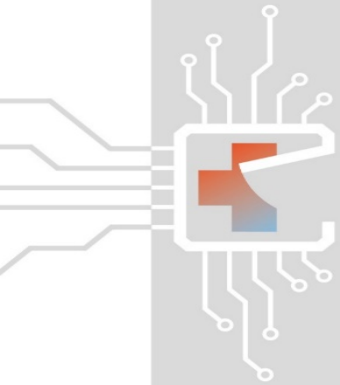

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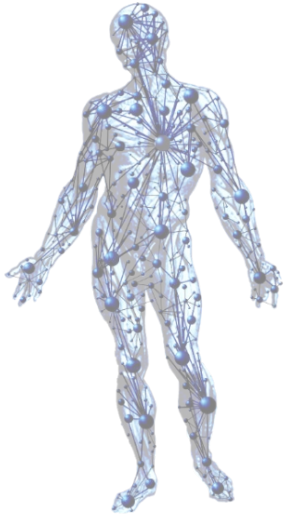
UNIVERSITÄT LEIPZIG

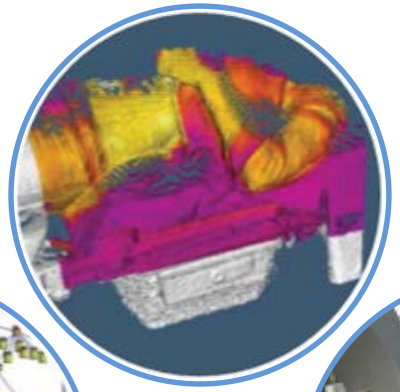
Thomas Neumuth

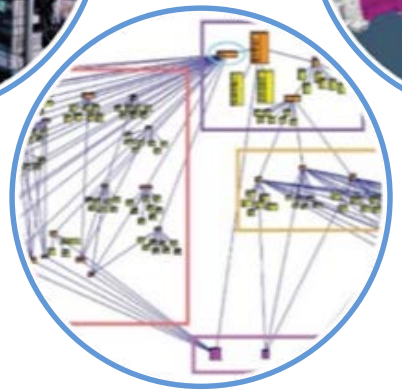
Artificial intelligence and robots in the OR
- Still room for ebM?

Innovation Center Computer Assisted Surgery (ICCAS)

- Affiliated to Medical School of Universität Leipzig
- ~85 engineering and computer science researchers







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Technology is integral part of medicine

Medicine

Biomedical and information technology

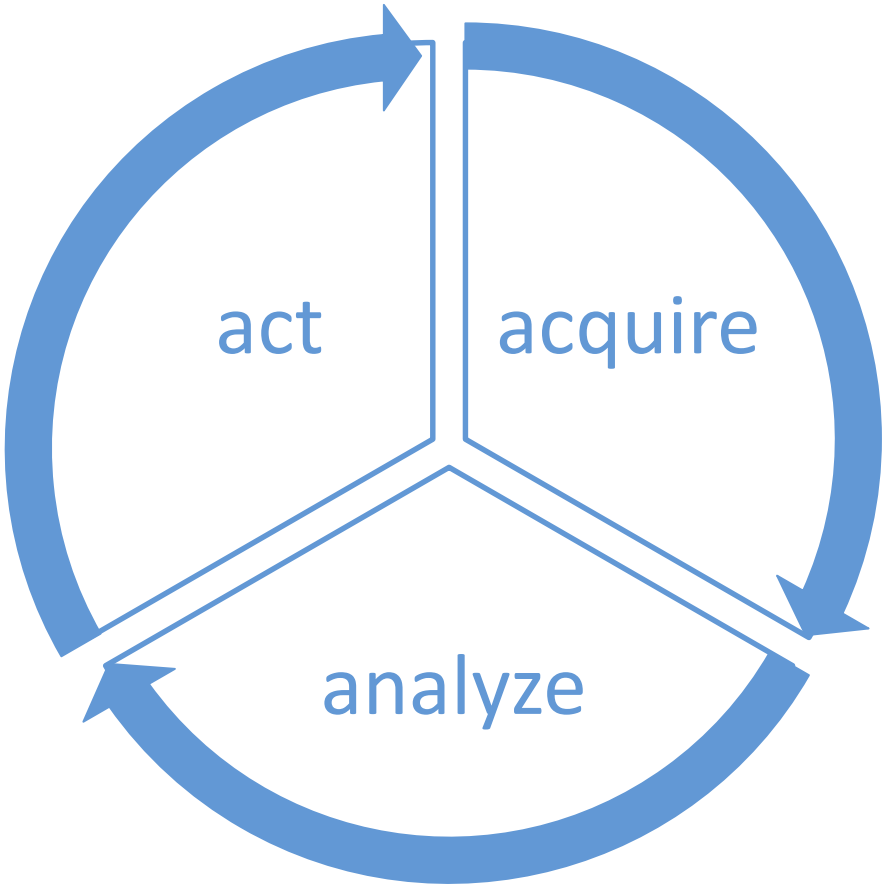
4P medicine

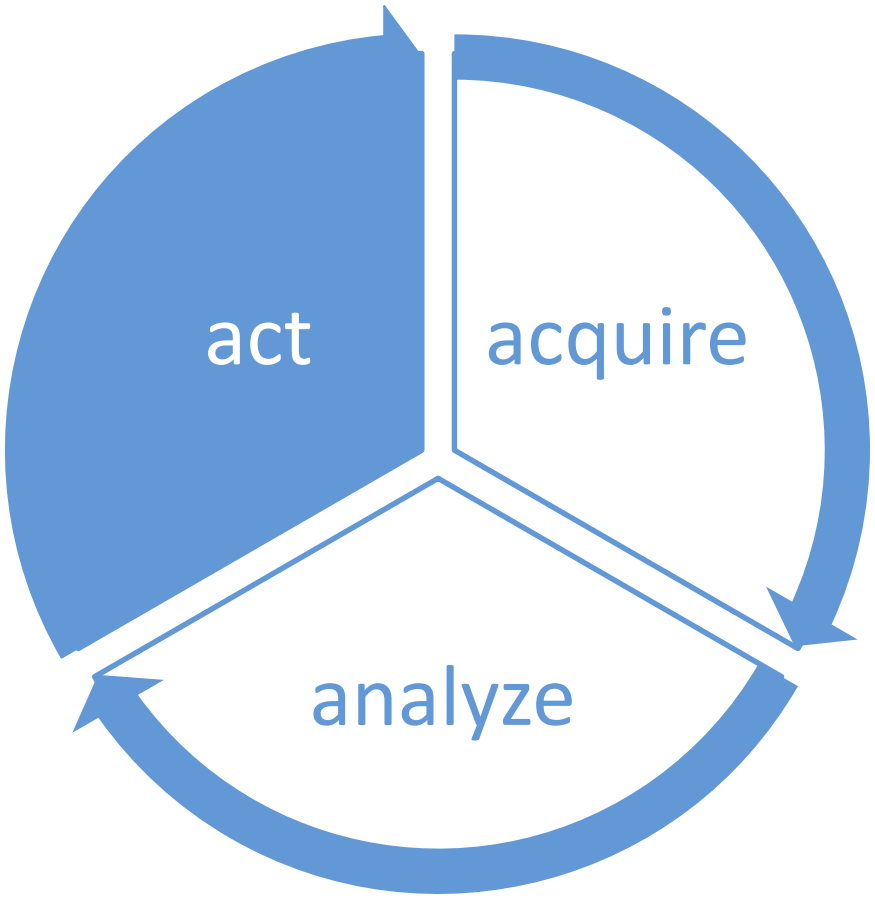
Personalized
Predictive
Preventive
Particatory

