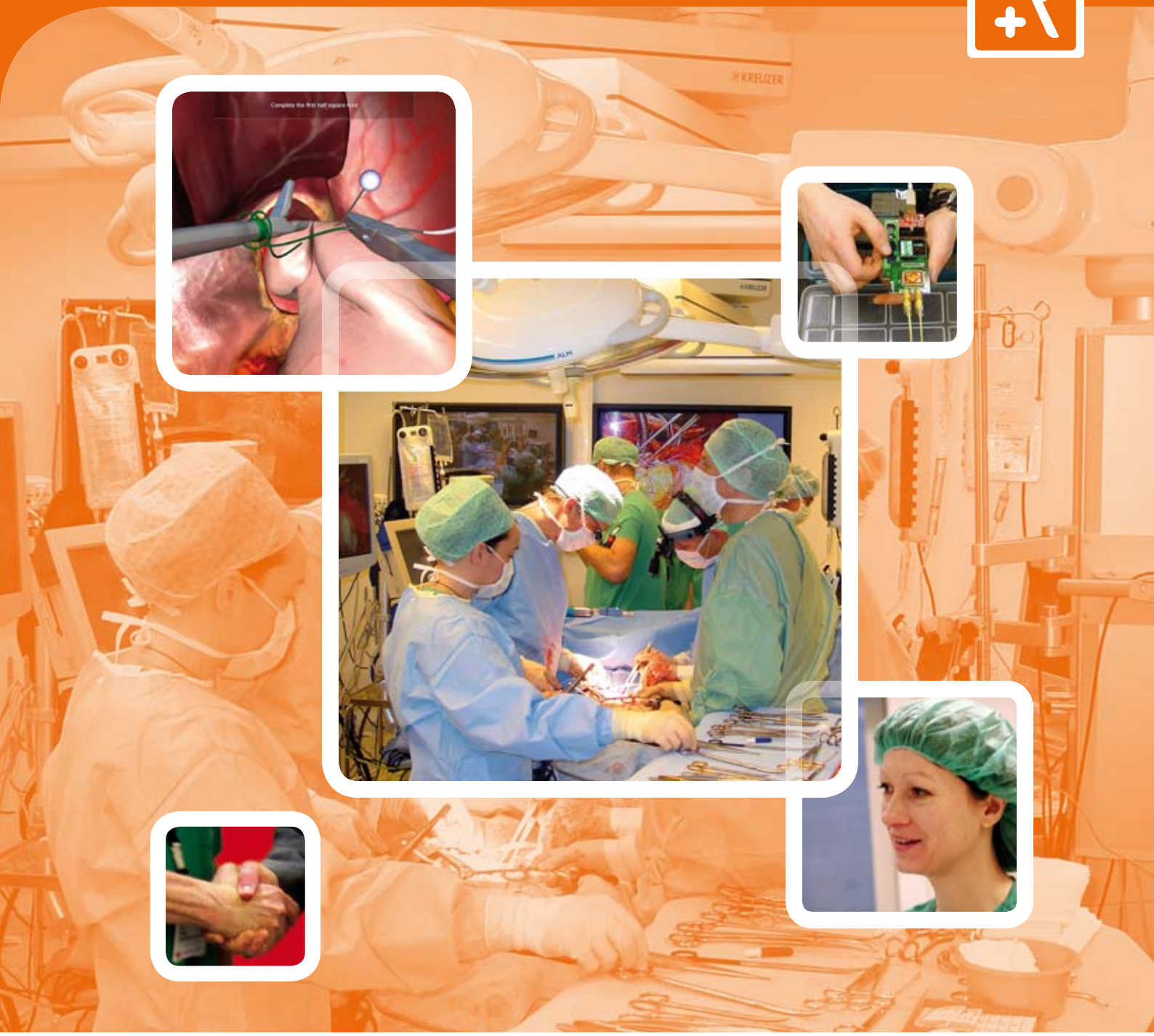

Annual report 2007

The Interventional Centre

Rikshospitalet University Hospital

ANNUAL REPORT 2007

The Interventional Centre

ANNUAL REPORT 2007

More information at the web pages
www.ivs.no

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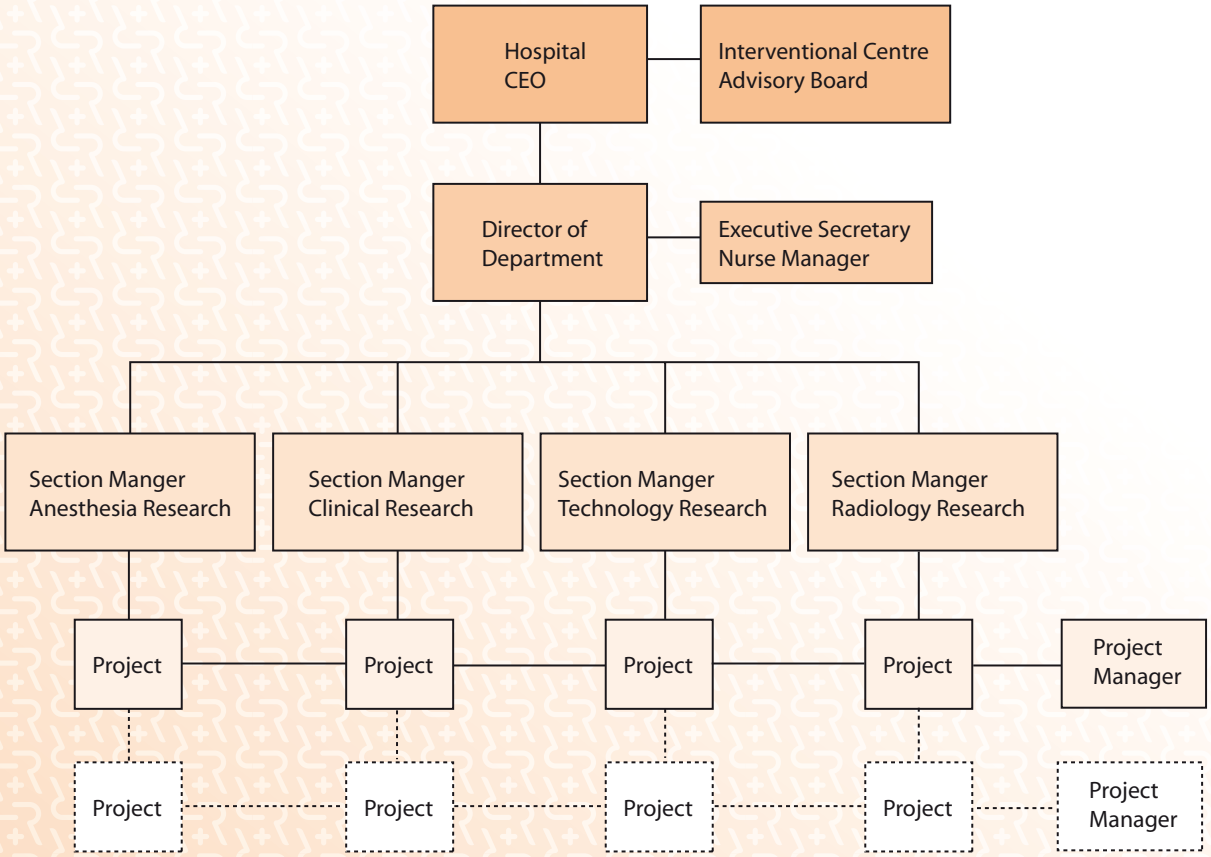
Organisation

THE INTERVENTIONAL CENTRE 2007
RIKSHOSPITALET UNIVERSITY HOSPITAL



The Interventional Centre
– new imaging technologies

Integrating advanced medical technologies in the ORs is challenging. Today imaging technology rapidly gets outdated. MRI goes through technological changes allowing imaging of small details, functional imaging etc. The videoscopic technologies move towards high definition and angiographic systems move towards more advanced 3D imaging and robotic control systems.

Thus, in 2007 it was time to change virtually all imaging systems at the Interventional Centre. In April we could acquire a 3T MRI system for our advanced OR/MRI interventional suite. This was possible due to joint funding from the hospital, the Norwegian research council, the University of Oslo and the Faculty of Social Sciences, Institute for Psychology. The ten year old open Signa SP 0,5 T magnet from GE had proved a significant tool for research, but had limited clinical impact.

During ten years four PhDs and more than 50 scientific papers were based on research in the open MRI system. In April it was hoisted out through the roof of our MRI suite, and replaced by a closed 3T magnet by Phillips. The MRI suite was totally rebuilt with a two suite system with sliding doors in between. In one suite there is a standard OR and in the other the MR scanner. This allows for operating patients with standard equipment and intermittently perform MR scanning. Training of our staff in the new MRI started in December 2007.

