




**Surgical Robots**

Seminar in physiology and instrumentation


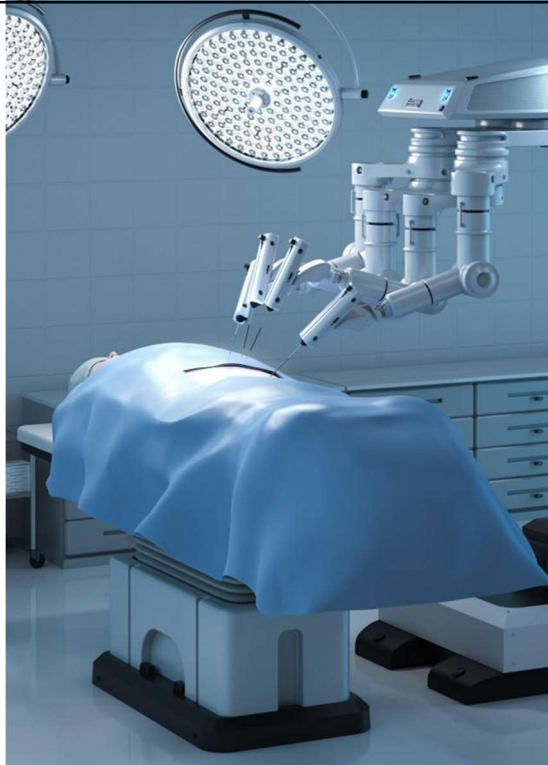
Supervisors  
Prof. RADENOVIC  
Marianna MITSIONI

Ecole polytechnique fédérale de Lausanne

Youri GANDEL

13th November 2025

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**OUTLINE**

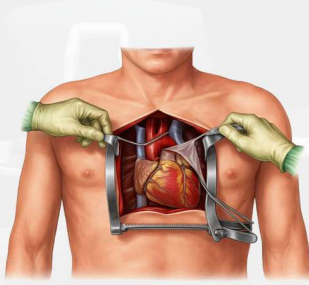
- Introduction
- Physiological aspects
- Technical description
- Specifications
- Medical significance
- Clinical applications and regulatory pathway
- Product aspects
- Future perspectives
- Conclusion

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# Introduction

*“Robotic surgery or robot-assisted surgery is any type of surgical procedure that is performed with the use of robotic systems.”*