Hood and Friend 2011

Technology has a different evolution speed

- Information retrieval from distant monitors and devices
- Vendor dependent device operation
- Technical obstacles for advanced workflow management
- Limited flexibility in the selection and combination of systems


act
acquire
analyze


act
acquire
analyze

Robotic systems for surgery

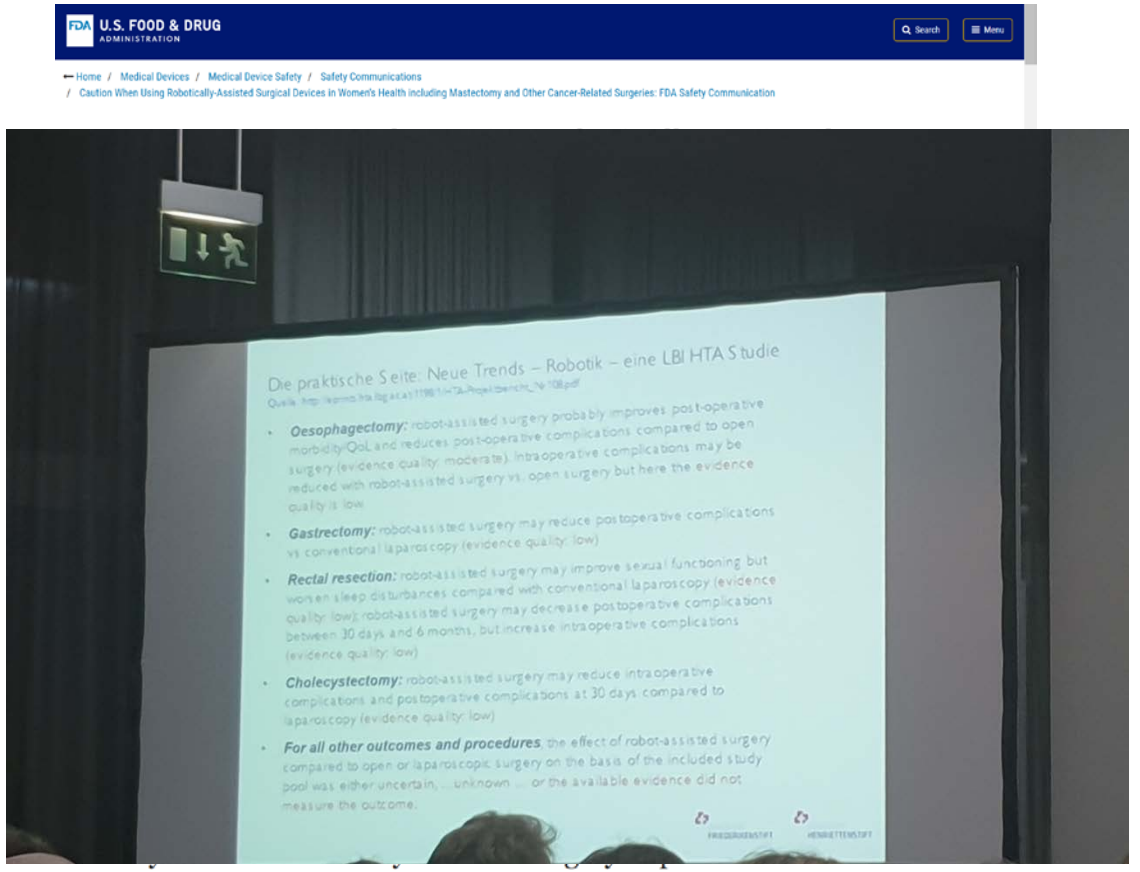
- **Master-slave systems**

- **(Semi-) autonomous systems**

Current evidence for robotic systems

- Operation times
- Operative costs

- Blood loss
- Complication rates
- Hospital stay length
- Transfusion rate



- Be aware that that the safety and effectiveness of using robotically-assisted surgical devices in mastectomy procedures or in the prevention or treatment of cancer has not been established.

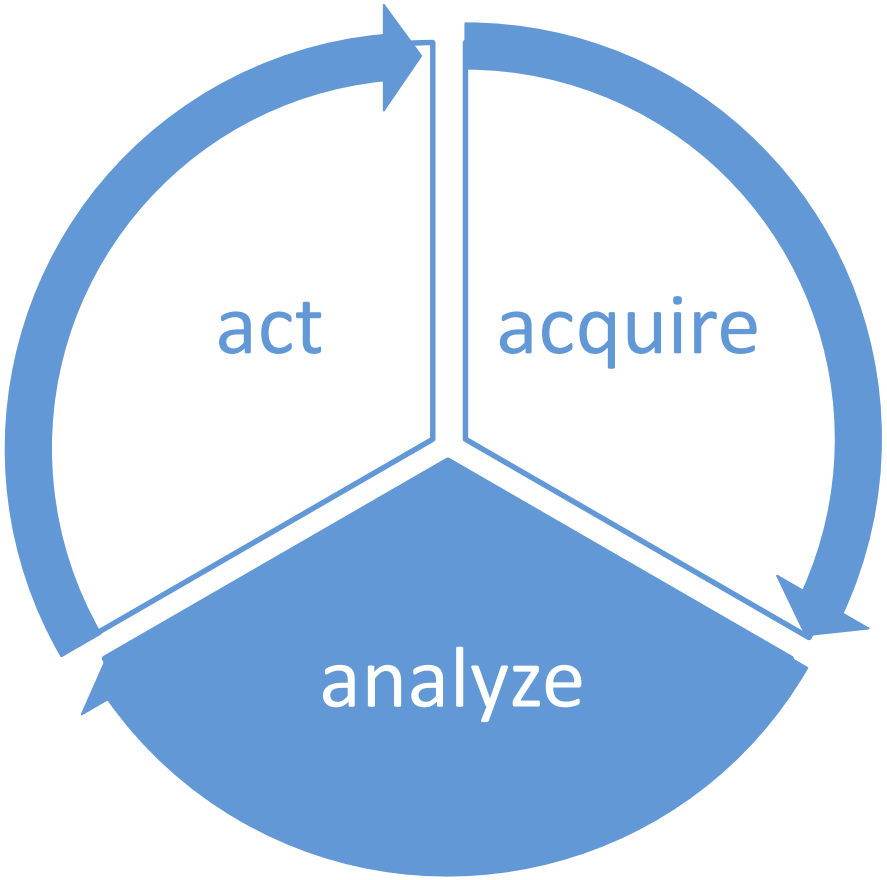
FDA, Feb 28, 2019

Imaging and cooperative robots

© Siemens Artis Zeego

Imaging and cooperative robots

Bieck et al. 2017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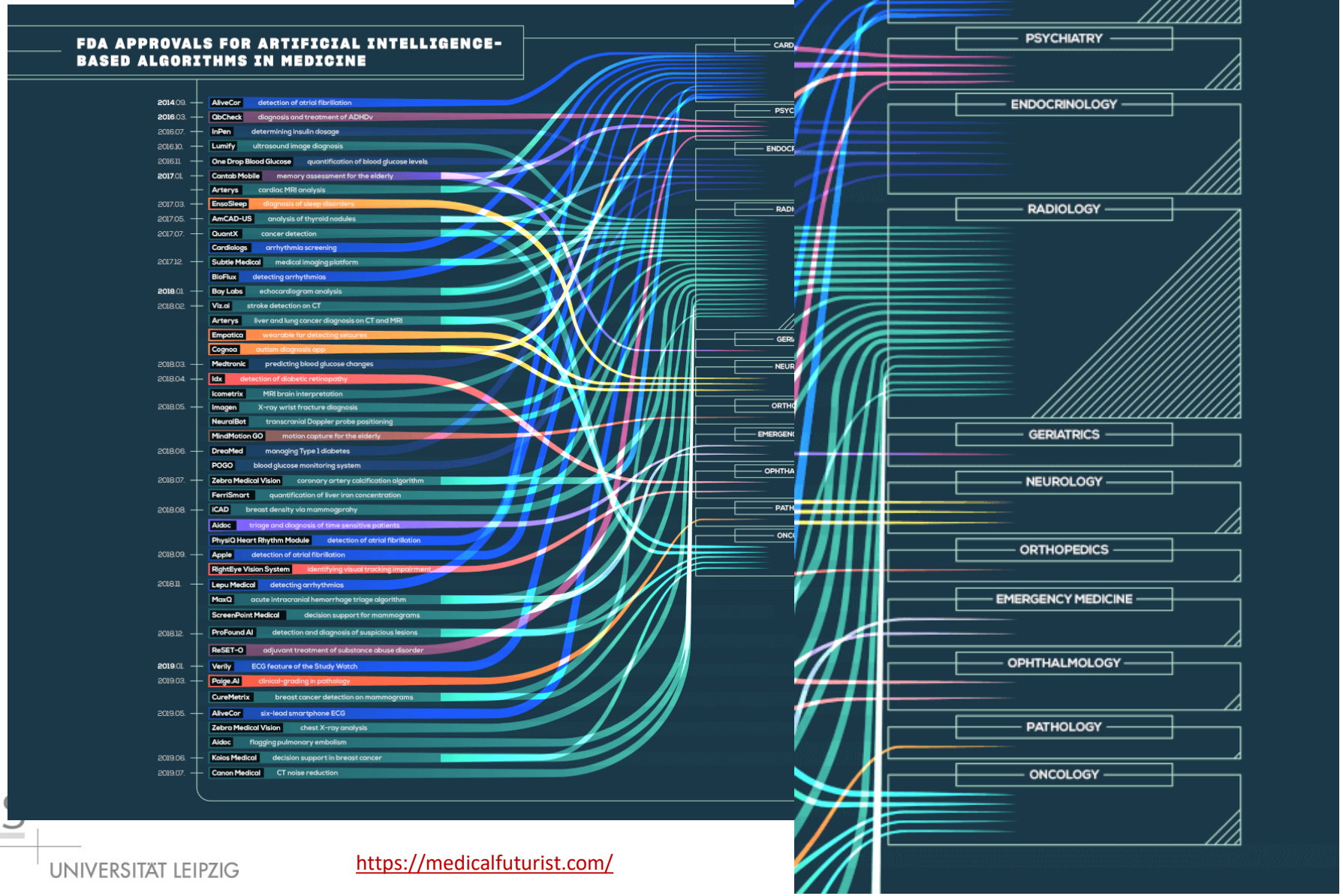
FDA-approved AI-algorithms



