The Intervention Centre
Annual report 2015

Oslo University Hospital and
Facility of Medicine, University of Oslo
ANNUAL REPORT 2015
The Intervention Centre

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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 society.

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
The Intervention Centre • Annual report 2015

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Main goals and objectives

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.

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
**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.
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 Oslo University Hospital and to the following 15 hospitals and radiological institutes at 38 locations within the South-Eastern health region including:

- Akershus Universitetssykehus HF
- ALERIS
- Diakonhjemmet sikhus
- Feiringklinikkken
- Glittre klinikkken
- Helsehuset Kongsberg
- Lovisenberg Diakonale sykehus
- Martine Hansens hospital
- Sunnåsy 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
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Vibeke Nordheøy, PhD MR physicist
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Caroline Stokke, PhD Medical physicist
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Kristin Jensen, Medical physicist, PhD Student
Bjørn Helge Østerås, Medical physicist, PhD Student
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David Volgyes, PhD Student
Endre Grøvik, MR physicist, PhD Student
Ingrid Digerne, PhD Student
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Svein Are Vatnehol, MSc, PhD Student

PosDoc’s
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Sandra Tcelao, PhD PostDoc
Siri Leknes, PhD Post Doc

Master students
Johan Blakkisrud, Master student
Donates Sederevicius, Master student
**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 tomodraphy 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.
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 has 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 Hospital 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.
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 dysfunction during adjuvant breast cancer therapy (PRADA)
A study addressing 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 times 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.
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 transcatheter aortic valve implantation (TAVI)
7. Establish new prognostic markers for mortality and morbidity after (TAVI)

STAFF
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Helge Skulstad, MD, PhD
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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

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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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 gastrointestinal- 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)
ABOUT
Development and assessment of minimal invasive therapy in all surgical fields.

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

Development of and assessment of implants from Bio-medical materials, (percutaneous 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 Bjarneth, Leader, MD, PhD Bård Råsok, MD, PhD Anne Waage, MD, PhD Olaug Villanger, MD, PhD Knut Jørgen Labori, MD, PhD Dejan Ignjatovic, MD, PhD Airazat Kazaryan, MD, PhD Leonid Barkhatov, MD Karl Øyri, Research fellow Stig Ronny Kristiansen, (IT) Erik Naess-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 Immunosuppression
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 Naessgård  
Musheg Sahakyan  
Gudrun Waaler Bjørnelv  
Vegard Dagenborg  
Rafael Palomar

**Oslo CoMet-study**

- Randomized controlled trial of open vs laparoscopic liver resection for colorectal metastases  
- Planned to include 280 patients  
- 260 patients included since Feb. 2012  
- Primary end point: 30 d morbidity

**Study 1: Immune response**
- A comparison of the inflammatory response in the first 45 patients included in the study (cytokine, chemokine and...

**Study 2: Tumor biology**
- Establishment for a bio bank for molecular analysis of tumour tissue.  
- Linking of genome data to clinical information provides an opportunity for identifying...

**Study 3: Health economy**
- A health economy evaluation of the two procedures  
A. In hospital costs  
B. 1-year cost/quality of life  
C. Lifetime cost (Markov model)

**Study 4: Pain and QoL**
- Pain measurement at 5 postoperative days, 30 days and 120 days.  
- SF 36 at 30 days, 4 months and...

**Study 5: Imaging**
- Liver specific FDG-PET (respiratory gating)  
- CT perfusion of liver

**Study 6: Software development**
- Software for clinical trials  
- Focus on integration of all data, including  
  • Molecular data from tumors  
  • Immunology data

**Study 7: Liver resection map**
- Software for automatic segmentation of liver anatomy and tumors  
- Tracing of laparoscopic instruments in model

**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 Aldighetti Chief of Liver Unit, Department of Surgery, Scientific Institute SanRaffaele, University Vita-Salute San Raffaele, Milan, Italy.

Prof Alessandro Ferrero, Direttore ff. S.C. Chirurgia Generale ed Oncologica Ospedale Mauriziano, Torino, Italy.
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.

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.

