



Annual report 2017

The Intervention Centre

Oslo University Hospital and
Institute of Clinical Medicine, University of Oslo



ANNUAL REPORT 2017

The Intervention Centre

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Tomorrow's patient management

In 2017 The Intervention Centre underwent a major reorganization. From the first of January the section for Imaging physics was separated from the Intervention Centre and was established as a department in the Clinic for Radiology and Nuclear Medicine. The Intervention Centre remained with the tasks we have had since 1996 and we chose to be organized in the Division of Emergencies and Critical Care. The clinic is responsible for running operation theatres at the Oslo University Hospital.

As the technological solution that were termed "the operation theatres of tomorrow" some years back, now is a requirement for many routine surgical and interventional procedures, the collaboration with a unit responsible for routine surgery was a good match. An expansion of the Intervention Centre adding four more advanced suites was already decided in 2016. In April we could start the second MR funded in collaboration with the Institute for psychology at the University of Oslo. The Intervention Centre is responsible for running the suite in collaboration with the department of radiology and nuclear medicine at our hospital. The construction of two suites integrating CT and the latest Siemens Pheno angiography was started in the spring 2017 will be running in the second quarter of 2018.

The expansion is funded partly by the Research council as a large infrastructure in collaboration with the St Olav hospital in Trondheim. The expansion is welcome, as the number of patients requiring the advanced hybrid suites is steadily increasing.

In 2016 together with several partners at the University of Oslo and the University of Science and Technology in Trondheim, in Oslo University Hospital and with several industrial partners and patient organizations we were granted a lighthouse project by the Norwegian Research council. The BigMed project that aims at identifying and eliminating some of the bottlenecks for precision medicine was officially started in March 2017. With a budget of

130 mill NOK and 11 work packages covering the spectrum of clinical, computer science and legal challenges the project is a major national effort to bring precision medicine and advanced decision support into everyday clinical life.

In 2017 The Intervention Centre has been coordinating two Marie Curie actions under the EU Horizon 2020 program, one is the wireless in body Environment project, (WiBEC) and the other Hipernav developing in body navigation.

Artificial Intelligence and deep learning algorithms are now central ingredients of most of the projects at the Intervention centre. We are just glimpsing into the future possibilities and challenges this technology represent for health care.

Thus, the technological projects and the BigMed project aim at harvesting and analyzing the large amount of data we now are able to acquire for every patient, and which we are under the obligation to implement in clinical practice. Utilizing health data in this way is new, and therefore the legal framework and the technological solutions need to be developed parallelly.

One of the challenges of precision medicine will be the funding.

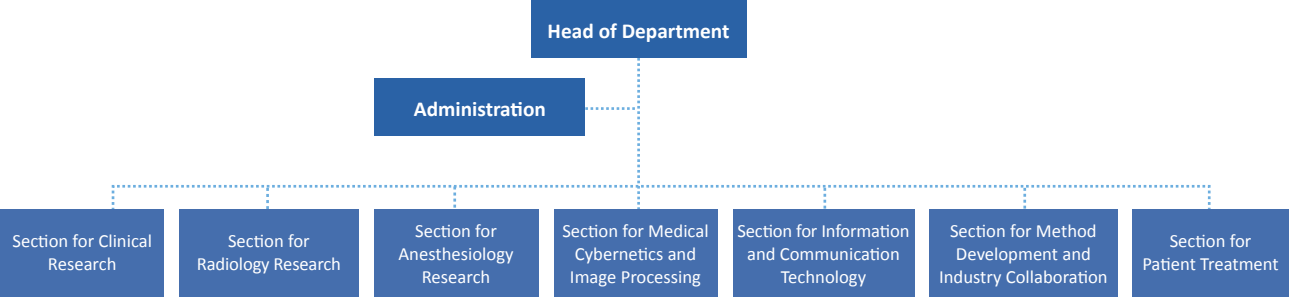
Value based health care has been proposed by the Michael Porter at the Harvard business school. The main vision in the Intervention Centre strategy is to be a leading European centre for value based healthcare research.

In 2017 we expanded our staff with Karl Arne Johannessen, former CEO of Ullevål hospital as part of our team to reach this goal. We aim at in collaboration with our partners the Oslo Business school (BI) and the department of health administration and economy at the University of Oslo to broaden the economical and organizational research at the Centre.

Erik Fosse
Head of The Intervention Centre

ORGANIZATION

2.1 ORGANIZATION MAP



2.2 SECTIONS

2.2.1 Section for Clinical Research

Section Manager: Bjørn Edwin, Professor, MD

Staff

Linda Engvik, Nurse Manager

Björg Scheele, OR nurse

Anne Hege Andreassen, OR nurse

Jennifer Teruel Tamson, OR nurse

Victoria Juhasz, Laboratory assistant

Deliveries

- Research and development in minimally invasive surgery in the premises of The Intervention Centre
- Development and education in new techniques at Oslo University Hospital and other hospitals in Norway
- Clinical R&D in all medical domains
- Perform minimally invasive treatment of patient groups where the volume of patients within these disease groups is too low to develop secure new treatment strategies on many sites
- Perform minimally invasive treatment of patient groups requiring established multiprofessional collaboration and infrastructure currently uniquely found at The Intervention Centre. Examples are; laparoscopic pancreas and liver surgery, laparoscopic endocrine surgery, laparoscopic endometriosis surgery, laparoscopic back surgery

Main Objectives

- The section's activities are focused on minimally invasive treatment in all surgical specialties
- The section shall be leading both nationally and internationally within its focus area within research and development
- The section shall assist and initiate research minimally invasive therapy projects
- The section promotes education locally, regionally, nationally and internationally
- The section stimulates multiprofessional collaboration because
- Minimally invasive therapy is performed in many professional settings by various specialists and thereby a common field of interest across specialties
- Minimally invasive therapy depends on development within technology and radiology

ORGANIZATION

2.2.2 Section for Radiology Research

Section Manager: Per Kristian Hol, Professor, MD, PhD

Staff

Hilde Sofie Korslund, radiographer
Grethe Løvland, radiographer
Martine Minge, radiographer
Kenneth O. Pedersen, radiographer
Jorunn Fraser-Green, radiographer

Deliveries

- Radiological support and service to all experimental and clinical projects at The Intervention Centre
- Radiological examinations of animals and patients treated at The Intervention Centre
- Training and supervision of healthcare personnel in new image-guided treatment techniques
- Research group in the field of MR guided High Intensity Focused Ultrasound Treatment

Main Objectives

- Have a high qualified staff
- To be nationally and internationally leading environment for image guided treatment
- Strengthen interdisciplinary research and increase number of regional, nationally and internationally joint projects
- Contribute to innovation and secure intellectual property



2.2.3 Section for Anesthesiology Research

Section Manager: Per Steinar Halvorsen, MD, PhD

Staff

Per Steinar Halvorsen, anesthetist

Viesturs Kerans, anesthetist

Kjersti Wendt, nurse anesthetist

Anton Amalathasan Josephmary, nurse anesthetist

Kari Westby, nurse anesthetist

Torill Schou, nurse anesthetist

Deliveries

- Anesthesia service to all clinical and experimental projects at the Intervention Centre
- Training/supervision of healthcare personnel in new cardiovascular monitoring techniques
- Innovation/DOFI/patents
- Research group in the field of cardiovascular monitoring

Main Objectives

- Contribute to improved quality of experimental and clinical research
- Have a high qualified staff
- Interdisciplinary research and increase the number of joint projects
- Contribute to increased innovation and secure intellectual property



2.2.4 Section for Medical Cybernetics and Image Processing

Section manager: Ole Jakob Elle, Associate professor, PhD

Staff

Espen Remme, Senior Researcher in 30%, PhD

Rafael Palomar, PhD fellow (HiG/OUS, MSc.)

