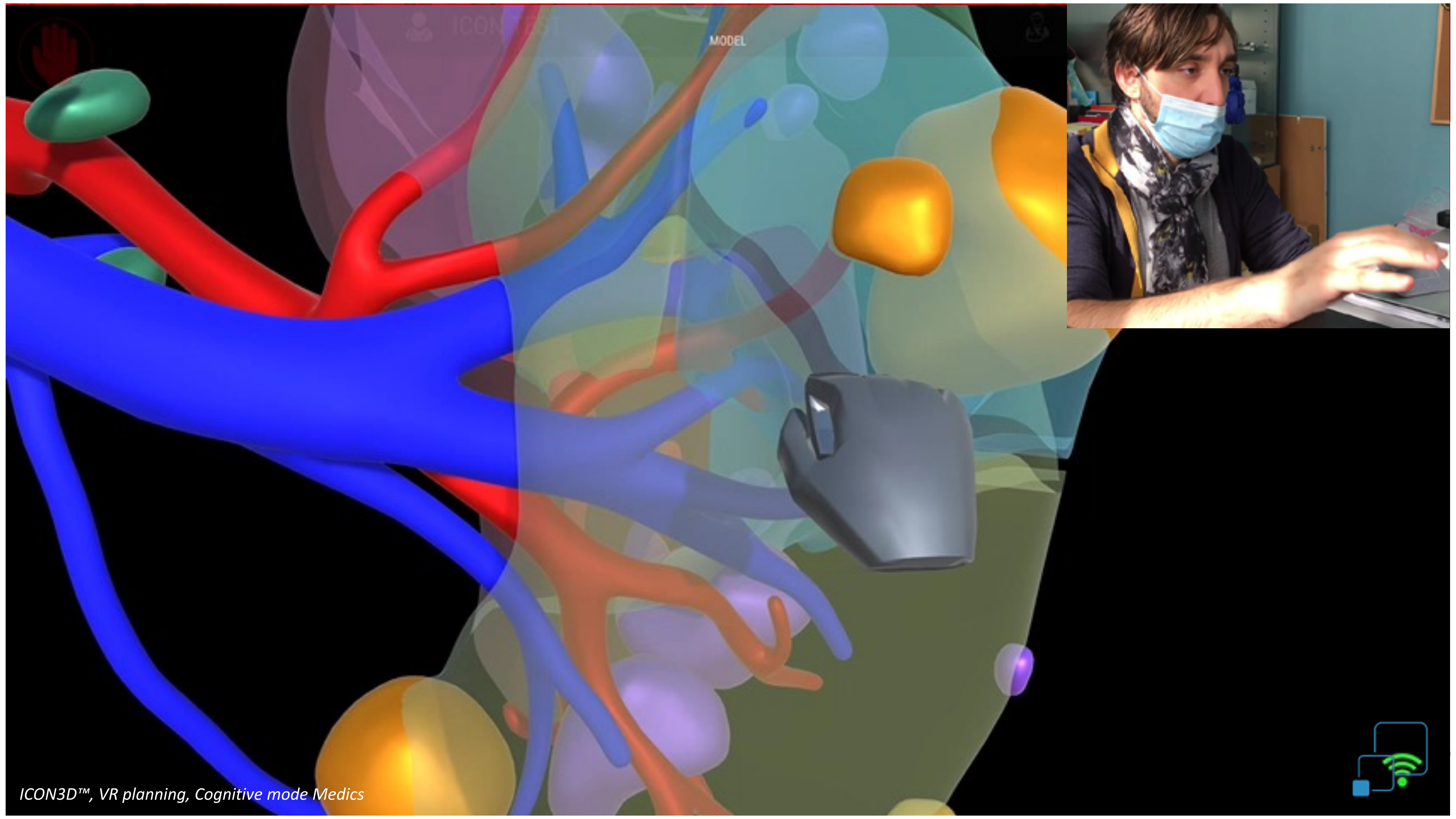
PREOPERATIVE PLANNING

- From the idea to the field
- Accurate staging
- Anatomy definition and vascular anomalies
- Mental prefiguration
- Mental prevision of tricky manoeuvres

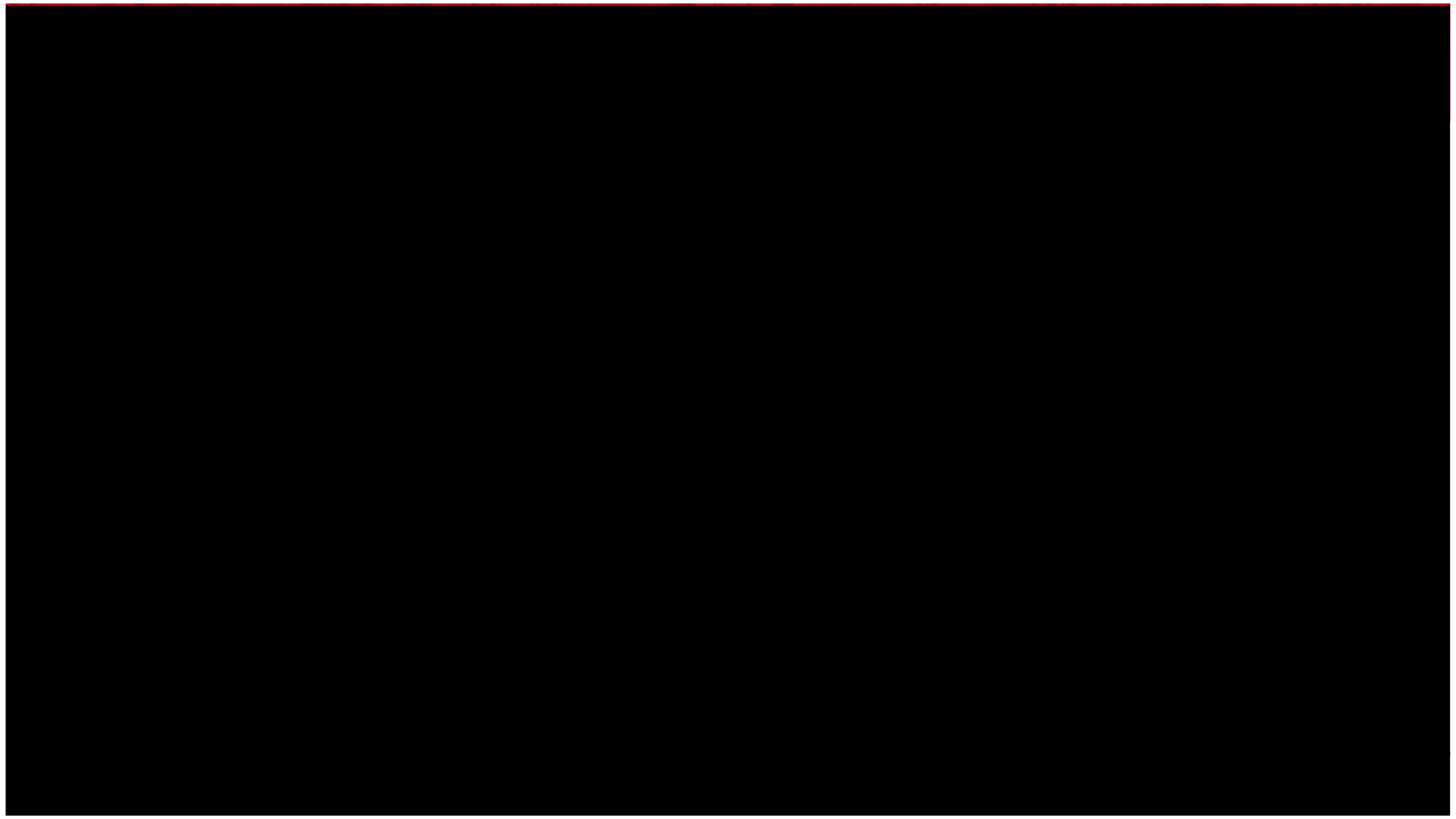
- 3D visualisation
- 3D manipulation
- 3D simulation


m3Dics
tools for medicine


INTRAOPERATIVE NAVIGATION



ICON3D™, VR planning, Cognitive mode Medics



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cancers MDPI

Review

Augmented Reality and Image-Guided Robotic Liver Surgery

Fabio Giannone [1,2,3], Emanuele Felli [1,2,3], Zineb Cherkaoui [1,2], Pietro Mascagni [3] and Patrick Pessaux [1,2,3,*]

Characteristics:

- Accurate detections of lesions (post-CT ghost lesions?)
- Complex anatomy
- Multiple anatomical variations
- Lack of manipulation in robotic surgery

