Medical technolog - Research and innovation

Thomas Langø (PhD) Research Director
Dept. Medical Technology, SINTEF

Fagseminar FOR
28. januar 2016
Røros Hotell
SINTEF is the largest independent research organisation in Scandinavia

A multidisciplinary research organisation with international top level expertise in specific fields

- Leading expertise in the natural sciences and technology, environment, health and social science
- 2100 employees from 70 countries
- Customers in more than 60 countries
- A notfor-profit research institute
Current healthcare challenges

• Growing aging population
• Shortage of care providers
• Increasing prevalence of chronic conditions
• Fragmented care management
• Rising health care costs
• …

Disruptive change is needed
Trends show change - Enabling technologies

- Patient take a more active role in managing health and wellness
- Empowered patient through availability of health information
- Smart phones + gadgets and internet of things
- As people age, more technology in home: sensors
- Earlier detection of disease: camera pill, lab-on-a-chip, smart contact lenses, nano-sensors
- High-tech healing and care
Evolution of therapy

From ancient times until the end of the 19th century

From the end of the 19th century until the middle of the 20th century

The 21st century

Body incision to remove the tumor

Minimal incision to remove the tumor

Non-invasive surgery
Strong collaboration between clinicians and technological research scientists since 1995

National Center for Advanced Laparoscopic Surgery

Norwegian National Advisory Unit on Ultrasound and Image-Guided Therapy

www.nsalk.org
www.usigt.org
Available infrastructure MedTech R&D, Trondheim

- National Advisory Unit for Ultrasound and Image-Guided Therapy (www.USIGT.org)
- National Center for Advanced Laparoscopic Surgery (www.NSALK.org)
- Future OR at St. Olavs Hospital (www.stolav.no/for)
- Ultrasound laboratories at SINTEF and NTNU
- NorMIT - Norwegian Centre for Minimally Invasive Image-Guided Therapy and Medical Technologies
- FAST - Framework for Heterogenous Medical Image Computing and Visualization
- CustusX - Navigation platform for research and development in image-guided interventions
Intraoperative navigation platform for research and development in image-guided interventions

Open source platform for R&D (since Jan 2015)


www.custusx.org
www.usigt.org
Areas of clinical use, testing, or development

- Neurosurgery
- Vascular diagnostics
- Endovascular therapy
- Laparoscopic surgery
- Bronchoscopy (lung diagnostics)
- ENT
- Training / Simulation
- Orthopaedics
- Spine interventions
- HIFU / FUS (kidney, liver)
- Local ablation (RFA)
- Anaesthesia (nerve block)
- Guiding injections, biopsies
- …
Future OR

http://give.brighamandwomens.org/stories/entry/ultimate-operating-room
Ultrasound and image-guidance in Neurosurgery
Intrasellar ultrasound in transsphenoidal surgery - a novel technique

Ultrasound and navigation in Laparoscopic surgery
Tracking surgical tools
Tool controlled visualisation
Image fusion, overlay preop CT segmented data onto video laparoscope image

3D patient specific modeling from CT images

cirrhosis, focal nodular hypertrophy, HepatoCellular-carcinoma and Liver Metastases from colorectal cancer

Real-time 3D image reconstruction guidance in liver resection surgery
Luc Soler, Stephane Nicolau, Patrick Pessaux, Didier Mutter, Jacques Marescaux
HBSN, Vol 3, No 2, 2014
Image fusion, overlay preop CT segmented data onto video laparoscope image

Real-time 3D image reconstruction guidance in liver resection surgery
Luc Soler, Stephane Nicolau, Patrick Pessaux, Didier Mutter, Jacques Marescaux
HBSN, Vol 3, No 2, 2014
Planning and guidance in laparoscopic liver resections

HepaNavi planning platform
Courtesy: O J Elle et al, IVS

CustusX intraoperative guiding platform

EM tracked LUS probe

Norwegian Centre for Minimally Invasive Image Guided Therapy and Medical Technologies