In the spring of 2007 the Interventional Centre was invited by Siemens to be a trial centre for the new Zeego angiographical system. The system represents a new concept in angiography in the OR as the C-bow is steered by a robotic arm and there is completely new application software allowing advanced examinations like perfusion imaging etc. During the autumn the old Angiostar system was replaced by the new Zeego and the room was ready for patient treatment by the end of December.

In our third suite, dedicated for endoscopic or laparoscopic procedures all equipment was replaced by Olympus high definition systems. The videoscopic guided intervention reached an all time high.

During 2007 two European research programs were running at the Centre. The Marie Curie project ARIS*ER which is well established developing an augmented reality in surgery proceeded as planned. And CREDO, a biosensor research network also proceeded.

Erik Fosse, Professor
Head of department

The Interventional Centre

MAIN GOALS AND OBJECTIVES

The Interventional Centre is a research and development department for image guided and minimally invasive therapy at Rikshospitalet University Hospital (RH-HF) in Oslo.

The Interventional Centre has the following tasks:

1. Development of new procedures
2. Development of new treatment strategies
3. Compare new and existing strategies
4. Study the social, economic, and organisational consequences of new procedures on health care

STRATEGY

The Interventional Centre shall be a research and development resource for all the clinical and laboratory departments at Rikshospitalet University Hospital.

The Interventional Centre shall actively offer similar services to the healthcare community in Norway outside the hospital.

The Interventional Centre shall work as a link between technology institutions (commercial and academic) and the clinical medical environment in the hospitals.

The Interventional Centre shall promote and work actively to protect new knowledge and facilitate commercial exploitation.

The research is focused in four strategic areas:

1. MR guided intervention and surgery
2. X-ray, CT, ultrasound, video-guided interventions and surgery
3. Robotics and simulators
4. Biosensors, data management and communication

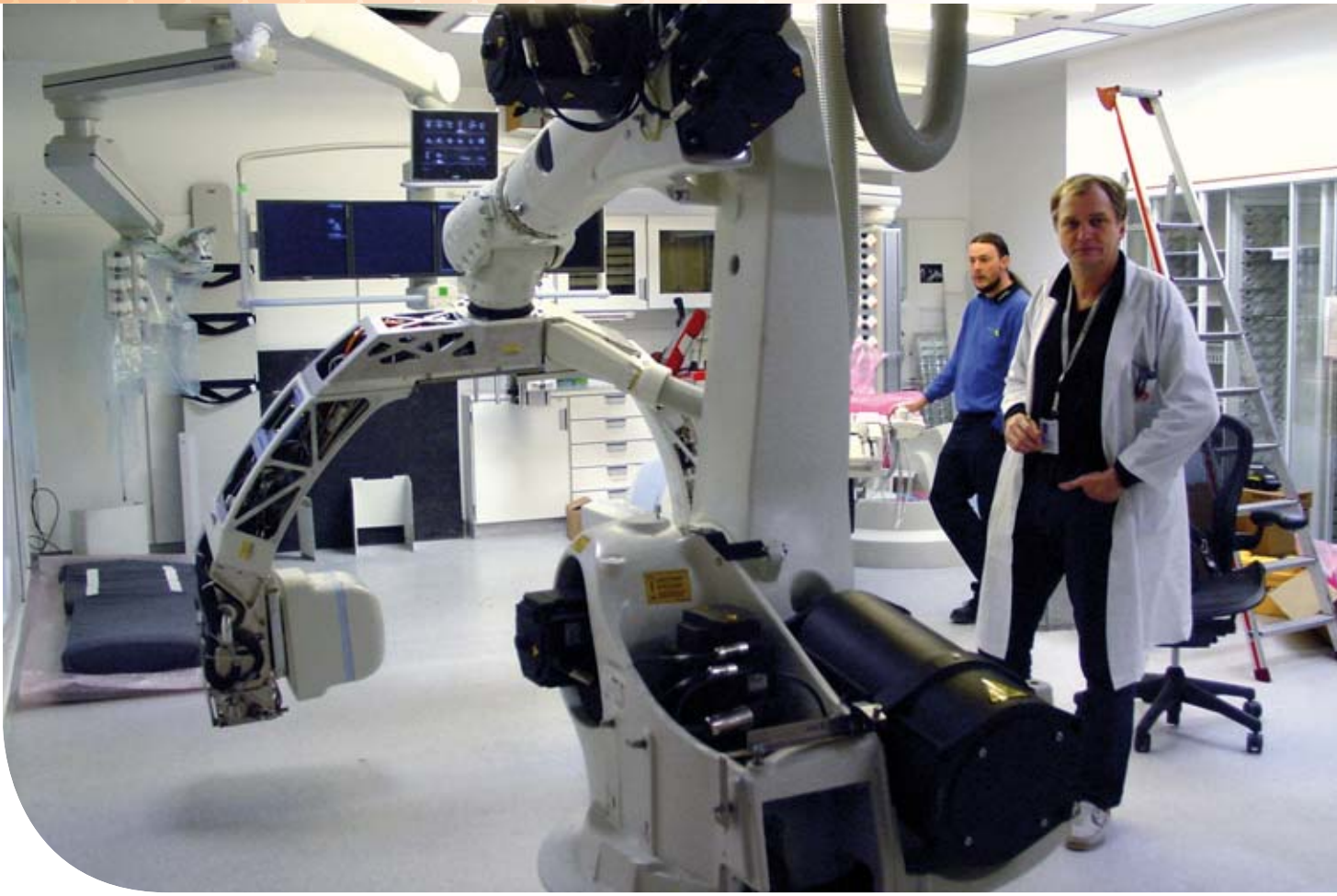
DELIVERIES

The Centre delivers the following:

1. New clinical methods
2. Research
3. Intellectual property/innovation

ORGANISATION

The Interventional Centre is an independent hospital department. The Head of department reports directly to the hospital CEO. A National Advisory board with representatives from all universities and university hospitals in Norway and the main departments at Rikshospitalet monitors and gives advice on research and activity. In 2007 the Interventional Centre had a cross-disciplinary staff of 24 employees. Seven doctors, nurses, radiographers and engineers employed by other departments worked regularly at the Centre while a large number of medical staff from most departments in the hospital worked at a less regular basis at the Centre. There were three university-employed professors (*Erik Fosse, Tor Inge Tønnessen* and *Halfdan Ihlen*) at the Faculty of Medicine, University of Oslo, one professor at the Department of Informatics, University of Oslo (*Eigil Samset*) and one professor from the Department of Electronics and Telecommunication at the Norwegian University of Science and Technology (*NTNU*) in Trondheim (Ilangko Balasingham). Professor Atle Bjørnerud from the Department of Physics, University of Oslo established his research group at the Centre in 2006. In addition 20 scientists were working at the Centre by external funding.



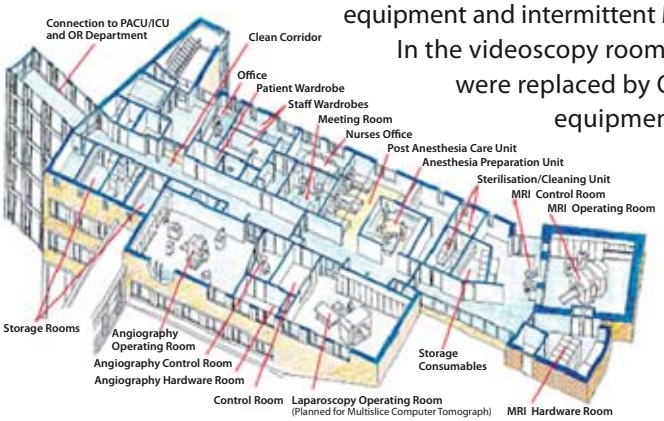
MATRIX ORGANISATION

In order to facilitate effective execution of cross-disciplinary projects, the personnel and equipment at the Centre were allocated to four sections in a matrix organisation *(illustrated in the figure on page 4)*. Each section is headed by a section manager. Each project has a project manager and the project manager reports to the section manager in charge of the project. The head of department and the section managers constitute the management group where new projects are approved. Both the equipment and the staff are available as a common resource for departments and research groups aiming at developing and quality assess new methods. Scientists/clinical departments outside the Centre were responsible for a substantial number of the projects run in 2007. 40% of the staff had a technological, non-medical background.

By the end of 2007 the employees of the Interventional Centre came from 13 different nations all over the world. The Interventional Centre thus represented a unique multinational environment of medical and technological expertise.

FACILITIES

The Centre has a unique architectural structure. In the three suites advanced imaging equipment was integrated in an operation room environment. In 2007 all advanced imaging equipment was renewed. In the combined surgical and radiological suite, the conventional angiographic equipment was substituted by the Siemens Zeego system, based on robotic technology and containing new advances in imaging and functionality. Our MRI suite was completely rebuilt into a dual room suite where a 3T was installed in one room beside a state of the art OR. The two rooms were separated by a sliding door, allowing surgery with standard equipment and intermittent MRI imaging. In the videoscopy room all systems were replaced by Olympus HD equipment.