Rahul Kumar, Postdoc, PhD

Louise Oram, Software developer in NorMIT, MSc.

Magnus Leon Reinsfelt Krogh, PhD fellow

Robin Bugge, Image processing in 20%, MSc.

Pravda Jit Ray, PhD-fellow

Andrea Teatini, PhD-fellow

Deliveries

The Section for Section for Medical Cybernetics and Image Processing at The Intervention Centre aims to develop cutting-edge technological solutions supporting the whole chain in patient diagnostic and treatment. such as user interaction and information exchange in the operating suites, procedure planning, patient monitoring, and technology for minimally invasive therapies including intra-operative model update. This R&D covers a span of different technologies like monitoring technology, image and video processing, visualization, navigation technologies, biomechanical organ modelling and robotics. The solutions should give more information to the surgeon, such as sensor information and image information, during intervention and presenting this information by real-time visualization. With the ability to adapt and compensate to the deformations and motions, this information can be used to effectively guide the clinician throughout the procedure or update a robotic path to perform the desired action. This means that when you develop algorithms for diagnostics and preoperative use, less effort is put into making the algorithm fast and effective. Intra-operative use means that the algorithms used should be able to run in real-time or close to real-time. Image and video processing methods are key elements in any software system which supports minimally invasive procedures. In particular, we are focused on developing real-time image-segmentation and - registration

methods where segmentation methods finds important anatomical structures such as tumors and vessel structures in images, while registration methods enables fusion of images and images to patient. Visualization and navigation is required to present the medical images to the surgeon intra-operatively. Increased accuracy and safety may result by cross-linking medical image information with robotic systems in so-called semi-autonomous robotic systems. Biomedical models and simulation technology are developed, intended for clinical decision support such as if, when and type of surgery should be performed.

In order to be able to lead large research projects in the forefront internationally, the section should at all time have the needed competence and in-depth knowledge within medical informatics, such as software engineering, computer graphics and visualization, signal processing, image and video processing, robotics, cybernetics and mechanics. The head of section as well as the research group leaders should have high scientific qualifications, if possible at a professor or associate professor level and work in the intersection between technology and medicine. The section should work closely with different clinicians within the hospital as well as collaborating with well-known research institutions and industry both nationally and internationally. It is a goal that senior researchers have adjunct positions at UIO or NTNU.

Main Objectives

It aims to be a nationally and internationally leading research environment in technological solutions for in the following research areas:

Main research areas:

- Developing new building block for navigation technology in different surgical disciplines like laparoscopic liver resection, neurosurgery and catheter-based interventions. Such building blocks rely on new preoperative and intra-operative image analysis/processing algorithms, where the intra-operative methods need to consider real-time or near to real-time constraints such as segmentation, volume visualization and co-registration.
- Robotic technology ranging from haptic feedback and augmented reality in tele-surgical systems, semi-autonomous systems for support in the operating theatre and miniaturized robotic systems on the tip of a catheter or in a pill-cam system.
- Explore more research in areas like targeted treatment, new imaging techniques and micro technology
- Biomedical modelling of organs like heart, liver etc. , using advanced mathematical models like finite element (FEM) describing tissue properties, flow pattern for prediction and simulation.
- Development of new monitoring technology e.g. accelerometer and gyro sensors including advanced signal processing for detection of changes in heart conditions.

The section for Medical Technology Research aims for supporting the clinicians in the OR with new technological methods and new technology



ORGANIZATION

2.2.5 Section for Information and Communication Technology

Section Manager: Ilangko Balasingham, Professor

Staff

Sr. Researcher Jacob Bergsland, MD, PhD

Associate Professor Ali Khaleghi, PhD

Associate Professor Laura Slaughter, PhD

Project Leader Knut Korsell

Deliveries

- Research and publications
- Innovation in medical signal processing and communication technology
- Development of technological solutions, prototypes and demonstrators
- Intellectual property and management methods
- Multidisciplinary expertise in medical signal processing and communication technology
- Supervising students and fellows
- Teaching

Main Objectives

- to be at the forefront nationally and internationally in research and development of medical signal processing and communications technologies, and to advise on operational and acquisition projects at the center
- to lead advanced research projects that are in the forefront of international research to develop technological solutions for patient monitoring and new treatments, including minimally invasive and image-guided therapy
- to encourage their staff to have academic adjunct positions outside hospital and have sufficient staffing and expertise to assist various projects initiated by other communities and contribute to a seamless collaboration between technologists and clinicians
- to provide any necessary technical manpower and expertise to participate in the multidisciplinary projects at the Intervention Centre and support patient diagnosis and treatment with the following target areas during the period:
 - develop new medical sensors based on bio-nano technologies (biological nano electronics)
 - develop communications and computing systems based on biological organisms, such as molecules, cells and organs that can communicate with the Internet and cloud services for storing and processing large amounts of data
 - develop new algorithms and machine learning methods for processing and understanding of complex, large amounts of data from sensors, germplasm, medical records, test results, images, etc. in conjunction with high precision diagnosis, treatment and follow-up
 - perform research and development of basic research in the form of new theories, mathematical modeling, computer-aided simulations and prototype development to preclinical testing and validation - "from bench to bedside"

2.2.6 Section for Method Development and Industry Collaboration

Section Manager: Karl Øyri, PhD

Staff

Leif-Petter Rustad, Research Coordinator

Bjørn Tjønnås, Quality Coordinator

Karl Arne Johannessen, MD, PhD, Senior Consultant

Deliveries

- Coordination of the commercial Test-Bed function at The Intervention Centre
- Collaboration with Inven2 and negotiate with companies who intends to explore new technologies and collaborate with industrial partners about development protocols
- Involves relevant clinical groups at Oslo University Hospital in projects
- Make sure that all test projects are made in compliance with guidelines at Oslo University Hospital and the health authorities regarding animal and human research
- Project management support and health economy evaluation support to clinical groups who establish new technology dependent treatment methods
- Update of the project database at The Intervention Centre
- Edit the Annual Report at The Intervention Centre
- Responsible for the communication strategy at The Intervention Centre
- Responsible for the Quality System at The Intervention Centre

Main Objectives

- Is a gateway to the hospital for companies who need testing of new technologies. At least five new collaboration agreements are made with industrial companies annually
- Assists project leaders with organization, contracts and required documentation
- The Annual Report is published in the spring semester
- Regular updates of the webpage
- Responsible for Quality System maintenance including editorial responsibility
- Monthly updates of project database
- Responsible for health economy competence at The Intervention Centre

2.2.7 Section for Patient Treatment

Section Leader: Erik Fosse, professor, MD

This is an administrative section.