Open surgery



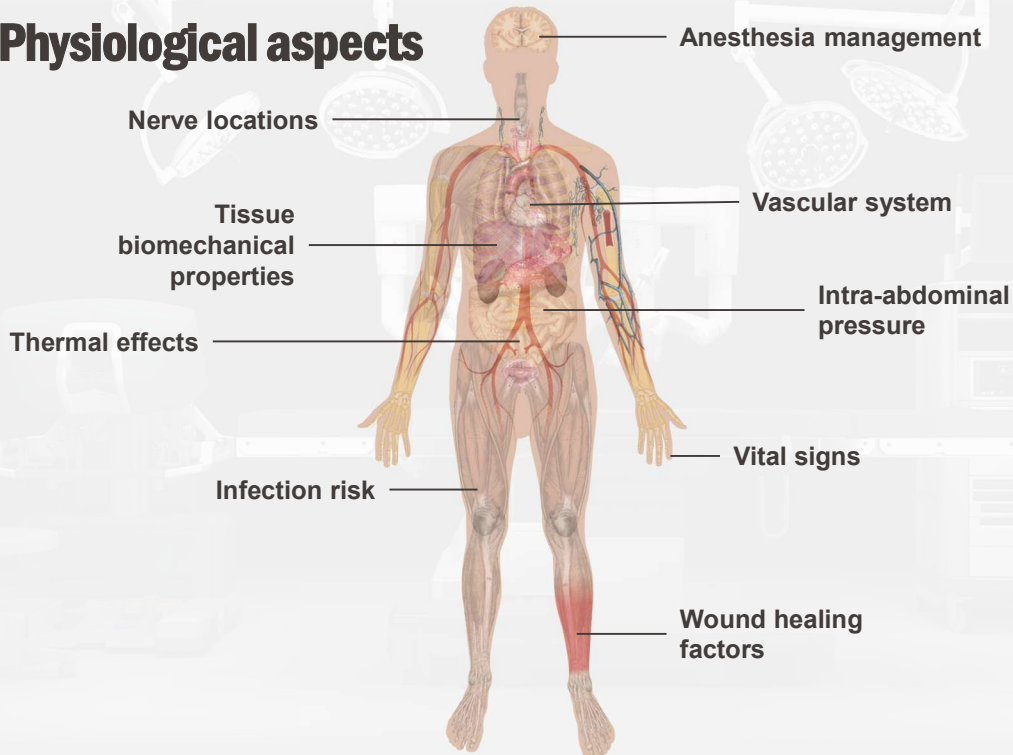
Laparoscopy



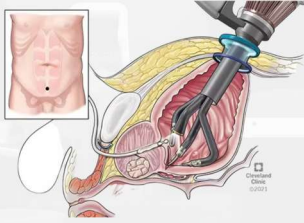
Robotic surgery



# Physiological aspects



# Functional objectives



Repair



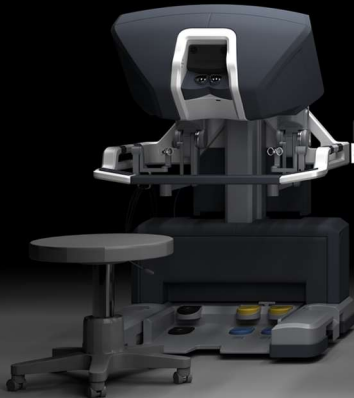
Control



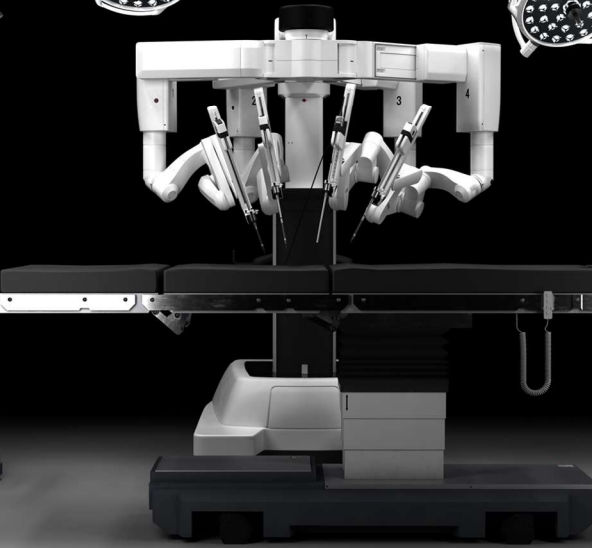
Measure

# Technical description

Surgeon console



Patient cart



Imaging cart



# Mode of action

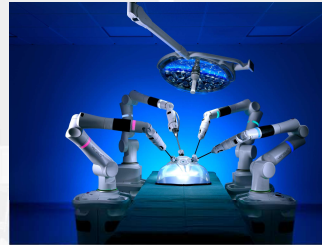


# Different systems



## Intuitive Surgical Da Vinci

- 2000
- 10'000 robots
- 17 million total procedures



## CMR Surgical Versius

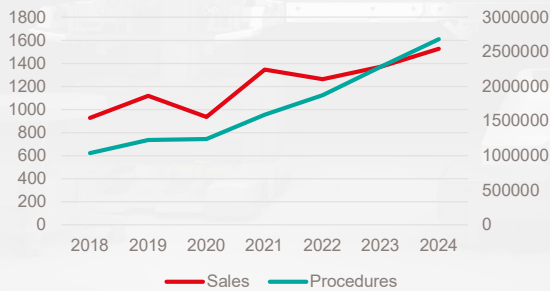
- 2019
- 20 thousand total procedures



## Medtronic Hugo RAS

- 2021

Worldwide sales and procedures



## Asensus Senhance

- 2017

**EPFL Specifications**

**Degrees of freedom**  
 7 DOF  
 Pitch, Yaw, Rotation, Grasp, Wristed Yaw, Wristed Pitch

**Energy**

- Electrosurgery
- Ultrasonic

**Materials**

- Stainless steel
- Titanium
- Polymer insulator
- Tungsten

**Instrument life**

- 7 to 10 uses

**Motion scaling**

- 1:1 to 5:1

**Latency**

- 50-100 ms

**Imaging**

- 3D
- 4K

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**EPFL Promise vs Reality**

**Promise (2000)**

- Intuitive Surgical
  - Next step in surgery
  - Will become standard
  - Transcontinental surgeries
  - Faster
  - Lighter intervention
  - Faster recovery
  - Gain in productivity
- Hospitals
  - Strategic
    - Patients' attraction
    - Prestige (private)
- Surgeons
  - Very enthusiastic

**Reality (2014)**

- Complications
  - Undetected during surgery
