Oslo University Hospital

The Intervention Centre

Annual report 2015

Oslo University Hospital and
Facility of Medicine, University of Oslo

ANNUAL REPORT 2015

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More information: www.ivs.no

PUBLISHER: Oslo University Hospital
EDITOR: Leif-Petter Rustad

PHOTO: The Intervention Centre
LAYOUT: Falke S. Lirhus

-Time for change

During the last decades we have seen increasing number of therapeutic procedures move from open, major surgery to minimal-invasive techniques with image guidance and therefore causing less burden to the patients, families and the socitety.

The Intervention Centre has for 20 years been focusing on developing and introducing new image guided procedures to create less invasive methods within many medical specialities. As an example, laparoscopic liver resection is now a routine procedure in our hospital, most of the patients are admitted to the hospital on the day of surgery and stay one, maximally two nights for observation. To ensure safety and quality of the procedure, Professor Bjørn Edwin and his team have for the last few years conducted a major randomized trial –The COMET-study, where laparoscopic surgery is compared with traditional, open liver resection. In 2016 the first results from this trial will be presented.

In our MR/surgery suite neurosurgeons are conducting a randomized trial to compare the efficacy of intraoperative MRI, ultrasound or fluorescence in optimizing the resection of glioblastomas, a serious malignancy of the brain.

In the combined angiography and surgery suite, the ENT team is developing and testing the benefits of fluoroscopic guidance during cochlear implantation for the hearing impaired.

The combined angiography and surgery suite is otherwise the main arena for development of new cardiovascular techniques. Stentgrafting for abdominal and thoracic aneurysms has been going on for 20 years, but the development of branched grafts and of combined procedures where stentgrafting is combined with surgery on the carotid vessels has given new treatment options to patients where we before had no options.
The most disruptive developments have probably been seen in the treatment of structural heart disease. In 2013 we performed 65 transcatheter aortic valve implantation in the hybrid room, in 2015 the cardiologists and cardiac surgeons increased this treatment-modality to 155 patients. This technology is rapidly evolving and was in 2015 expanded to the implantation of devices in the mitral ostium. There is no doubt these image guided techniques will change the whole field of cardiac surgery and intervention. We believe that to meet –the demands of the cardiovascular field, at least three combined angiography and surgical suites are needed in the coming years. This is one of the main challenges if Oslo University Hospital is going to stay at the cutting edge, nationally and internationally.

Erik Fosse
Head of Department

Main goals and objectives

THE INTERVENTION CENTRE

TASKS

- Develop new procedures
- Develop new treatment strategies
- Compare new and existing strategies
- Optimizing and developing advanced imaging techniques
- Study the social, economic, and organisational consequences of new procedures on health care
- Administration of radiation protection for all departments in the hospital and affiliated institutions

RESEARCH AREAS

- MR guided intervention and surgery
- X-ray, CT, ultrasound, video-guided interventions and surgery
- Robotics and simulators
- Sensor technology, data management and communication technology
- Physics in MR, CT, X-ray, US, PET and nuclear medicine

The Centre is physically located close to the general operation rooms at Oslo University Hospital, Rikshospitalet. In addition to clinical procedures, The Intervention Centre has approval to perform in vivo animal trials, following the strict Norwegian regulations of such activities. Advanced imaging equipment is integrated in an operation room environment. At present there are three such suites, according to plans three more will be added due to the increased demand for the facilities and the need to share these expensive resources between many clinical departments in need for such resources.

In 2007, all advanced imaging equipment at the Centre was renewed. In the combined surgical and radiological suites, the conventional angiographic equipment was substituted with a Siemens Zeego system, based on robotic technology. The Intervention Centre is a test site for this system using its expertise with the human and technological specialists from the company. The MRI suite was rebuilt into a dual room suite where a Philips 3 Tesla MRI was installed connected to a state-of-the-art operation theater. The MRI was funded as a joint effort by the Norwegian Research Council, the University of Oslo and Rikshospitalet. In the videoscopy room all systems are equipped with state of the art Olympus HD equipment.

STAFF

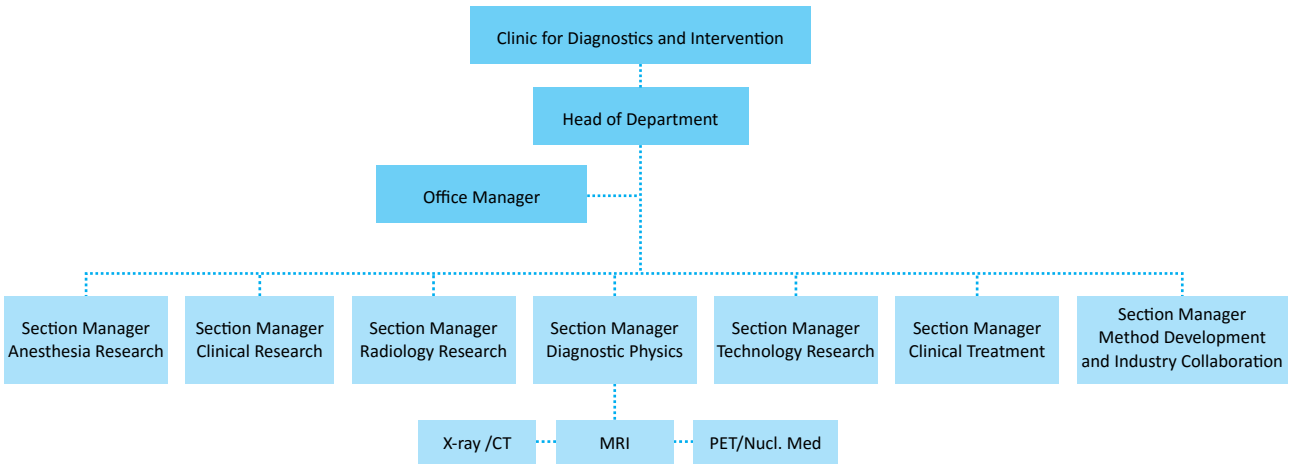
The multi-disciplinary staff includes 45 full time positions (doctors, nurses, radiographers, medical physicists, technologists and mercantile staff). Four professors and two associate professors, employed at the Faculty of Medicine and the Faculty of Mathematics and natural sciences of University of Oslo (UiO) and the Department of Electronics and Telecommunication of the Norwegian University of Technology (NTNU), are included in the staff.

ORGANIZATION

To facilitate effective management of multi-disciplinary projects, personnel and equipment at the Intervention Centre are allocated to five sections. Projects are assigned to one or more of the sections, and the project manager is reporting to section leaders. The operating rooms are managed by the unit head nurse, reporting directly to the department-head. The sections work closely together under the leadership of the department chief, thereby creating an optimal stage for cross-fertilization.

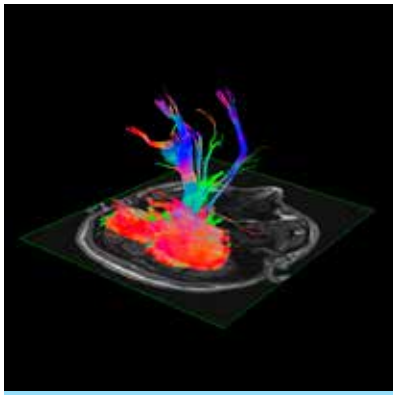
In 2005, Oslo University Hospital established a group of medical physicists specialized in diagnostic radiology, nuclear medicine and intervention. The establishment was supported by both the Southern and the Eastern Norway regional health authorities.

From 2010, the section for diagnostic physics was incorporated in the Intervention Centre, providing hospitals in the South-Eastern Norway Regional Health Authority physics services and physics research infrastructure.



Section for Diagnostic Physics

Section manager Associate Professor Anne Catrine Trægde Martinsen, PhD



ACTIVITY

The Intervention Centre employs 23 full-time physicists, covering the full range of imaging modalities and associated technologies; CT, X-ray, intervention and radiation protection, PET-CT and MRI, this is the largest department of diagnostic physics in Norway, offering a regional service to 38 departments of radiology and nuclear medicine in the South Eastern Health region of Norway.

In addition to quality assurance and radiation protection, the section is co-responsible for the daily follow-up and management of the MR core facility at Oslo University Hospital, and is heavily involved in research in a wide range of areas, including MR- and CT physics, mammography, nuclear medicine including PET-CT, image processing and radiation protection with special focus on paediatrics. In addition, multi/modal comparative studies, interventional radiology and internal dosimetry are also active fields of research.

REGIONAL PHYSICIST SERVICE

In 2015, the Intervention Centre provided service to all Radiology and nuclear medicine departments in OsloUniversityHospital and to the following 15 hospitals and radiological institutes at 38 locations within the South-Eastern health region including:

Akershus Universitetssykehus HF
ALERIS
Diakonhjemmet sykhus
Feiringklinikken
Glittreklinikken
Helsehuset Kongsberg
Lovisenberg Diakonale sykehus
Martine Hansens hospital
Sunnås sykehus HF
Sykehuset Innlandet HF
Sykehuset Østfold HF
Telemark Sykehus HF
Unilabs
Vestre Viken HF
Volvat AS

This is a non-profit service and the contracting hospitals pay for direct costs of the physicists support (salary, travel and accommodation). Recognizing that multi-disciplinary teamwork is a key factor for success, the service is organized in a way that whenever possible, each hospital is supplied with a specific contact physicist who works closely with radiologists and technicians in the radiology department. The section's staff works closely together to provide education and development opportunities to both employees and customers.