RESEARCH GROUPS

3.1 CLINICAL RESEARCH

Image guided general surgery and intervention

Group Leader: Bjørn Edwin, professor, MD

Group Members

Mushegh Sahakyan, PhD student
Anne Waage PhD, Surgeon
Knut Jørgen Labori PhD, Surgeon
Kjersti Flatmark, professor
Stig Ronny Kristiansen, IT-researcher
Karl Øyri, PhD, Researcher
Dejan Ignatovic Ph.D, Surgeon
B.A. Bjørnbeth PhD, Surgeon
Trond Buanes, professor

Bård Røsok PhD, Surgeon
Airazat Kazaryan PhD, Researcher
Vegard Dagenborg, PhD student
Åsmund Avdem Fretland, PhD-student
Leonid Barkhatov, PhD-student
Sven Petter Haugvik, PhD-student
Davit Aghayan, PhD-student
Gudrun Maria Waaler Bjørnelv, PhD student

Background

Minimally invasive surgery is evolving rapidly, and the need for systematic development and evaluation of these methods is great. Our group focuses on research on the results of new minimally invasive surgical techniques in addition to development of new procedures. Most of the research is conducted in the field of HPB-surgery (diseases in liver, bile ducts and pancreas) and adrenal surgery.



Ongoing Projects

- The Oslo CoMet-study (Oslo randomized laparoscopic vs open liver resection for colorectal liver metastasis – study). Funding: HSØ.
In addition to the evaluation of surgical and oncological results, several translational studies are performed, such as bio banking of tumour tissue, studies on the inflammatory response, health economy evaluation and pain/quality of life studies.
- Multicentre studies on laparoscopic liver surgery
- Research on pancreatic cancer: Examining the Role of Laparoscopic Distal Pancreatectomy in the Treatment of Pancreatic Cancer: From a Consensus Study to Randomized Controlled Trials. The main aim is to assess the oncologic outcomes of Laparoscopic Distal Pancreatectomy (LDP) in patients with Pancreatic Distal Adeno- Carcinoma, determine the prognostic factors and provide justified recommendations for its use. Funding: Kvote programmet UiO
- The research group also does research on MRI-guided High Intensity Focused Ultrasound (HIFU) of lesions in liver and prostate. Funding: Kreftforeningen
- Together with the University of Gothenburg, we do research on biomaterials in implants.
- Research on imaging of liver tumours (CT, MRI, PET-CT) is conducted with other research groups at the IVS and OUS.
- In a joint project, a method for automatic segmentation of liver anatomy including tumors is developed. The final goal is to create an interactive map for liver surgeons that will greatly ease both planning and the actual surgery.
- Research on reasons to onset of type 1 diabetes, DiVid study.
- Research on D3 resection of colon cancer
- The Group is also involved in many major projects e.g. HiPerNav, (EU prosjekt), NorMit, MetAction and BigMed.

Collaborations

In all the projects, the group has a large international network of collaborators e.g.

- Nasjonalt kompetansetjeneste for ultralyd og bildeveiledet behandling, Trondheim
- Tumorbologi, Radiumhospitalet, OUS
- PubGene, Oslo

A strong cooperation between the different research groups in The Intervention Centre:

- Prof Robert Troisi, Dept. of General and Hepato-Biliary Surgery and Liver Transplantation Service, Ghent University Hospital Medical School, Belgium.
- Ass. Prof Mohammad Abu Hilal, Faculty of Medicine, Southampton University, Research and development lead for Surgery, Southampton University Hospital –Great Britain
- Prof Luca Aldrighetti Chief of Liver Unit, Department of Surgery, Scientific Institute SanRaffaele, University Vita-Salute San Raffaele, Milan, Italy.
- Prof Alessandro Ferrero, Direttore f.f. S.C. Chirurgia Generaleed OncologicaOspedale Mauriziano, Torino, Italy.

PhD students

Tom Nordby
Kim Ånonsen
Gudrun Maria Waaler
Mushegh Sahakyan
Åsmund Avdem Fretland
Jens Marius Næssgaard
Rafael Palomar
Andrea Teatini
Egidijus Pelanis
Davit Aghayan
Hilde Kjernlie Andersen
Martin Johansson
Vanja Cengija
Sven Petter Haugvik
Leonid Barkhatov
Ulrik Carling
Vegar Dagenborg
Milan Spasojevic

RESEARCH GROUPS

3.2 RADIOLOGY RESEARCH

MR guided High Intensity Focused Ultrasound treatment

Group Leader: Per Kristian Hol, Professor, MD, PhD

Group Members

Bjørn Edwin, Professor MD PhD,
The Intervention Centre (researcher)

Eric Dorenberg, MD PhD, Dept of Radiology,
OUS Rikshospitalet (researcher)

Tryggve Storås, PhD, The Intervention Centre
(researcher)

Grethe Løvland
(technician)

Jorunn Fraser-Green
(technician)

Kenneth O Pedersen
(technician)

Ulrik Carling, MD
(PhD candidate)

Per Istre, MD
(researcher)

Silje Velle Dypbukt, MD
(researcher)

Associated group members

Viktor Berge, MD PhD, and Eduard Baco, MD, Dept of Urology, OUS Aker (researcher)

Kirsten Hald, MD, PhD, Dept of Gynecology, OUS Ullevål (researcher)

Ellen Viktil, MD, Dept of Radiology, OUS Ullevål (researcher)

Johann Baptist Dormagen, MD, PhD, Dept of Radiology OUS Ullevål (researcher)

Background

High Intensity Focused Ultrasound (HIFU)-therapy is completely non-invasive as the ultrasound energy is delivered outside the body, but focused in defined areas in an organ. MR provides three-dimensional treatment planning and real-time temperature feedback. Integrating HIFU in MR-scanners melds the technology for visualization and treatment, optimize the procedure and increase the therapeutic potential of HIFU treatment. The 3 T MR at the Intervention Centre has integrated HIFU equipment as part of a research agreement with Philips Medical Systems. Focus has been on both basic and clinical research projects.