Research Groups

ADVANCED MR NEURO IMAGING

Professor Atle Bjørnerud, PhD

The main focus of the Advanced MR Neuro Imaging (AMRNI) group is in the development of novel MR-based imaging techniques and software tools for improved diagnosis of brain tumours and neuro-degenerative disease.

In brain tumour diagnosis, the group has initiated the project: Combined structural, microvascular and functional mapping of brain tumours for improved diagnosis and treatment planning. This is a multi-disciplinary project run by the AMRNI group, but involving both physicists, software engineers, neuro-surgeons, neuroradiologists and pathologists.
The project has received research grants from both the Norwegian Research Council and Helse Sør.

The AMRNI group is also heading up the imaging part of a MR/PET project called Go/MCI which is part of the MedCoast program. The main objective of the Go/MCI project is to find new bio/imaging markers for vascular dementia and Alzheimer's disease.
The AMRNI group is further involved in many MR-projects where our main focus is on MR sequence optimization and data handling. The group has also developed a large image processing software system (called *nordicICE*) in collaboration with a Bergen-based company (*NordicImagingLab*). The software system has been fully integrated into the hospital PACS system and has become an important clinical tool for advanced analysis of MR images.

IMAGE GUIDED NEUROSURGERY

Section manager Torstein Meling MD, PhD

For a number of years the Department of Neurosurgery has used the GE open magnet for MR-guided neuro-surgery. There have been substantial developments in technological solutions, and many clinical studies in brain tumour resections, pituitary tumour surgery and brain biopsies have been performed. The open GE-magnet was replaced by a closed bore 3T MR in 2007, and we started to perform transphenoidal pure endoscopic pituitary surgery in this 3T OR room. The activity will be extended to include brain tumour surgery when all the hardware is installed.

In 2006 we started to perform vascular neurosurgical procedures guided by angiography in our combined angiography-operation suite. The angio-suite was refurbished and fitted with state-of-the-art intraoperative angiography equipment from Siemens in 2007, allowing rotational angiography with 3D representation intra-operatively. This will facilitate our work on vascular neurosurgery guided by angiography.

Main projects in cooperation with the advanced imaging group are:

- A study on whether 3T MRI characteristics can predict pituitary tumour consistency and hence suitability for transsphenoidal resection of macroadenomas.
- Establishing intraoperative tractography/DTI in the 3T MR.

IMAGE GUIDED GENERAL SURGERY AND INTERVENTION

Section manager Bjørn Edwin MD, PhD

Several new techniques in laparoscopic surgery have been introduced in Norway through this group. Some of the methods are now routine procedures, like laparoscopic adrenalectomy and laparoscopic prostatectomy. The group validates new procedures and establishes effective training. One multi-centre study on the quality of laparoscopic colonsurgery is ongoing. Education programs in minimal invasive surgery in both gastrointestinal- and urological surgery are organized in collaboration with other hospitals in Norway, Sweden, Russia and Denmark.

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

- Minimal invasive surgery on the liver, pancreas, stomach, esophagus, kidney, adrenal gland and colon/rectum.
- Minimal invasive techniques in children.
- Thermal liver ablation.

Two PhD dissertations have been successfully defended, and in 2007 two were ongoing. In a series of studies the monitoring of thermal ablation and the efficacy of this treatment in liver metastasis has been documented. So far two medical dissertations have been completed and one program was ongoing in 2007.

In all, the group had two PhD programs in 2007:

1. Cand. Polit. Marit Andersen:
   Health related quality of life after kidney graft harvesting.
   Mentors: Erik Fosse, the Interventional Centre, RR-HF, Berit Rokne Hanestad, Inst. Social Sciences, Univ. of Bergen, Astrid Klopstad Wahl, University College of Oslo
2. Ph.D. research fellow: Airazat M. Kazaryan M.D.:
   Extracorporeal high intensity focused ultrasound ablation of liver malignancies.
   Mentors: Bjørn Edwin, M.D., Ph.D., Erik Fosse, M.D., Ph.D. Rikshospitalet, University Oslo

IMAGE GUIDED CARDIAC SURGERY AND INTERVENTION

Section manager Jacob Bergsland, MD

The group conduct numerous projects related to less and minimally invasive cardiac surgery, using alternative imaging as well as thoracoscopy and radiology. An area of priority has been the OPCAB program, which has focused on quality assurance in coronary artery bypass surgery without cardiopulmonary bypass. Although the procedures have been done surgically with direct vision, quality assurance of graft patency has been investigated using flowmetry, ultrasound and angiography. Another new development is the introduction of minimally invasive mitral valve repair, so far using direct vision but with an ultimate plan of introducing a totally thoracoscopic procedure. In adult cardiac intervention a program of ablation therapy in septal hypertrophy is ongoing. A program of interventional repair of the high mortality condition post infarct ventricular septal defect is at the planning stage in co-operation with cardiology and cardiothoracic surgery. A research program for the endovascular repair and replacement of valvular pathology is under preparation. In addition a clinical program of transcatheter implantation of valvular prosthesis in high risk patients with aortic stenosis is under preparation as a cooperative project with Rikshospitalet and Ullevål University Hospital.

One PhD thesis was successfully defended in 2007:

1. Cand. Med. Per Kristian Hol:
   The importance of angiography and doppler flow measurements in coronary surgery.
   Mentors: Erik Fosse, the Interventional Centre, Sigurd Nitter-Hauge, Dept Cardiology, Hans Jørgen Smith Dept Radiology, Rikshospitalet

The group had three ongoing PhD programs in 2007:

1. Cand. Med. Jacob Bergsland:
   Anastomotic devices in coronary surgery.
   Mentor: Erik Fosse, Interventional Centre, Jan Ludvig Svennevig, Dept of Cardiovascular Surg., RR-HF

2. Cand. Med. Per Snorre Lingaas:
   Beating heart coronary surgery-clinical outcomes.
   Mentor: Erik Fosse, the Interventional Centre, Jan Ludvig Svennevig, Dept of Cardiovascular Surg., RR-HF

3. M.Sc. Lars Mathisen:
   Health related quality of life after coronary artery bypass surgery.
   Mentor: Erik Fosse, the Interventional Centre, Berit Rokne Hanestad, Inst. Social Sciences, Univ. of Bergen, Astrid Klopstad Wahl, University College of Oslo

PAEDIATRIC CARDIAC INTERVENTION

Section manager Erik Thaulow, MD, PhD

Rikshospitalet has been a prime mover in the Norwegian initiatives to decrease the invasiveness of repair of cardiac defects in children. It is well known that cardiac surgery in the young can contribute to psychological and developmental difficulties which are of concern for families of such children. The uses of non-operative methods are desirable to replace surgery, especially those procedures that require heart lung machine and circulatory arrest. Using the combined operating suites and the multi-specialty approach of the Interventional Centre, repair of atrial septal defects has now become a non operative procedure for most Norwegian children. Similarly, some patients with VSD can also be treated in a similar fashion. The IVS is now embarking, as one of the first centers in the world on the non operative replacement of the pulmonic valve in a certain group of children. A comprehensive program of evaluation of short and long term outcomes in these patients as well as cost considerations for individuals and society are under planning. One PhD program is focusing on the patient experiences.

CARDIAC IMAGING

Prof. Halfdan Ihlen, MD, PhD
Prof. Thor Edvardsen, MD, PhD

Under the leadership of the ECHO group of the Department of Cardiology numerous important discoveries have been made in this field.

The co-operative work on the OPCAB patients has been particularly successful in imaging during ischemia and the detection of non-functional coronary anastomosis. The work has contributed to numerous PhD degrees and international publications. The project was finished and the last study was published in 2007.

The introduction of 3T MRI at the Interventional Centre has already augmented the research efforts in cardiac imaging of structure and function of the heart. Several PhD students have ongoing projects that include cardiac MR and PET-scanning.

The group had 6 ongoing PhD programs in 2007:

1. Cand. Med. Trond Vartdal:
   Viability in myocardial ischemia.
   Mentors: Thor Edvardsen / Halfdan Ihlen, the Interventional Centre / Dept of Cardiology, RR-HF

2. Cand. Med. Thomas Helle-Valle:
   Viability in myocardial ischemia.
   Mentor: Otto A Smiseth, the Interventional Centre / Dept of Cardiology, RR-HF

3. Cand. Med. Eirik Pettersen:
   Myocardial function studies.
   Mentor: Kai Andersen, the Interventional Centre / Dept of Cardiology, RR-HF

4. Cand med. Andreas Espinoza:
   Miniaturized epicardial ultrasound probes for perioperative myocardial monitoring.
   Mentors: Thor Edvardsen / Halfdan Ihlen, the Interventional Centre / Dept of Cardiology, RR-HF

5. Cand. Med. Marit Kristine Smedsrud:
   Myocardial viability in patients with stable angina pectoris.
   Mentor: Thor Edvardsen, the Interventional Centre / Dept of Cardiology, RR-HF

6. Cand. Med. Ckristian Eek:
   Diagnostic and therapeutic stratification of patients with acute coronary syndrome (Echo-str-acs).