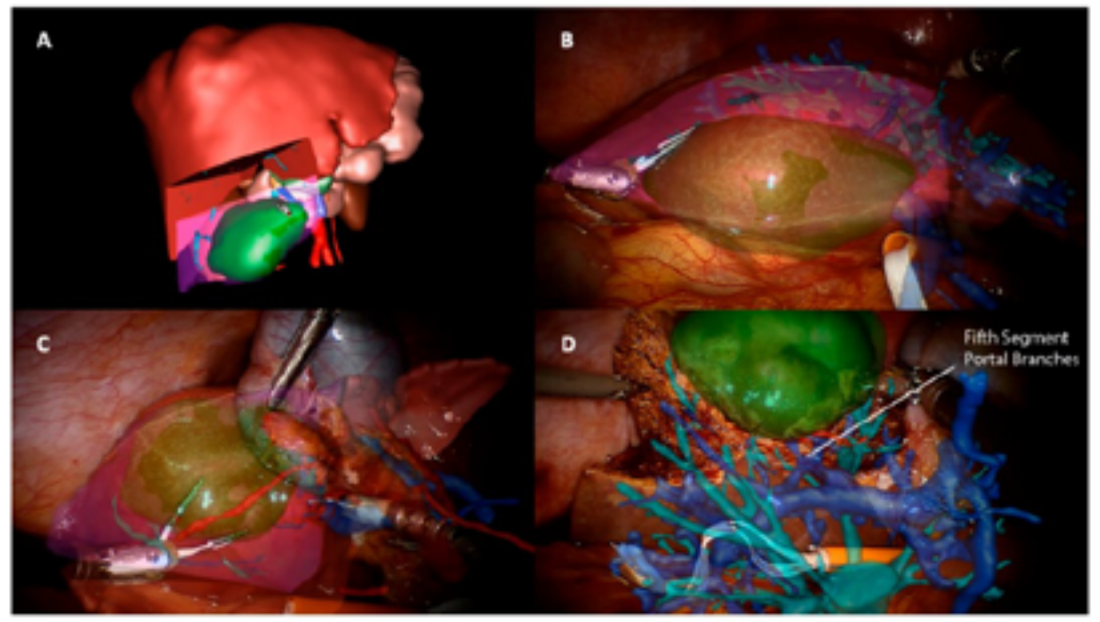

Figure 1. (A) Surgical preoperative planning through 3D reconstruction of an anatomical S5 segmentectomy. The tumor is colored in green and the theorical resection plane in red. (B–D) Intraoperative superimposition of planned resection area rendering. Vascular and biliary structures are projected during different phases of parenchymal transection, with the identification of the S5 vascular pedicle.

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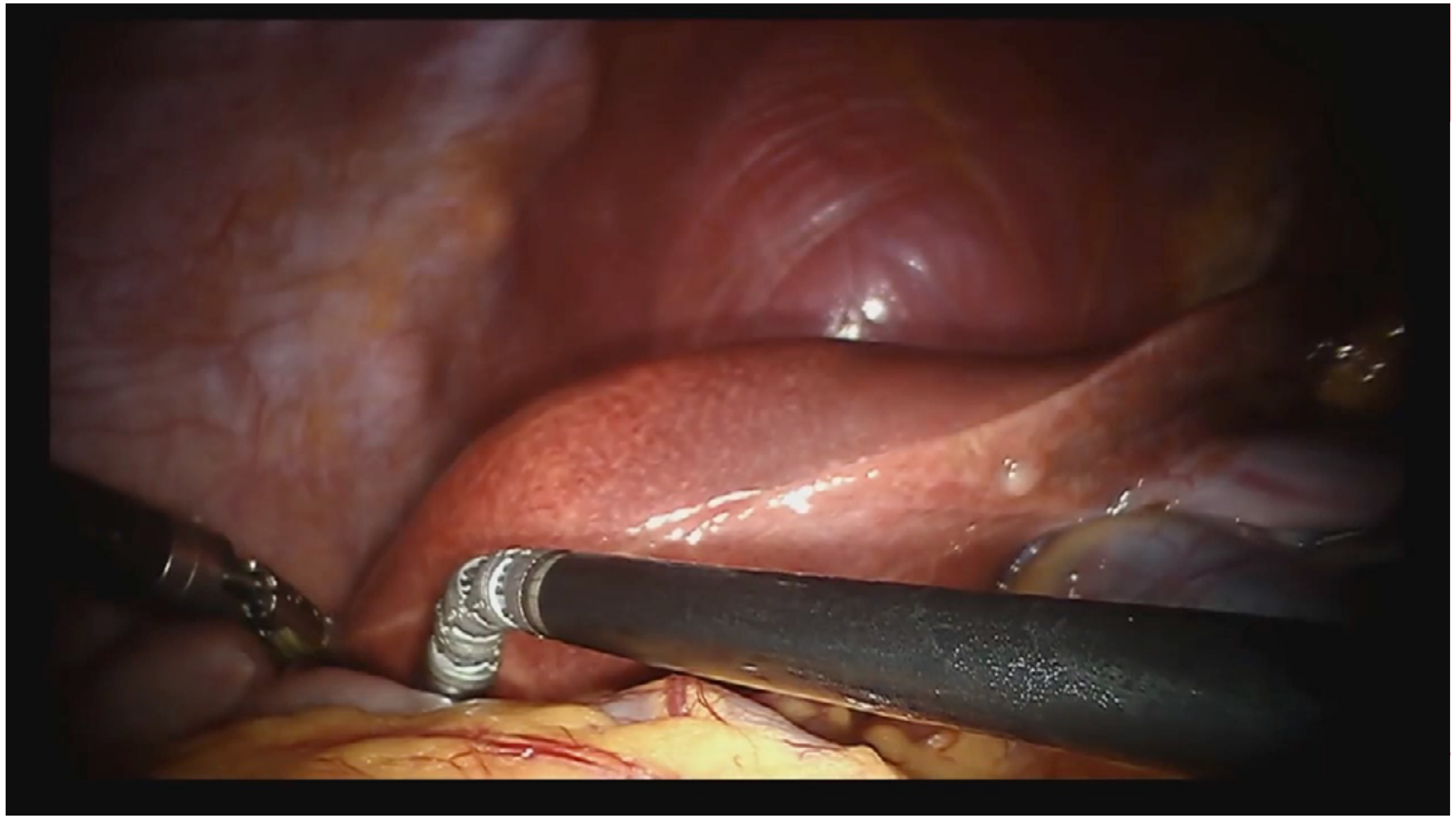

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Dig Surg 2015

Navigation Surgery Using an Augmented Reality for Pancreatectomy

Tomoyoshi Okamoto[a] Shinji Onda[b] Jungo Yasuda[a] Katsuhiko Yanaga[b]
Naoki Suzuki[c] Asaki Hattori[c]

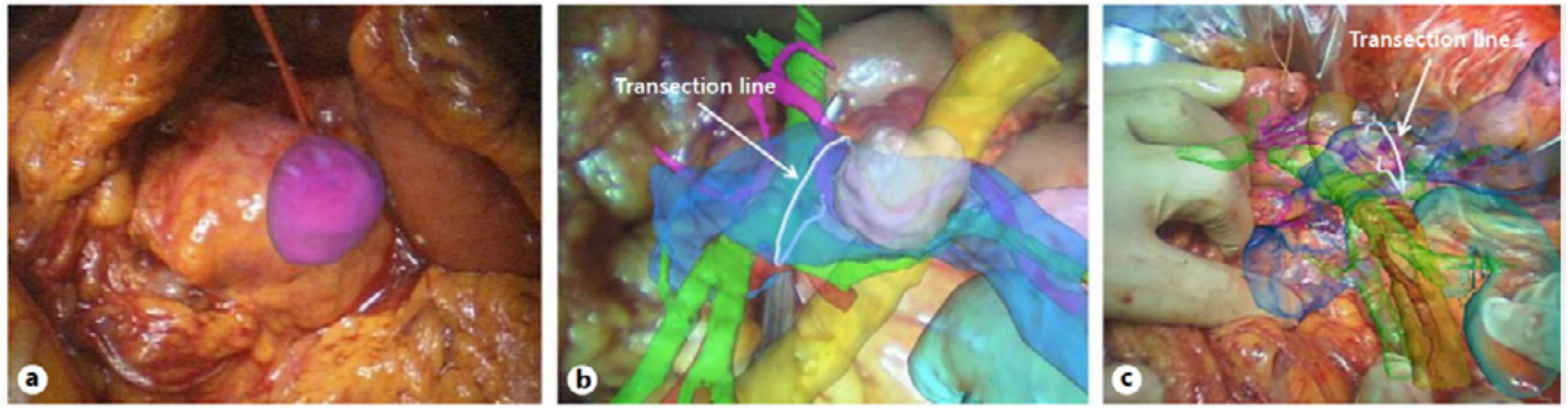

Fig. 1. Image overlay onto the monitor display in patient 2. The surgeon was able to select an image type and displayed organs on demand in any situation. **a** Only tumor was displayed on the pancreas. **b** The main tumor, preoperatively estimated transection line, and surrounding organs were displayed with paint-out image. **c** The condition described in **b** was displayed in a semitransparent fashion.