Oslo University Hospital

NorMIT
Norwegian Centre for Minimally Invasive Image Guided Therapy and Medical Technologies
Lap ultrasound in liver navigation - Before shift correction

Courtesy: L C Rekstad, P E Uggen, R Márvik, St. Olavs Hospital, Trondheim
Lap ultrasound in liver navigation

After (manual) in-the-OR shift correction

Courtesy: L C Rekstad, p E Uggen, R Mårvik, St. Olavs Hospital, Trondheim
Liver phantom with flow (CT, MR, ultrasound)

Courtesy: A Rethy, J Sæternes, J Halgunseth, R Mårvik, EF Hofstad, DH Iversen

SINTEF
Navigation in Bronchoscopy

Navigation in endobronchial ultrasound (EBUS), patient
Navigation in endobronchial ultrasound (EBUS)
Other stuff ...
Imaging modalities for endoscopy

Imaging modalities for flexible endoscopes

Anders M et al. Journal of Gastrointestinal Oncology, Vol 2, No 2 (June 2011)
Imaging modalities for flexible endoscopes
Confocal laser scanning microscopy

Intestinal Metaplasia
Visualized with
Cellvizio GastroFlex
UHD minprobe

Adenocarcinoma
Visualized with
Cellvizio GastroFlex
UHD minprobe

http://www.maunakeatech.com/
Robotics in medicine
Integrating Surgical Systems for Autonomy in the future OR

“Penelope” – robotic scrub nurse
Michael Treat MD, Columbia Univ, NYC. 2003

da Vinci
Surgical master-slave “robot” system
Robotics in medicine
Microrobotics in medicine

Nanoroboticist Metin Sitti shows the tiny robot that can take pictures, biopsy, and deliver medicine inside of you.
Microrobotics in medicine

www.vector-project.com
Focused ultrasound therapy
Advantages FUS to other ablative techniques and surgery

- Non-invasive
- Not tumor specific
- Serious complications are rare
- Pain is minimized
- No scars
- Fast recovery
- May stop bleeding
- No cumulative effect on tissue: Treatment may be repeated
- Non-ionizing: May be used after radiation therapy failure
- Relatively safe to ablate tumors close to major blood vessels (the blood flow “cools down” the vessel wall)
- Low cost compared with traditional surgery (after initial investment...)
In clinical use or initial phase clinical trials and preclinical testing

- **Uterine fibroids**: Annual market in G7 - $3B
- **Bone metastasis**: Annual market in G7 - $10B
- **Prostate cancer**: Annual market in G7 - $15B
- **Breast cancer**: Annual market in G7 - $10B
- **Liver cancer**: Annual market in G7 - $5B
- **Brain treatments**: Annual market in G7 - $75B

Other: Rectum, Pancreas, Kidney, Testes, Lymph node, Bladder

*Estimated values by InSightec Inc., Israel*
Novel Multifunctional Nanoparticle-Microbubble Platform for Ultrasound-Enhanced Drug Delivery

Gas microbubbles 1-6 µm

Ultrasound contrast agent

Disruption by US leads to release of particles and cavitation and hyperthermia in tissue

Nanoparticle 100-200 nm

Drug

Fluorescent probe

Targeting ligand

MRI contrast agent

PEG

Courtesy: R Hansen, SINTEF / NTNU, Yrr Mørch, SINTEF
Targeted drug delivery
Tissue engineering

Artificial ear

Liver scaffolding

Artificial blood vessel
Tissue engineering

- Artificial organs
- Smart prosthesis
- Genetic engineering
- Regeneration
- ...

Who are you if you replace 95% of your body?
... still human?
Technology will change the future

Differing responses to scientific discovery by various sectors

The best way to predict your future is to create it...
Acknowledgement / Funding

- Helse- og omsorgsdept.
- Helsedirektoratet
- Helse Midt-Norge
- St. Olavs Hospital
- SINTEF
- Samarbeidsorganet HMN
- Forskningsrådet
- EU FP7 (expect Horizon2020)
- Innovasjon Norge
- Industri