Projects

- MR guided HIFU in the treatment of uterine fibroids
- Basic research on MR guided HIFU of liver
- Basic research on MR guided HIFU of prostate

Collaborations

Philips Healthcare, Nederland: Dr Thomas Andrea
Profound Medical, Canada



3.3 ANESTHESIOLOGY RESEARCH

Clinical and experimental cardiovascular monitoring

Group Leader: Per Steinar Halvorsen

Research group members

Senior researchers

Jan Fredrik Bugge, Dep. of Anesthesia and Critical Care Medicine

Andreas Espinoza, Dep. of Anesthesia and Critical Care Medicine

Helge Skulstad, Dep. of Cardiology

Associated group members

Professor Erik Fosse, The Intervention Centre

Professor Thor Edvardsen, Department of Cardiology

Professor Arnt Fiane, Department of Cardiothoracic Surgery

Ass. professor Ole Jacob Elle, The Intervention Centre

Professor Svend Aakhus, Department of Cardiology

Lars Aaberge, Department of Cardiology

Jan Otto Beitnes, Department of Cardiology

Espen Remme, Department of Cardiology/ The Intervention Centre

PhD-candidates

Viesturs Kerans, MD, The Intervention Centre,
viesturs.kerans@medisin.uio.no, HYPOTHERMIA

Jo Eidet, MD, Dep. of Anesthesia and Critical Care Medicine,
jeidet@ous-hf.no, TAVI

Harald Bergan, MD, Dep. of Anesth. and Critical Care Medicine,
haaber@ous-hf.no, ECMO

Ole-Johannes Grymyr, MD, The Intervention Centre,
olegry@ous-hf.no, SENSORS

Stefan Hyler, MD, The Intervention Centre and Sørlandet sykehus
st.hyler@bluewin.ch, SENSOR

Itai Schalit, MD, The Intervention Centre,
itasch@ous-hf.no, LVAD/SENSORS

Kristin Wisløff-Aase, MD, Dep. of Anesthesia and Critical Care Medicine,
HYPOTHERMIA

Siv Hestenes, MD, The Intervention Centre/Sykehuset Akser og Bærum,
smereteh@online.no, SEPSIS

Hilde Karlsen, MD, Dep. of Anesthesia and Critical Care Medicine,
hikarl@ous-hf.no, ECMO

Marte Sævik, MD, The Intervention Centre/Dep. Of Cardiology,
masa2@ous-hf.no, TAVI

Pengfei Lu, MSc, The Intervention Centre,
pengfei.lu2016@gmail.com. PACEMAKER/CRTT

Mohammad Albatat, MSc, The Intervention Centre,
malbatat.90@gmail.com. PACEMAKER/CRT

Background

A trend in cardiovascular therapies involves development of minimal invasive surgical techniques for valve repair and treatment of severe heart failure by biventricular pacing. Even though a method can be classified as minimal invasive, the procedural risks still may be high, as demonstrated by treatment of severe aortic stenosis by catheter technique (TAVI) instead of open chest surgery. Another trend in severe heart failure treatment is implantation of mechanical pumps, as either bridge to transplantation or as destination therapy as an alternative to heart transplantation. In contrast to the other therapies, implantation of a mechanical pump is a highly invasive procedure and justifies more invasive monitoring of the patient. In both cases, assessment of cardiovascular status is equally important, but requires different approaches which need to be adapted to the risks and invasiveness of the procedures. New methods for cardiovascular monitoring in the operative setting may also be used to guide and optimize treatment in hemodynamically compromised patients in the intensive care unit, such as in patients with septic or cardiogenic shock, and patients treated with therapeutic hypothermia after cardiac arrest.

Main aims

- Develop and test new technologies in cardiovascular monitoring
- Cardiovascular response to new cardiovascular therapies
- Myocardial function in therapeutic hypothermia and severe sepsis

This includes evaluating hemodynamic responses of 1) new cardiovascular image guided procedures, 2) ECMO strategies, 3) treatment for end stage heart failure with ventricular assist devices (VAD). Technologies under investigation for cardiac function monitoring include implantable 3D accelerometers, gyro, magnetometer, miniaturized ultrasound sensors, biosensors and radar. The sensors are tested in both clinical and experimental models in cooperation with other research groups at The Intervention Centre, departments at OUS and external institutions.

Ongoing research projects

- TAVI: is myocardial reserve related to long term outcome?
- Accelerometer for detection of thromboembolic events in LVAD
- Accelerometer/gyro/magnetometer for monitoring changes in right and left ventricular load and detection of graded myocardial ischemia
- Can betablockers improve survival and cardiovascular function after cardiac arrest: an experimental ECMO study
- Left and right ventricular dysfunction in severe sepsis; the effect of pulmonary hypertension and interventricular septal shift
- Myocardial effects of therapeutic hypothermia in cardiac surgery
- Effects of epinephrine and betablockers on systolic and diastolic left ventricular function during therapeutic hypothermia
- Multifunctional pacemaker systems for cardiac resynchronization therapy (CRT)

Collaborations

- OSCAR research network at Oslo University Hospital: Professor K. Sunde
- Complement Research Group at Oslo University Hospital: Professor Tom Eirik Mollnes
- Biosensor Research Group at Oslo University Hospital: Professor T. I. Tønnessen
- WiBEC EU-project at The Intervention Centre: Professor Ilango Balasingham
- University College of Southeast Norway: Professor Kristin Imenes

RESEARCH GROUPS

3.4 MEDICAL CYBERNETICS AND IMAGE PROCESSING RESEARCH

Group Leader: Associate professor Ole Jakob Elle, PhD

Group members

Rafael Palomar, PhD-fellow/Software developer/Computer Graphics/Navigation

Rahul Kumar, Postdoc, Liver Image segmentation/Navigation

Louise Oram, Software developer in NorMIT.

Espen Remme, Senior Researcher in 30% (shared IVS/Kirurgisk forskning), Heart Physiology

Magnus Krogh, PhD fellow, Cardiac sensor and signal processing

Robin Bugge, Image processing in 20%, MSc., 3D-print/Heart segmentation

Pravda Jit Ray, PhD-fellow, HiPerNav

Andrea Teatini, PhD-fellow, HiPerNav

Egidijus Pelanis, PhD-fellow, HiPerNav

Kim Mathiassen, PhD-fellow (also at ROBIN-group at IFI/UIO), US-robot

Justinas Miseikis, PhD-fellow (also at ROBIN-group at IFI/UIO), Collision avoidance

Congcong, PhD-fellow (also at NTNU-Gjøvik), Denoising of lap. stereo video/3D surface extraction

Research aims

Most minimally invasive procedures restrict the access and direct vision to the regions which require surgery. Such procedures require intra-operative image modalities such as x-ray, ultrasound or endoscopic images to be able to monitor the procedure in real-time. In many cases this information is not sufficient to perform the procedure accurately and safely. Merging information acquired pre-operatively, mainly from for instance MRI, CT or PET, with intra-operative data can increase the basis for decisions and thereby improve the safety and accuracy of the procedure. The Medical Robotics, visualization and navigation group develops cutting edge technological

solutions which support minimally invasive procedures. In particular, the group is focused on developing real time image-segmentation and - registration methods. Visualization and navigation is required to present the medical images to the surgeon intra-operatively. 3D video will be more and more cross-linked with medical image information and move toward robotics and automation of surgical procedures. The research group is doing research in all these fields of technology facilitating minimally invasive surgery.