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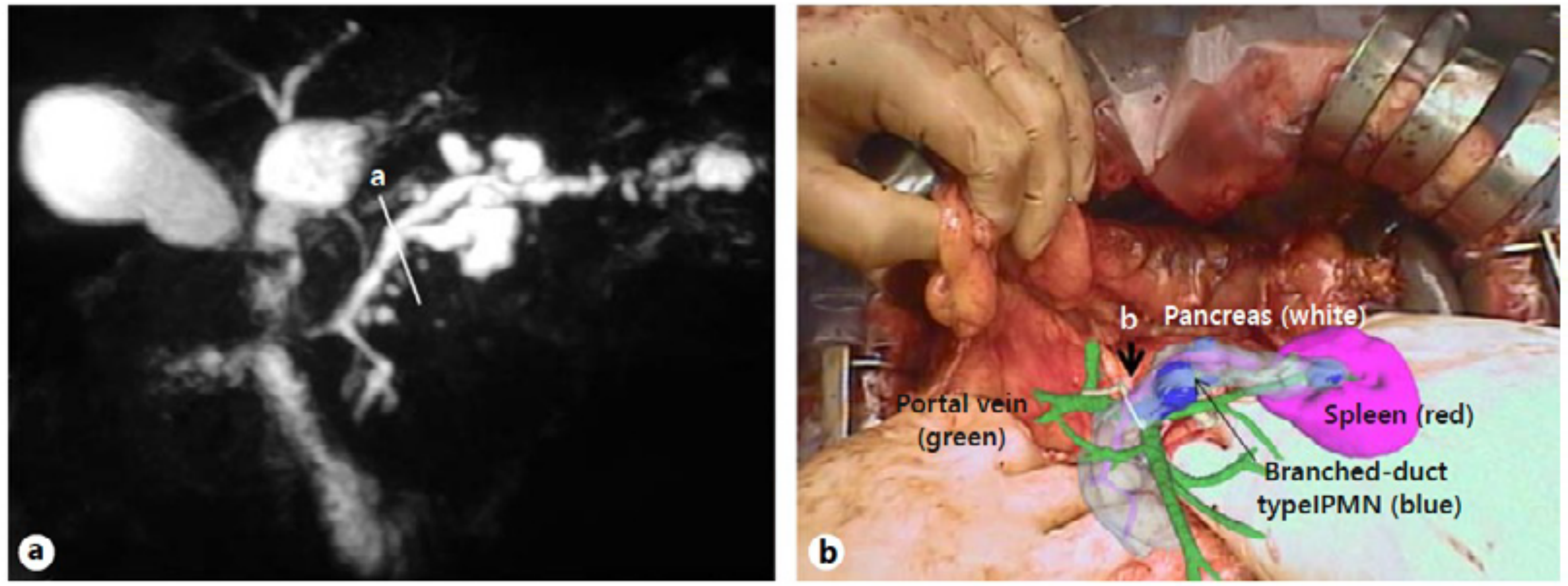

Fig. 2. a Several branched-type IPMNs were detected in MRCP of patient 3. The transection line was drawn on the main pancreatic duct (MPD). **b** Transection line marked on the reconstructed 3D image was overlaid on the pancreas.

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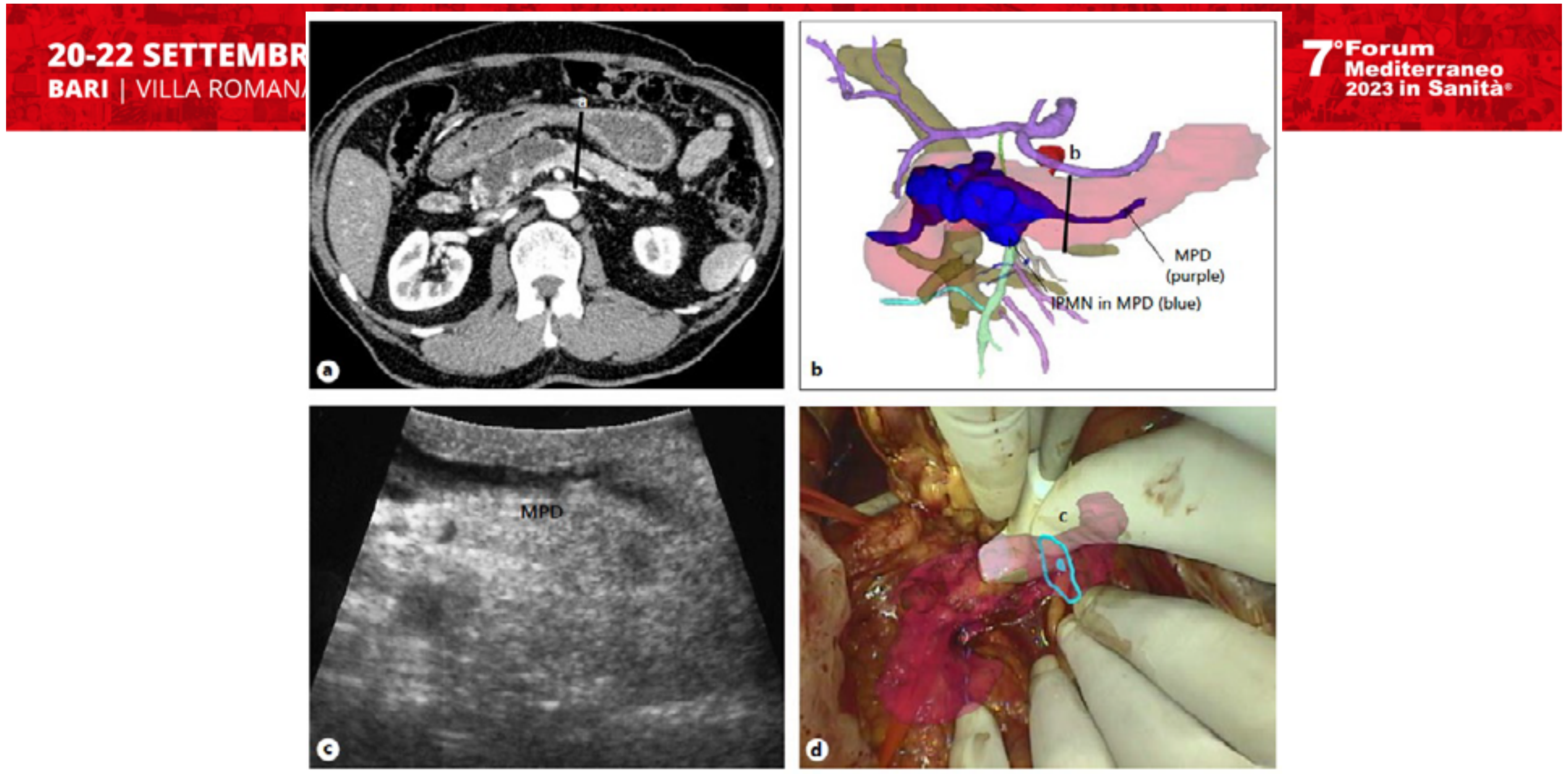
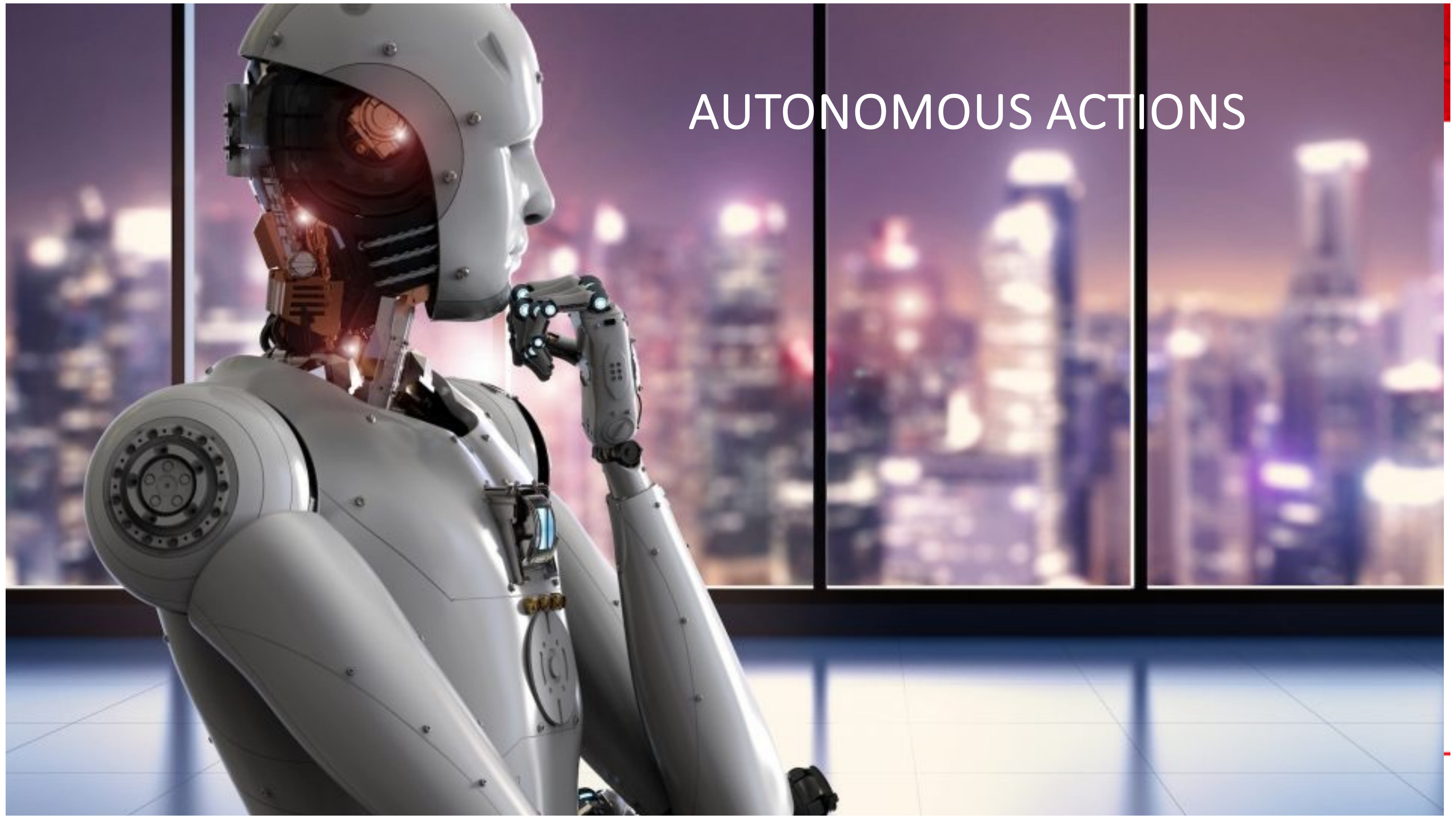