  - Unexplained
- Consequences
  - Longer surgeries
  - Anastomotic leak, perforation, fistulas
  - Septic shock
  - 2<sup>nd</sup> surgery
  - Death

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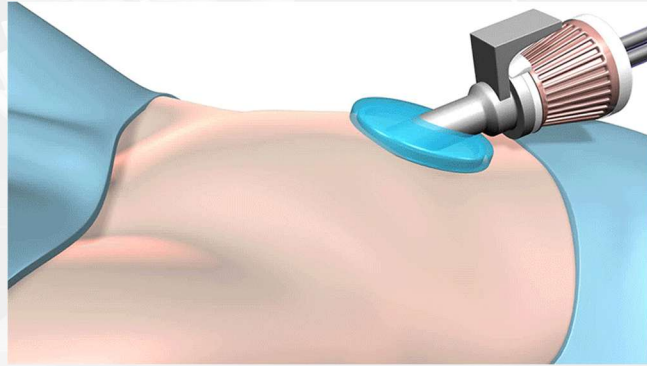


# Real-world scenarios

## Common procedures

- Radical prostatectomy
- Cholecystectomy
- Hysterectomy
- Colorectal resections
- General and thoracic surgeries
- Bariatric surgery
- ENT
- ...

## Robotic Prostatectomy



# Regulatory path

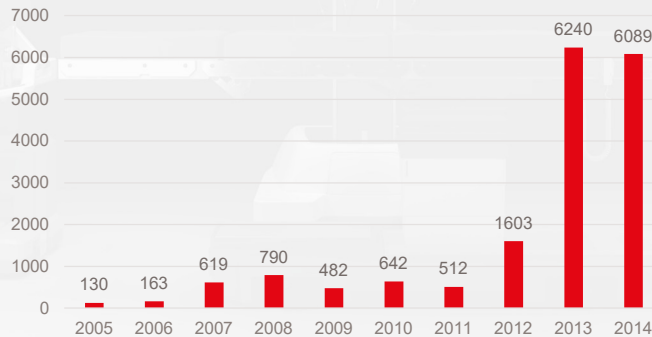
## United States

- 510(k)
- Investigational Device Exemption (IDE)
- Premarket Approval (PMA)
- Post-market surveillance (MAUDE)

## Switzerland

- CE marking (Conformité Européenne)
- Swissmedic approval
- Incidents confidential

Incidents reported to the FDA



# Costs and Business perspectives

	2015	Today
Da Vinci robot	3.5 million CHF	0.5 – 2.5 million CHF
Maintenance	250k CHF/year	190k CHF/an
Instrument cost	5k – 7k CHF/surgery	600–3.5k CHF/surgery
Insurance	Not always	Yes

### Future potential

- Improved profitability for hospitals
- Market growth

### 2025 perspective

- 1'800 expected unit sold worldwide (+18%)
- 10 billion USD expected revenue (+22%)



# Timeline

- 6500 BC ● Open surgeries
- 1972 ● First laparoscopic surgery
- 2000 ● FDA clearance for Da Vinci
- 2001 ● 1<sup>st</sup> remote surgery
- 2003 ● Merge Intuitive Surgical & Computer Motion
- 2008 ● 1<sup>st</sup> robot in Switzerland
- 2013 ● FDA intervenes
- 2019 ● Versius 1<sup>st</sup> surgery
- 2025 ● 3.1 million procedures (+17%)