https://medicalfuturist.com/

Current research areas

- **Anaesthesia management**
  - Risk for postoperative pain, nausea, and respiratory depression
  - Predict hypotension, hypoxemia
- **Surgery**
  - Prediction of procedure times and anticipation of risk situations
  - Decrease human-technology interaction, Automatic documentation
- **Administration**
  - Decrease non-value-adding activities
  - Provide KPIs

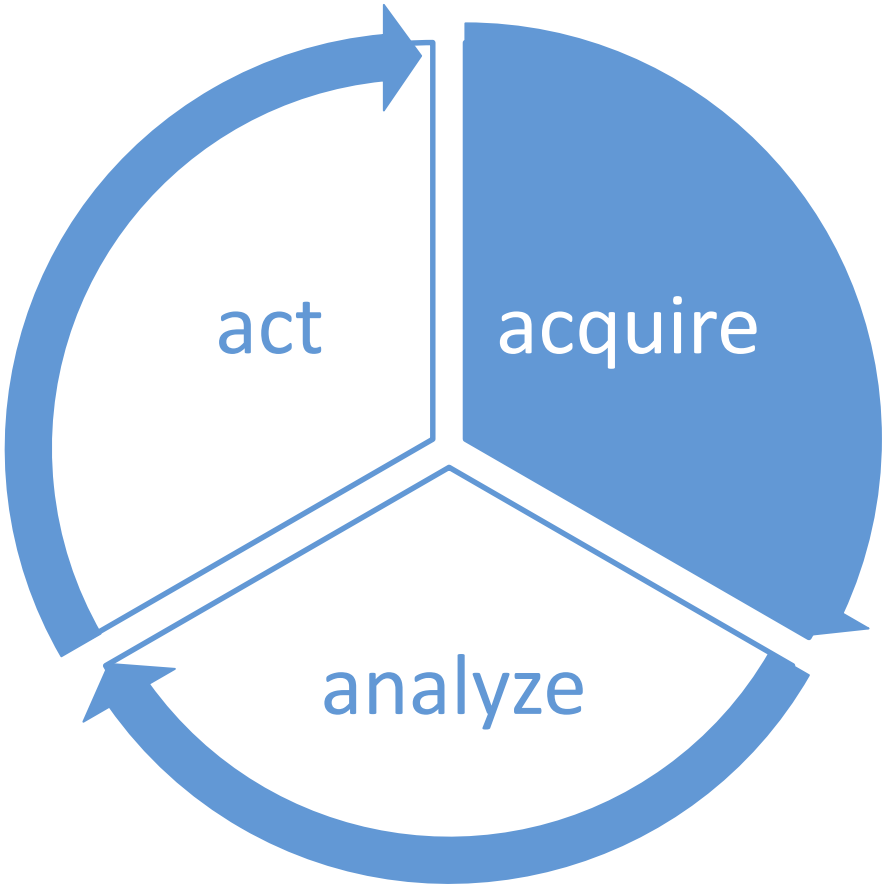
Situation aware biomedical technologies

Neumuth et al. 2009, Franke et al. 2015

Situation aware biomedical technologies

Medical device interoperability

ISO/IEEE 11073-10207
IEEE 11073-20701
ISO/IEEE 11073-20702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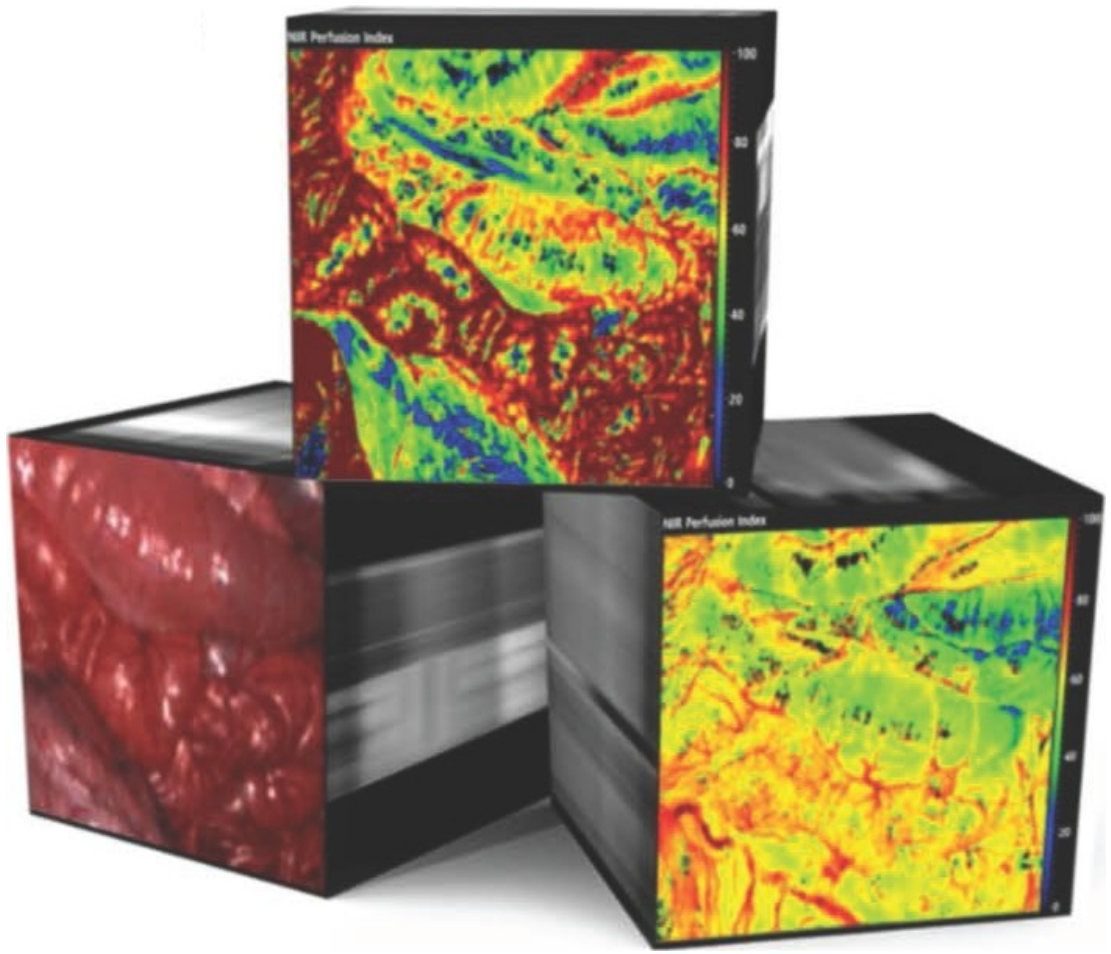
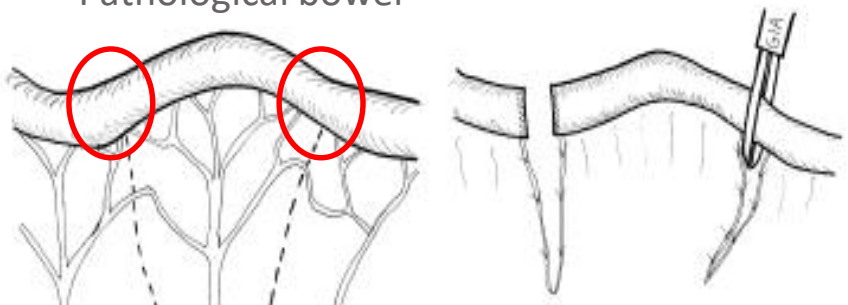
Hyperspectral Imaging