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
Trygve Storás, PhD

Affiliated scientific staff
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Eric Dorenb erg, MD, PhD
Torstein Meling, MD, PhD
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Ulrik Malt, Professor, MD, PhD
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Greg Jablonski, MD, PhD

Clinical staff
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Svein Are Vatnehøl, MSc
Hilde Korslund, BSc
Siv-Eli Simonsen

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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.
**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 Matthiassen, 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/OUAS, 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-UlO-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.
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 and image 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

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

Research Council of Norway


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 Omnisense Inc.

WiBEC. EU-project

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Fabio Mesiti (Postdoc)
Miloud Bagaa (Postdoc)
Juan Felipe Miranda Medina (Postdoc)
Kasif Habib Sheik (PhD student)

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E-mail: ilangkob@iet.ntnu.no

Bjørn Rustad (PhD student)
Øyvind Janbu (PhD student)
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
### Budget and finances

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

**IVS – 910 936**

<table>
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<tr>
<th>ALLOCATION FROM OUS</th>
<th>INCOME</th>
<th>EXPENDITURES</th>
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<tbody>
<tr>
<td>Basic funding</td>
<td>29 000 000</td>
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<tr>
<td>Variable income</td>
<td>524 000</td>
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<tr>
<td>Cost of goods</td>
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<td>6 160 000</td>
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<tr>
<td>Salaries and social costs</td>
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<td>24 136 000</td>
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#### Diagnostic Physics administered by the Intervention Centre in 2015 (In NOK)

**IVS - 776 000**

<table>
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<th>ALLOCATION FROM HEALTH SOUTH EAST</th>
<th>INCOME</th>
<th>ACTUAL</th>
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<tr>
<td>Basic funding</td>
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<tr>
<td>Variable income</td>
<td>6 880 000</td>
<td>1 610 000</td>
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<tr>
<td>Cost of goods</td>
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<td>19 315 000</td>
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<td>Salaries and social costs</td>
<td></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>ALLOCATED</th>
<th>INCOME</th>
<th>RESULT</th>
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<tbody>
<tr>
<td>Total</td>
<td>41 391 000</td>
<td>7 404 000</td>
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</table>

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

**IVS – 910 711**

<table>
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<tr>
<th>SOURCE</th>
<th>AWARDED GRANTS</th>
<th>RESEARCH EXPENDITURES</th>
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<tbody>
<tr>
<td>Research Council of Norway NFR</td>
<td>10 859 000</td>
<td>9 339 679</td>
</tr>
<tr>
<td>Regional Health Authority HSØ</td>
<td>12 118 000</td>
<td>11 300 136</td>
</tr>
<tr>
<td>European Commission EU</td>
<td>2 342 215</td>
<td>592 857</td>
</tr>
<tr>
<td>University of Oslo UIO</td>
<td>230 250</td>
<td>230 250</td>
</tr>
<tr>
<td>Norwegian Cancer Society</td>
<td>823 000</td>
<td>754 785</td>
</tr>
<tr>
<td>INVEN2</td>
<td>124 500</td>
<td>0</td>
</tr>
<tr>
<td>Others</td>
<td>20 000</td>
<td>0</td>
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<tr>
<td><strong>Total in NOK</strong></td>
<td><strong>26 516 965</strong></td>
<td><strong>22 217 702</strong></td>
</tr>
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</table>
## 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](http://www.dbh.nsd.uib.no/kanaler)). There are two levels: Ordinary publication channels (level 1) and highly prestigious publication channels (level 2).