MINIMAL INVASIVE VASCULAR SURGERY

Section manager Kirsten Krohg-Sørensen, MD, PhD

The development of minimally invasive vascular surgery has been executed by a multi-speciality group in the combined angio/surgery suite at the Centre. The program has been focused on endovascular treatment of thoracic and abdominal aneurysms using endovascular stenting. The team led by Kirsten Krohg-Sørensen, has performed repair of thoracic and aortic stent grafts in a highly successful manner. The results have been documented in highly quoted international publications.

One PhD program related to this project is planned. Contacts are being established to expand this program to more complex aortic pathology.

ENDOBRONCHIAL PROCEDURES

Arve Sundset, MD

This program has become a national program for the interventional bronchoscopy and treatment of airway lesions, including patients with lung cancer obstructing large functional areas of the lungs, patients with benign airway stenosis, and patients with airway complications following lung transplantation. The latest addition to this program is the introduction of EBUS (endobronchial ultrasound), a novel method of mediastinal staging in lung cancer, and diagnostic fine needle aspiration of mediastinal disease. A PhD program related to the program is under preparation.

IMAGE PROCESSING, VISUALIZATION AND NAVIGATION

Professor Eigil Samset, PhD

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. 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 image processing, visualization and navigation group develops cutting edge technological solutions which support minimally invasive procedures. As the title of the group indicates, the research focus is divided into three areas. Image processing methods are key elements in any software system which supports minimally invasive procedures. In particular, we are focused on developing real-time image-segmentation and – registration methods where segmentation methods finds important anatomical structures such as 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.

The group had 4 ongoing PhD programs in 2007:

1. Tangui Morvan (ARIS*ER- Early stage researcher): *Development of general purpose algorithms for collision detection using GPU (Graphics Processing Unit).* Mentors: Eigil Samset, the Interventional Centre and Martin Reimers, Department of Informatics, University of Oslo

2. Sergiy Milko (ARIS*ER Early stage researchers): *Automatic registration of Ultrasound and CT/MRI images.* Mentors: Prof. Eigil Samset, the Interventional Centre and Timor Kadir, Siemens Magnet Technologies

3. Petter Risholm (MATMED PhD student): *Intra-operative deformable registration.* Mentor: Prof. Eigil Samset, the Interventional Centre

4. Eivind Lyche Melvær (MATMED PhD student): *Reconstruction of 3D images from free-hand 2D ultrasound.* Mentors: Prof. Knut Mørken, CMA/UiO and Prof. Eigil Samset, the Interventional Centre

5. Egil Bae (MATMED PhD student): *Image Segmentation and Reconstruction using level sets and graph cuts.* Mentors: Prof. XueCheng Tai, CIPR/UiB and Prof. Eigil Samset, the Interventional Centre

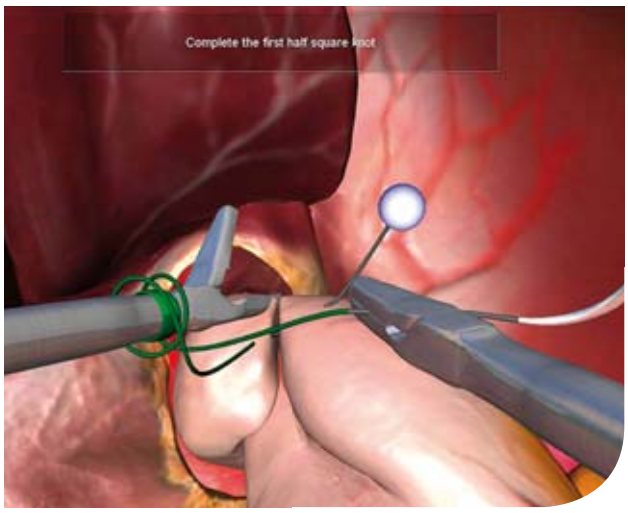
ARIS*ER AUGMENTED REALITY IN SURGERY

Professor Eigil Samset, PhD

ARIS*ER is a Marie Curie Research Training Network funded by the EU and aims at developing an augmented reality system supporting minimally invasive procedures. In 2007 an innovative solution for improved control of aortic clamping during minimally invasive cardiac surgery was developed and demonstrated. Advanced methods for image processing and visualization for improved RF-ablation was also developed and tested during several user studies.

Other important research results which originate from ARIS*ER are

- Methods for fast and reliable image segmentation of liver structures.
- Visualization tools which enables information filtering.
- Novel navigation tools which improve targeting during needle insertion.



- New methods for performing requirements engineering.
- Methods for registration of MR and US.

A demonstrator that incorporates the different general technology features are developed to communicate with the clinicians. The ARIS*ER research group has in total 8 PhD-programs and 5 Post-docs employed by the 8 different European academic and industrial partners.

MATMED

Professor Eigil Samset, PhD

The project "Mathematical and computational methods for co-registering multi-modal medical images" (MATMED) is funded under the eScience program at the Norwegian Research Council for the period 2007-2011. It is a joint project between the Interventional Centre, Centre for Mathematics and Applications (CMA) at UiO and Center for Integrated Petrolium Research at the University of Bergen and funds three PhD positions.

MEDICAL ROBOTICS APPLICATION AND CONTROL

Section manager Ole Jakob Elle, PhD

Surgical robotics has been a research topic of the Interventional Centre since 1998. The Zeus Micro Joint telemanipulator has been used for animal studies performing coronary bypass-surgery and human trials for thoracoscopic IMA-takedown and sympatectomy.

The robotic group has developed a new head tracking control modality for steering the scope with a robotic scope holder using gyroscope sensors to track the head motion. This resulted in a PhD defended in 2004.
In 2005 the research group was strengthened by a PhD fellow, Edvard Nærum, with the research topic of haptic and tactile feedback in remote surgery. This project runs until December 2008.

A post.doc in robotics, Jordi Cornella was employed in June 2006 to develop robotic control strategies with the use of a force sensor. The study is part of the ARIS*ER project and will provide the robotic system with both haptic feedback capabilities and autonomous function by sensing the force between the environment and the robot.

In 2007 a master project on haptic guidance was started. The purpose of the project is to help the surgeon follow an insertion path, e.g. needle insertion, and to provide no-go zones near critical structures based on segmented image data.

Other areas of research are development of collision detection systems and visualisation systems to help and guide the surgeon while doing telemanipulated surgery. The ARIS*ER PhD-student, Tangui Morvan, made a demonstrator of this system in 2006, which was demonstrated at the mid-term review of the ARIS*ER project in December 2006.

In 2006 a cross-disciplinary research collaboration between engineers and surgeons at the Interventional Centre and Department for Neurosurgery at Rikshospitalet University Hospital together with Neurosurgical Department and Department of Neuro Radiology at Ullevål University Hospital and Armstrong Healthcare Ltd., England. The dedicated person at Neurosurgical Department is Jon Ramm- Pettersen, MD *(neuro surgeon),* at the Interventional Centre, Ole Jakob Elle, PhD (*engineer in robotics*) and at Armstrong Healthcare Ltd., Patrick Finlay. Hege Fredø at Ullevål University Hospital is dedicated to the project as a PhD student. The project is aimed at precise positioning of a tool within target points in the brain using image guidance and without the use of a stereotactic frame, by use of the neuro-surgical PathFinder robot.

The Robotic research group had one Post.doc. in 2007:

1. Dr. Jordi Cornella (ARIS*ER – Experienced Researcher):
   Integrating haptics with robotic systems and tele-manipulators.
   Mentor: Ole Jakob Elle and Eigil Samset, the Interventional Centre, Rikshospitalet University Hospital.

The Robotic research group had two PhD projects running in 2007:

1. M.Sc. Edvard Nærum:
   Haptic and tactile feedback in remote surgery.
   Mentors: Ole Jakob Elle and Erik Fosse, the Interventional Centre, Rikshospitalet University Hospital.

2. Cand.Med. Hege Fredø:
   Precise intracranial positioning – Robot controlled tool guidance in Neurosurgery.
   Mentors: Iver A. Langmoen, Department of Neuro Radiology at Ullevål University Hospital and Ole Jakob Elle, the Interventional Centre, Rikshospitalet University Hospital.