The following services are offered as part of the regional service:

- System acceptance tests
- Annual quality assurance (QA) tests
- Optimisation of image quality and radiation dose
- Multidisciplinary image quality optimization projects
- Teaching programs for surgical personnel using X-ray equipment
- Teaching programs in imaging physics and dosimetry for radiologists and technicians/radiographers.
- Dose measurements and dose estimates
- Consultancy in purchases of new imaging equipment in radiology- and nuclear medicine

The establishment of a regional physicist service provides several key advantages. First, a central pool of up-to-date educational material, reports and expertise is made available to all parties. Furthermore, centralized purchase of expensive measuring devices and equipment is made available to the hospitals leading to significant cost-savings. Finally, the collaboration between hospitals results in improved knowledge exchange between hospitals and departments. By centralizing major Quality Assurance and analytic services to one expert unit it becomes easier to compare the performance of modalities and systems between hospitals, thereby detecting sub-optimal performance (in terms of image quality or radiation exposure). This is accomplished utilizing the constantly increasing database which includes historical data collected from a large number of comparative instruments in the health region.

COURSES

The section is responsible for three master/PHD courses in imaging physics at the University of Oslo: "FYS 4760 Physics in diagnostic X-ray", "FYS-KJM 4740/9740 MR-theory and medical diagnostics", "FYS 9750 Medical imaging" and one CT post educating course ("ViCT") for radiographers at the University College in Oslo and Akershus (HiOA).

QUALITY ASSURANCE

Methodology for acceptance tests and quality assurance for the modalities MR, PET-CT, nuclear medicine, CT, fluoroscopy and X-ray were revised and further developed. In 2015 QA was performed on 371 imaging systems, including equipment from all major vendors.

STAFF

Clinical staff
Hilde Olerud, PhD Associate Professor
Siri Fløgstad Svensson, MSc Medical physicist
Ellen Marie Husby, MSc Medical physicist
Anette Aarsnes, MSc Medical physicist
Kristin Forså, MSc Medical physicist
Alise Larsen, MSc Medical physicist
Camilla Walle Serkland, MSc Medical physicist
Jon Erik Holtedahl, MSc Medical physicist
Lars Tore Gyland Mikaelsen, PhD Medical physicist
Tone Elise Døli Orheim, MSc Medical physicist
Anikken Dybwad, MSc Medical physicist
Ingerid Helen Ryste Hauge, PhD Medical physicist
Robin Bugge, MSc Medical physicist
Tanja Holther, Radiation protection officer

Scientific staff
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Atle Bjørnerud, PhD, Professor
Kyrre Eeg Emblem, PhD Research scientist
Tryggve Holch Storaas, PhD MR physicist
Øystein Beck Gadmar, PhD MR physicist
Wibeke Nordheøy, PhD MR physicist
Oliver Marcel Geier, PhD MR physicist
Caroline Stokke, PhD Medical physicist
Trine Hjørnevik, PhD Medical physicist

PhD students
Hilde Kjernlie Andersen, Medical physicist, PhD Student
Kristin Jensen, Medical physicist, PhD Student
Bjørn Helge Østerås, Medical physicist, PhD Student
Magne Mørk Kleppestø, MR physicist, PhD Student
David Volgyes, PhD Student
Endre Grøvik, MR physicist, PhD Student
Ingrid Digernes, PhD Student
Jonas Vardal, MD, PhD Student
Christopher Larsson, MD, PhD Student
Paulina Due-Tønnessen, MD, PhD Student
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PosDoc's
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Sandra Tecelao, PhD PostDoc
Siri Leknes, PhD Post Doc

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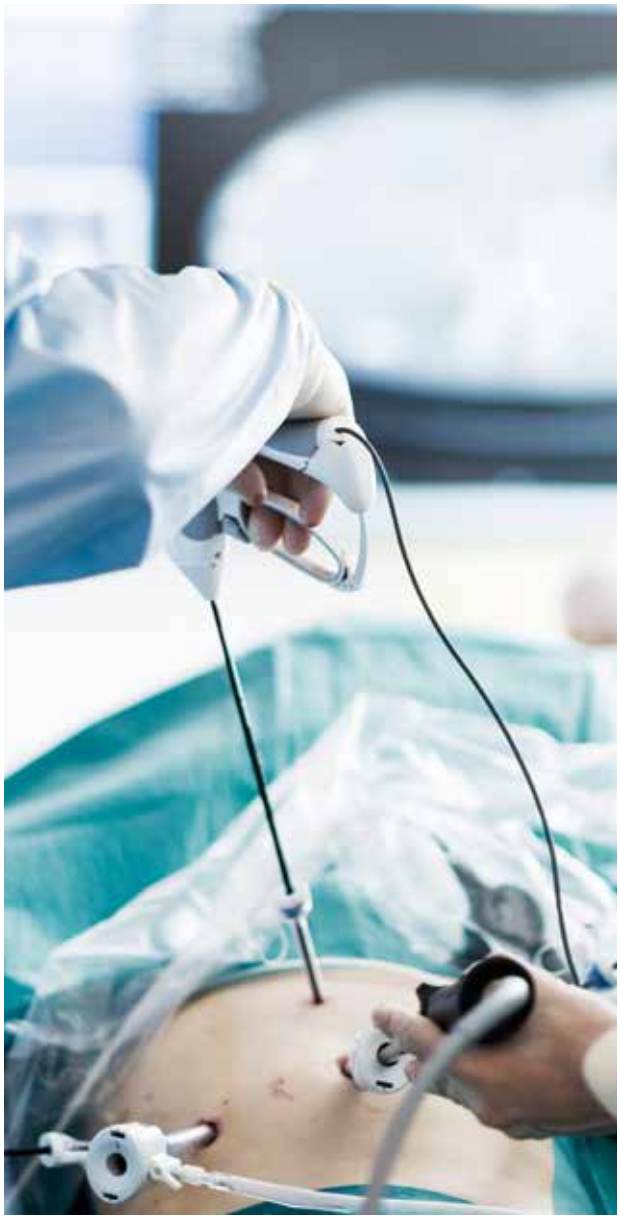
Donates Sederevicius, Master student



RESEARCH AREA

CT PHYSICS AND TECHNOLOGY | *Section Manager: Associate Professor Anne Catrine Trægde Martinsen, PhD*

AIMS

The group was established in 2012 with an ambition to establish a leading centre for CT physics and technology research in Norway. There has been little focus on CT research in Norway to date, but given a steady increase in the number of CT examinations, with about 80% of the total population radiation exposure from medical procedures stemming from CT, an increased research effort in this field is clearly needed. The research topics addressed by the group include the development of new imaging methods, clinical implementation, radiation dose reduction and further development of new image reconstruction algorithms and image post processing tools, such as CT perfusion, CT spectral imaging and iterative reconstruction techniques.

The CT physics and technology research group focuses on the development and implementation of advanced image reconstruction and processing techniques with specific focus on improved patient diagnostics combined with reduced radiation dose. Future objectives include validation of new methodology, such as iterative image reconstruction, spectral imaging, CT organ perfusion, in terms of improved diagnostic outcome and socioeconomic value.

ONGOING PROJECTS

Spectral imaging and iterative reconstruction in CT imaging: Image quality and radiation doses

The aim of the study is to introduce new applications in the clinic using new CT reconstruction techniques to improve image quality and lowering radiation doses to the patient. Comparison of lesion conspicuity for five different iterative reconstruction algorithms from four different vendors has been performed, and studies evaluating iterative reconstruction in chest, liver and brain are ongoing.

Optimization of diagnostic image quality and radiation dose of radiological tomography techniques using advanced post processing reconstruction algorithms

The aim of the project is to introduce new applications to improve image quality and potentially lowering radiation doses. Diagnostic image quality and radiation dose for the new Hologic tomosynthesis mammography imaging system has been evaluated in this project. Besides, density classification by Quantra II has been compared to the radiologists' BIAS score for density in mammography screening. The projects are part of the large, ongoing Oslo tomosynthesis screening trial lead by Professor Per Skaane (UiO).

CT quality assurance test methodology

The aim of the study is to analyze the characteristics of the commonly used QA phantoms, Catphan 500/504/600 (The Phantom Laboratory, NY), examine possible interphantom and interscanner variations in Hounsfield Units, homogeneity and low contrast detectability and to further develop methodology and phantoms and sophisticated analysing tools for CT image quality assurance tests. This study is performed in collaboration with the Phantom Laboratory (US) and Radforin (Iceland).