Ongoing Projects

Ongoing NFR:

- NorMIT, National Research Infrastructure for Minimally Invasive Treatment

Ongoing Helse Sør-Øst:

- Hepa-Navi, Liver Navigation platform (Postdoc)
- Fast vessel segmentation algorithm (Innovation)
- Service at OUS – 3D printing of organ models (Innovation)
- Modulbasert Operasjonslys for Hybride Operasjonsstuer (Innovation)
- Måling av hjertefunksjon ved hjelp av en ny miniaturisert bevegelsessensor (Innovation)
- MimiQ: Tilpasningsdyktig LED sporing for navigasjon og medisinsk robotikk (Innovation)
- HoloViz and HoloNav: 3D Mixed reality Visualization of medical images in planning and treatment (Innovation)

Other ongoing projects:

- Semi-autonomous ultrasound robot for needle insertion
- EU-project funded:
- As participant of the Marie Curie ITN-project: PIC (Personalized Cardiology)
- As coordinator of the Marie Curie ITN-project: HiPerNav (High Performance soft-tissue Navigation), start date 01.11.2016

Collaborations

- University of Bern (ARTOrg)
- Technical University of Delft (TUDelft)
- University Paris13
- University of Cordoba
- Cascination AG
- Inselspital, University of Bern
- INRIA
- SIEMENS
- University of California, San Diego (UCSD)
- University of Dundee
- University of St. Andrews
- Norwegian University of Science and Technology
- University of Homburg, SAAR
- MR Comp GmbH
- GE Medical Systems
- Katholieke Universiteit Leuven, Leuven, Belgium
- Zürcher Hochschule für Angewandte
- Wissenschaften, Winterthur, Switzerland
- Imperial College London, London, United Kingdom
- Institute of Biomechanics, Center of Biomedical Engineering, Graz, Austria
- Endosense SA, Geneva, Switzerland
- Scuola Superiore Sant'Anna, Pisa, Italy
- University of Verona
- Tallin University
- San Raffaele Hospital
- Yeditepe University
- ETH Zurich
- King's College London
- University of Oxford
- GE Vingmed
- Sintef Medical Technology
- Sheffield Hallam University
- Universidad de Zaragoza
- Universidad politecnica de Madrid

3.5 INFORMATION AND COMMUNICATION TECHNOLOGY RESEARCH

Wireless Biomedical Sensor Network Research Group

Group Leader: Professor Ilanko Balasingham

Signal Processing Group, Dept. of Electronic Systems, NTNU

Group members

Senior researchers

Jacob Bergsland, MD, PhD

Ali Khaleghi, PhD

Postdoctoral Fellows

Ali Chelli, PhD

Younghak Shin, PhD

Nabiul Islam, PhD

PhD Students

Øyvind Janbu

Pritam Bose

Mladen Veletic

Pengfei Lu

Hamed Fouladi

Hemin Qadir

Mohammad Albatat

Salman Mahmood

Deepak Palaksha

Muhammad Faheem Awan



Background

The research group performs fundamental research and development in information and communication technologies, specifically in wireless sensors and systems for applications in diagnosis, minimal invasive therapy, and ambient point of care monitoring. One of the technological focused areas is on ultra-low power and reliable wireless implant sensor networks, where the research is on novel transceiver design, low power data compression, and data processing algorithms for event and anomaly detection, data fusion, etc. Special interest topics are in implantable/ingestible sensors like cardiac pressure sensors, capsule endoscopes, bio-nano scale communications, and nanomachine-to-cell interfaces for stimulation for applications in cardiac, gastrointestinal, and neurodegenerative diseases. Moreover, the group also performs research in patient record and data mining, signal and image processing, and developing novel sensing and imaging systems using electromagnetic waves.

International collaboration

- Prof. Jianqing Wang, Nagoya Institute of Technology, Japan
- Prof. Narcis Cardona, Universitat Politècnica de València, Spain
- Prof. Ram Narayanan, Penn State University, USA
- Prof. Wout Joseph, Ghent University, Belgium
- Prof. Dirk Pletemeier, Technical University of Dresden, Germany
- Prof. Ian F. Akyildiz, Georgia Institute of Technology, USA
- Prof. Christopher Contag, Michigan State University/Stanford University, USA

Selected Externally Funded Research Projects

1. Project Manager/PI of Wireless In-body Sensor and Actuator Networks (WINNOWN).
(Funded by the Research Council of Norway, IKTPLUSS, 01.04.2017-30.04.2022, Award NOK 16 million)
2. Coordinator/PI of Wireless In-Body Environment (WiBEC),
(Funded by the European Commission, H2020- MARIE Skodowska-CURIE ACTIONS (MSCA-ITN-2015), 01.01.2016-31.12.2019, budget €3.957 million)
3. PI/Work Package Leader of Holistic Monitoring of Indoor Environment (HOME),
(Funded by the Research Council of Norway, Idea Lab program, 01.06.2014 - 31.12.2017, Award NOK 10 million)
4. Project Manager/Principle Investigator of Medical Sensing, Localization, and Communications Using Ultra Wideband Technology (MELODY II),
(Funded by the Research Council of Norway, VERDIKT program, 01.01.2013 - 31.12.2017, Award NOK 14.7 million)

3.6 METHOD DEVELOPMENT AND INDUSTRY COLLABORATION RESEARCH

Clinical Testing Work Group

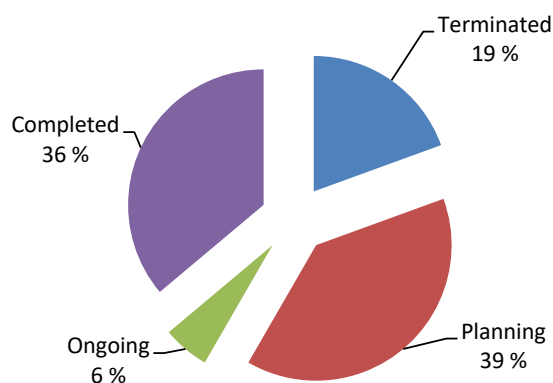
Group Leader: Karl Øyri, PhD

In 2017 36 new project inquiries from companies were made to the TestBed. Seven were terminated 14 projects are currently in the planning phase, 2 are ongoing, and 13 projects were completed in 2017. The complex projects involving early phase technologies often have long planning phases due to protocol development and adjustments, regulatory requirements and resource mapping at the hospital.

Inven2, the technology transfer office (TTO) at Oslo University Hospital handles legal contracts and economy for the industry-sponsored projects in the testbed. We continue the close collaboration with Norway Healthtech. SMI is present at Aleap in Forskningsparken on a weekly basis to meet with companies and Norway Healthtech.

The quality coordinator in SMI is continuously involved in refinement of the quality systems at The Intervention Centre. A Good Clinical Practice (GCP) framework has been implemented in the Quality System, and can be used if companies are in need of GCP compliant services.

TestBed Projects in 2017 (n=36)



Ongoing Projects:

The Nordic Network of Testbeds Project funded by Nordic Innovation was finalized in 2017. With continued funding from Nordic Innovation the project ended with the establishment of Nordic Proof where all project partners are collaborating in a consortium of testbeds. Nordic Proof provides professional services for testing of new and innovative healthcare products in the Nordic region. With a “one point of contact” for all the testbeds, Nordic proof aim to match (supply? provide?) the companies with a variety of test facilities to meet industry needs.