Fig. 3. a CT of patient 5 presented the caliber change of MPD and the transection line was determined preoperatively. **b** The transection line was marked on the reconstructed 3D image. **c** The transection line was unclear in IOUS. **d** The overlaid line on the pancreas.


AUTONOMOUS ACTIONS

The importance of machine learning in autonomous actions for surgical decision making

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Martin Wagner[1], Sebastian Bodenstedt[2,5], Marie Daum[1], Andre Schulze[1], Rayan Younis[1], Johanna Brandenburg[1], Fiona R. Kolbinger[3], Marius Distler[3,5], Lena Maier-Hein[4], Jürgen Weitz[3,5], Beat-Peter Müller-Stich[1], Stefanie Speidel[2,5]

Art Int Surg 2022

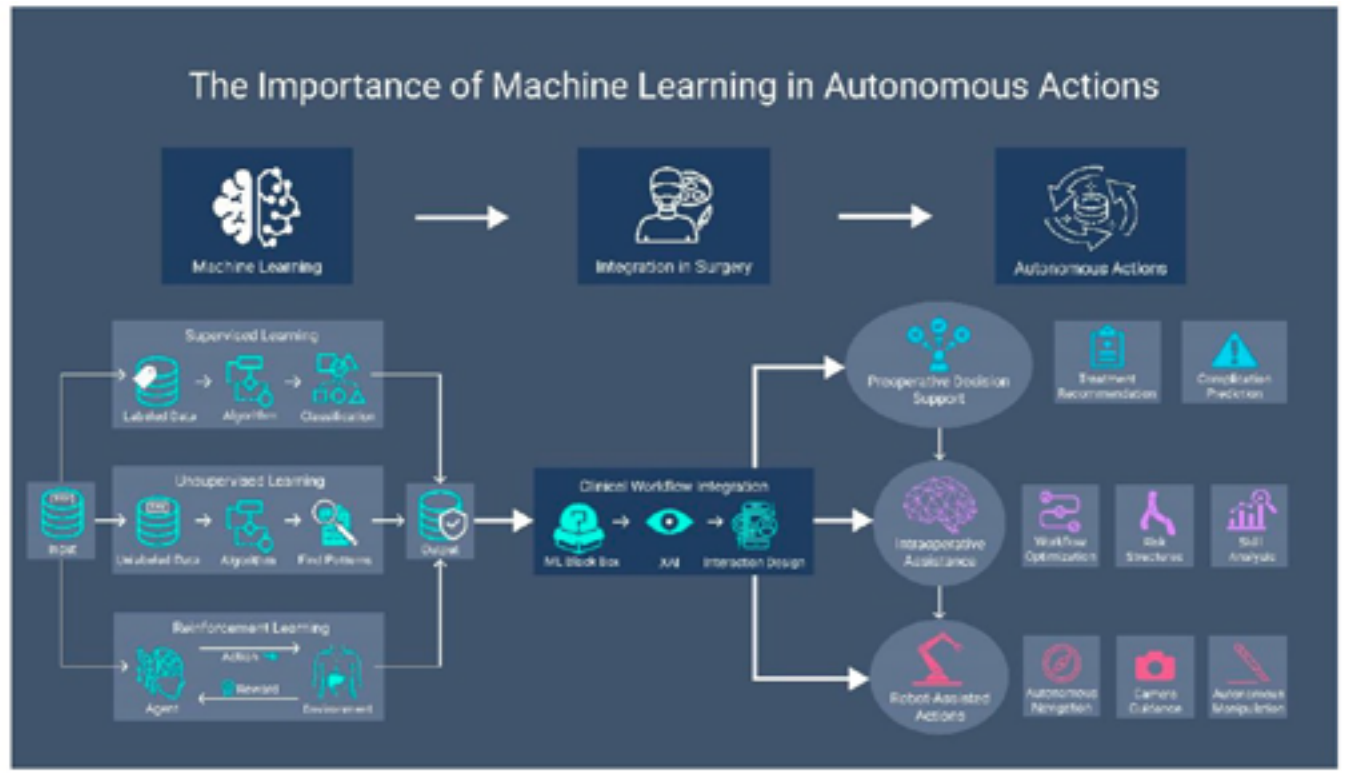

Figure 1. Autonomous actions in surgery along the surgical treatment path based on machine learning and clinical integration as a prerequisite.