Ultralow dose chest CT

The aim of this study is to compare image quality, radiation dose and laboratory time for standard chest radiography (CR) with ultra low dose chest CT (ULD-CT) reconstructed with adaptive iterative dose reduction (AIDR 3D). Preliminary results from the pilot was presented on the RSNA international meeting, and demonstrated that the diagnostic information from ultra low dose CT is superior to that of CR. The corresponding radiation dose and laboratory time leave cost as the only reasonable argument in favour of CR.

HyPerCept

– Color and Quality in higher dimensions: Optimizing visual and diagnostic image quality in radiography.

In collaboration with the University College on Gjøvik we will investigate the transfer of knowledge from color imaging in the media industry to the radiography/radiology arena. Our motive is to develop new models, and re-use established models, for predicting the diagnostic quality of images in terms of the sensitivity and specificity of diagnostic imaging protocols.

RESEARCH AREA

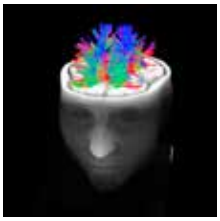
MR IMAGING AND ANALYSIS GROUP | *Section Manager: Professor Atle Bjørnerud, PhD*

AIMS

The research focus of the MR Imaging and Analysis (MRIA) Group is related to the application of novel functional MRI methods for improved disease detection and characterization. There is currently a particular focus on MR based imaging for diagnosis, prognosis- and treatment response assessment in oncology.

A second focus is the application of multi-modal imaging for early detection of dementia. Finally, the group has a strong track record in implementing and testing novel imaging techniques and in the development of advanced image processing tools with the aim of improving the diagnostic value of new imaging methods in a clinical setting.

The MRIA Group is a multi-disciplinary effort and is collaborating closely with many other groups both internally within the OUS and externally with world-class research groups inEurope and the US. The group also has a close link to industry through collaboration/ co-development with software companies (NordicNeuroLab, Bergen, Norway and CorTechs Labs, SanDiego, USA). The group has filed several patent applications related to novel image processing techniques which have been sub-licensed to our industrial partners. The MRIAgroup members are further involved in a large number of imaging studies ongoing in the Oslo-region. In particular, the group provides MR expertise in several morphometric MR studies where high resolution MRI is used to assess neuro-structural changes related to neurodegenerative disease, Alzheimer's disease and normal aging.



The MRIA group has been central in the development of an extensive software package for advanced image processing in MRI, with special focus on dynamic analysis. The software package, called nordicICE, has become a commercial product sold in more than 20 countries through our industry partner NordicNeuroLab AS (www.fmri.no).

nordicICE is one of very few medical image analysis software packages for advanced perfusion analysis with full FDA-approval (510K). At Rikshospitalet, nordicICE has been fully integrated into (Sectra) PACS and is now an integral part of routine diagnostic MR procedures, including BOLD fMRI, DTI and perfusion analysis. The MRIA hs recently completed a major upgrade of the nordicICE software package for integration into the next generation Sectra PACS (IDS7) and is currently focusing on expanding the functionality of the package towards automated tumor segmentation and implementation of advanced statistical methods for computer aided diagnosis (CAD).

ONGOING PROJECTS

Evaluation of functional Magnetic Resonance in the Diagnosis of Brain Tumors for Assessment of Clinical Efficacy - EMBRACE

This project financed by the Norwegian Research Council (NRC) and the Southern and Eastern Norway Regional Health Authority has been the cornerstone of much of our ongoing brain tumor research, resulting in several key publications during the last five years. The project focuses on developing novel methods for improved diagnostics in patients with primary brain tumors.

As part of EMBRACE we are also in the process of completing a two–center study (in collaboration in Harvard/MGH) to investigate if perfusion MRI provides additional relevant radiological information to the neuroradiologist in providing diagnostic- or decision making-support for brain tumor patients.

A third project is related to the application of perfusion MRI for early detection of malignant transformation of low-grade gliomas. Given the fact that the latency time for malignant transformation of gliomas can be many years, this study constitutes a long-term effort, but preliminary data for publication became available by the end of 2015.

Serial Diagnostic Assessments in Glioblastoma Therapy – SAILOR

This project aims at identifying MRI derived biomarkers for monitoring of treatment response in patients with glioblastomas. We have established a comprehensive MR protocol including state-of-the-art imaging techniques for serial imaging pre-, during-, and post- radio-chemo therapy. A total of 27 patients were followed closely with serial MRI over 1-3 years. The study is now close to completion. To date, several articles focusing on methodology have been published. Outcome data for publication are expected by the end of 2016.

Mapping the vessel architecture of cancer - LOOPS
This project focuses on a novel MRI analysis technique termed 'Vessel Architectural Imaging' (VAI), a unique method for non-invasive micro-vessel characterization (vessel diameter, type and function) and may in addition provide information about oxygen extraction. This information is of critical importance in brain tumor patients and we demonstrated that VAI based imaging provides unique biomarkers for stratification of patients with aggressive brain tumors undergoing anti-angiogenic treatment. The main aim of the LOOPS project (supported by the Southern and Eastern Norway Regional Health Authority) is to implement the VAI method on key centers across Norway and to test the method as a means of predicting treatment response in patients with brain metastases and to validate the technique against complimentary analysis methods. The project will be performed in close collaboration with researchers at Harvard University and Massachusetts General Hospital in Boston, USA.

Automated white matter lesion quantification
This is a collaborative project with the Dept of Neurology at Akershus University Hosptial and Department of Artificial Intelligence, UNED, Madrid, Spain. The aim is to develop fully automated methods for segmentation and characterization of white matter lesions (WML) in the brain from MR images. WML is known to be an early marker for many pathological processes related to neurodegeneration and dementia and quantification of WML extent is therefore of significant clinical importance. Manual WML segmentation is time consuming and prone to user bias and there is a strong need for automated methods. Through our collaboration with colleagues in Madrid, we developed a comprehensive toolbox named AMOS for automated WML segmentation. The tool is currently tested in large patient cohorts and further developments are in progress to extend the application to segmentation of MS lesions and brain tumors.

The OxyTarget study – Functional MRI of Hypoxia-mediated Rectal Cancer Aggressiveness
The primary objective of this project is to establish a reliable method for detection of rectal cancer patients with aggressive tumor at risk of metastatic disease and death by various functional MRI methods.

Single Bolus Split Dynamic MRI: A Novel Method for Combined Morphologic and Functional Assessments of Breast Masses
This project tests, through simulations and clinical data, the feasibility of combining a high temporal resolution dynamic sequence for quantitative assessments of both T1-weighted and R2* characteristics in breast masses interleaved with a high spatial resolution acquisition following a single CA injection.

MRI-derived Cellularity Index as a Potential Non-invasive Imaging Biomarker for Prostate Cancer
The purpose of this project is to improve prostate tumor diagnosis and patient stratification by delivering novel non-invasive diagnostic MR techniques providing increased sensitivity and tumor grade specificity to help predict tumor malignancy and extraprostatic extension.

Prediction of radiation therapy response by MRI and PET
This is a substudy to ANCARAD – prospective study of anal cancer at OUS and the aim of the study is to assess the value of Intra voxel incoherent motion (IVIM-) and DWI-measurements in predicting response to radiation therapy.

MyoGlu
A study addressing the effects of physical activity on insulin sensitivity, body composition and some hormones from adipose tissue and skeletal muscle – a 12 weeks training intervention in normal weight controls and overweight subjects with prediabetes. Total body fat fraction and fat distribution pre and post training intervention was assessed by whole body MRI. Liver, pancreas and muscle fat fractions were measured by MRS.

Prevention of cardiac dysfuntion during adjuvant breast cancer therapy (PRADA)
A study adressing the use of cardioprotective medication in relation to cytostatic treatment of breast cancer. Cardiac function is measured by MRI (CMRI). An MRI based quantitative assessment of extracellular volume is tested as an early marker of cardiac dysfunction.

Pre-clinical genotype-phenotype predictors of Alzheimer's disease and other dementias (APGeM).
Multi-institutional project, supported by the EU joint programme on neurodegenerative disease research (JPND) with the overall aim to establish genotype-phenotype matching in incipient Alzheimer's disease and Lewy-body diseases. IVS is a collaborating partner in the project in charge of the image and analysis work-package.

Effect of oral intake of oxygenated water on liver relaxation rimes measured by MRI.
This project, carried out in collaboration with the company OxySolutions AS aims at investigating the MR-observable liver in vivo effects of oral intake of oxygenated water.

Section for Anesthesia Research

Section Manager: Steinar Halvorsen MD, PhD

RESEARCH AREA

Clinical and experimental cardiovascular monitoring

Our research area is the development and testing of new technologies in cardiovascular monitoring. This includes evaluation of hemodynamic response to; 1) new and advanced cardio- vascular image guided procedures, and 2) advanced treatment for end stage heart failure with ventricular assist devices (VAD). New technologies developed or investigated for measuring cardiac function and hemodynamic status include implantable 3D accelerometers, miniaturized ultrasound sensors, biosensors and radar technology. The sensors are tested in both clinical and experimental models in cooperation with many departments at OUS and external institutions.