## Limitations



- **Safety & transparency**
  - Device problems
  - Underreporting
- **Training**
  - Variable standards lead to surgeon-dependent outcomes
- **Cost and access**
  - High costs limit broad access
  - Not always profitable

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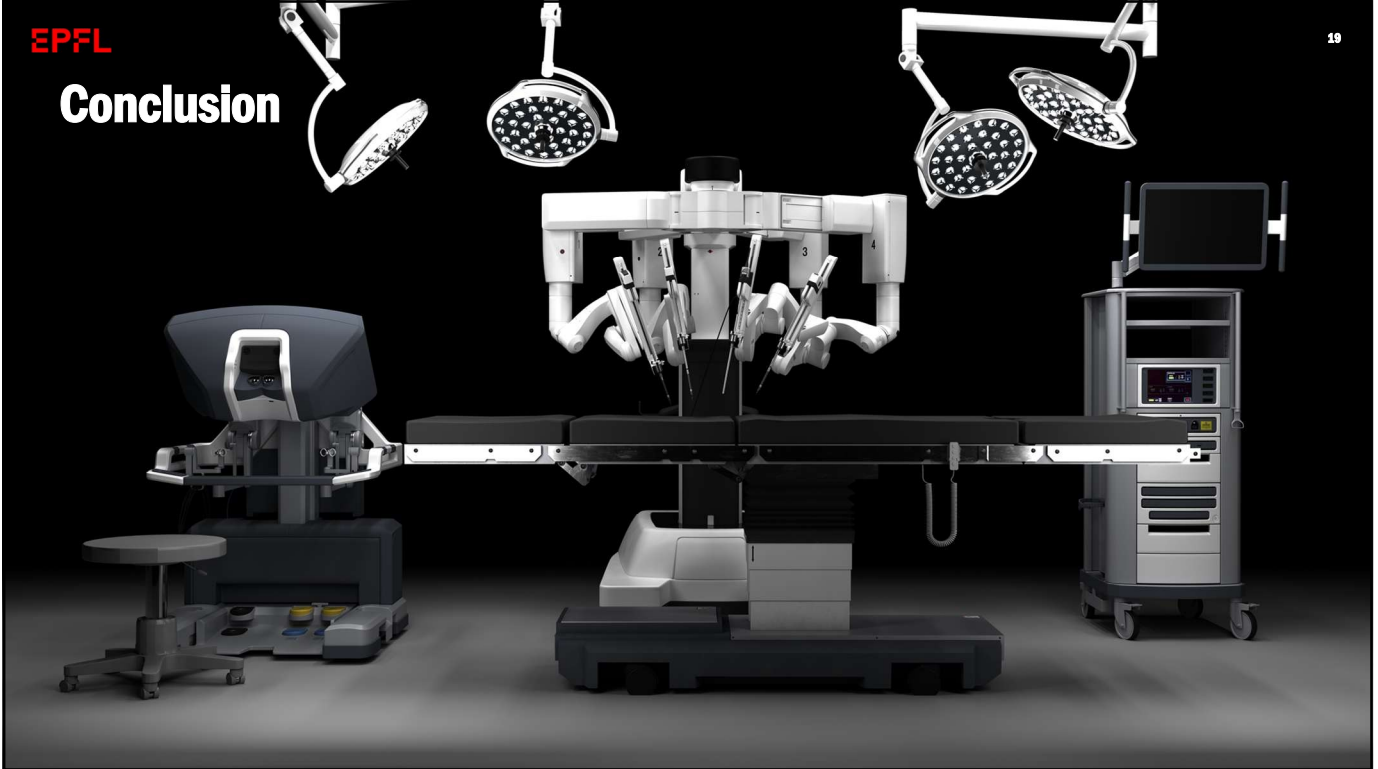
## Technology trends