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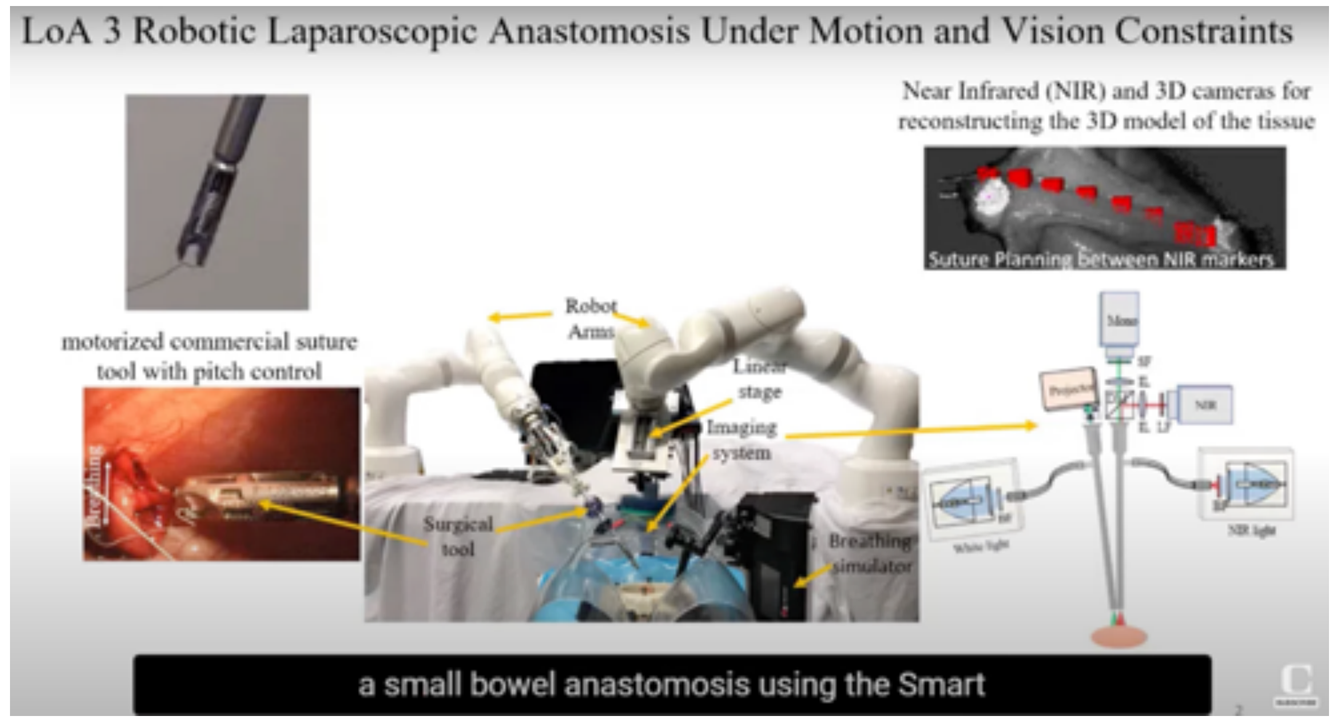
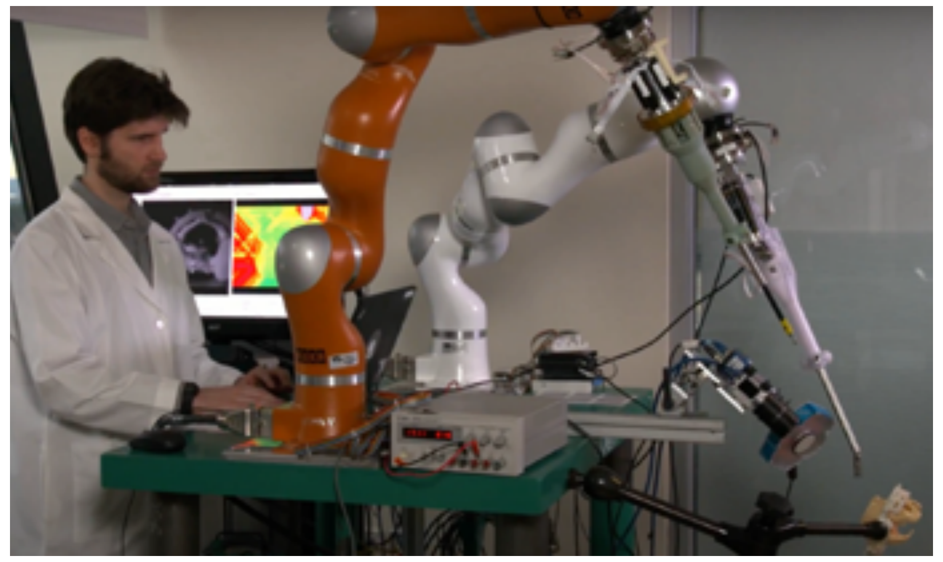
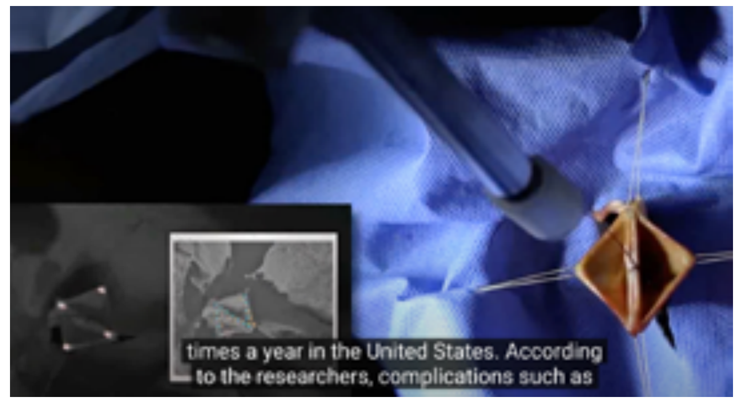
IEEE Int Conf Robot Autom. 2019

Autonomous Laparoscopic Robotic Suturing with a Novel Actuated Suturing Tool and 3D Endoscope

H. Saeidi[1], H. N. D. Le[2], J. D. Opfermann[3], S. Leonard[2], A. Kim[4], M. H. Hsieh[3], J. U. Kang[2], A. Krieger[1] [Member, IEEE]







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INTRAOPERATIVE ASSISTANCE

- OR data monitoring and planning
- Cognitive cameras with automatic recognition of surgery phases (instruments use, time assessment)
- Training and skills analysis
- Automatic identification of anatomy and “alarms”
- “In vivo” pathology with tissue diagnosis
- Molecular and spectroscopy guidance
- Robotic autonomous guidance (the perfect table assistant)
- Autonomous blood suction

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How molecular imaging will enable robotic precision surgery

The role of artificial intelligence, augmented reality, and navigation

Thomas Wendler[1] · Fijs W. B. van Leeuwen[2,3,4] · Nassir Navab[1,5] · Matthias N. van Oosterom[2,3]

European Journal of Nuclear Medicine and Molecular Imaging (2021)

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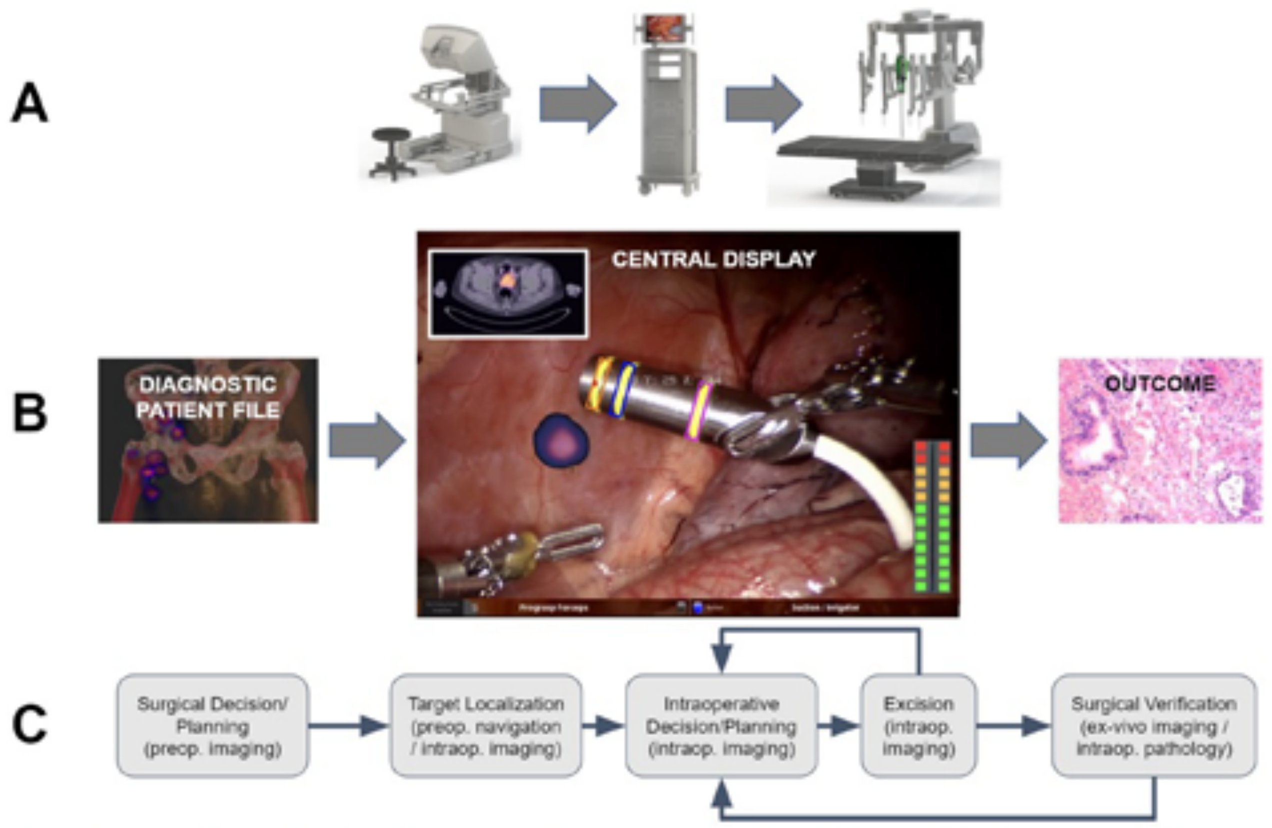

Fig. 1 **A** Components in a robotic telemanipulator system. The surgeon operates the robot from a console that connects to the robotic arms over a central data processing unit where also the video signal of the laparoscope is processed. **B** Molecular images, like PET, SPECT, or scintigraphy, and so-called metadata of the patient are fed to the data processing unit. There, intraoperative information is merged and shown in a single central display. There, augmented reality (AR) image overlays can be shown with the instruments and signals from the surgery (theoretical possibilities indicated). As a result of the procedure, the diseased tissue is removed. This results in an outcome, e.g., the resection borders' status. **C** A molecular imaging-enhanced robotic surgery can be abstracted as surgical decision/planning, target localization, intraoperative decision/planning, excision, and surgical verification, all of which are interconnected