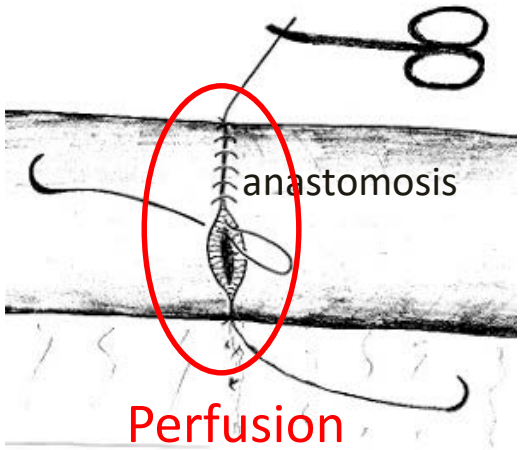


Hyperspectral imagung for tissue perfusion

Pathological bowel



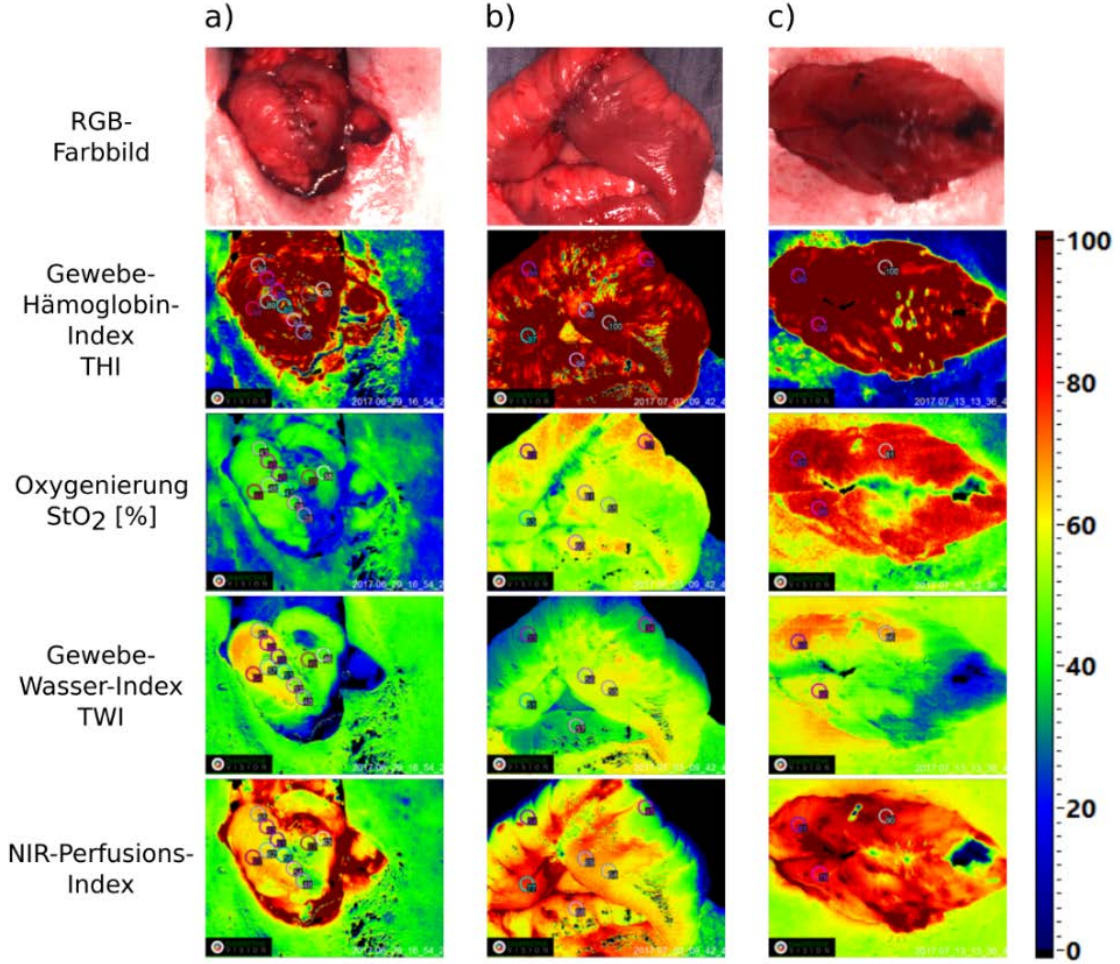
Perfusion state ?



Perfusion state ?

a) Patient **with** postop. perfusion insufficiency

b) and c) Patients **without** postop. perfusion insufficiency



Jansen-Winkeln et al. Chirurg 2018

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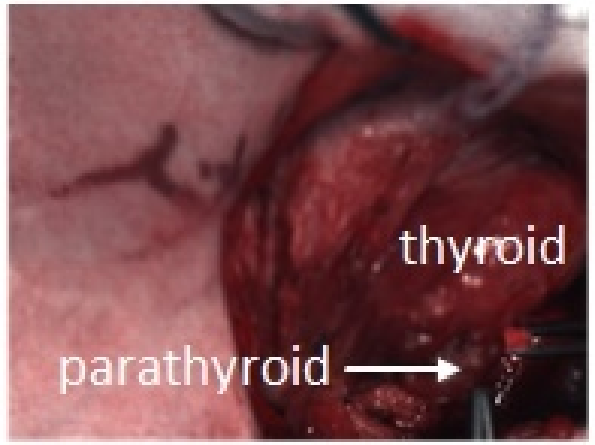
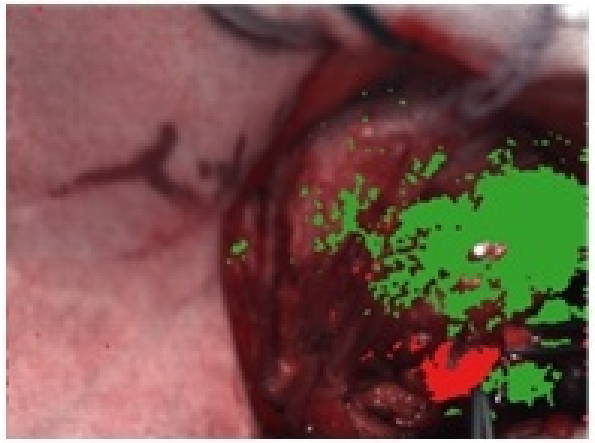
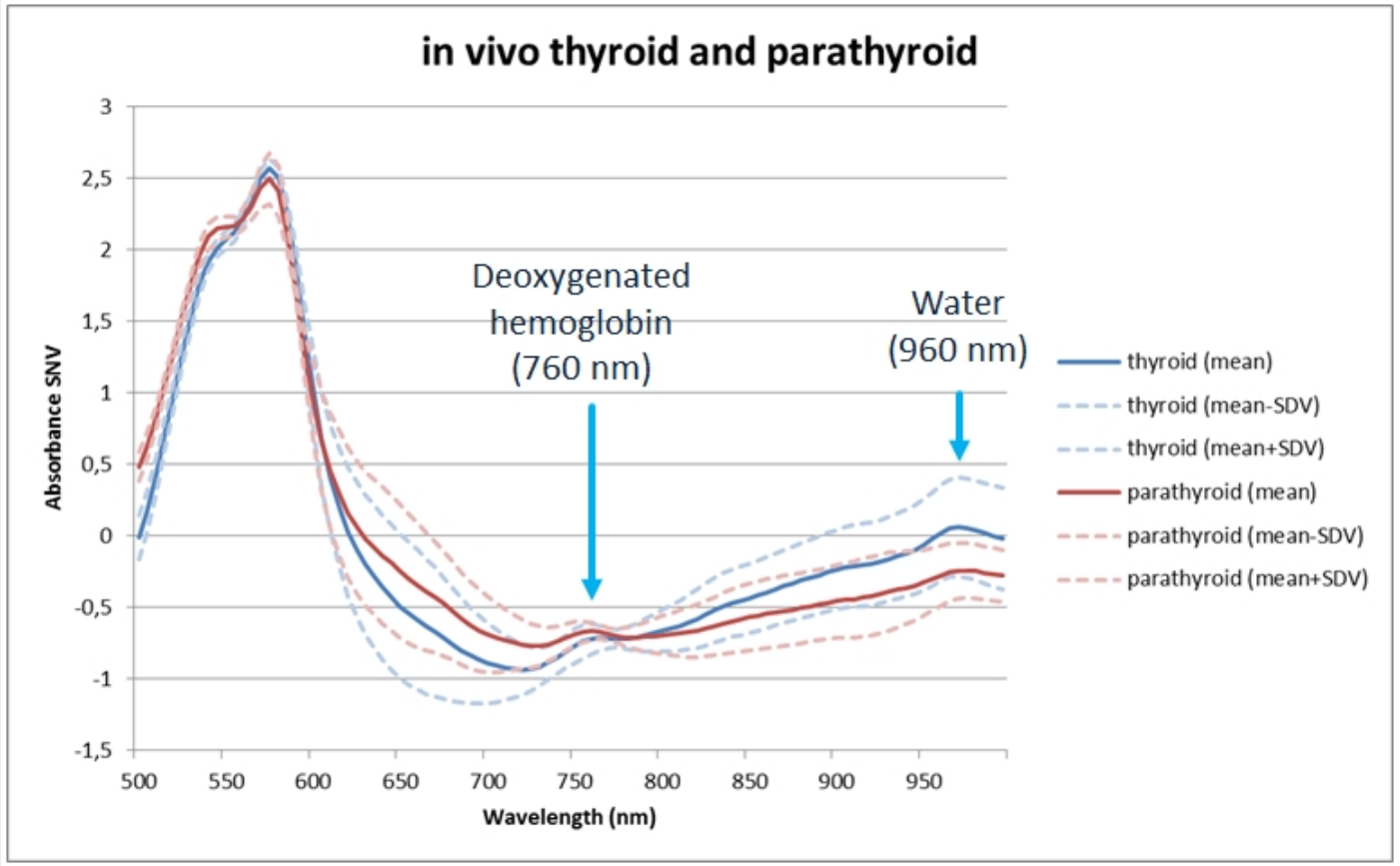
HSI-based discrimination of thyroid and parathyroid