AIMS AND LONG TIMES GOALS

1. **To detect regional and global myocardial ischemia with implantable sensor systems**
2. **Evaluate left and right ventricular function using implantable sensors**
3. **Monitoring of ventricular assist devices with accelerometers**
4. **Evaluate the effect of therapeutic hypothermia on cardiac function**
5. **Evaluate the role of extra corporeal membrane oxygenation after cardiac arrest**
6. **Describe cardiovascular response to transaortic valve implantation (TAVI)**
7. **Establish new prognostic markers for mortality and morbidity after (TAVI)**

STAFF

Scientific staff-affiliated researchers
Steinar Halvorsen, MD. PhD
Jan Fredrik Bugge, MD, PhD
Andreas Espinoza, MD, PhD
Helge Skulstad, MD, PhD

PhD-students
Viesturs Kerans, MD
Ole-Johannes Grymyr, MD
Harald Bergan, MD
Jo Eidet, MD
Stefan Hyler, MD
Siv Hestenes, MD
Itai Scalit, MD
Kristin Wissløf-Aase, MD

Clinical staff
Steinar Halvorsen, MD, PhD
Viesturs Kerans, MD
Kjersti Wendt
Anton Amalathasan Josephmary
Kari Westby
Torill Schau

ONGOING RESEARCH PROJECTS

- Intraoperative monitoring during TAVI: Can immediate improvement in longitudinal systolic motion predict short and long term outcome after TAVI?
- Accelerometer used for detection of tromboembolic events in VAD.
- Accelerometer for monitoring changes in pre-and afterload during VAD treatment.
- Accelerometers used for monitoring left and right ventricular function after aortic valve resection.
- Can therapeutic hypothermia improve left ventricular function after cardiac arrest: an experimental ECMO study?
- Can betablockers improve survival after cardiac arrest: an experimental ECMO study?
- Left and right ventricular dysfunction in severe sepsis.
- Protective effects of therapeutic hypothermia in cardiac surgery.

ACTIVITY

Peer reviewed papers in international journals: 13 (2 in Level 2 and 11 in Level 1 journals)

Grants:

1. Improved patient selection for treatment of severe aortic stenosis with transcatheter aortic valve implantation (NOK 3 mill, PhD-candidate, Norwegian Health Authorities for Southern and Eastern Norway).
2. Improved monitoring of patients treated with left ventricular assist device (NOK 0.5 mill, Innovation funding, Norwegian Health Authorities for Southern and Eastern Norway).
3. University lectureship (6 years funding, 50% research): Myocardial function during therapeutic hypothermia in cardiac surgery.

The section for anesthesia research also provides clinical support to all research groups performing experimental and clinical studies at The Intervention Centre.

COLLABORATIONS

- OSCAR research network at Oslo University Hospital: Professor K. Sunde
- Complement Research Group at IMMI, Oslo University Hospital: Professor Tom Eirik Mollnes
- Biosensor Research Group at Department of Anesthesiology and Critical Care Medicine: Professor T. I. Tønnessen,Oslo University Hospital
- Professor Erik Fosse, MD, PhD, The Intervention Centre, Oslo University Hospital
- Professor Thor Edvardsen, MD, PhD, Department of Cardiology, Oslo University Hospital
- Professor Arnt Fiane, Department of Cardiothoracic Surgery, Oslo University Hospital
- Jacob Bergsland, MD, PhD
- Professor Svend Aakhus, MD, PhD, Department of Cardiology, Oslo University Hospital
- Associate Professor Ole Jakob Elle, MSc, PhD, The Intervention Centre, Oslo University Hospital
- Espen Remme, MSc, PhD. Department of Cardiology and The Intervention Centre, Oslo University Hospital
- Gudrun Høiseth, MD, PhD and Liliana C. Bachs, MD, PhD, Division of Forensic Medicine, Norwegian Institute of Public Health, Oslo

Section for Method Development and Industrial Cooperation (SMI)

Section Manager: Jacob Bergsland MD, PhD

RESEARCH AREA

The section members are involved in various research groups within the hospital and beyond. The section cooperates with a number of commercial projects with relevant industrial partners.

AIMS AND LONG TIMES GOALS

The sections goal is to assist clients within The Intervention Centre or Health South East in R&D related activities. Cooperation with companies, both start-ups and established commercial ventures is a priority for the section.

STAFF

Section Manager	Jacob Bergsland MD, PhD
Project Leader	Karl Øyri, RN, PhD
Health Economist	Sandre Svatun Lirhus, M.Sc
Quality Coordinator	Bjørn Tjønnås
Research Coordinator	Leif-Petter Rustad
Consultant	Knut Korsell
IT- specialist	Stig Ronny Kristiansen

ACTIVITY

The section is responsible for organizing The Intervention Centre's activities related to development and evaluation of new clinical methods. The section is also responsible for relations to and the organization of projects with med-tech industry, and serves as a primary or secondary contact point for scientific- or commercial clients who want to utilize the resources at IVS. The section staff is participating in the Council for Method Development of Oslo University Hospital and assists departments in the organization that needs to perform Health Technology Assessments (HTA), before introducing new high technology medical procedures. The Industrial cooperation takes various forms and involves start-ups- and established- companies. The section participates in concept developments, application for funds and development of research protocols developed in cooperation with the commercial sector. Industrial cooperation, related to the so-called Testbed function of the Intervention Centre is based on a non-profit principle. Expenses related to industrial projects should be covered by industry or through funding from national- or EU- funding. The section works closely with Oslo Med-Tech and Inven2 to supply optimal service to cooperating partners.

IVS / TESTBED ACTIVITIES

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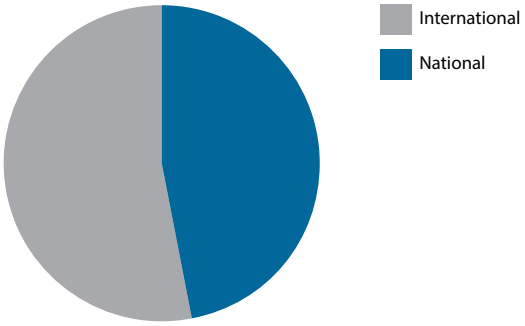

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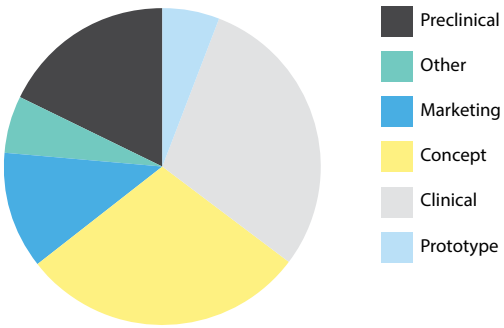

Section for Clinical Research

Section Manager: Professor Bjørn Edwin, MD, PhD

ACTIVITY

The Section for Clinical Research is responsible for the ongoing clinical projects at The Intervention Centre.

Several new techniques in laparoscopic surgery have been introduced in Norway through this group. Some of the methods are now routine procedures, The group validates new procedures and establishes effective training.

Education programs in minimal invasive surgery in both gastro-intestinal- and urological surgery are organized in collaboration with other hospitals in Norway, Sweden, Denmark, Finland, Germany, Armenia, Belgium, Palestine and UK.

The Department of Surgery is one of our main collaborators with research projects ongoing in:

- Minimal invasive surgery on the liver, pancreas, stomach, oesophagus, kidney, adrenal gland and colon/rectum
- Minimal invasive techniques in children
- Thermal liver ablation (HIFU and RF)

IMAGE-GUIDED SURGERY AND MINIMAL INTERVENTION

ABOUT

Development and assessment of minimal invasive therapy in all surgical fields.

Development and assessment of local ablation in liver malignances, Cryotherapy, Radio frequency ablation and High Intensity focused ultrasound (HIFU).

Development of and assessment of Implants from Bio-medical materials, (percutaneus implants for stomas).

Development and assessment of a 3D map for liver and pancreas used to navigate before and during the navigation.

Development and assessment of a new database platform including possibilities to make data from this platform anonymous and use them in public search engine, e.g. PubGen.

Development and assessment of training programs for laparoscopic and single port surgery (LESS).

LONG TIMES GOALS

Completion of above mentioned research program. Initiate, stimulate and assess more advanced minimal invasive procedures, e.g. Whipple's procedure and advanced liver resections. Assessment of 3D vision and navigation to see if 3D navigation will simplify laparoscopic liver and pancreatic surgery. Assess use of robots in surgery.