### LEVEL 2


5. Banjanović B, Bergsland J, Mujanović e, Kabil e (2015) Importance of Full-Length Scan of Arterial Grafts in Coronary Artery Bypass Grafting Innovations (Phil), 10 (5), 352-3 PubMed 26575382(SFX(Details)


Continuous monitoring of regional function by a miniaturized ultrasound transducer allows early quantification of low-grade myocardial ischemia
Am Soc Echocardiogr, 28 (4), 486-94
PubMed 25636385

Repeatability of Cerebral Perfusion Using Dynamic Susceptibility Contrast MRI in Glioblastoma Patients
Transl Oncol, 8 (3), 137-46
PubMed 26055170

Improved Liver Lesion Conspicuity With Iterative Reconstruction in Computed Tomography Imaging
Curr Probl Diagn Radiol (in press)
PubMed 26790606

Liquid chromatography-mass spectrometry platform for both small neurotransmitters and neuropeptides in blood, with automatic and robust solid phase extraction
Sci Rep, 5, 9308
PubMed 25791195

Impaired Verbal Learning Is Associated with Larger Caudate Volumes in Early Onset Schizophrenia Spectrum Disorders
PLoS One, 10 (7), e0130435
PubMed 26230626

35. **Khaleghi A, Balasingham I (2015)**
Wireless communication link for capsule endoscope at 600 MHz
PubMed 26737191

Effect of Perfusion Fluids on Recovery of Inflammatory Mediators in Microdialysis
Scand J Immunol, 82 (5), 467-75
PubMed 26099791

37. **Khodambashi S, Slaughter L, Nytrø Ø (2015)**
Stud Health Technol Inform, 216, 954
PubMed 26262256

38. **Kjelstrup T, Sauter AR, Hol PK (2015)**
The relationship of the musculocutaneous nerve to the brachial plexus evaluated by MRI
J Clin Monit Comput (in press)
PubMed 26384952

Insulitis and characterisation of infiltrating T cells in surgical pancreatic tail resections from patients at onset of type 1 diabetes
Diabetologia, 59 (3), 492-501
PubMed 26602422

Blood Vessel Segmentation and Centerline Tracking Using Local Structure Analysis
IFMBE PROC, 45, 122-125

Impact of early disease progression and surgical complications on adjuvant chemotherapy completion rates and survival in patients undergoing the surgery first approach for resectable pancreatic ductal adenocarcinoma - A population-based cohort study
Acta Oncol, 55 (3), 265-77
PubMed 26213211

42. **Khalessi, Ali; Balasingham, Ilangko. (2015)**
Astrocyte to Neuron Communication Channels With Applications.
IEEE TRANSACTIONS ON MOLECULAR, BIOLOGICAL, AND MULTI-SCALE COMMUNICATIONS 2015; volum 1.(2) s. 164-175.

43. **Khalessi, Ali; Fabio; Floor, Pål Anders; Balasingham, Ilangko. (2015)**
Astrocyte-neuron communication as cascade of equivalent circuits. Nano Communication Networks.
2015 ;Volum 6.(4) s. 183-197.
Navigating the mesentery: a comparative pre- and per-operative visualization of the vascular anatomy
Colorectal Dis, 17 (9), 810-8
PubMed 25983475SFX WOS 000359351000013 Cristin

54. Ramm-Pettersen J, halvorsen H, evang JA, Rønning P, hol PK
Phase-contrast magnetic resonance imaging reveals net retrograde aqueductal flow in idiopathic normal pressure hydrocephalus
Ringstad G, emblem Ke, eide PK (2015)
PubMed 26612883SFX Cristin

Towards an Integrated Semantic Framework for Neurological Multidimensional Data Analysis
LECT NOTES COMPUT SC, 9107, 175-184
WOS 000363263300018 Cristin

Factors determining the magnitude of the pre-ejection leftward septal motion in left bundle branch block
Expression of Human Leukocyte Antigen Class I in Endocrine and Exocrine Pancreatic Tissue at Onset of Type 1 Diabetes.

Phase-contrast magnetic resonance imaging reveals net retrograde aqueductal flow in idiopathic normal pressure hydrocephalus
J Neurosurg, 1-8 (in press)
PubMed 26636385SFX Cristin

Aqueudal Stroke Volume: Comparisons with Intracranial Pressure Scores in Idiopathic Normal Pressure Hydrocephalus
AJNR Am J Neuroradiol, 36 (9), 1623-30
PubMed 25977480SFX WOS 000361044700001 Cristin

Respiratory gated PET/CT of the liver: A novel method and its impact on the detection of colorectal liver metastases
Eur J Radiol, 84 (8), 1424-31
PubMed 26044293SFX WOS 000357474200002 Cristin

Expression of Human Leukocyte Antigen Class I in Endocrine and Exocrine Pancreatic Tissue at Onset of Type 1 Diabetes.