The research group had one Master student in 2007:

1. Andreas Nygaard:
   High-level control system for remotely controlled surgical robots – Haptic Guidance in robot assisted surgery.
   Mentors: Øyvind Stavdal, NTNU, Ole Jakob Elle, and Jordi Cornella, the Interventional Centre, Rikshospitalet University Hospital.

+ MULTIPLE PARAMETERS MONITORING OF MUSCLE TISSUE USING NEAR INFRARED SPECTROSCOPY

Peyman Mirtaheri, PhD

Ischemia is still the most prevalent cause of death in the western world. In many cases the ischemia is reversible and an early detection could lead to appropriate treatment to save the patient's life. Thus, there is now increasing effort to bring about methods to detect organs in real time. In a collaboration project started in 2007 between Prof. Babs Soller at University of Massachusetts Medical School and the Interventional Centre, we are making a multiple sensory scheme based on Near Infra red light to monitor patients for ischemia without any invasiveness involved.

Collaborators
Boston, USA: Prof. Babs Soller, Prof. Olusola Soyemi, Dr. Michael A. Shear, Dr. Songbiao Zhang.

BIOSENSORS

Professor Tor Inge Tønnessen, MD, PhD

The Biosensor research group has three main branches of interest, namely the biologic basis for ischemia and the choice of parameters for detection thereof, the second is the development of a specific pCO2 sensor and the third is developing methods for early detection of rejection in transplant patients. The biologic basis has been studied through animal experiments and we have several ongoing clinical studies. Concerning the development of the sensor IscAlert™, we have collaboration with Alertis Medical AS and Memscap AS. The development of the sensor has now come into a clinical phase where we currently have finished the work on the clinical proof of principle of the sensor and have received CE mark and FDA approval. We are now running two clinical studies to test the sensors ability to detect ischemia in patients at risk of compartment s syndrome. Another study where we put microdialysis catheters in 22 patients undergoing liver transplantation, two catheters in the liver and one catheter subcutaneously has been finished. Every hour metabolic parameters of ischemia were measured and every four hours we collected analyses for measuring cytokines and complement factors for detection of rejection.
We found that the method has the ability to detect ischemia caused by thrombosis of the hepatic artery, and that an increase in IL-8, IP-10 and C5a detects a rejection of the liver 2 – 4 days earlier than methods currently used.

1. Cand. Med. Berit Dahl:
   Clinical application of PCO2 measurements for the detection of ischemia.
   Mentor: Tor Inge Tønnessen, the Interventional Centre/Dept of Anaesthesiology, RR-HF.
2. Cand. Med. Lars Wælgaard:
   New clinical methods for detection of ischemia.
   Mentor: Tor Inge Tønnessen, the Interventional Centre/Dept of Anaesthesiology, RR-HF.

MEDICAL SENSORS

Professor Erik Fosse, MD, PhD

The Interventional Centre is co-ordinating a joint project called "Micro-Heart" for detection of motion changes of the heart surface. The goal is to develop a system for early detection of ischemia through continuous per- and post-operative monitoring using a 3-axis accelerometer for patients undergoing coronary revascularization *(Patent number: NO 20016385)*. The "Micro-Heart" project is in close collaboration with Vestfold University College in Tønsberg. The Interventional Centre is responsible for the clinical research activity, and both an animal study and a human study are ongoing to verify the sensitivity and specificity of the detection method. Vestfold University is responsible for miniaturizing a three-axis accelerometer for incorporation into a temporary pacemaker electrode. The project is partly financed by the Research Council of Norway *(NRC)* with 4 PhD scholarships at Vestfold University College.

Together with the Department of Clinical Engineering, professor Sverre Grimnes this group was also involved in the development of a sensor for measuring the sweat production in different parts of the body by a bio-impedance technique.

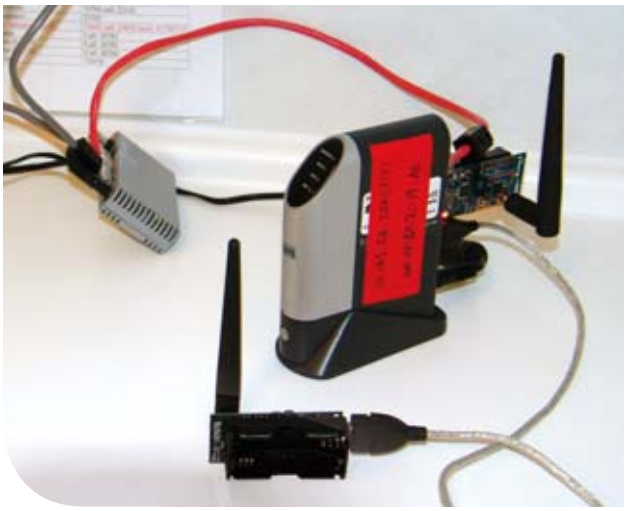
1. Cand. Scient Lars Fleischer:
   Accelerator sensor data for monitoring cardiac ischemia and function.
   Mentors: Erik Fosse, Ole Jakob Elle, the Interventional Centre, RR-HF, Lars Hoff Vestfold University College, Faculty of Science and Engineering, Horten.
2. Cand. Med. Steinar Halvorsen:
   Basic and clinical studies on cardiac ischemia by biosensors.
   Mentors: Erik Fosse and Tor Inge Tønnessen, the Interventional Centre/Dept of Anaesthesiology, RR-HF.
3. Stud med. Gaute Gjein:
   Evaluation of patients with hyperhidrosis.
   Mentor: Erik Fosse, the Interventional Centre, RR-HF.
4. Christian Trondstad.
   Development of a sensor for sweat measurement.
   Mentor: Sverre Grimnes dept of Clinical Egineering.

WIRELESS SENSOR NETWORKS

Professor Ilangko Balasingham, PhD

The sensors, signals, and systems research group aims to facilitate deployment intelligent sensors and systems for different procedures in surgery, minimal invasive therapy and ambient point of care monitoring. The main focus area of research is in efficient design and development of novel sensors, power efficient real time signal processing algorithms, sensor data fusion, and wireless communication solutions for in vivo and ex vivo purposes. Some of our activities are on designing novel optical sensors to measure pH and medical radar based on ultra wide band impulse electromagnetic signals to measure blood pressure, blood flow and tissue /organ motions. Furthermore, novel signal processing algorithms to facilitate power efficient processing of digital data in sensors, which are popularly called as sensor nodes in wireless communications networks. The digital sensor data fusion and multi paramter analysis are also active areas of research. We are working to design reliable, power efficient and robust wireless body area sensor networks for in vivo *(implantable)* and ex vivo use.

We have a close collaboration with the Department of Electronics and Telecommunications at the Norwegian University of Science and Technology *(NTNU)* in Trondheim and several national and international research institutions and companies participate in different projects. Collaboration with the Nordic academic and industry has been through the Nordic project on Biomedical Wireless Sensor Network *(BWSN)*. Furthermore, we have established contacts with Prof. Anders Rydberg at the Uppsala University, Sweden and



Prof. Hannu Kattelus at VTT in Finland. The research group participated in 3 EU FP7 project proposals, where the project ULTRAsponder was selected for funding by the EU. This project is for 3 years and will start from September 2008. Furthermore, the research group has established collaboration with the Norwegian Defence Research Establishment (FFI) and the Nanoelectrnonics group at the Department of Informatics, University of Oslo. This consortium submitted a STORIKT-project proposal on Medical Sensing, Localization, and Communication using Ultra Wideband Technology *(MELODY)* to the VERDIKT program at the Research Council of Norway. The project has been selected for funding for 7 years and will start from September 2008. The project will have 7 PhD and 3 Postdoc fellows, where 3 PhD fellows will be located at NTNU in Trondheim while the rest will be in Oslo.

There is also an effort to establish a testbed for designing, developing and testing new technologies in sensors and wireless systems at the Interventional Centre in collaboration with SINTEF and industry. A pilot study on establishing a testbed is underway.

A resource network group on Wireless Healthcare *(Trådløs pasient)* has been established funded, in part, by the VERDIKT program at the Research Council of Norway, Oslo Bio and MedCoast Scandinavia. The aim of the group is to define roadmap and R&D strategy to facilitate use of wireless and sensor technologies to provide personalized health and care in a ubiquitous manner. It also aims to bring together academia and industry, and also inform different ministries about similar initiatives in the Nordic and European arenas.

The research group, which is split between Oslo and Trondheim, has presently six PhD fellows, two Post doctoral fellows, and one Research Engineer (Lars Erik Solberg) employed through the projects. Vegard Nossum has joined the group as a Programmer and works part time. Dr. Sang-Seon Byun joined as a Postdoc fellow for one year and is located at NTNU in Trondheim. His project on Cognitive systems is funded by the ERCIM program within the EU. PhD student David Turgis is visiting for one year from Katholieke Universiteit Leuven in Belgium and will be located at NTNU in Trondheim. Six MSc students completed with their theses and graduated from NTNU. Two researchers from SINTEF in Trondheim and Norwegian Computing Centre in Oslo are working, in part, in the SAMPOS and WISENET projects.