RESEARCH GROUP MEMBERS

Trond Buanes, Prof.
Kjersti Flatmark, MD, PhD
Åsmund Avdem Fretland, MD
Marit H. Andersen MN, PhD
Bjørn Atle Bjørnbeth, Leader, MD, PhD
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Olaug Villanger, MD, PhD
Knut Jørgen Labori, MD, PhD
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Leonid Barkhatov, MD
Karl Øyri, Research fellow
Stig Ronny Kristiansen, (IT)
Erik Næss-Ulseth (PubGene)
Kjell Arne Rein, MD, PhD
Gry Dahle, MD
Cecilie Våpenstad, MSc
Astrid Jones Lie (PubGene)
Ivar P. Gladhaug, Prof.

ONGOING PROJECTS

OsloCoMet-study:
Oslo randomized laparoscopic vs. open liver resection for colorectal metastases – Randomized Controlled study.

***Study 1:* Surgical stress and Immunosupression**
Comparing stress and immunosuppression following laparoscopic and open liver resection.

***Study 2:* Immediate and short term outcomes**
Comparing intraoperative and early postoperative outcomes, and immediate oncologic outcomes.

***Study 3:* Postoperative pain and quality of life**
- Comparing health related quality of life before the procedure, on 2nd postoperative day and in 4, 8, 12 months after the procedure.
- Comparing pain on the 2. postoperative day and after 1 month.

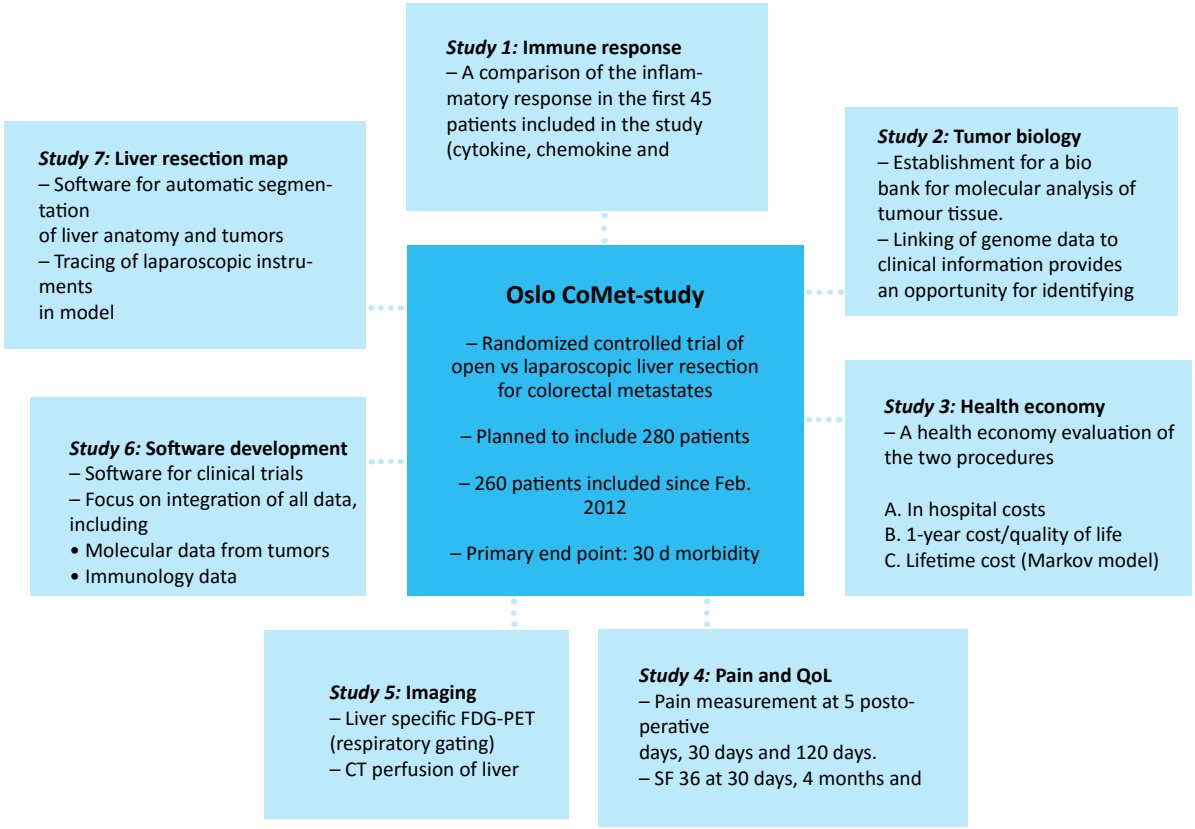
***Study 4:* Repeat resections**
Defining and comparing surgical outcomes and major oncologic indexes between sub-groups of repeat resections.

***Studies 5-6:* Long term oncologic outcomes**
- Defining and comparing major oncologic indexes in the 3 and 5 year follow-up period (Study 5)
- Defining and comparing major oncologic indexes in 10 year follow-up period (study 6)

***Study 7:* CoMet Mol**
The aim is to perform molecular characterization of biological samples harvested perioperatively using (Biobank) and follow-up of results correlated with clinical end points.

***Study 8:* CoMet anti-tumor immunology**
The aim is to evaluate immunological parameters related to anti-tumour immunity and inflammatory factors.

***Study 9:* CoMet Imaging**
The aim is to compare CT perfusion to conventional CT and MRI, with respect to the detection of liver metastases from colorectal carcinoma.



ProjectTAVI:

Project MitraClip

ProjectMecMed (COREMINE/Metajournal)

Project3D map and navigation (liver and pancreas)

PHD CANDIDATES

Åsmund Avdem Fretland
Kim Ånonsen
Sven Petter Haugvik
Leonid Barkhatov
Martin Johansson
Rahul P. Kumar
Hilde Kjernlie Andersen
Jens Marius Næssgård
Musheg Sahakyan
Gudrun Waaler Bjørnelv
Vegar Dagenborg
Rafael Palomar

COLLABORATION

Nasjonalt kompetansetjeneste for ultralyd og bildeveiledet behandling, Trondheim

Tumorbiologi, 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, SouthamptonUniversity,
Research and development lead for Surgery, SouthamptonUniversity 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 Generale ed OncologicaOspedale Mauriziano,
Torino, Italy.

Section for Radiology Research

Section Manager: Professor Per Kristian Hol, MD, PhD

RESEARCH AREA

A number of research projects using the 3T MR scanner or the combined angiographic suite are performed in corporation with different academic partners, including Departments of Neuropsychiatry and Psychosomatic Medicine, Department of Nutrition, Oncology, Ear Nose and Throat, Neurosurgery, Neurology, Anesthesiology and Radiology.
The research topics cover brain, spine, liver, prostate, brachial plexus and inner ear.
High Intensity Focused Ultrasound (HIFU)-therapy is a completely-non-invasive ablation method, 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. At the Intervention Centre focus has been on both basic and clinical MR-guided HIFU research projects. Organs to be studied have been uterus (uterine fibroids), liver and prostate.

AIMS

The aim is to be nationally and internationally leading research environment in MR- and hybrid angio-guided treatment, including MR-guided High Intensity Focused Ultrasound therapy.

STAFF

Scientific staff
Per Kristian Hol, Professor, MD, PhD
Frederic Courivaud, PhD
Tryggve Storås, PhD

Affiliated scientific staff
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David Russell, Professor, MD, PhD
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Axel Sauter, MD, PhD
Greg Jablonski, MD, PhD

Clinical staff
Grethe Løvland, BSc
Svein Are Vatnehol, MSc
Hilde Korslund, BSc
Siv-Eli Simonsen

PhD students
Ulrik Carling, MD
Trygve Kjelstrup, MD

Affiliated PhD students
Karolina Ryeng Skagen
Erlend Bøen
Ralf Greisiger

Affiliated post doc student
Einar Vik-Mo

ONGOING PROJECTS

MR-guided HIFU of the prostate
MR-guided HIFU of the liver
MR-guided HIFU of uterine fibroids
Axillary plexus block assessed by MRI
The vulnerable carotid artery plaque
Bipolar disorders and cortical thinning
MR-guided neurosurgery
Nutrition, growth and development of premature children

COLLABORATIONS

Philips Medical System
Siemens Healthcare
Research group of cognitive and clinical neuroscience, Dept of Psychology
Norwegian School of Veterinary Science (Professor Lars Moe)