Voxel-Wise Perfusion Assessment in Cerebral White Matter with PCASL at 3T: Is It Possible and How Long Does It Take?
PloS One, 10 (8), e0135596
PubMed 26267615SFX WOS 000359492300013 Cristin

Experimental investigation into radar-based central blood pressure estimation
WOS 000350210700005 Cristin

Reduced perfusion in white matter lesions in multiple sclerosis
Eur J Radiol, 84 (12), 2605-12
PubMed 26391230SFX WOS 000367357700036 Cristin

Temporal distribution and behaviour of sand flies (Diptera: Psychodidae) in a cutaneous leishmaniasis focus of the Kani Tribe settlements in the Western Ghats, India


Hyperemesis gravidarum and maternal cancer risk, a Scandinavian nested case-control study
Int J Cancer, 137 (5), 1209-16
PubMed 25651635SFX WOS 000356429000021 Cristin

Hyperemesis gravidarum and risk of cancer in offspring, a Scandinavian registry-based nested case-control study
BMC Cancer, 15, 398
PubMed 26279465SFX WOS 000361044700001 Cristin

68. Veletic, Mladen; Meseti, Fabio; Floor, Pål Anders; Balasingham, Ilango.
    Trends in Abdominal Aortic and Iliac Aneurysm Repairs in Norway from 2001 to 2013
    Eur J Vasc Endovasc Surg, 51 (2), 194-201
    PubMed 26482508SFX Cristin 1337466(Details)

    RF and Communication Technologies for Wireless IMPLANTS
    IEEE J Biomed Health Inform, 19 (3), 899-900
    PubMed 26167552SFX WOS 000356511900015(Details)

    Myocardial Function by Two-Dimensional Speckle Tracking Echocardiography and Activin A May Predict Mortality in Patients with Carcinoid Intestinal Disease
    Cardiology, 132 (2), 81-90
    PubMed 26111973SFX WOS 000361683000003 Cristin 1322172(Details)

    Electroencephalogram complexity analysis in children with attention-deficit/hyperactivity disorder during a visual cognitive task
    J Clin Exp Neuropsychol, 38 (3), 361-9
    PubMed 26678277SFX(Details)

73. Veletic, Mladen; Mesiti, Fabio; Floor, Pål Anders; Balasingham, Ilango.

    Laparoscopic resection of recurrent ectopic hepatocellular carcinoma: A case report with review of the literature and guidelines for follow-up
    Int J Surg Case Rep, 17, 92-5
    PubMed 26590353SFX Cristin 1325558(Details)
PhD theses 2015 – 2003

2015
1. Pischke, Søren Erik
   Tissue PCO2 for Real-Time Detection of Internal Organ Ischemia
   The Intervention Centre and Division of Emergencies and Critical Care, Dept. of anaesthesiology,
   Oslo University Hospital HF - Rikshospitalet and Faculty of Medicine,
   Norway (29.04.2015).

2. Neumann, Kirill
   Intervventional Bronchoscopy in Treatment of Lung Cancer
   The Intervention Centre and Department of Respiratory Medicine, Oslo University Hospital HF – Rikshospitalet
   And Faculty of Medicine, Norway (30.04.2015).

3. Øyri, Karl
   Feasibility of short-range wireless monitoring in critical care environments
   The Intervention Centre and Oslo University Hospital HF – Rikshospitalet and Institute of Medicine, Norway
   (16.09.2015).

2014
1. Halvorsen Fredrik Herman.
   Virtual Reality Simulation in Laparoscopic Surgical Education
   Faculty of Medicine, University of Oslo, Norway. 2014.

2. Kumar Rahul Prasanna.
   Fast blood vessel segmentation for surgical and intervention planning and navigation.
   Faculty of Mathematics and Natural Sciences, University of Oslo. 2014.

2013
1. Moussakhani B.