- **Hardware**
  - Modularity
  - Different ergonomics
- **Software**
  - Haptics
    - Force Dimension Company
  - Safety
    - Delimit surgical space
  - Artificial Intelligence
    - Assistance
    - Imitation learning
    - Identify cancer tissue in vivo



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## Conclusion



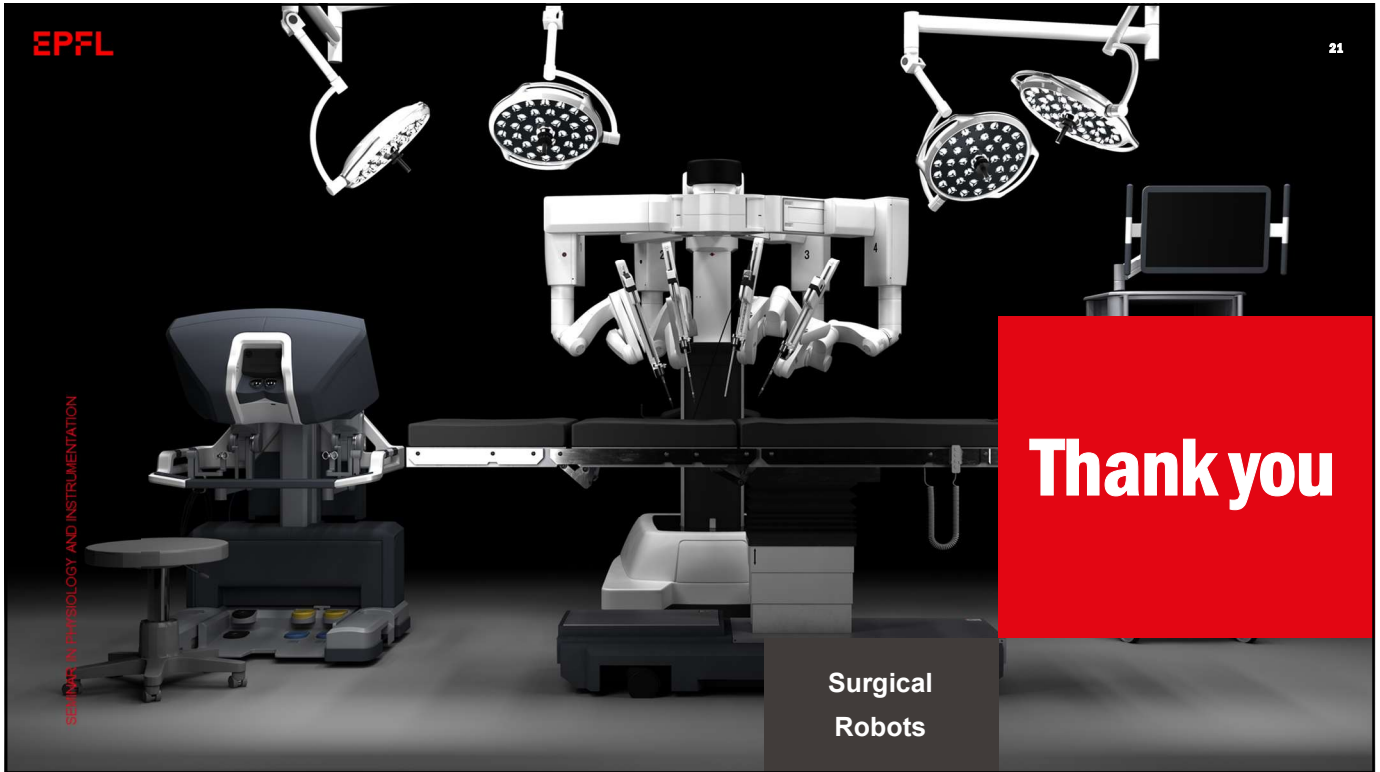
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## References