Section for Technology Research

Section Manager: Associate Professor Ole Jakob Elle, PhD

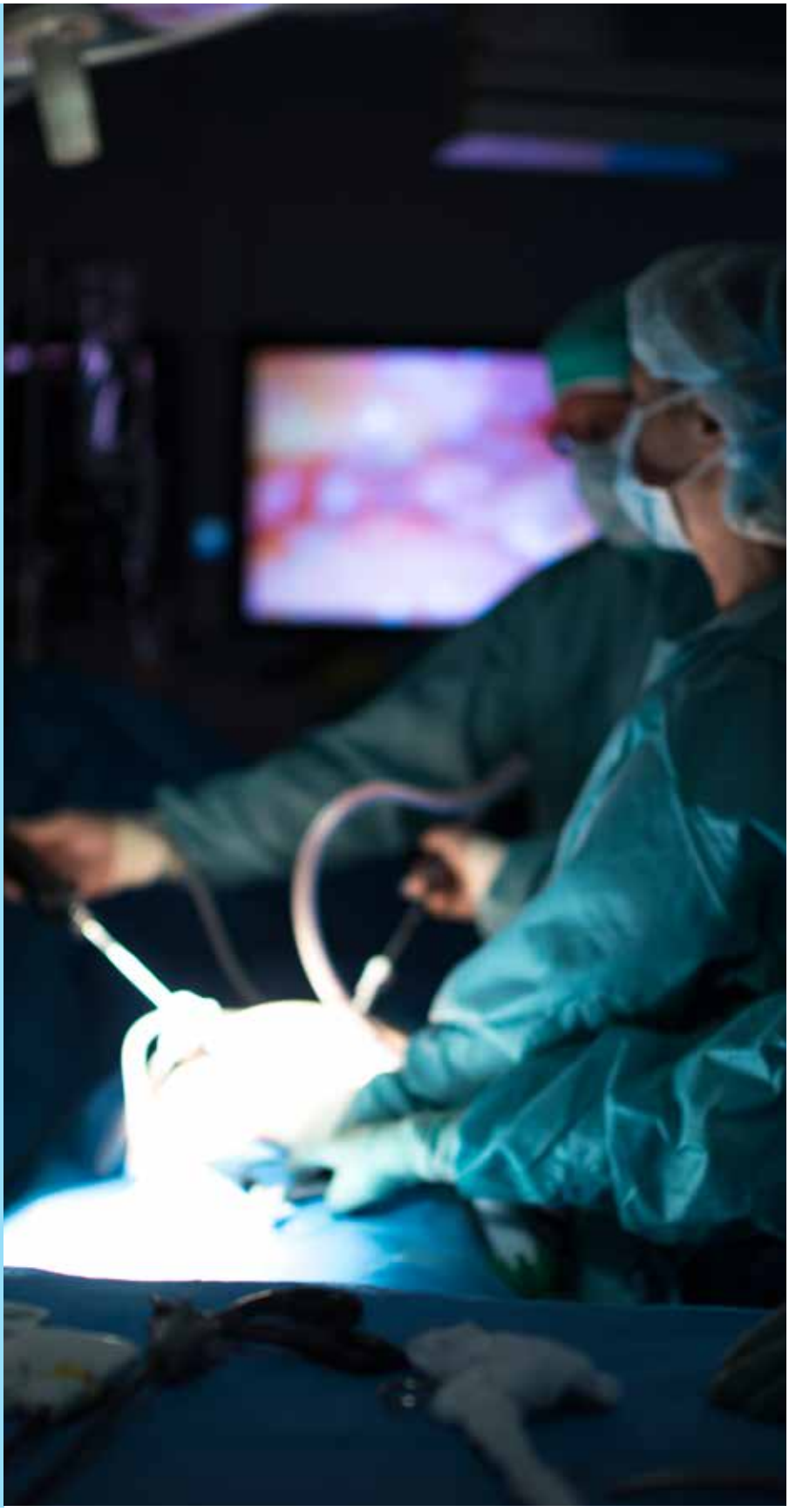
CLINICAL ACTIVITY

The Section for Technology Research at The Intervention Centre aims to develop cutting edge technological solutions which support minimally invasive procedures and intra-operative monitoring.

In addition to the research group members, the section has 4.3 permanent employees with various technological backgrounds supporting research at the operating suites, all with PhD degree and 20% academic positions as professors or associate professors.

The R&D covers a span of different technologies like bio-sensor technology and communication technology including wireless communication, image processing and visualisation, navigation technology, robotics and 3D printing of patient specific organs.

What is a common aim is that the technology is mainly focusing on solutions for intra-operative use. 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.



MEDICAL ROBOTICS VISUALISATION AND NAVIGATION

RESEARCH PROFILE

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 ultrasound or endoscopic images to be able to monitor the surgery 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. The research focus is on image processing methods that 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 tumours and vessel structures in images, while registration methods enables fusion of images. Visualization and navigation is required to present the medical images to the surgeon intra-operatively. We are developing visualization systems which use advanced techniques such as augmented reality and volume rendering for this purpose.

Robotic surgery which so far primarily has been tele-manipulators like Da Vinci, will in the future in addition to use real-time sensors like force/torque, inertia (accelerometer/gyro) and 3D video be more

and more cross-linked with medical image information and move toward automation of surgical procedures. The research group is doing research in all these fields of technology facilitating minimally invasive surgery.

GROUP MEMBERS

Ole Jakob Elle, *Section Manager – Technology Research/Associate. Prof., PhD*
Frederic Courivaud, *Senior Researcher, PhD*
Espen Remme, *Senior Researcher, PhD*
Laura Slaughter, *Senior Researcher/Ass. Prof., PhD*
Rafael Palomar, *PhD fellow (HiG/OUS, MSc)*
Rahul Kumar, *Postdoc, PhD*
Louise Oram, *Software developer in NorMIT , MSc.*
Kim Mathiassen, *PhD fellow, MSc (also at ROBIN-group at IFI/UIO)*
Ralf Greisiger, *PhD fellow, MSc (also at ROBIN-group at IFI/UIO)*
Magnus Leon Reinsfelt Krogh, *PhD fellow*
Liubov Nikitushkina, *PhD fellow (UIO/SIMULA/UCSD and OUS)*
Sigmund J L Rolfsjord, *PhD fellow (UIO/OUS, MSc)*
Bilel Sdiri, *PhD fellow (HiG/OUS, MSc)*

PROJECTS

The section is partly financed through the hospital (permanent staff), but to a larger extent through pro-jects funded by NFR and EU. We are currently participating in 3 EU-projects as well as several NFR-projects and projects financed by Innovasjon Norge.

NorMIT
NFR funded the two-nodes' (St.Olavs Hospital (FOR) and The Intervention Centre, OUS) national infrastructure for minimally invasive therapy. Part of this funding is the establishment of a national Navigation Platform for image guided treatment led from the research group at IVS.

HyperCept
The research group has a collaboration on video processing in Video assisted surgery with Norwegian Colour and Visual Computing Laboratory, Faculty of Computer, Science and Media Technology, Gjøvik University College. Two PhD fellows are connected financed through the HyperCept-project (NFR), one with main supervision from the research group and the other co-supervised from the same.

IQ-Med (Image Quality enhancement in MEDical diagnosis, monitoring and treatment)
The research group has a collaboration on video processing in Video assisted surgery with Norwegian Colour and Visual Computing Laboratory, Faculty of Computer, Science and Media Technology, Gjøvik University College. One PhD fellow is financed through the IQ-Med project (NFR), with main supervision from the research group.

SUUURPh project is a Simula-UiO-UCSD Research and PhD Training Collaboration. The SUURPh collaboration is an initiative funded by the Norwegian Ministry of Research and Education to promote multidisciplinary research in computational biology and medicine. The programme seeks to provide international training opportunities for PhD students enrolled in Norway, and support collaboration among scientists at Simula, the University of Oslo (UiO), and the University of California San Diego (UCSD). One PhD fellow in biomechanical modelling of the heart in order to predict when to treat in case of heart valve leakage.

MEDICAL ROBOTICS VISUALISATION AND NAVIGATION

LONG TERM GOALS

The research group aims to be nationally and internationally leading research environment in technological solutions for image guided minimally invasive treatment. The group will strive to have competent personnel within the following technological areas:

- Real-time Image-processing (image- and video analysis, segmentation…)
- Real-time volume visualisation
- Navigation technology
- Robotic technology
- Real-time sensing and monitoring
- Technology support to Minimally Invasive Treatment in the hybrid OR's in general

The research group want to further extend the national and international research networking by applying research grants as coordinator through NFR and EU- calls as well as participating in consortiums within EU initiatives.

The group will strive towards increasing the number of publications in peer reviewed journals and conferences of high standing.

The **MEDIMA** project (Multimodal medical imaging andimage analysis) at Department of Informatics, University of Oslo has one PhD fellow in image co-registration combining 3D ultrasound with fluoroscopy in catheter – based procedures supervised by the research group.

Helse Sør-Øst financed Innovation funding for the establishment of a service within 3D printing of patient specific organ models.

Helse Sør-Øst financed Postdoc for the Hepa-Navi project, Planning and Navigation system for Liver Resections.

Helse Sør-Øst financed PhD position - Medical Sensor Development, Signal processing and testing, where the PhD-fellow work on signal processing to detect abnormal heart function using 6 degree of freedom motion sensor.

EU I-SUR project (Intelligent Surgical Robotics):
This project addresses a very complex problem that can be expressed in a very simple form: is it possible to automate surgery? To explore the feasibility of a solution to this problem, in this project we develop general methods for cognitive surgical robots capable of combining sensing, dexterity and cognitive capabilities to carry out autonomously simple surgical actions, such as puncturing, cutting and suturing.