Collaborations

- Inven2 TTO
- Innovasjonsavdelingen, Oslo University Hospital,
- Norway Healthtech
- Sunnaas Sykehus
- Nordic Medtest, Karlstad, Sweden
- SLL Innovation, Stockholm Läns Landsting, Stockholm, Sweden
- Innovationsplatsen , Karolinska University Hospital, Stockholm, Sweden
- HUS, Hospital District of Helsinki and Uusimaa, Helsinki, Finland
- Region H, Capital Region of Denmark, Copenhagen, Denmark

Development of organizational performance and innovative logistics

Group Leader: Karl Arne Johannessen

New ambitions: SMI has an ambition to expand its competence and capabilities to a new dimension; how may our experience and competence related to technological innovations be extended to the organizational perspective? Whereas new solutions from technology research are accelerating, the impact of their implementation will not be achieved at full potential if the involved organizational solutions are unchanged. Despite implementation of numerous new technological solutions in a large span of clinical activities, many services remain organized and operate with a traditional approach that may delay and even obstruct improvements in resource utilization and quality. We have the ambition to identify basic cultural and organizational characteristics that may trigger innovative transformation of clinical services in concordance with technological innovations in a two-fold perspective:

- How may we improve logistics in services which implement new technological solutions?
- How may we extend such experience and logic to clinical services that are not directly involved in the technological development, but where services may replicate and benefit from experiences from more technology based services?

3.7 THE BIGMED PROJECT

Group Leader: Thomas Smedsrud

The BigMed project is an ICT Lighthouse project funded by The Research Council of Norway to promote development and technology and services with advanced computer science. The project is managed and owned by the Intervention Centre at Oslo University Hospital, and includes a broad consortium of partners from several other departments in the hospital, three faculties at the University of Oslo, industry organisations and four patient associations. The project aims to lay a foundation for implementing precision medicine and big data analytics in healthcare, and will do so through testing and developing of ICT solutions to support the implementation of precision medicine in three clinical areas: rare diseases, sudden cardiac death and metastatic colorectal cancer. When developing solutions, the cross-competence teams in BigMed will discuss barriers and identify actions to overcome them. The barriers for implementation of precision medicine include legal, ethical and social aspects that must be discussed and addressed.

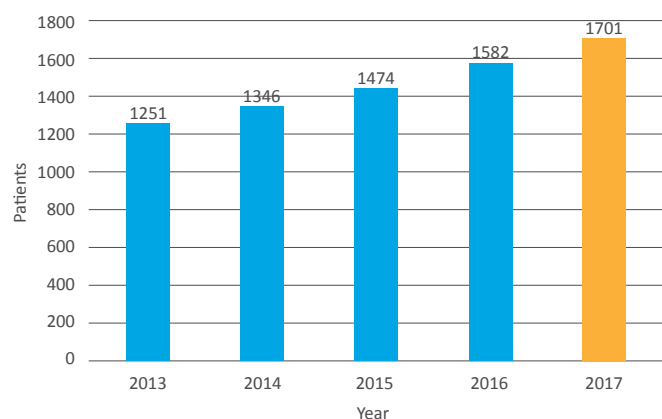
Website: www.bigmed.no



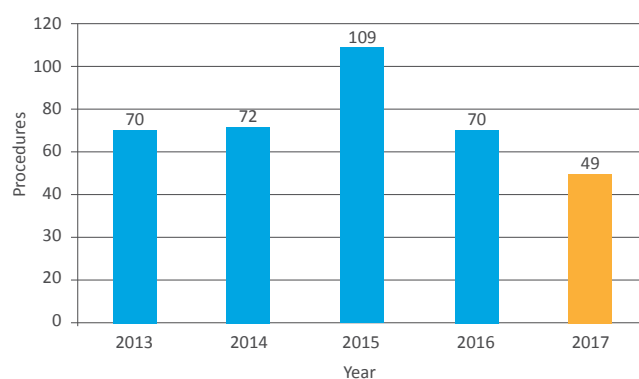
4 STATISTICS

4.1 Clinical activity

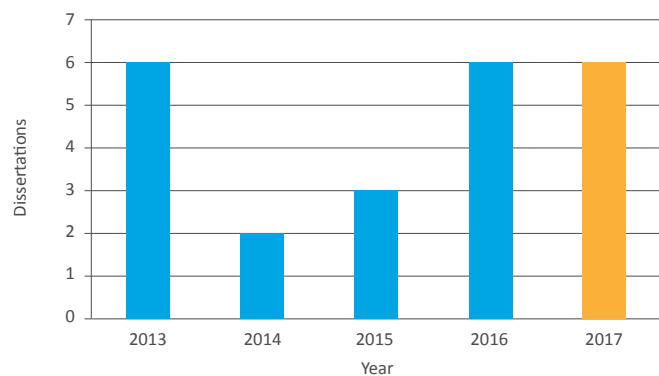
Patients at the Intervention Centre last 5 years



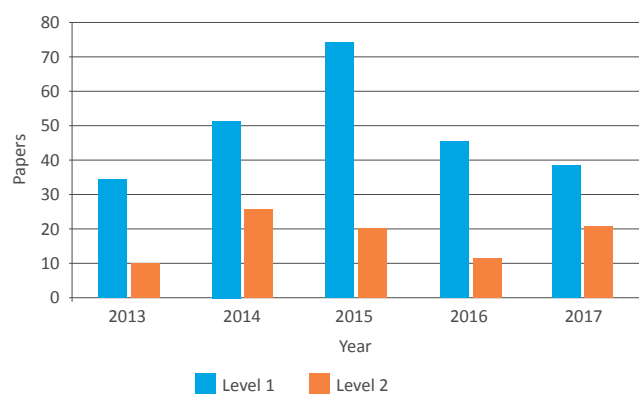
Preclinical procedures last 5 years



Dissertations last 5 years



Papers published last 5 years



4.2 Financial statements

Expenditures funded by hospital (NOK)

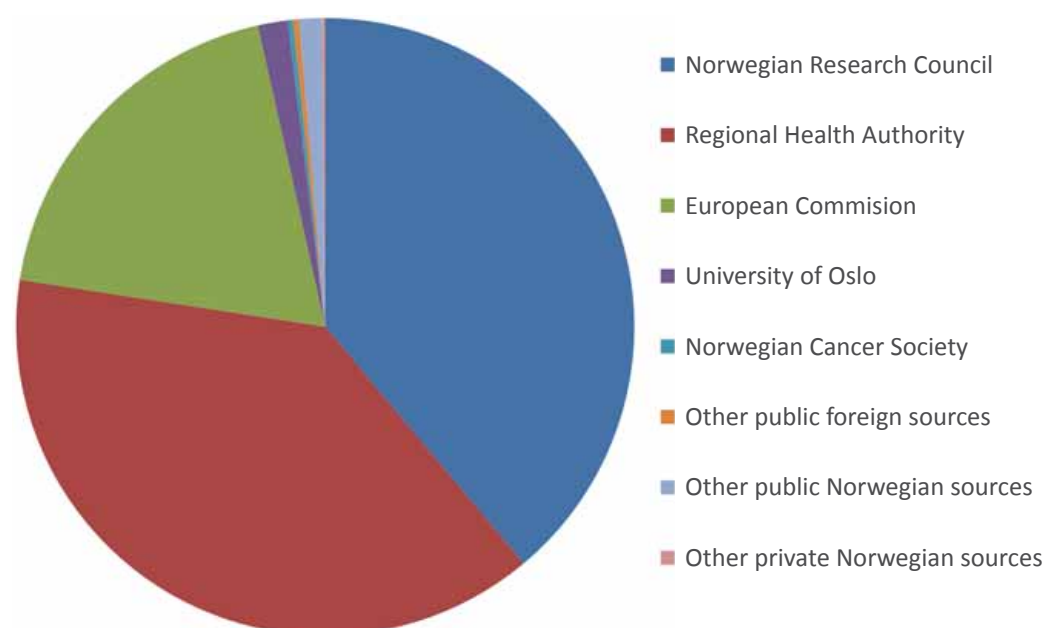
CATEGORY	BUDGET (NOK)
Operating expences	6 452 000
Payroll expences	25 257 000
Total	31 709 000