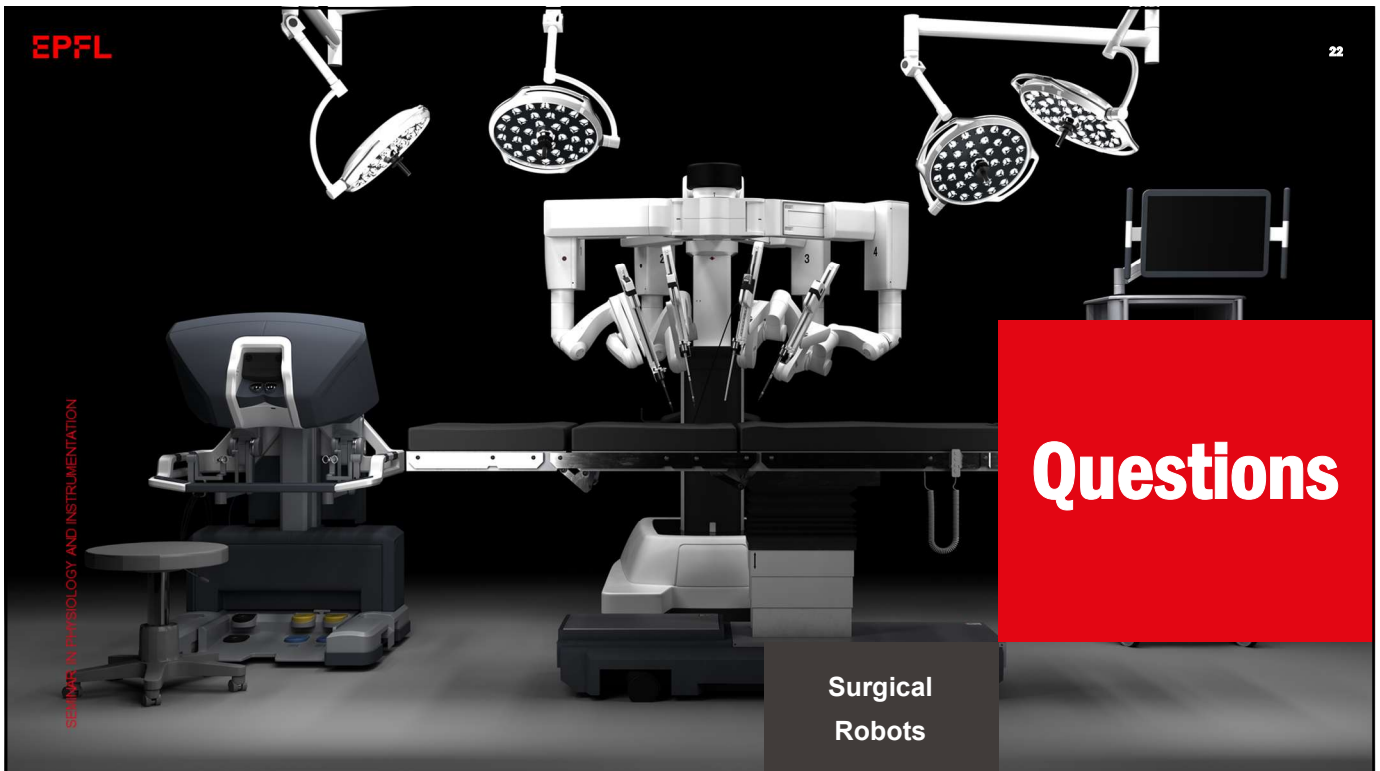
- Guyton, A. C. (2006). Textbook of Medical Physiology (11th ed.). Elsevier-Saunders.
- U.S. Food & Drug Administration. (n.d.). MAUDE database. Retrieved Nov 13, 2025, from <https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfmaude/search.cfm>
- RTS. (2015). Au secours : le chirurgien est un robot? [TV programme]. RTS Play. <https://www.rts.ch/play/tv/temps-present/video/au-secours--le-chirurgien-est-un-robot?urn=urn:rts:video:6635837>
- Intuitive Surgical, Inc. Annual Reports. <https://isrg.intuitive.com/>
- Webster, J. G. (Ed.). (2006). Encyclopedia of Medical Devices and Instrumentation [PDF]. (wiley\_minimal\_inv\_surg.pdf)

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