COLLABORATIONS

- University of California, San Diego (UCSD)
- University of Dundee
- University of St. Andrews
- Norwegian University of Science and Technology
- University of Homburg, SAAR
- Delft University of Technology
- MR Comp GmbH
- University of Lubeck
- Fakultni Nemocnice u sv. Anny v Brne
- GE Medical Systems
- Katholieke Universiteit Leuven, Leuven, Belgium
- Oslo Universitetssykehus HF, Oslo, Norway
- 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
- Oslo University Hospital
- Tallin University
- San Raffaele Hospital
- Yeditepe University
- ETH Zurich
- King's College London
- University of Oxford
- GE Vingmed
- Cascination
- Sintef Medical Technology
- Sheffield Hallam University
- Universidad de Zaragoza
- Universidad politecnica de Madrid

Wireless Sensor Network Research Group

Professor Ilangko Balasingham

CHALLENGES

The research group performs fundamental research and development on wireless sensors and systems for applications in diagnostics, minimal invasive therapies, and ambient point of care monitoring. One of the technological focused areas is on ultra low power and reliable wireless sensor networks, where the research is on novel transceiver design (coding, modulation, antenna, etc.), low power sensor data compression, and signal and image processing algorithms for anomaly detection, data fusion, etc. Special interest topics are wireless pacemakers, capsule endoscopes, brain machine interfaces, and nano scale communication technologies using nanomaterials and synthetic biology.

PROJECTS

European Commission
Coordinator/PI of Wireless In-Body Environment Communications (WiBEC), (H2020- MARIE Skodowska-CURIE ACTIONS (MSCA-ITN-2015), 01.01.2016-31.12.2019, budget €3.957 mill)

Research Council of Norway
Work Package Leader/PI of Holistic Monitoring of Indoor Environment (HOME) (Idea Lab Program, 01.09.2014 31.12.2017, budget NOK 10 million)

Project Manager/PI of Medical Sensing, Communications, and Localization Using Ultra Wideband Technology (MELODY, Phase II) (VERDIKT/ICT2015 Program, 01.01.2013 - 31.07.2017, budget NOK 14.7 million)

Co-PI Adaptive Security for Smart Internet of Things in eHealth (ASSET) (VERDIKT Program, 02.01.2012 - 31.12.2015, budget NOK 13.2 million)

The Norwegian Ministry of Foreign Affairs
PI of Norway Balkan Project (NORBAS), (The HERD/ICT Balkan Program, 01.01.2012 - 31.12.2016, budget NOK 6.25 million)

Health South East
Project Manager/PI of Medical Cloud and Cancer Diagnostic APP, (Innovation Grant, 01.09.2014-31.12.2015, budget NOK 1.5 million)

Project Manager/PI of Battery-Less Wireless Data Communication With Medical Implants(Innovation Grant, 01.01.2016-31.08.2017, budget NOK 1.0 million)

Developing next generation Pill Camera. Industrial PhD program with Omnivision Inc.

WiBEC. EU-project

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Juan Felipe Miranda Medina (Postdoc)
Kasif Habib Sheik (PhD student)

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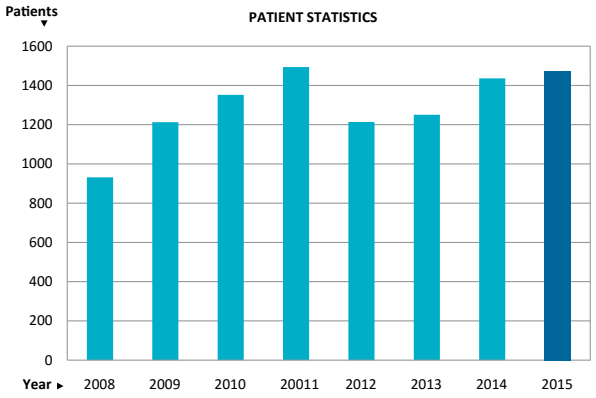
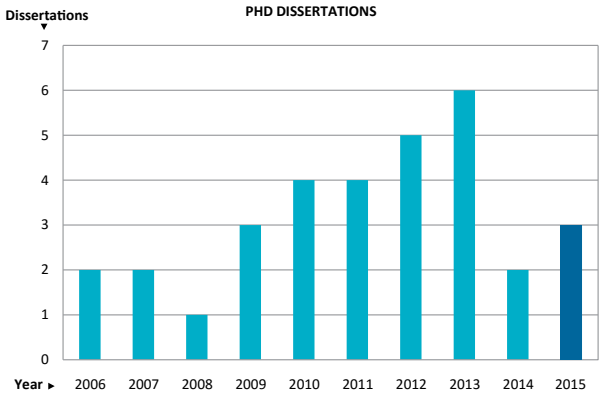
Mladen Veletic (PhD student)
Hamed Fouladi (PhD student)
Karl Øyri (PhD student)
Lars Erik Solberg (PhD student)
Anders Bjørnevik (MSc student)
Alicja Kwaśniewska (MSc student)

Surgical procedures

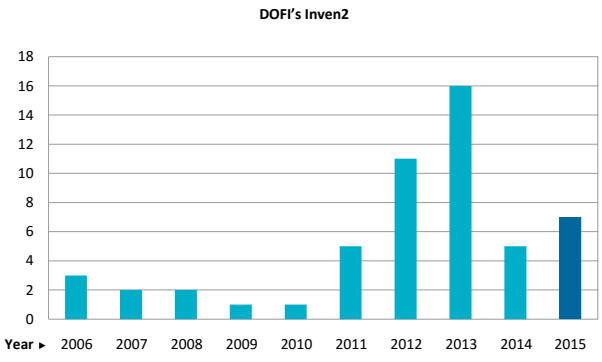
The Intervention Centre 2006-2015



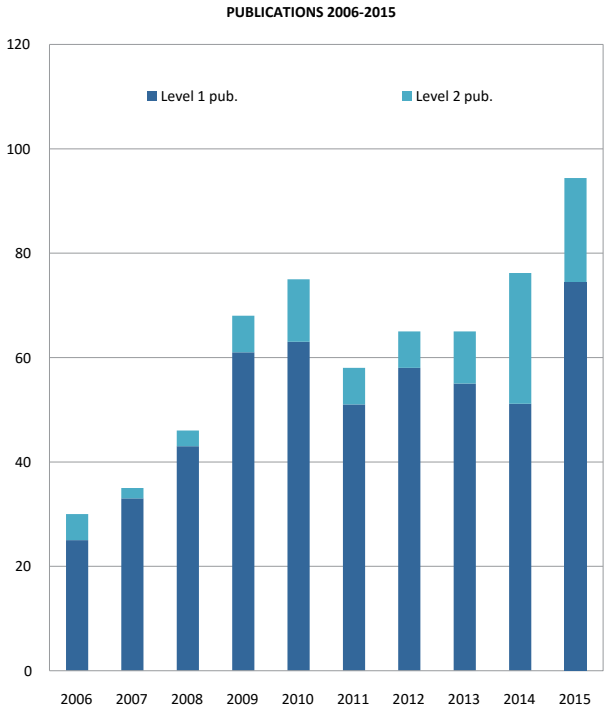
Surgical and interventional procedures at IVS shown by year



PhD-dissertations originating from IVS



Disclosure of interventions (DOFI) at the IVS by year



Publications from IVS


SONY

Budget and finances

Internal hospital funds administered by the Intervention Centre in 2015 (In NOK)

IVS – 910 936

ALLOCATION FROM OUS	INCOME	EXPENDITURES
Basic funding	29 000 000	
Variable income	524 000	
Cost of goods		6 160 000
Salaries and social costs		24 136 000

Diagnostic Physics administered by the Intervention Centre in 2015 (In NOK)

IVS - 776 000

ALLOCATION FROM HEALTH SOUTH EAST	INCOME	ACTUAL
Basic funding	12 391 000	
Variable income	6 880 000	
Cost of goods		1 610 000
Salaries and social costs		19 315 000

	ALLOCATED	INCOME	RESULT
Total	41 391 000	7 404 000	- 242 000

External funds administered by the Intervention Centre in 2015 (In NOK)

IVS – 910 711

SOURCE	AWARDED GRANTS	RESEARCH EXPENDITURES
Research Council of Norway NFR	10 859 000	9 339 679
Regional Health Authority HSØ	12 118 000	11 300 136
European Commission EU	2 342 215	592 857
University of Oslo UiO	230 250	230 250
Norwegian Cancer Society	823 000	754 785
INVEN2	124 500	0
Others	20 000	0
Total in NOK	**26 516 965**	**22 217 702**

Publications

Scientific publications1 from The Intervention Centre 2015

1 Scientific channels are journals, series and publishers that fulfill specific criteria given by the Norwegian register for scientific journals, series and publishers (NSD: www.dbh.nsd.uib.no/kanaler). There are two levels: Ordinary publication channels (level 1) and highly prestigious publication channels (level 2).