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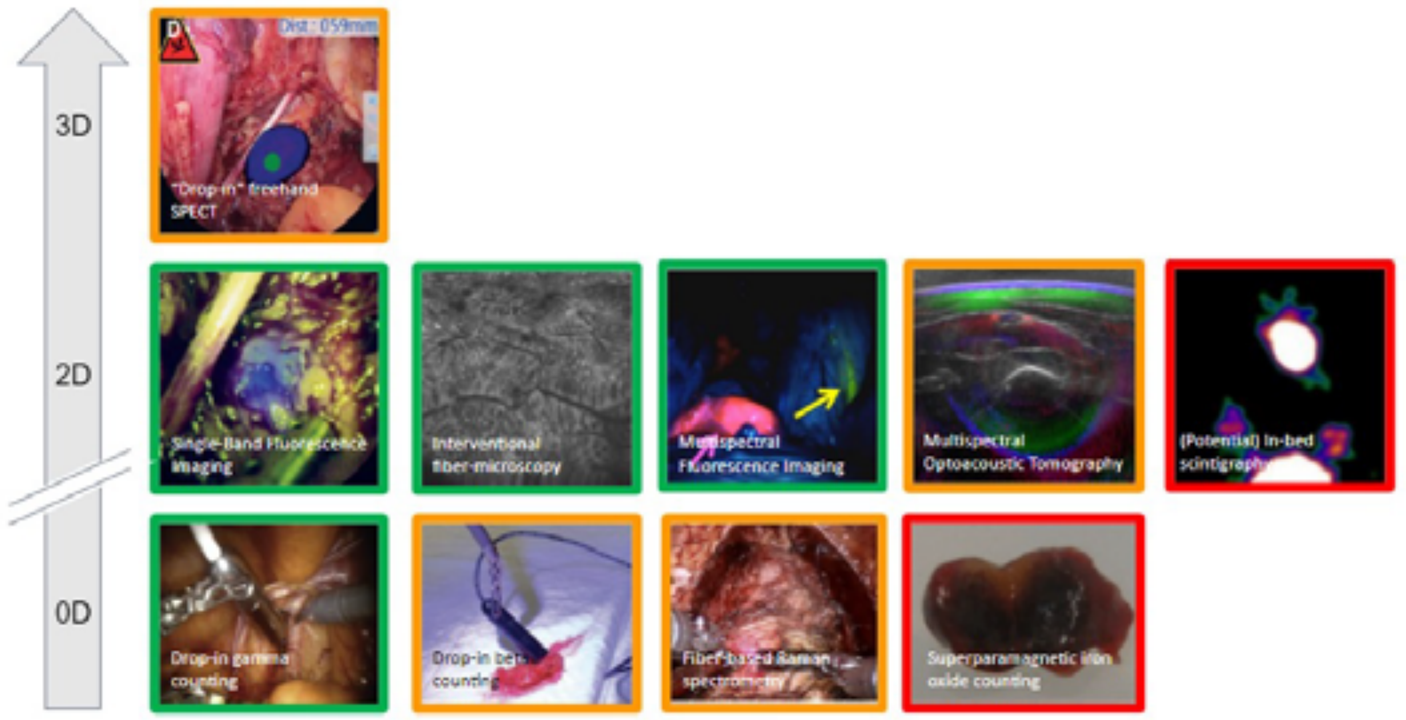

Fig. 6 Non-exhaustive overview of some current and possible future technologies for robotic intraoperative molecular imaging separated by their dimensions and development status (green, commercially available; orange, research prototypes available; red, potential developments). Non-imaging devices are defined as zero-dimensional as they are a single pixel detector and not a line detector which would be one-dimensional

Table 1 Robotic indications where tracer-based molecular imaging has already clinically demonstrated value in surgical planning, intraoperative guidance, and postoperative control

Indication	Tracer	Preop. imaging	Intraop./ex vivo detection	Reference
Lymphatics				
(Sentinel) Lymph node biopsy	^{99m}Tc-radiocolloids	Sz, SPECT/CT	DROP-IN γ Counting, ioSz, fhSPECT	[21]
	ICG-^{99m}Tc-HSA nanocolloid	Sz, SPECT/CT	DROP-IN γ Counting, ioSz, fhSPECT, FluoLap	[22]
	ICG	-	FluoLap	[23]
	Fluorescein	-	FluoLap	[24]
	Methylene blue	-	FluoLap	[25]
High blood perfusion				
Tumors (e.g., liver, adrenal glands)	ICG	-	FluoLap	[26]
Vessels (e.g., ureters, anastomosis, vasculature)	ICG	-	FluoLap	[27]
Receptor-targeted				
Prostate cancer	^{99m}Tc-PSMA I&S	Sz, SPECT/CT	DROP-IN γ Counting, ioSz, fhSPECT	[28]
	^{68}Ga-PSMA-914	PET/CT, PET/MR	DROP-IN β Counting (experimental), FluoLap, Cerenkov Imaging	[29]
Clear cell renal cell carcinoma (ccRCC)	^{111}In-DOTA-girentuximab IRDye800	Sz, SPECT/CT	DROP-IN γ Counting, ioSz, fhSPECT, FluoLap	[30]
	OTL38	-	FluoLap	[31]
Pulmonary nodules	OTL38	-	FluoLap	[32]

io intraoperative; *Sz* scintigraphy; *fhSPECT* freehand SPECT; *FluoLap* fluorescence laparoscope

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CT and MRI of pancreatic tumors: an update in the era of radiomics

Marion Bartoli[1] · Maxime Barat[1,2] · Anthony Dohan[1,2] · Sébastien Gaujoux[2,3] · Romain Coriat[2,4] · Christine Hoeffel[5] · Christophe Cassinotto[6] · Guillaume Chassagnon[1,2] · Philippe Soyer[1,2]

Japanese Journal of Radiology 2020

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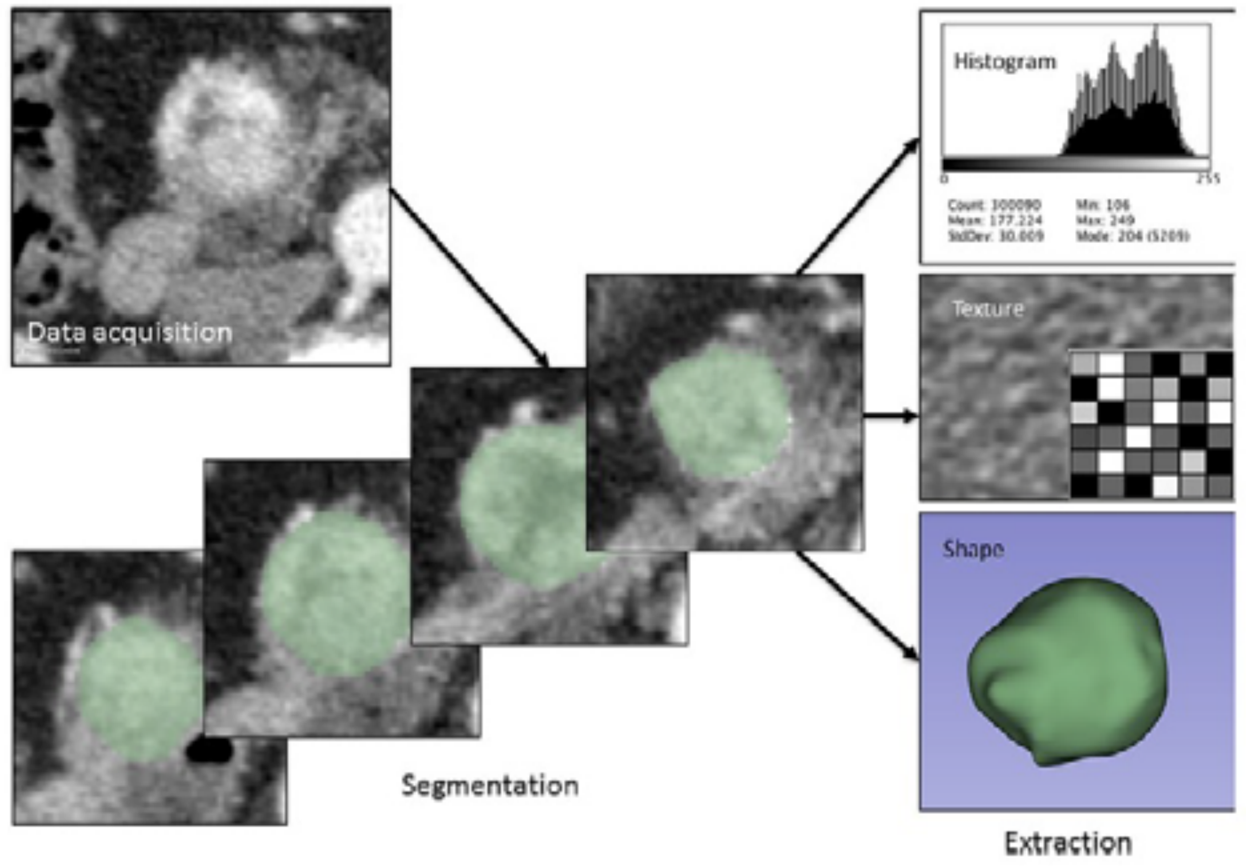