Total number of spectra: $n_{thyroid}$ = 3128, $n_{parathyroid}$ = 383

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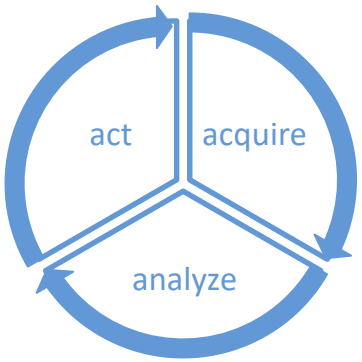
Barberio et al. 2018

But surgery is just one option …

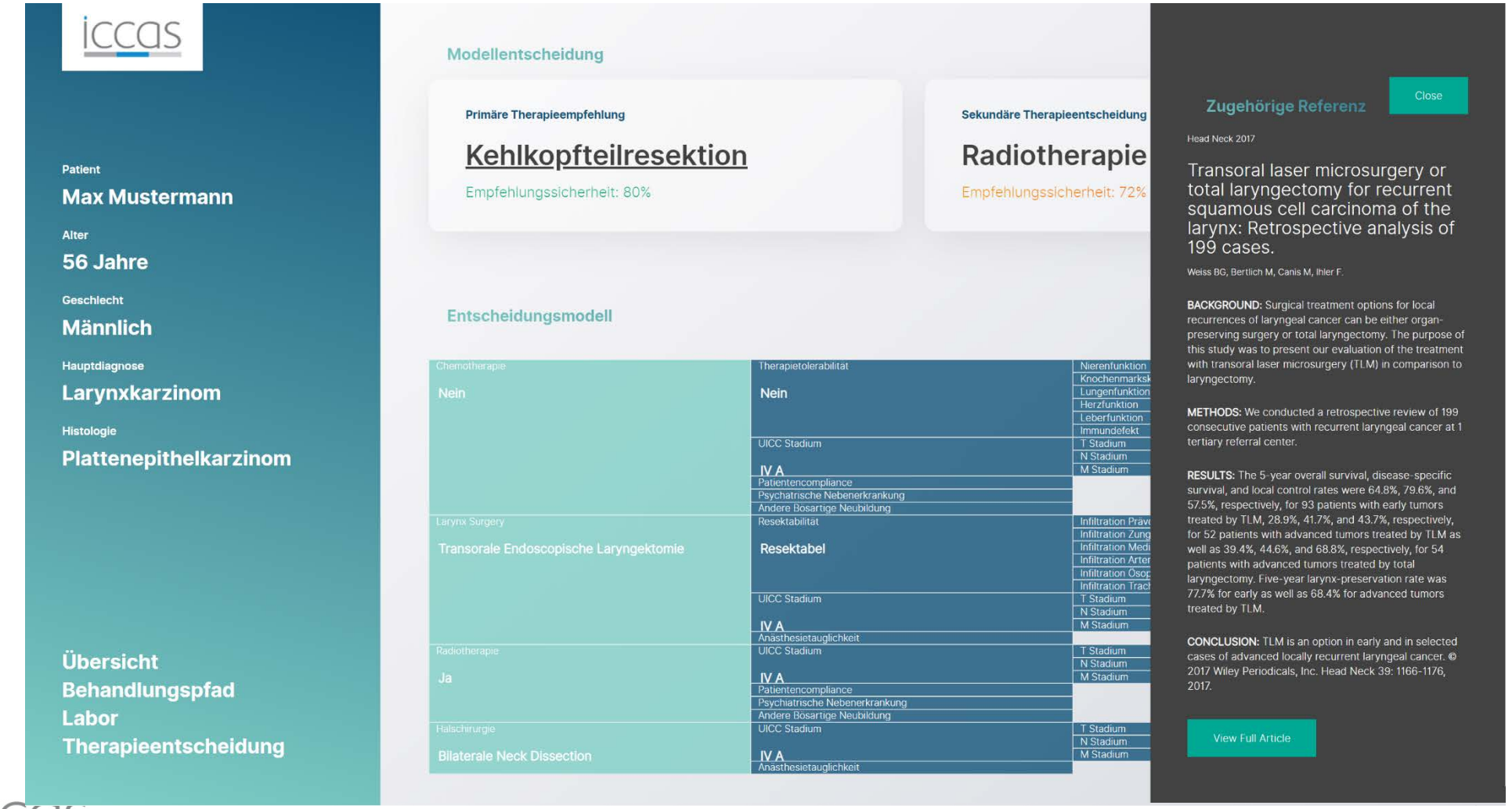


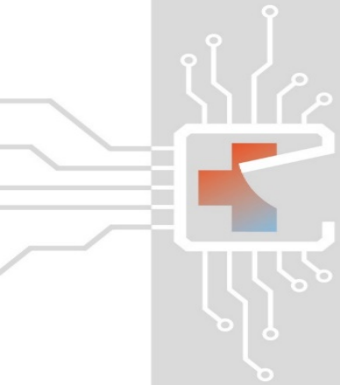
Digital patient models for decision-making

Cypko et al. 2017

ENT-Tumorboard at the University Hospital Leipzig, Germany

Prediction and clinical decision support





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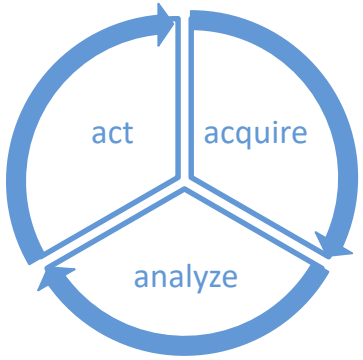
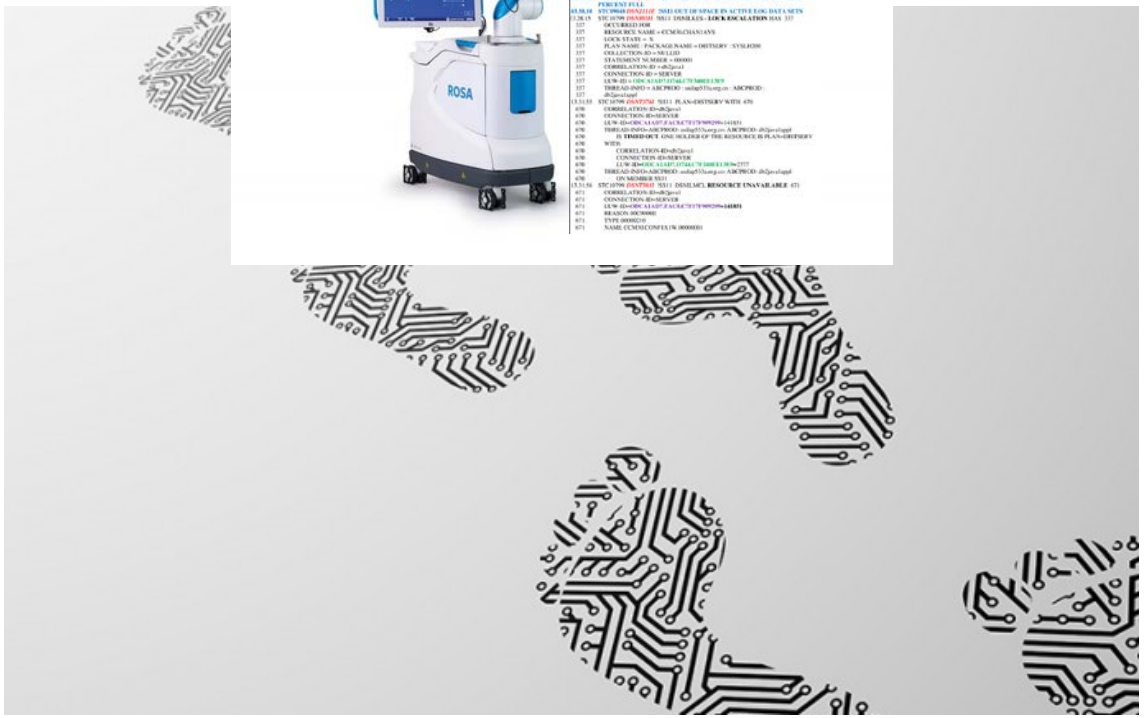
Artificial intelligence and robots in the OR