LEVEL 2

1. *Chávez-Santiago R, Garcia-Pardo C, Fornes-Leal A, Vallés-Lluch A, Vermeeren G, Joseph W, Balasingham I, Cardona N (2015)*
Experimental Path Loss Models for In-Body Communications Within 2.36-2.5 GHz
IEEE J Biomed Health Inform, 19 (3), 930-7
PubMed 25838532SFX WOS 000356511900019 Cristin 1252128(Details)

2. *Dale Rein I, Stokke C, Jalal M, Myklebust JH, Patzke S, Stokke T (2015)*
New distinct compartments in the G2 phase of the cell cycle defined by the levels of γH2AX
Cell Cycle, 14 (20), 3261-9
PubMed 26317799SFX WOS 000363971200014 Cristin 1335348(Details)

3. *Di Fabio F, Barkhatov L, Bonadio I, Dimovska E, Fretland AA, Pearce NW, Troisi RI, Edwin B, Abu Hilal M (2015)*
The impact of laparoscopic versus open colorectal cancer surgery on subsequent laparoscopic resection of liver metastases: A multicenter study (vol 157, pg 1046, 2015)
Surgery, 158 (5), 1450
WOS 000363005800040(Details)

4. *Di Fabio F, Barkhatov L, Bonadio I, Dimovska E, Fretland ÅA, Pearce NW, Troisi RI, Edwin B, Abu Hilal M (2015)*
The impact of laparoscopic versus open colorectal cancer surgery on subsequent laparoscopic resection of liver metastases: A multicenter study
Surgery, 157 (6), 1046-54
PubMed 25835216SFX WOS 000354910600009 Cristin 1253015(Details)

5. *Fjell AM, Grydeland H, Krogsrud SK, Amlien I, Rohani DA, Ferschmann L, Storsve AB, Tamnes CK, Sala-Llonch R, Due-Tønnessen P, Bjørnerud A, Sølsnes AE, Håberg AK, Skranes J, Bartsch H, Chen CH, Thompson WK, Panizzon MS, Kremen WS, Dale AM, Walhovd KB (2015)*
Development and aging of cortical thickness correspond to genetic organization patterns
Proc Natl Acad Sci U S A, 112 (50), 15462-7
PubMed 26575625SFX WOS 000366404200068 Cristin 1306103(Details)

6. *Floor PA, Chávez-Santiago R, Brovoll S, Aardal Ø, Bergsland J, Grymyr OJ, Halvorsen PS, Palomar R, Plettemeier D, Hamran SE, Ramstad TA, Balasingham I (2015)*
In-Body to On-Body Ultrawideband Propagation Model Derived From Measurements in Living Animals
IEEE J Biomed Health Inform, 19 (3), 938-48
PubMed 25861089SFX WOS 000356511900020 Cristin 1238739(Details)

7. *Floor PA, Kim AN, Ramstad TA, Balasingham I, Wernersson N, Skoglund M (2015)*
On Joint Source-Channel Coding for a Multivariate Gaussian on a Gaussian MAC
IEEE Trans. Commun., 63 (5), 1824-1836
WOS 000354944100026 Cristin 1242434(Details)

8. *Fyhn TJ, Knatten CK, Edwin B, Schistad O, Aabakken L, Kjosbakken H, Pripp AH, Emblem R, Bjørnland K (2015)*
Randomized Controlled Trial of Laparoscopic and Open Nissen Fundoplication in Children
Ann Surg, 261 (6), 1061-7
PubMed 26291953SFX WOS 000369611600034 Cristin 1327886(Details)

9. *Kaufmann T, Elvsåshagen T, Alnæs D, Zak N, Pedersen PØ, Norbom LB, Quraishi SH, Tagliazucchi E, Laufs H, Bjørnerud A, Malt UF, Andreassen OA, Roussos E, Duff EP, Smith SM, Groote IR, Westlye LT (2015)*
The brain functional connectome is robustly altered by lack of sleep
Neuroimage, 127, 324-32
PubMed 26712339SFX Cristin 1302339(Details)

10. *Knatten CK, Kvello M, Fyhn TJ, Edwin B, Schistad O, Aabakken L, Pripp AH, Kjosbakken H, Emblem R, Bjørnland K (2015)*
Nissen fundoplication in children with and without neurological impairment: A prospective cohort study
J Pediatr Surg (in press)
PubMed 26787273SFX Cristin 1329345(Details)

11. *Krogsrud SK, Fjell AM, Tamnes CK, Grydeland H, Mork L, Due-Tønnessen P, Bjørnerud A, Sampaio-Baptista C, Andersson J, Johansen-Berg H, Walhovd KB (2015)*
Changes in white matter microstructure in the developing brain--A longitudinal diffusion tensor imaging study of children from 4 to 11years of age
Neuroimage, 124 (Pt A), 473-86
PubMed 26375208SFX WOS 000366646700044(Details)

12. *Krogvold L, Skog O, Sundström G, Edwin B, Buanes T, Hanssen KF, Ludvigsson J, Grabherr M, Korsgren O, Dahl-Jørgensen K (2015)*
Function of Isolated Pancreatic Islets From Patients at Onset of Type 1 Diabetes: Insulin Secretion Can Be Restored After Some Days in a Nondiabetogenic Environment In Vitro: Results From the DiViD Study
Diabetes, 64 (7), 2506-12
PubMed 25677915SFX WOS 000356934000033 Cristin 1337309(Details)

13. *Lu-Emerson C, Duda DG, Emblem KE, Taylor JW, Gerstner ER, Loeffler JS, Batchelor TT, Jain RK (2015)*
Lessons from anti-vascular endothelial growth factor and anti-vascular endothelial growth factor receptor trials in patients with glioblastoma
J Clin Oncol, 33 (10), 1197-213
PubMed 25713439SFX(Details)

14. *Mutsaerts HJ, van Osch MJ, Zelaya FO, Wang DJ, Nordhøy W, Wang Y, Wastling S, Fernandez-Seara MA, Petersen ET, Pizzini FB, Fallatah S, Hendrikse J, Geier O, Günther M, Golay X, Nederveen AJ, Bjørnerud A, Groote IR (2015)*
Multi-vendor reliability of arterial spin labeling perfusion MRI using a near-identical sequence: implications for multi-center studies
Neuroimage, 113, 143-52
PubMed 25818685SFX WOS 000354392700014 Cristin 1337435(Details)

15. *Pischke SE, Hyler S, Tronstad C, Bergsland J, Fosse E, Halvorsen PS, Skulstad H, Tønnessen TI.*
Myocardial tissue CO2 tension detects coronary blood flow reduction after coronary artery bypass in real-time. Br J Anaesth. 2015;114(3):414-22. PMID:25392231

16. *Ratti F, Barkhatov LI, Tomassini F, Cipriani F, Kazaryan AM, Edwin B, Abu Hilal M, Troisi RI, Aldrighetti L (2015)*
Learning curve of self-taught laparoscopic liver surgeons in left lateral sectionectomy: results from an international multi-institutional analysis on 245 cases
Surg Endosc (in press)
PubMed 26572765SFX Cristin 1315496(Details)

17. *Sahakyan MA, Kazaryan AM, Rawashdeh M, Fuks D, Shmavonyan M, Haugvik SP, Labori KJ, Buanes T, Røsok BI, Ignjatovic D, Abu Hilal M, Gayet B, Kim SC, Edwin B (2015)*
Laparoscopic distal pancreatectomy for pancreatic ductal adenocarcinoma: results of a multicenter cohort study on 196 patients
Surg Endosc (in press)
PubMed 26514135SFX Cristin 1319963(Details)

18. *Selnes P, Grambaite R, Rincon M, Bjørnerud A, Gjerstad L, Hessen E, Auning E, Johansen K, Almdahl IS, Due-Tønnessen P, Vegge K, Bjelke B, Fladby T (2015)*
Hippocampal complex atrophy in poststroke and mild cognitive impairment
J Cereb Blood Flow Metab, 35 (11), 1729-37
PubMed 26036934SFX WOS 000364259900004 Cristin 1280872(Details)

19. *Skog O, Korsgren S, Wiberg A, Danielsson A, Edwin B, Buanes T, Krogvold L, Korsgren O, Dahl-Jørgensen K (2015)*
Expression of human leukocyte antigen class I in endocrine and exocrine pancreatic tissue at onset of type 1 diabetes
Am J Pathol, 185 (1), 129-38
PubMed 25524212SFX WOS 000346887200012 Cristin 1212767(Details)

20. *Wakabayashi G, Cherqui D, Geller DA, Buell JF, Kaneko H, Han HS, Asbun H, O'Rourke N, Tanabe M, Koffron AJ, Tsung A, Soubrane O, Machado MA, Gayet B, Troisi RI, Pessaux P, Van Dam RM, Scatton O, Abu Hilal M, Belli G, Kwon CH, Edwin B, Choi GH, Aldrighetti LA, Cai X et al. (2015)*
Recommendations for laparoscopic liver resection: a report from the second international consensus conference held in Morioka
Ann Surg, 261 (4), 619-29. PubMed 25742461SFX(Details)

LEVEL 1

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Oslo University Hospital

Oslo University Hospital is Norway's largest hospital, and accounts for a large part of medical research and the education of health personnel in Norway.

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