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- Tumour characterization
- Survival prediction after curative surgery
- Treatment response and survival after CT-RT
- NET tumour grade and differential diagnosis
- Cystic tumours differentiation

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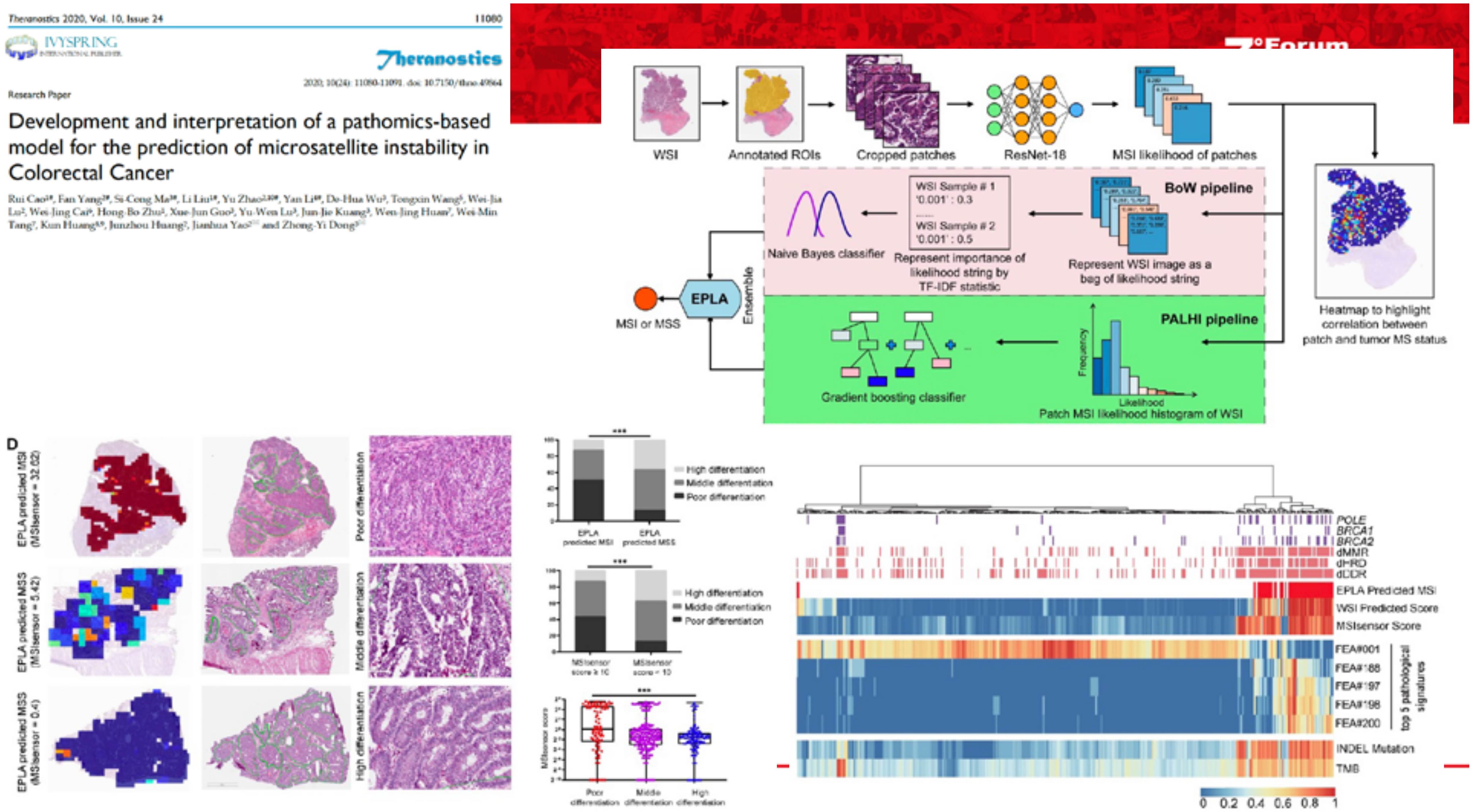

Theranostics 2020, Vol. 10, Issue 24
11080
IVYSPRING
Theranostics
Research Paper
Development and interpretation of a pathomics-based model for the prediction of microsatellite instability in Colorectal Cancer
WSI
Annotated ROIs
Cropped patches
ResNet-18
MSI likelihood of patches
BoW pipeline
Naive Bayes classifier
Represent importance of likelihood string by TF-IDF statistic
Represent WSI image as a bag of likelihood string
EPLA
Ensemble
MSI or MSS
PALHI pipeline
Gradient boosting classifier
Patch MSI likelihood histogram of WSI
Heatmap to highlight correlation between patch and tumor MS status
High differentiation
Middle differentiation
Poor differentiation
POLE
BRCA1
BRCA2
dMMR
dHRD
dDDR
EPLA Predicted MSI
WSI Predicted Score
MSIsensor Score
INDEL Mutation
TMB

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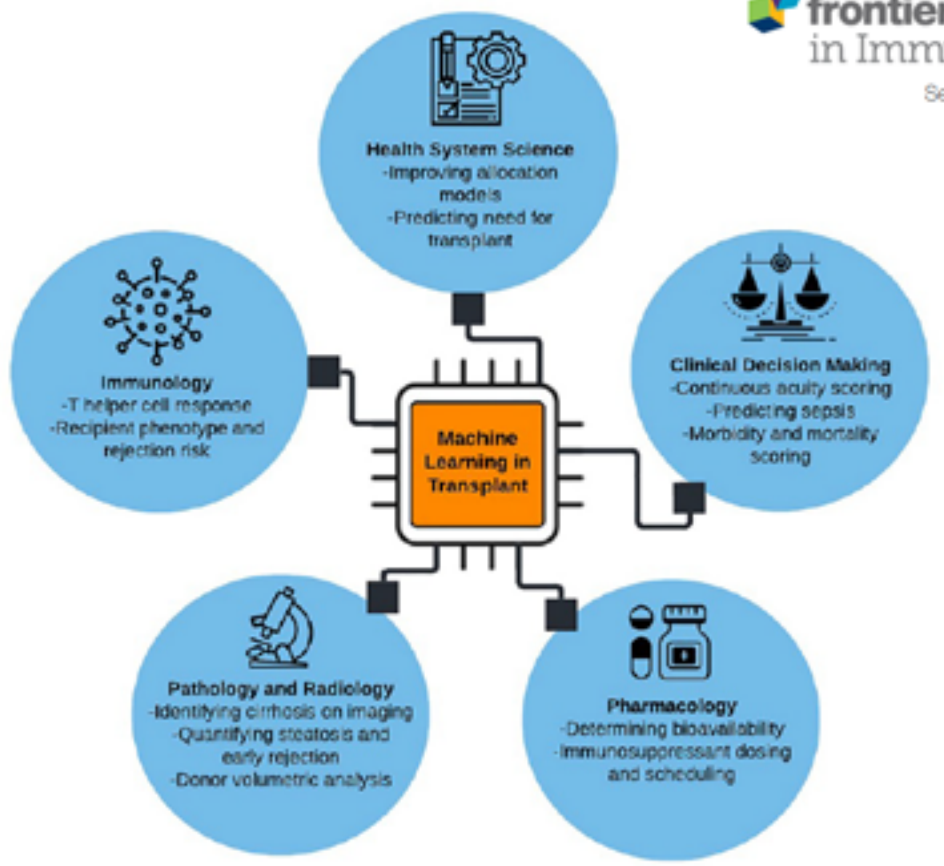
frontiers in Immunology
September 2021

Machine Learning Applications in Solid Organ Transplantation and Related Complications

Jeremy A. Balch[1†], Daniel Delitto[2†], Patrick J. Tighe[3,4,5†], Ali Zarrinpar[1†], Philip A. Efron[1†], Parisa Rashidi[6,7,8,9†], Gilbert R. Upchurch Jr[1], Azra Bihorac[9,10†] and Tyler J. Loftus[1,9*†]