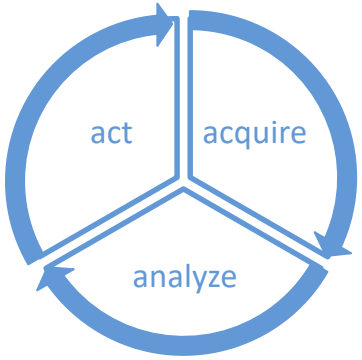
- Still room for ebM?

The digital footprint





The digital footprint



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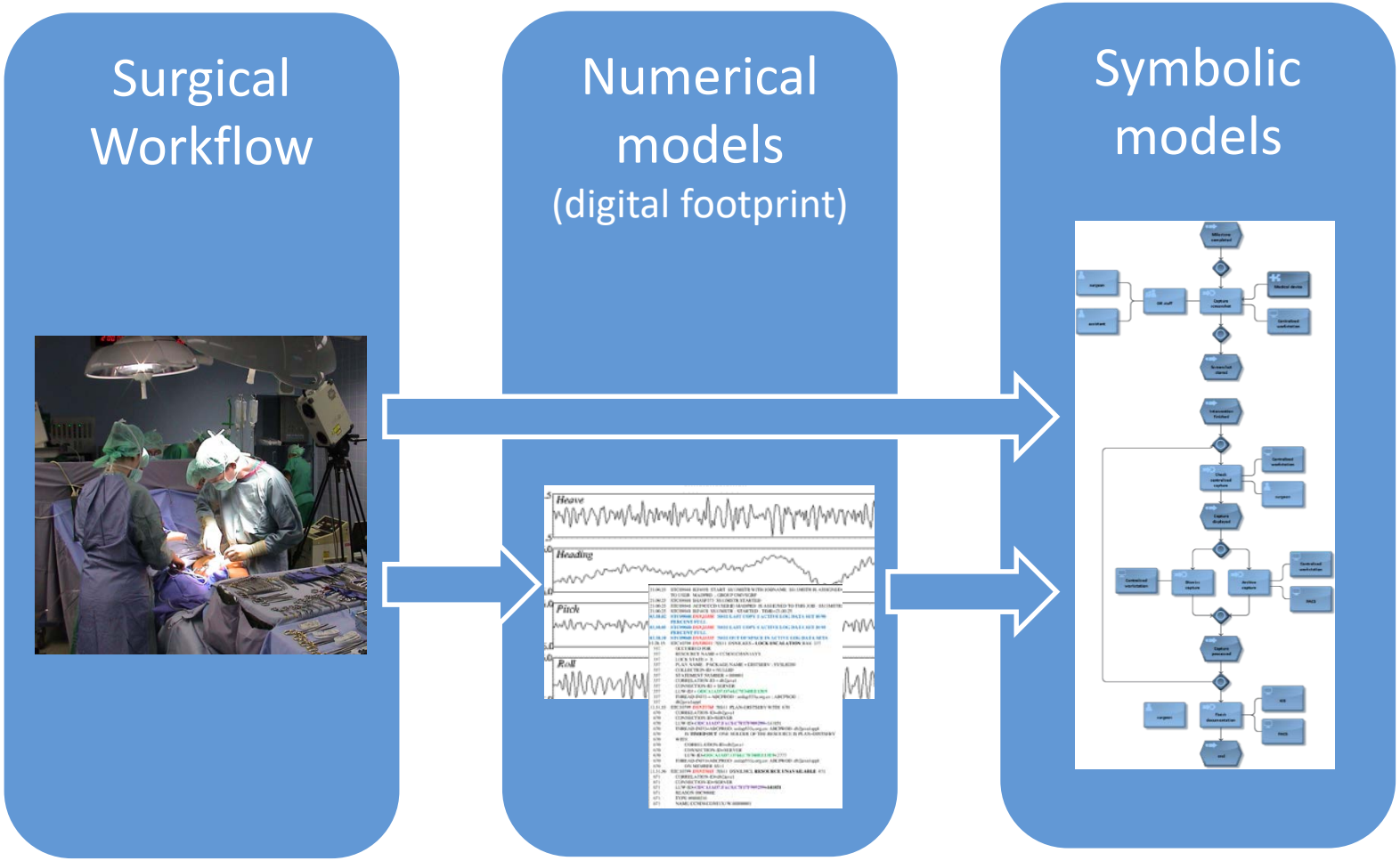
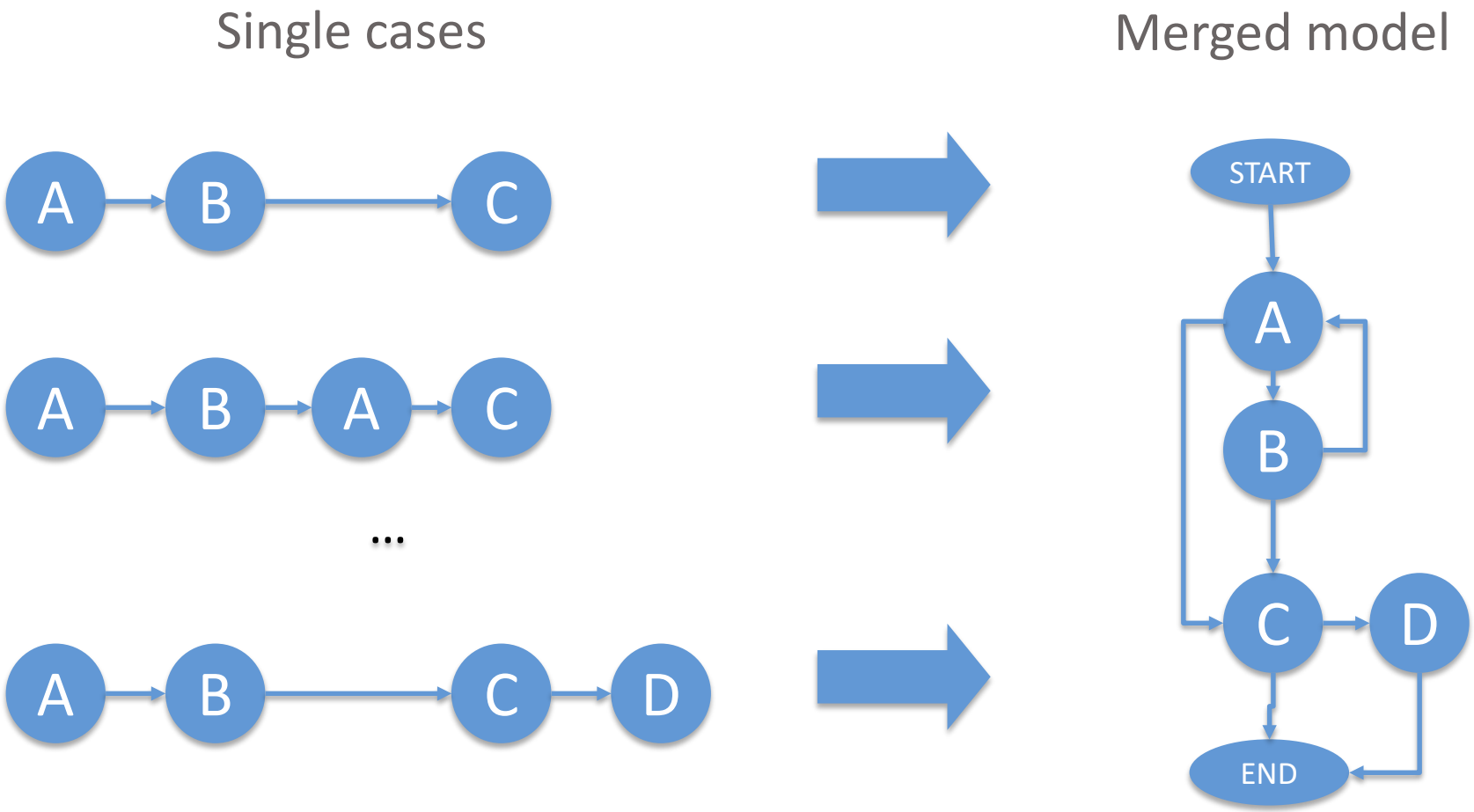
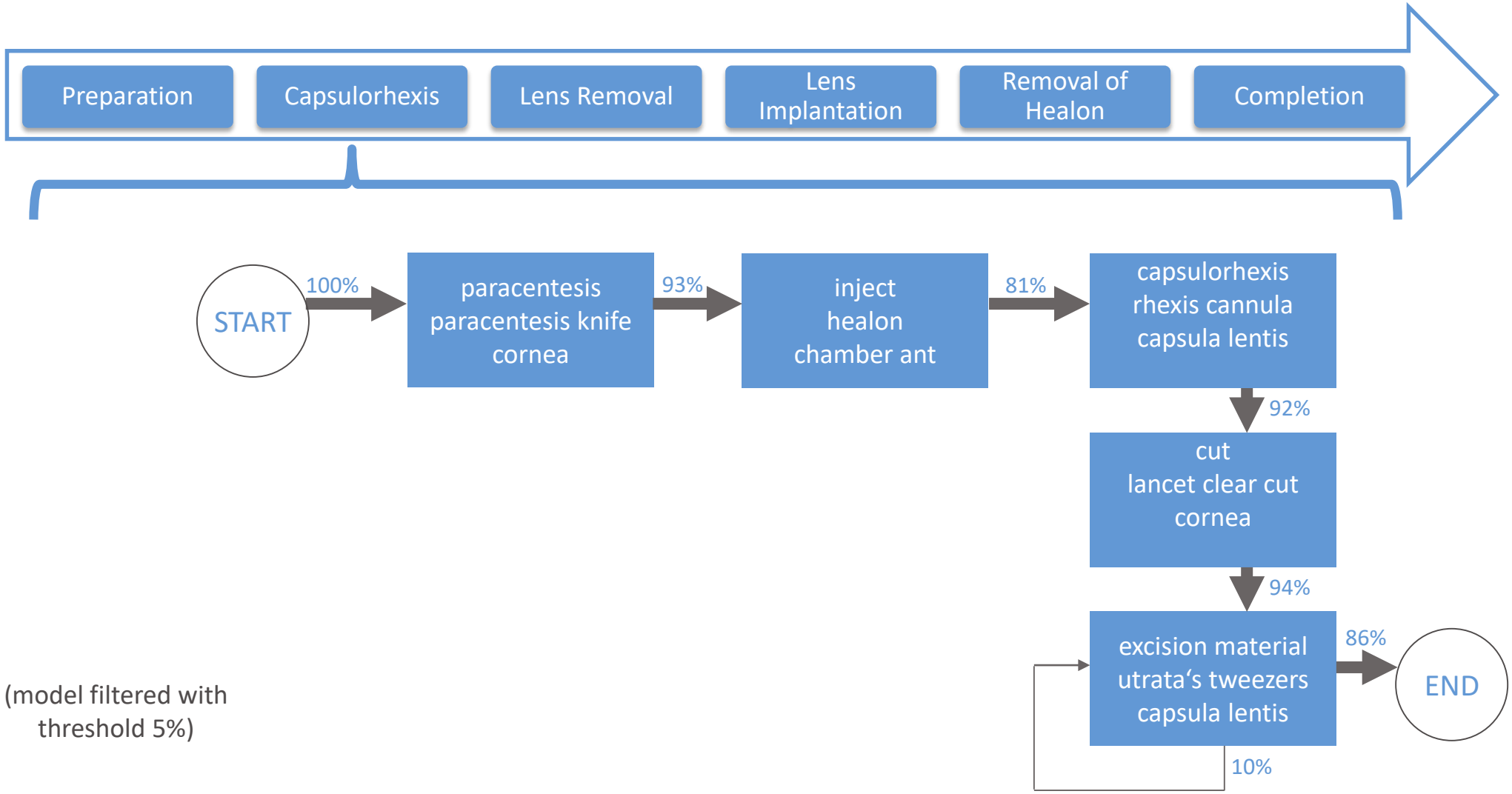
Numeric vs. symbolic process models