SOURCE	2017 RESEARCH EXPENDITURES (NOK)
Norwegian Research Council	10 021 946
Regional Health Authority	9 875 370
European Commission	4 946 390
University of Oslo	400 132
Norwegian Cancer Society	65 785
Other public foreign sources	74 998
Other public Norwegian sources	314 652
Other private Norwegian sources	45 375
Total	25 827 516

Commentary to the expenses

Total expenditures at the Intervention Centre in 2017 was 57 536 516 NOK.
45% was funded by external research sources and 55% by the hospital.

Sources for external research funding are presented in the graph below.



5.1 PEER REVIEWED SCIENTIFIC PAPERS

5.1.1 Level 2 Publications

1. Andersen OS, Smiseth OA, Dokainish H, Abudiab MM, Schutt RC, Kumar A, Sato K, Harb S, Gude E, Remme EW, Andreassen AK, Ha JW, Xu J, Klein AL, Nagueh SF. Estimating Left Ventricular Filling Pressure by Echocardiography. *J Am Coll Cardiol.* 2017;69(15):1937-1948.
2. Bjørnerud A, Vatnehol SAS, Larsson C, Due-Tønnessen P, Hol PK, Groote IR. Signal Enhancement of the Dentate Nucleus at Unenhanced MR Imaging after Very High Cumulative Doses of the Macrocyclic Gadolinium-based Contrast Agent Gadobutrol: An Observational Study. *Radiology.* 2017;285(2):434-444.
3. Digernes I, Bjørnerud A, Vatnehol SAS, Løvland G, Courivaud F, Vik-Mo E, Meling TR, Emblem KE. A theoretical framework for determining cerebral vascular function and heterogeneity from dynamic susceptibility contrast MRI. *J Cereb Blood Flow Metab.* 2017;37(6):2237-2248.
4. Edwin B, Sahakyan MA, Abu Hilal M, Besselink MG, Braga M, Fabre JM, Fernández-Cruz L, Gayet B, Kim SC, Khatkov IE, EAES Consensus Conference Study Group. Laparoscopic surgery for pancreatic neoplasms: the European association for endoscopic surgery clinical consensus conference. *Surg Endosc.* 2017; 31(5):2023-2041.
5. Wong-Lun-Hing EM, van Dam RM, van Breukelen GJ, Tanis PJ, Ratti F, van Hillegersberg R, Slooter GD, de Wilt JH, Liem MS, de Boer MT, Klaase JM, Neumann UP, Aldrighetti LA, Dejong CH; ORANGE II Collaborative Group. Randomized clinical trial of open versus laparoscopic left lateral hepatic sectionectomy within an enhanced recovery after surgery programme (ORANGE II study). *Br J Surg.* 2017 Apr;104(5):525-535.
6. Martínez-Cecilia D, Cipriani F, Vishal S, Ratti F, Tranchart H, Barkhatov L, Tomassini F, Montalti R, Halls M, Troisi RI, Dagher I, Aldrighetti L, Edwin B, Abu Hilal M. Laparoscopic Versus Open Liver Resection for Colorectal Metastases in Elderly and Octogenarian Patients: A Multicenter Propensity Score Based Analysis of Short- and Long-term Outcomes. *Ann Surg.* 2017 Jun;265(6):1192-1200.
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8. Eikemo M, Biele G, Willoch F, Thomsen L, Leknes S. Opioid Modulation of Value-Based Decision-Making in Healthy Humans. *Neuropsychopharmacology.* 2017;42(9):1833-1840.
9. Elvsåshagen T, Zak N, Norbom LB, Pedersen PØ, Quraishi SH, Bjørnerud A, Alnæs D, Doan NT, Malt UF, Groote IR, Westlye LT. Evidence for cortical structural plasticity in humans after a day of waking and sleep deprivation. *Neuroimage.* 2017;156:214-223.
10. Francis N, Kazaryan AM, Pietrabissa A, Goitein D, Yiannakopoulou E, Agresta F, Khatkov I, Schulze S, Arulampalam T, Tomulescu V, Kim YW, Targarona EM, Zaninotto G. A research agenda for the European Association for Endoscopic Surgeons (EAES). *Surg Endosc.* 2017;31(5):2042-2049.
11. Kleive D, Sahakyan MA, Berstad AE, Verbeke CS, Gladhaug IP, Edwin B, Fosby B, Line PD, Labori KJ. Trends in indications, complications and outcomes for venous resection during pancreatoduodenectomy. *Br J Surg.* 2017;104(11):1558-1567.
12. Kuric E, Seiron P, Krogvold L, Edwin B, Buanes T, Hanssen KF, Skog O, Dahl-Jørgensen K, Korsgren O. Demonstration of Tissue Resident Memory CD8 T Cells in Insulitic Lesions in Adult Patients with Recent-Onset Type 1 Diabetes. *Am J Pathol.* 2017;187(3):581-588.
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17. Sahakyan MA, Røsok BI, Kazaryan AM, Barkhatov L, Haugvik SP, Fretland ÅA, Ignjatovic D, Labori KJ, Edwin B. Role of laparoscopic enucleation in the treatment of pancreatic lesions: case series and case-matched analysis. *Surg Endosc.* 2017 May;31(5):2310-2316.