2. Nguyen T.H.

3. Moussavinik H.

4. Kazarany A.M.
   New minimally invasive techniques in the treatment of patients with lesions in the liver: Laparoscopy and extracorporeal high intensity focused ultrasound.
   Medical Faculty, University of Oslo, Norway. 2013.

5. Kazemeyni FS.
   Collaborative wireless sensor networks: Modeling and analysis.
   Faculty of Mathematics and Natural Sciences, University of Oslo, 2013: 168.

6. Espinoza A.
   Monitoring of myocardial function by epicardial ultrasonic transducers.
   Faculty of Medicine. University of Oslo. 2013.

2012
1. Eric Dorenb erg.
   Minimal invasive therapies for the treatment of symptomatic uterine leiomyomas – a multimodal approach.
   Department of Nuclear Medicine and Faculty Division of Clinical Medicine, Faculty of Medicine, University of Oslo.

2. Stig Søra.
   Wireless Sensor Networks for Medical Applications.
   Faculty Division of Clinical Medicine, Faculty of Medicine, University of Oslo. 2012: ISBN: 978-82-8264-280-4.

3. Irina Pavlik Marangos.
   Minimally invasive surgery in abdominal endocrine organs.
   Faculty Division of Clinical Medicine, Faculty of Medicine, University of Oslo. 2012: ISBN: 978-82-8264-460-0.

4. Tangui Morvan.
   Efficient Proximity Queries for Minimally Invasive Surgery.
   Faculty Division of Clinical Medicine, Faculty of Medicine, University of Oslo. 2012. ISBN: 978-82-8264-559-1.

5. Edvard Nærum.
   Faculty Division of Clinical Medicine, Faculty of Medicine, University of Oslo. 2012. ISBN: 978-82-8264-394-8.

2011
1. Jacob Bergslund.
   Safe introduction and quality control of new methods in coronary surgery.
   Oslo University Hospital, Faculty Division of Clinical Medicine, Faculty of Medicine, University of Oslo. 2011.

2. Petter Risholm.
   Intra-operative Non-Rigid Registration of Brain Images.
   Centre of Mathematics for Applications, Department of Informatics, Faculty of Mathematics and Natural Sciences, University of Oslo. ISSN: 1501-7710.

3. Lars Wælgaard.
   Intraorgan monitoring for detection of ischemia and rejection.
   Faculty Division of Clinical Medicine, Faculty of Medicine, University of Oslo. ISBN: 978-8072-503-5.
4. Anne Catrine Trægde Martinsen.
The possibilities of reducing radiation dose and improve image quality in CT-diagnostics using advanced image processing.
The Department of Radiology and Nuclear Medicine, Oslo University Hospital, Faculty Division of Clinical Medicine, Faculty of Medicine, University of Oslo.

2010

1. Per Steinar Halvorsen.
Continuous monitoring of left ventricular function by epicardial 3-axis accelerometers.
The Intervention Centre, Oslo University Hospital, Faculty Division of Clinical Medicine, University of Oslo. 2010. ISBN 978-82-8072-364-2.

2. Lars Mathisen.
Patient-reported outcomes after on-pump and off-pump coronary artery bypass surgery.
The Intervention Centre, Oslo University Hospital, Department of Thoracic and Cardiovascular Surgery, Faculty Division of Clinical Medicine, University of Oslo. ISBN 978-82-8072-352-9.

3. Sergiy Milko.
Fusion of intra-operative ultrasound and diagnostic images during liver-intervention.
Siemens Molecular Imaging Ltd, Kongsberg SIM AS, Institute of Informatics, University of Oslo, The Intervention Centre, Oslo University Hospital, Faculty Division of Clinical Medicine, University of Oslo. ISSN 1501-7710.

4. Trygve Holck Storås.
MRI of the prostate gland.
The Intervention Centre, Oslo University Hospital, Faculty Division of Clinical Medicine, Faculty of Medicine. ISBN 978-82-8072-921-7.

2008

1. Andersen MH.
Patient-reported outcomes following living donor nephrectomy.

2007

1. Hol PK.
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