Model generalization



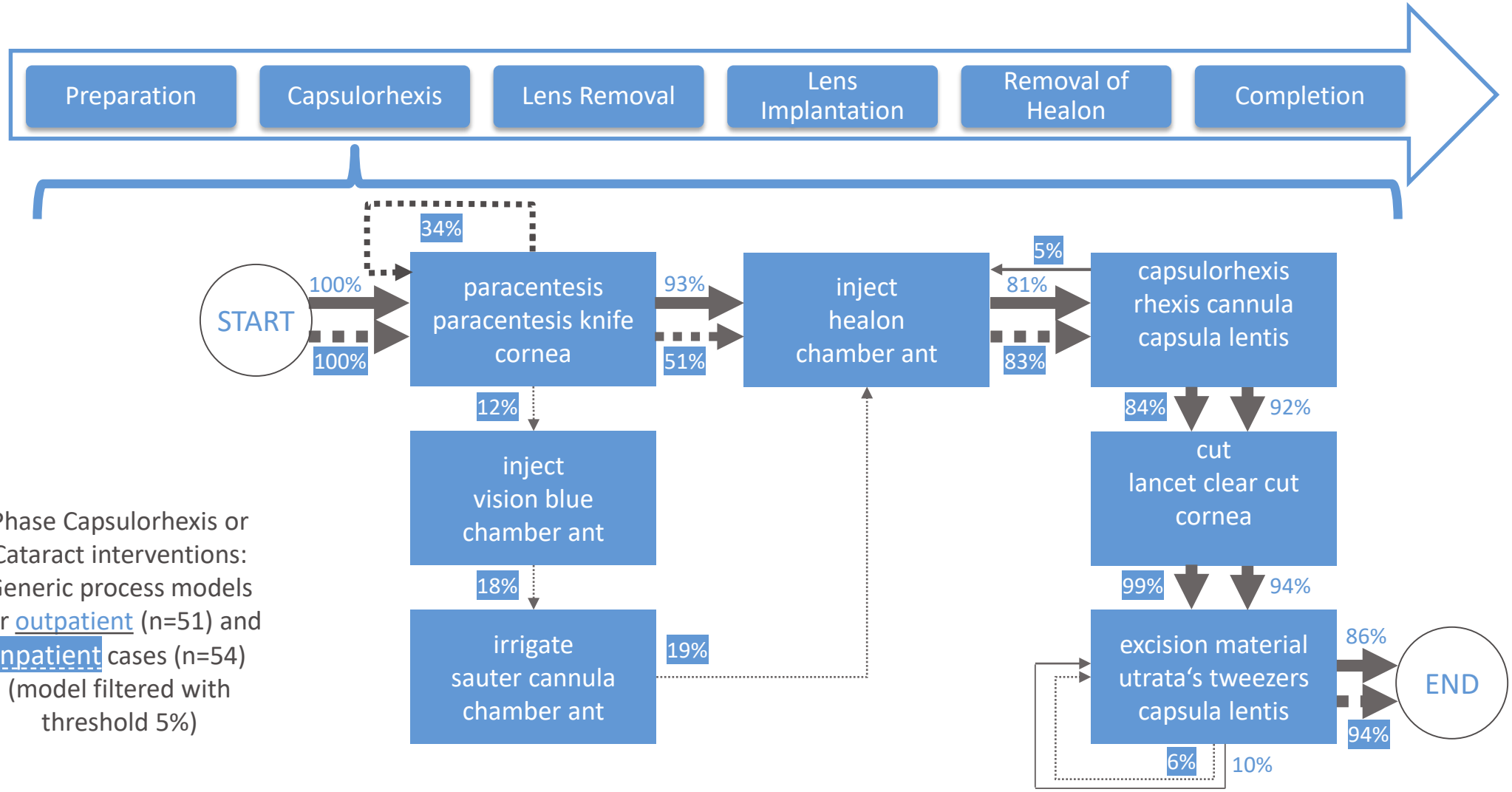
Model analysis: workflow assessment



(model filtered with threshold 5%)