In 2007 this group had 6 PhD programs:

1. MSc. Xuedong Liang:
   Modelling tools for cross layer optimization in sensor networks.
   Mentor: Ilangko Balasingham, the Interventional Centre, RHF, Olaf Owe & Einar Broch Johansen, University of Oslo.
2. MSc. Stig Støa:
   Ultra wide band impulse radio.
   Mentor: Ilangko Balasingham, the Interventional Centre, RHF.
3. MSc Hessam Moussavinik:
   Super robust short range wireless sensor network.
   Mentor: Ilangko Balasingham, the Interventional Centre, RHF, Geir Øien & Tor Ramstad. Norwegian University of Science & Technology, and Niels Aakvaag, Multihop Com AS.
4. MSc Pham Minh Long:
   Distributed signal processing for power efficiency.
   Mentor: Tor Ramstad, Norwegian University of Science & Technology and Ilangko Balasingham, the Interventional Centre, RHF.
5. MSc. Mariam Kaynia:
   Adaptive spectrum allocation in wireless sensor network.
   Mentor: Geir Øien & Tor Ramstad. Norwegian University of Science & Technology and Ilangko Balasingham, the Interventional Centre, RHF.
6. MSc Arash Jalali-Ghombavani:
   Modelling tools and optimization of wireless sensor network.
   Mentor: Ilangko Balasingham, the Interventional Centre, RHF, Olaf Owe & Einar Broch Johansen, University of Oslo.

In 2007 the group had two Post-docs:

1. Dr. Peyman Mirtaheri:
   Development of Multi-sensor probe.
   Mentor: Ilangko Balasingham, Ole Jakob Elle, Tor Inge Tønnessen, the Interventional Centre, RHF, Jaan Roots, Department of Chemistry, University of Oslo.
2. Dr. Sang-Seon Byun:
   Development of Cognitive wireless sensor networks.
   Mentor: Ilangko Balasingham, the Interventional Centre, RHF and Norwegian University of Science & Technology.

PATIENT COMMUNICATION

Professor Erik Fosse, MD, PhD

As part of a program to make the journal available to the patients, a program for automatic translation of medical terms into common Norwegian is being developed. One master thesis has so far been completed in this project.

ORGANISATION

Professor Erik Fosse, MD, PhD

The Interventional Centre co-operated with the Institute for Informatics and The Institute for Health Management and Health Economics at the University of Oslo, as well with the Norwegian School of Management *(BI)* in a research project focusing on the relationship between innovation, learning, technology and organizational change processes.

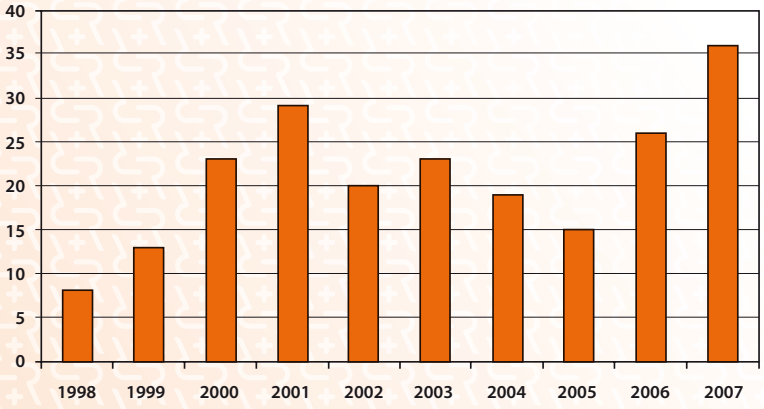
One PhD project was running as part of this program in 2007.

1. Cand. Polit. Bjørn Erik Mørk:
   Organising for learning and innovation in Norwegian hospitals – How new technologies challenge existing organizational structures and cultures.
   Mentors: Erik Fosse, the Interventional Centre, RR-HF, Johan Olaisen, Norwegian School of Management Oslo, Terje Hagen, Institute for Health Management and Health Economy, University of Oslo.

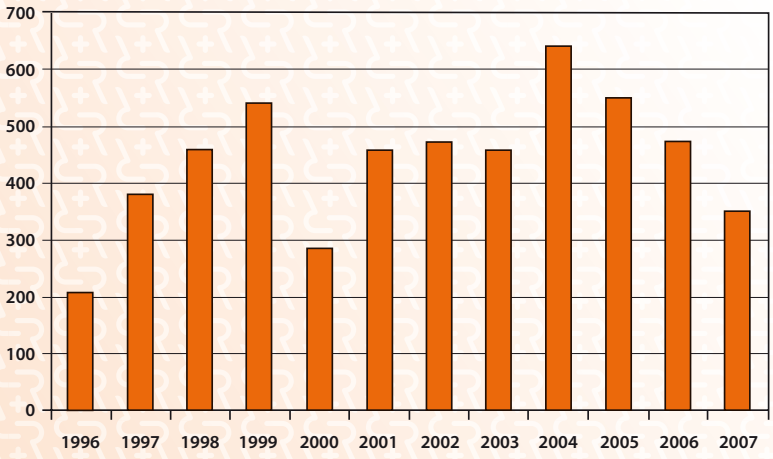
Scientific Statistics

THE INTERVENTIONAL CENTRE 2007

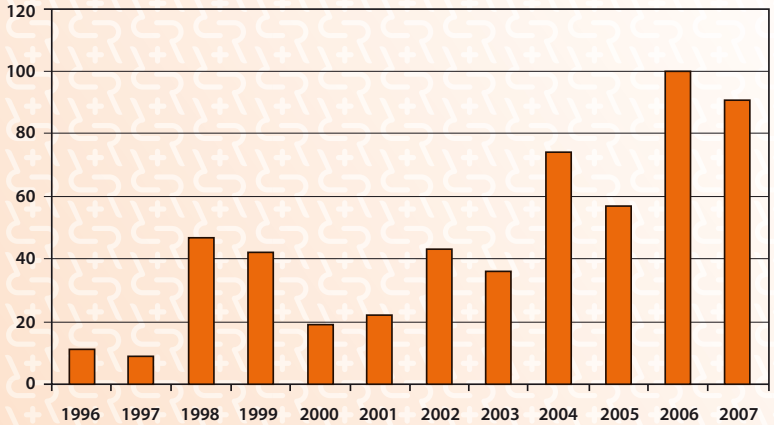
PEER REVIEWED PAPERS



HUMAN PROCEDURES



TEST ANIMALS



Budget and Expenditures

THE INTERVENTIONAL CENTRE 2007

INTERNAL HOSPITAL FUNDS ADMINISTERED BY THE INTERVENTIONAL CENTRE 2007

	BUDGET	EXPENDITURE
Payroll expences	12.393.000	11.567.000
Other operating expences	6.321.000	7.219.000
Sum internal finance	**18.714.000**	**18.786.000**

EXTERNAL FUNDS ADMINISTERED BY THE INTERVENTIONAL CENTRE 2007

SOURCE	INCOME	EXPENDITURE
EU – European Commission	2.306.472	
Research Council of Norway	6.709.500	
Regional Health Authority	530.000	
University of Oslo	112.000	
Industry/Medinnova	900.000	
Health and Rehabilitation	1.010.000	
Academic partners	1.038.000	
Innovation Norway	432.000	
Postgraduate, PhD and postdoc students	0	10.181.400
Research expenditures	0	1.267.000
Pending expenditures	0	1.530 000
Total expenditures		**12.978.400**
Transferred 2008		**1.325.600**
Balance	**14.304.000**	**14.304.000**

EXTERNAL FUNDS ADMINISTERED BY COLLABORATING PARTNERS, SPENT AT THE INTERVENTIONAL CENTRE

PARTNER	INCOME	EXPENDITURE
Vestfold University College	900.000	
NTNU	2.388.000	
Centre for Medical Studies, Russia	440.000	
University of Oslo	1.229.000	
Balance	**4.957.000**	

DRG-POINTS GENERATED AT THE INTERVENTIONAL CENTRE

	2004	2005	2006	2007
DRG	731,7	885,5	837,1	791,6
NOK	19 979	20 378	21 168	20 265

DRG INCOME BY THE CLINICS IN 2007

CLINIC	DRG POINTS	VALUE NOK
Heart and Lung Clinic	448	11 477 312
Surgical Clinic	328	8 403 032
ENT, Plastic, Orthopedics	5	128 095
Gynechology	1	25 619
Pediatric	2	51 238
Neuro	0	
Medical Clinic	8	204 952
Total	**791,6**	**20 290 248**