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Outcome after laparoscopic and open resections of posterosuperior segments of the liver.
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19. Stokke TM, Hasselberg NE, Smedsrud MK, Sarvari SI, Haugaa KH, Smiseth OA, Edvardsen T, Remme EW.
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5.2.2 Level 1 Publications

1. Aghayan DL, Pelanis E, Avdem Fretland Å, Kazaryan AM, Sahakyan MA, Røsok BI, Barkhatov L, Bjørneth BA, Jakob Elle O, Edwin B.
Laparoscopic Parenchyma-sparing Liver Resection for Colorectal Metastases.
Radiol Oncol. 2017;Nov 1;52(1):36-41.
2. Ali HY, Vikanes Å, Anti M, Hassan S, Ismail KM, Zimmo K, Zimmo M, Fosse E, Laine K.
Evaluation of an animated instructional video as a training tool for manual perineum support during vaginal delivery.
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5. Andresen B, Mishra V, Lewandowska M, Andersen JG, Andersen MH, Lindberg H, Døhlen G, Fosse E.
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Signal Enhancement of the Dentate Nucleus at Unenhanced MR Imaging after Very High Cumulative Doses of the Macrocyclic Gadolinium-based Contrast Agent Gadobutrol: An Observational Study.
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Evidence for cortical structural plasticity in humans after a day of waking and sleep deprivation. *Neuroimage.* 2017;156:214-223.
13. *Fladby T, Pålhaugen L, Selnes P, Waterloo K, Bråthen G, Hessen E, Almdahl IS, Arntzen KA, Auning E, Eliassen CF, Espenes R, Grambaite R, Grøntvedt GR, Johansen KK, Johnsen SH, Kalheim LF, Kirsebom BE, Müller KI, Nakling AE, Rongve A, Sando SB, Siafarikas N, Stav AL, Tecelao S, Timon S et al.*
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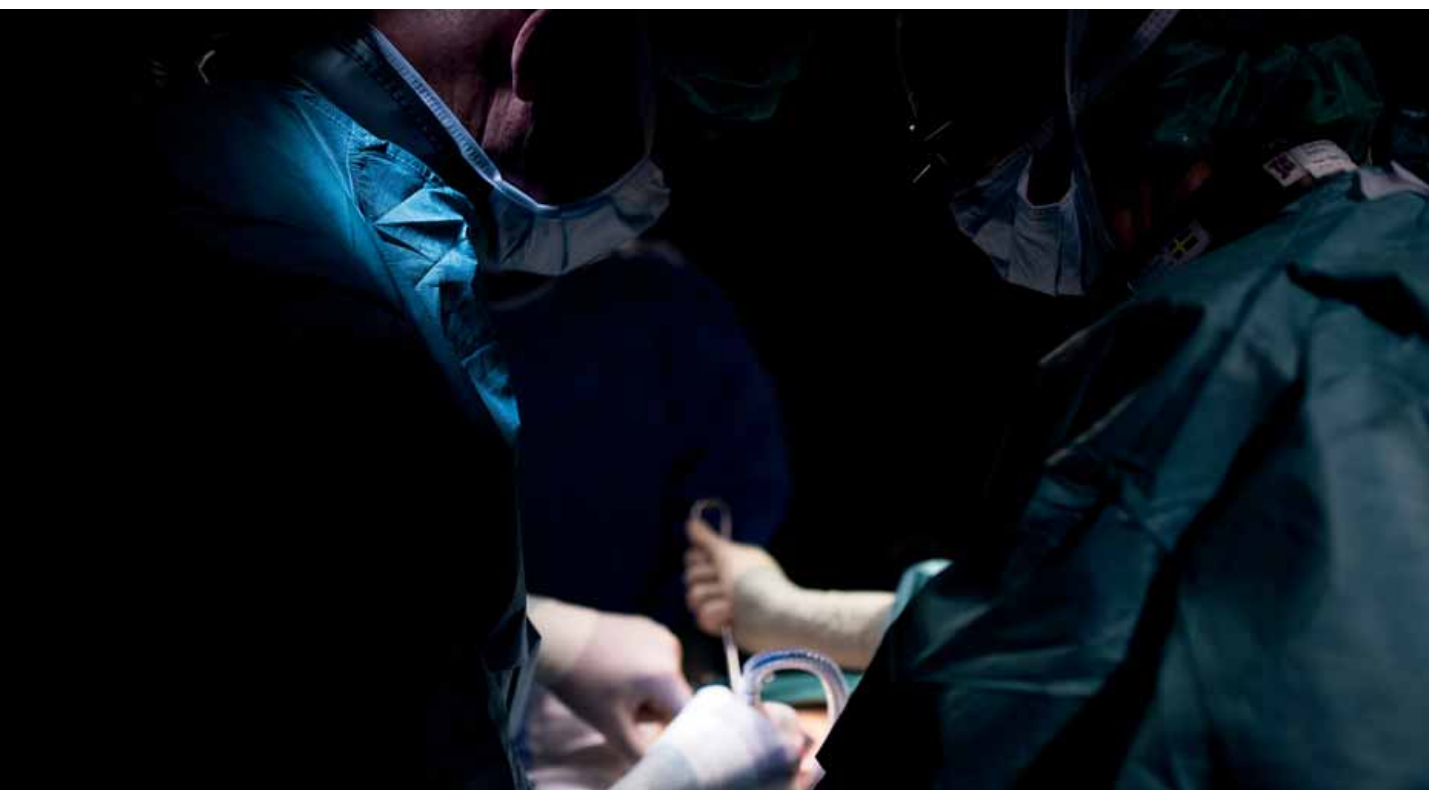
28. Pischke SE, Gustavsen A, Orrem HL, Egge KH, Courivaud F, Fontenelle H, Despont A, Bongoni AK, Rieben R, Tønnessen TI, Nunn MA, Scott H, Skulstad H, Barratt-Due A, Mollnes TE. Complement factor 5 blockade reduces porcine myocardial infarction size and improves immediate cardiac function. *Basic Res Cardiol.* 2017;112 (3):20.
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5.2 CONFERENCE PUBLICATIONS

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doi: 10.1109/IMBIOC.2017.7965778
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5.3 BOOK CHAPTERS

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5.4 PHD THESES

ENDRE GRØVIK

Multimodal Dynamic MRI for Structural and Functional Assessment of Cancer.

The Intervention Centre and Department of Diagnostic Physics
Oslo University Hospital, Rikshospitalet
Faculty of Mathematics and Natural Science
University of Oslo

MADS LUND PEDERSEN

Computational modeling as a tool for understanding learning and decision making process in ADHD.

The Intervention Centre
Oslo University Hospital, Rikshospitalet
Faculty of social Sciences
University of Oslo

MLADEN VELETIC

On natural communication for Data Transmission in Nano-Networks.

Department of Electronic Systems
Faculty of Information Technology and
Electronical Engineering
Norwegian University of Science and Technology
Faculty of Electrical engineering
University of Banja Luka
In collaboration with The Intervention Centre
Oslo University Hospital, Rikshospitalet

OLE-JOHANNES HOLM NIELSEN GRYMYR

Myocardial function and 3D motion analysis using a three-axis accelerometer during cardiac surgery.

The Intervention Centre
Oslo University Hospital
Faculty of Medicine
University of Oslo

KIM MATHIASSEN

A semi-autonomous robotic system for needle tracking and visual servoing using 2D medical ultrasound.

The Intervention Centre
Oslo University Hospital, Rikshospitalet
Department of Informatics
Faculty of Mathematics and Natural Sciences

MUSHEGH A SAHAKYAN

Laparoscopic surgery in the treatment of ductal adenocarcinoma in the distal pancreas.

The Intervention Centre
Oslo University Hospital, Rikshospitalet



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