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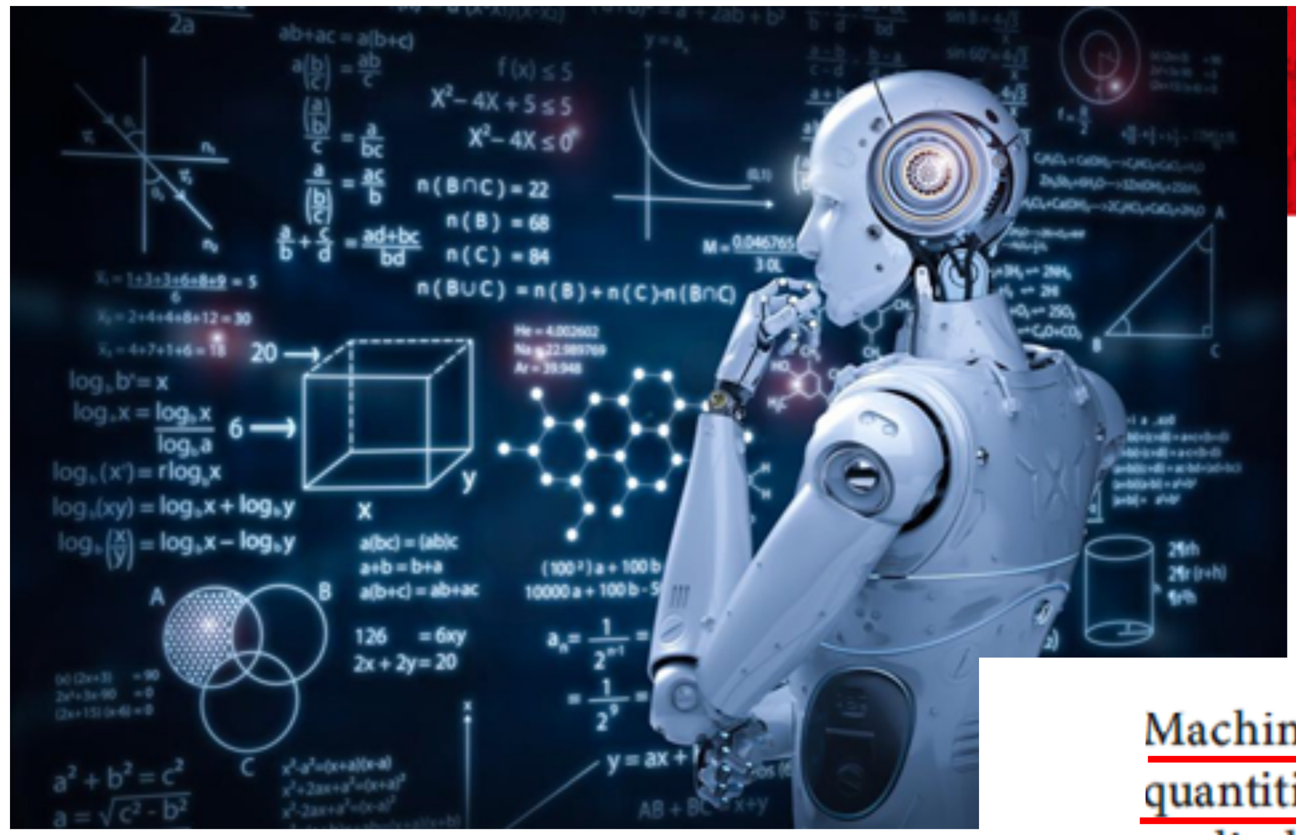

Machine learning offers the potential to synthesize large quantities of routinely collected clinical data into clinically applicable recommendations. Recent advances allow machine learning algorithms to accurately represent the complexity of host immune response, predict acute post-surgical and long-term outcomes, classify biopsy and radiographic data, and augment pharmacologic decision making. Yet, many of these applications exist in pre-clinical form only, supported primarily by evidence of single-center, retrospective studies. Prospective investigation of these technologies has the potential to unlock the potential of machine learning to augment solid organ transplantation clinical care and health care delivery systems.

Randomized clinical trial of immersive virtual reality tour of the operating theatre in children before anaesthesia

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Background: A virtual reality (VR) tour of the operating theatre before anaesthesia could provide a realistic experience for children. This study was designed to determine whether a preoperative VR tour could reduce preoperative anxiety in children.

Methods: Children scheduled for elective surgery under general anaesthesia were randomized into a control or VR group. The control group received conventional information regarding anaesthesia and surgery. The VR group watched a 4-min video showing Pororo, the famous little penguin, visiting the operating theatre and explaining what is in it. The main outcome was preoperative anxiety, assessed using the modified Yale Preoperative Anxiety Scale (m-YPAS) before entering the operating theatre. Secondary outcomes included induction compliance checklist (ICC) and procedural behaviour rating scale (PBRS) scores during anaesthesia.

Results: A total of 69 children were included in the analysis, 35 in the control group and 34 in the VR group. Demographic data and induction time were similar in the two groups. Children in the VR group had a significantly lower m-YPAS score than those in the control group (median 31·7 (i.q.r. 23·3–37·9) and 51·7 (28·3–63·3) respectively; $P < 0·001$). During anaesthesia, the VR group had lower ICC and PBRS scores than the control group.

Conclusion: This preoperative VR tour of the operating theatre was effective in alleviating preoperative anxiety and increasing compliance during induction of anaesthesia in children undergoing elective surgery. Registration number: UMIN000025232 (http://www.umin.ac.jp/ctr).

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a b c

Fig. 1 Virtual reality tour. **a** Pororo is transported to the reception area to confirm his identity after having an intravenous catheter placed in his forearm. **b** Monitoring devices, including ECG leads, non-invasive blood pressure cuff and pulse oximeter, are attached. **c** During the tour, Pororo explains the preoperative process in detail, in a friendly tone


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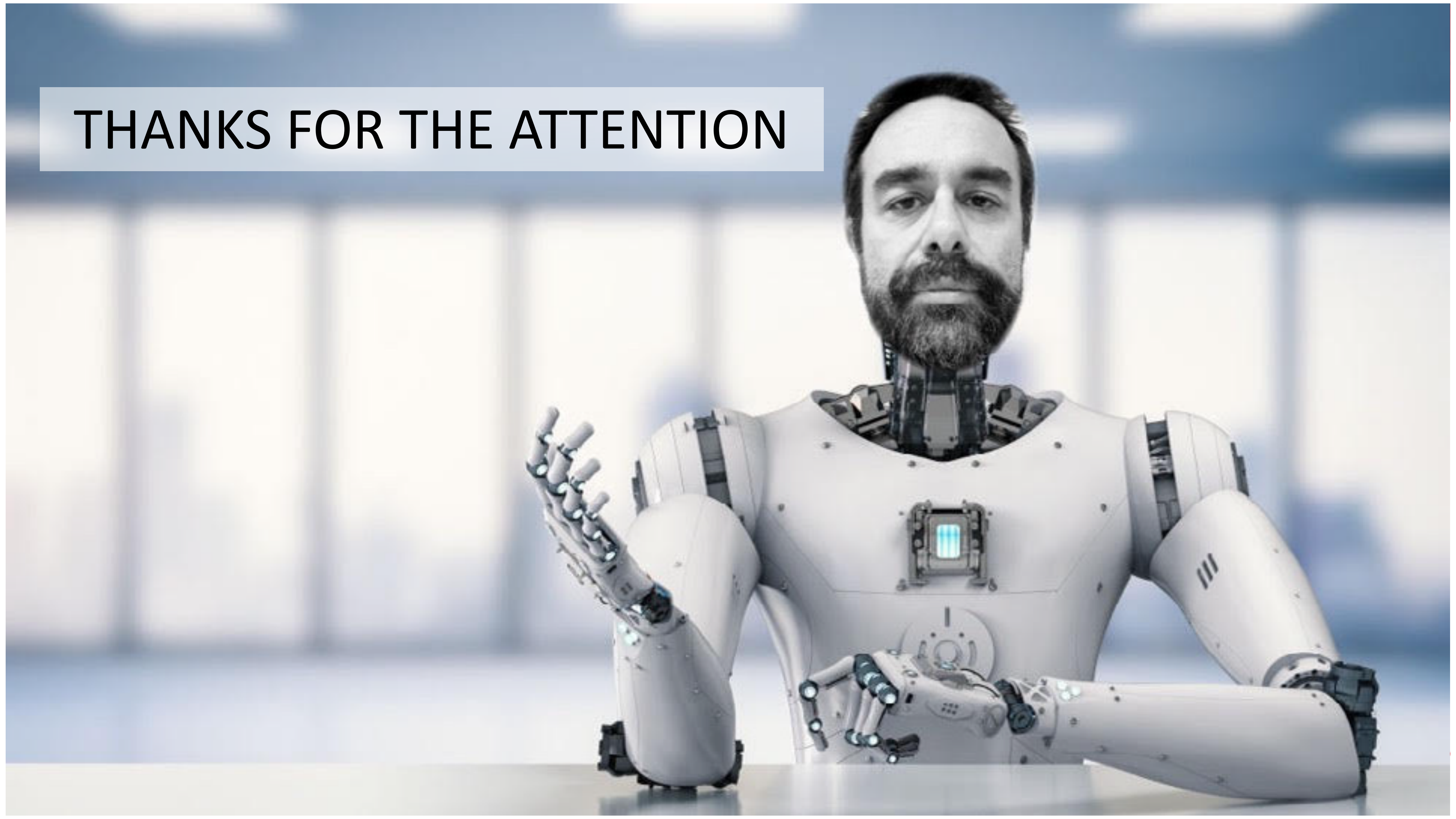
THANKS FOR THE ATTENTION

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