Patent Applications

THE INTERVENTIONAL CENTRE 1998 – 2007

ACTIVE PATENTS (GRANTED)

PATENT NR.	TITLE	INVENTORS
EP 1063923	Method and device for suturless anastomosis	Sumit Roy Erik Fosse
WO 0169130	Light system for use especially by operating theatre	Erik Fosse Frode Lærum Ole Jakob Elle
WO 0004386	Device for PCO2 detection	Tor Inge Tønnessen Peyman Mirtaheri
WO 9211823	Filtering device for preventing embolism and/or distension of blood vessel walls	Frode Lærum
NO 20016385	System for monitoring changes in movements of an organ, preferably a heart muscle	Erik Fosse Martin Gulbrandsen Ole Jakob Elle
NO 20023605	Method and device for connecting two tubular organs	Erik Fosse Ole Jakob Elle Sumit Roy
Filed by OstomyCure 2005	Device for medical implant	Erik Fosse Bjørn Edwin
Filed by OstomyCure 2006	Device for medical implant	Erik Fosse Bjørn Edwin

PENDING PATENTS

PATENT	TITLE
US PCT patent application: 2007	Method and Apparatus for visualization of a flexible body
Norwegian patent: 313573 20000067 A 61 B 019/00	Tool for neurosurgical interventions
Norwegian patent application: 2002 4630	System for image-guided interventions
US Patent: 20030114876	Device for use by brain operations
US provisional patent application: 2006	Method And Apparatus For Time-Synchronized And Real-Time Display Of Images Of Bodies

Research Partners 2007

NATIONAL ACADEMIC PARTNERS

CANCER CURE AS
Gunnar Myhr CEO
Collaboration for development of a system for targeted drug delivery under MR guidance.
Other partners: Institute for Cancer research.

CENTRE FOR MICRO TECHNOLOGY VESTFOLD UNIVERSITY COLLEGE
Assoc. Prof. Hans Jørgen Alker
Cooperation on the project "Micro-heart". Based on a patent idea by the Interventional Centre an implantable micro sensor is being developed. The sensor will monitor changes in heart movement caused by ischemia. The project is financed by the Norwegian Research Council and includes several research fellows at the University College of Vestfold.

CENTRE OF MATHEMATICS FOR APPLICATIONS UNIVERSITY OF OSLO
Prof. Knut Mørken
The Interventional Centre and the Centre of Mathematics for Applications in cooperation tutored a PhD degree which was defended by Martin Reymers. The PhD was part of research cooperation about fundamental mathematical methods for use in image-guided treatment. Together with the Simula Centre, the Interventional Centre and CMA are applying for the STORFORSK project "Mathematical methods supporting minimally invasive therapy in medicine".

DEPARTMENT OF COMPUTER AND INFORMATION SCIENCE, NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY (NTNU), TRONDHEIM
Bård Kjos, Prof. Richard Blake, Prof. Hery Ramampiaro
Image processing, data graphics, medical journal indexing and search engines. MSc student supervision.

DEPARTMENT OF ELECTRONICS AND TELE-COMMUNICATIONS, NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY (NTNU), TRONDHEIM
Prof. Ilangko Balasingham, Prof. Tor Ramstad, Prof. Andrew Perkis, Prof. Geir Øien
Signal processing algorithms, wireless sensor network, multimedia patient record systems. Supervision of several MSc and PhD students.

DEPARTMENT OF ENERGY- AND PROCESSING TECHNIQUE, NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY (NTNU), TRONDHEIM
Prof. em. Magne Lamvik
Thermodynamics, cryo ablation of the liver.

DEPARTMENT OF ENGINEERING CYBERNETICS, NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY (NTNU), TRONDHEIM
Prof. Olav Egeland and Prof. Bjørn Angelsen
Robotic technique and ultrasound.

DEPARTMENT OF INFORMATICS (IFI), FACULTY OF MATHEMATICS AND NATIONAL SCIENCES, UNIVERSITY OF OSLO
Prof. Knut Mørken, Prof. Olaf Owe
The Interventional Centre cooperated closely with IFI. The project consists mainly of supervision of master degree students *(in 2006: 1 student)*. The head of the technology section at the Interventional Centre is employed as assistant professor at IFI.

Group for Precise modelling and Analysis
The collaboration between the Precise Modelling and Analysis group and the Interventional Centre has resulted in an EU FP6 IST project and a project funded by the Norwegian Research Council on modelling tools for wireless biomedical sensor networks. Xuedong Liang was hired as a PhD fellow in the EU project for three years whereas another PhD fellow will be hired soon in the CONNECT project, which is funded by the Norwegian Research Council.

DEPARTMENT OF NEURO RADIOLOGY
ULLEVÅL UNIVERSITY HOSPITAL
Per Nakstad MD
Development of methods for precise intracranial positioning using Robot controlled tool guidance in Neurosurgery.

DEPARTMENT OF NEUROSURGERY
ULLEVÅL UNIVERSITY HOSPITAL
Prof. Iver Langmoen
Development of methods for precise intracranial positioning using Robot controlled tool guidance in Neurosurgery.

INSTITUTE OF PHYSICS, FACULTY OF MATHEMATICS AND NATURAL SCIENCES, UNIVERSITY OF OSLO
Prof. Sverre Grimnes
Development of a skin moisture sensor.
Two PhD programs.

DEPT OF RADIOLOGY
THE NORWEGIAN CANCER HOSPITAL
Prof. Arne Skretting
Development of a radioactive gel for treatment of bowel tumours.

THE SCHOOL OF PHARMACY, FACULTY OF MATHEMATICS AND NATURAL SCIENCES
UNIVERSITY OF OSLO
Prof. Jan Karlsen
Development of a radioactive gel for treatment of bowel tumours.

INTERNATIONAL ACADEMIC PARTNERS

COLLABORATION WITH SETCHENOV MOSCOW MEDICAL ACADEMY, MOSCOW, RUSSIA
The co-operation involved exchange of medical students in addition to an extensive collaboration in the development of laparoscopic surgery with guest instructors from Norway and several seminars in Moscow.

DEPARTMENT OF ANAESTHESIOLOGY
MASSACHUSETTS MEDICAL CENTER, BOSTON, USA
Contact person: Prof. Babs Soller
Collaboration in the SAMPOS project on optical pH-sensor.

DEPARTMENT OF CARDIOVASCULAR SURGERY
UNIVERSITY MEDICAL CENTER LJUBLJANA
SLOVENIA *(Academic partner – ARIS*ER)*
Contact person: Borut Gersak
They are a clinical academic partner in the ARIS*ER project and responsible for the development of new methods in minimally invasive Mitral Valve Repair and Replacement.

DEPARTMENT OF RADIOLOGY
BRIGHAM AND WOMEN'S HOSPITAL
HARWARD UNIVERSITY, BOSTON
Contact person: Prof. Ferenc Jolesz
BWH has been a leading hospital in introducing MR guided treatment as a research field and has made new methods for treatment of patients. The cooperation consists of exchange of research personnel. An application named "Development of novel applications for high-field MRI-guided therapies" was granted by the Norwegian research council (NRC) in 2004 for three years financing of the project.

GRAZ UNIVERSITY OF TECHNOLOGY
AUSTRIA *(Academic partner – ARIS*ER)*
Contact person: Dieter Schmalstieg
Their responsibility within the project is new methods for Augmented Reality Visualization.

IFC-CNR, INSTITUTE OF CLINICAL PHYSIOLOGY, BIOMEDICAL ENGINEERING SCIENCE AND TECHNOLOGY DIVISION, LECCE, ITALY
(Academic partner – ARIS*ER)
Contact person: Sergio Casciaro
Their responsibility is new methods for medical image segmentation.

SCHOOL OF COMPUTER AND COMMUNICATION SCIENCES, ECOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE (EPFL), SWITZERLAND & DEPARTMENT OF ELECTRICAL ENGINEERING, UNIVERSITY OF CALIFORNIA, BERKELEY, USA
Contact person: Prof. Martin Vetterli
Collaboration in the SAMPOS and WISENET projects on signal processing in sensor nodes.

SCHOOL OF ELECTRICAL ENGINEERING ROYAL INSTITUTE OF TECHNOLOGY (KTH) STOCKHOLM, SWEDEN
Contact person: Prof. Erik Larsson
Collaboration in the SAMPOS project on wireless sensor networks.

TECHNICAL UNIVERSITY OF DELFT THE NETHERLANDS *(Academic partner – ARIS*ER)*
Contact person: Adinda Freudenthal
Their responsibility is to link clinical needs into useful system features by using user-centred design methods.

THE KATHOLIEKE UNIVERSITEIT LEUVEN BELGIUM *(Academic partner – ARIS*ER)*
Contact person: Jos Vander Sloten
Their responsibility is haptic/tactile feedback related to telemanipulators and robotics to crosslink image information with robotic control.