Neumuth et al. 2011

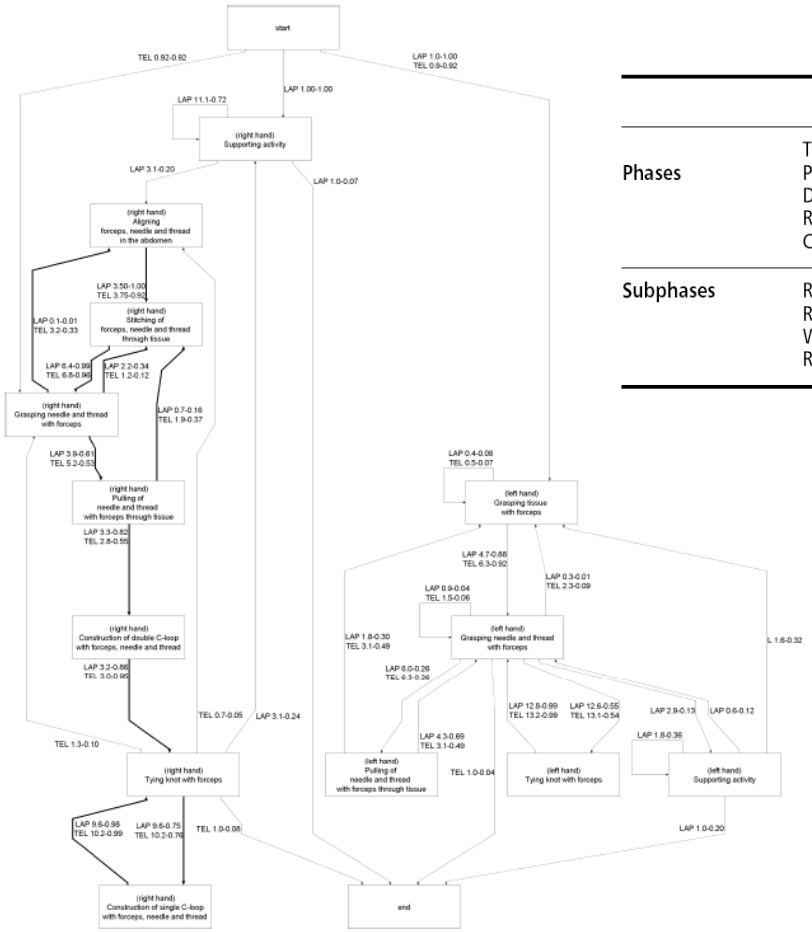
Model analysis: workflow assessment



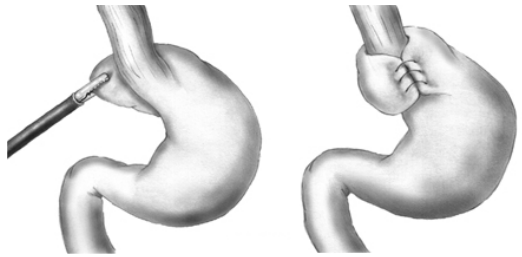
Phase Capsulorhexis or Cataract interventions: Generic process models for outpatient (n=51) and inpatient cases (n=54) (model filtered with threshold 5%)

Neumuth et al. 2011

Model analysis: resource impact estimation



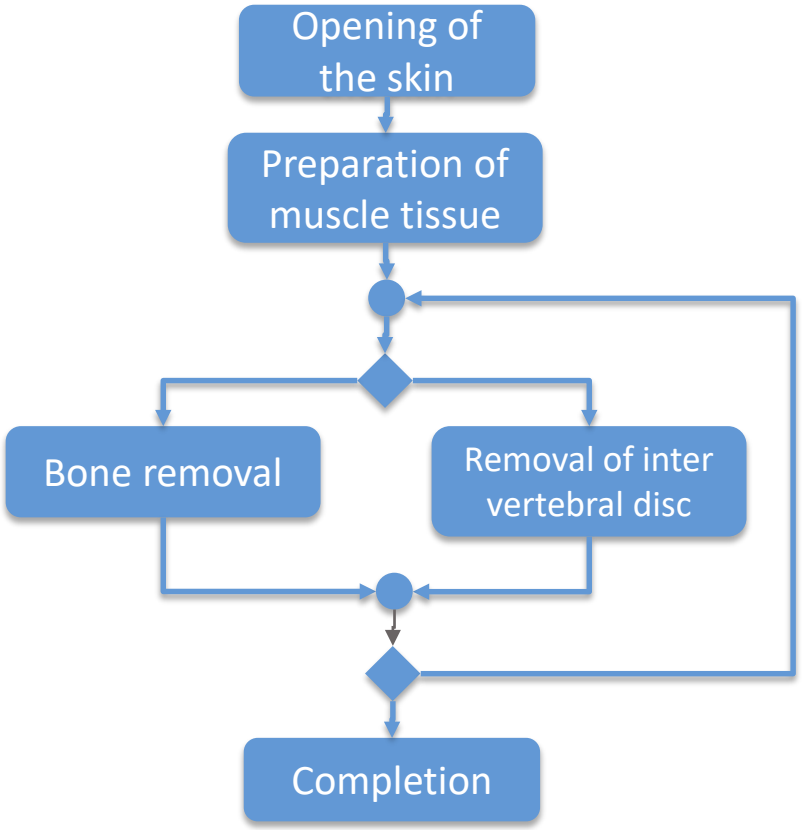
		LAP [avg±sdev]	TEL [avg±sdev]	*P*-value
Phases	Total intervention time	01 : 41 : 05 ± 00 : 21 : 56	01 : 36 : 47 ± 00 : 17 : 08	$p = 0.045$
	Preparation	00 : 42 : 31 ± 00 : 16 : 56	00 : 38 : 44 ± 00 : 07 : 34	$p > 0.05$
	Dissection	00 : 18 : 49 ± 00 : 10 : 44	00 : 13 : 18 ± 00 : 06 : 40	$p > 0.05$
	Reconstruction	00 : 33 : 25 ± 00 : 10 : 08	00 : 37 : 32 ± 00 : 07 : 44	$p > 0.05$
	Conclusion	00 : 06 : 19 ± 00 : 01 : 49	00 : 07 : 12 ± 00 : 02 : 22	$p > 0.05$
Subphases	Reconstruction hiatus suture	00 : 09 : 15 ± 00 : 07 : 22	00 : 06 : 54 ± 00 : 01 : 50	$p > 0.05$
	Reconstruction collar stitches	00 : 08 : 25 ± 00 : 02 : 13	00 : 10 : 49 ± 00 : 03 : 32	$p > 0.05$
	Wrap creation	00 : 03 : 00 ± 00 : 00 : 44	00 : 04 : 45 ± 00 : 05 : 10	$p = 0.014$
	Reconstruction Fundoplication suture	00 : 12 : 43 ± 00 : 02 : 31	00 : 15 : 32 ± 00 : 03 : 13	$p > 0.05$

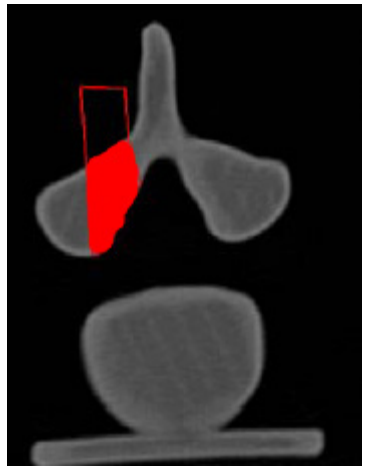


Nissen fundoplication, animal study
laparoscopic cases vs. telemanipulator-assisted cases (each n=12)

Krauss et al. 2012

Model analysis: technology requirements





n=14	Unit	AVG	Min	Max	SDEV
Time Frame	hh:mm:ss	**00:45:08**	00:22:23	01:13:43	00:13:08
Iterations	activity	**15.2**	7	27	6.3
Cumulated Duration	hh:mm:ss	**00:19:55**	00:12:40	00:32:11	00:06:52

Neumuth et al. 2009

KI KS

Künstliche Intelligenz für Klinische Studien

Bundesministerium
für Wirtschaft
und Technologie

Objective: Development of an eco system for data acquisition and AI-based analysis for post market surveillance of medical devices

Summary

- Robots have arrived in ORs
- AI in the OR has not yet arrived

- Technologies have digital footprints that enable continuous ebM without cognitive biases

If you can't measure it, you can't improve it.

(Peter F. Drucker)

Thank you.

Prof. Dr. Thomas Neumuth

Innovation Center Computer Assisted Surgery (ICCAS)

thomas.neumuth@iccas.de

www.iccas.de, Twitter: @iccasLeipzig