UNIVERSITY HOSPITAL OF TUZLA DEPT. CARDIAC SURGERY, BOSNIA
Contact persons: Prof. Emir Kabil, Dr. Jacob Bergsland
Since 1998 the Interventional Centre (IVS) has been active in building medical expertise in Bosnia.
The Cardiovascular Clinic in Tuzla which was started with assistance from USA, soon developed a close relationship with the Centre and Department of Thoracic Surgery at Rikshospitalet. The cooperative program has continued in 2006. The program has supported by grants from the Royal Norwegian Foreign Department. In 2006 the activity focused on further education of medical personnel and the development of academic expertise.
A simulator training program was initiated in cooperation with Sim Surgery a Interventional Center spin-off.
Research initiatives have included preparation for two important research projects to be conducted as collaborative programs between Rikshospitalet and Tuzla: A) A cross-sectional study to look at the incidence of cardiovascular risk factors in a rural and urban population in Bosnia, and a randomized study evaluating the effect of platelet active drugs in coronary artery bypass patients.
ICT initiatives have been continued to improve the access to clinical and research data for the hospitals in Bosnia.
A new application for funds to improve neurosurgery, radiology and the treatment of acute myocardial infarction will be focused together with e-health and reform.

Industrial Partners

ABB CORPORATE RESEARCH, OSLO
Contact person: Dagfin Brodtkorb
Collaboration in the SAMPOS and WISENET projects on robust wireless communications.

ACREO AB, GÖTEBORG, SWEDEN
Contact person: Dr. Michael Salter
Collaboration in the BWSN project.

ADIGO, OPPEGÅRD
Contact person: Øyvind Overskeid
Collaboration on devices for laparoscopic surgery.

ALERTIS MEDICAL AS
Contact person: CEO Stein Lorentzen Lund
Development of a pCO2 sensor.
Five PhD programs.

ERICSSON AB, GÖTEBORG, SWEDEN
Contact person: Dr. Arne Alping & Dr. Thomas Lewin
Collaboration in the BWSN project.

GE HEALTHCARE
Contact person: Audun Thornes
Development of MR contrast media.
The project involves the Clinic for intervention and imaging, the Institute for cancer research, The department for comparative medicine and the Interventional Centre.

GE VINGMED-SOUND
Contact person: Gunnar Hansen
Development of ultra sound equipment for cardiology.

HEALTHY POINTERS
Contact person: Stian Aldrin
Pointing device for laparoscopic surgery.

IMEGO AB, GÖTEBORG, SWEDEN
Contact person: Dr. Peter Bjökholm
Collaboration in the BWSN project.

KONGSBERG SIM *(Industrial partner – ARIS*ER)*
Contact person: Øyvind Rideng
Systems in Motion provides the project with a 3Dgraphics library. Their responsibility in the project is parallelized 3D rendering.

MEMSCAP AS, HORTEN
Contact person: Andre Larsen
Collaboration in the BWSN and WIREMED projects on MEMS based pressure sensors.

MILLICORE AB, NORRKÖPING, SWEDEN
Contact person: Mikael Löfgren
Collaboration in the BWSN project.

MULTIHOPP COMMUNICATIONS, OSLO
Contact person: Niels Aakvaag
Collaboration in the WISENET project on robust wireless communications.

NORWEGIAN COMPUTING CENTER, OSLO
Contact person: Dr. Wolfgang Leister
Collaboration in the SAMPOS project on security and authentication platform in wireless sensor systems.

NOVELDA AS, OSLO
Contact person: Eirik Næss-Ulseth
Collaboration in the BWSN, WIREMED, and Medical Radar projects on ultra wide band impulse radio platform for medical communications and remote sensor.

NOVOSENSE AB, LUND, SWEDEN
Contact person: Karl-Johan Ohman
Collaboration in the BWSN project.

OSTOMYCURE
Contact person: Martin Johansson
Development of medical implants.

PHILLIPS MEDICAL SYSTEMS
Contact person: Jørn Kværnes
Development of systems for MR-guided interventions and surgery.

PROSURGICS LTD
HIGH WYCOMBE, UNITED KINGDOM
Contact person: Patrick Finley
The collaboration is concentrated around the neuro-surgical robot PathFinder from Prosurgics Ltd.
The aim is to precisely position a tool within target points in the brain using image guidance and without the use of a stereotactic frame.

SIEMENS MEDICAL IMAGING,
ERLANGEN, GERMANY
Lutz Bluhm
Integration of the Zeego angiographic system in the OR.

SIEMENS MAGNET TECHNOLOGIES
(Industrial partner – ARIS*ER)
Contact person: Robert McLaughlin
They are responsible for image registration to ensure optimal correlation between the different medical image modalities like CT, MR and ultrasound.

SIMSURGERY AS
Contact person: M.D. Vidar Sørhus
SimSurgery AS is pioneering the development of advanced real-time 3D simulations for surgical procedures. SimSurgery AS started due to clinical needs specified by the Interventional Centre. After a feasibility study SimSurgery was established (Sept. 1999) with researchers from the Interventional Centre and SINTEF. There is an ongoing collaboration in development and quality assessment of the simulators.

SINTEF ICT, OSLO
Contact person: Dag Ausen
Collaboration in the WIREMED project on MEMS technology for implantable pressure sensors.

SINTEF ICT, TRONDHEIM
Contact person: Knut Grythe
Collaboration in the SAMPOS project on QoS metric in wireless sensor network.

VTT INFORMATION TECHNOLOGY
HELSINKI, FINLAND
Contact person: Marku Jennu
Collaboration in the BWSN project.

Publications

PEER REVIEWED PUBLICATIONS IN INTERNATIONAL JOURNALS

1997

1. Reiertsen O, Larsen S, Trondsen E, Edwin B, Faerden AE, Rosseland A.
Randomized controlled trial with sequential design of laparoscopic versus conventional appendectomy.
British Journal of Surgery. 1997; 84: 842-7.

2. Johansson B, Hallerback B, Stubberud A, Janbu T, Edwin B, Glise H, Solhaug J.
Preoperative local infiltration with ropivacaine for postoperative pain relief after inguinal hernia repair.
European Journal of surgery. 1997; 163: 371-8.

1998

3. Barstad RM, Fosse E, Geiran OR, Simonsen S, Vatne K, Andersen K, Tønnessen TI.
Minimally invasive direct coronary artery bypass grafting without cardiopulmonary bypass in combination with intraoperative percutaneous transluminal coronary angioplasty for palliative coronary revascularization in a heart-transplant recipient.
Journal of Heart Lung Transplantation. 1998; 17: 629-34.

4. Arafa OE, Pedersen TH, Svennevig JL, Fosse E, Geiran OR.
Intraaortic balloon pump in open heart operations: 10-year follow-up with risk analysis.
Annals of Thoracic Surgery. 1998; 65: 741-7.

5. Lærum F, Borchgrevink HM, Fosse E, Faye-Lund P.
The new Interventional Centre – a multidisciplinary R&D clinic for interventional radiology and minimal access surgery.
Computer methods and programs in biomedicine 1998; 57: 29-34.

6. Lærum F, Fosse E, Borchgrevink HM, Lilleås F.
The new Interventional Centre. Experiences after 12 months of operation.
Acad Radiol 1998; 5: 446-9.

7. Trondsen E, Edwin B, Reiertsen O, Faerden AE, Fagertun H, Rosseland A.
Prediction of common bile duct stones prior to cholecystectomy: a prospective validation of a discriminant analysis function.
Archives of Surgery 1998; 133: 162-6.

1999

8. Fosse E, Lærum F, Røtnes JS.
The Interventional Centre-31 months experience with a department merging surgical and imageguided intervention.
Minimally Invasive Therapy and Allied Technologies 1999; 8: 361-9.

9. Naesgaard JM, Edwin B, Reiertsen O, Trondsen E, Faerden AE, Rosseland A.
Laparoscopic and open operations in patients with perforated peptic ulcer.
European Journal of Surgery 1999; 165: 209-14.

10. Samset E, Hirschberg H.
Neuronavigation in intra-operative MRI.
Journal of Computer Aided Surgery 1999; 4: 200-7.

11. Lundbom J, Hatlinghus S, Wirsching J, Amundsen S, Staxrud LE, Gjølberg T, Hafsahl G, Oskarsson W, Krohg-Sørensen K, Brekke M, Myhre HO.
Endovascular treatment of abdominal aortic aneurysms in Norway. The first 100 patients.
Eur J Vasc Endovasc Surg 1999; 18: 506-9.

12. Klaastad Ø, Lilleås FG, Røtnes JS, Breivik H, Fosse E.
Magnetic resonance imaging demonstrates lack of precision in needle placement by the infraclavicular brachial plexus block described by Raj et al.
Anaesthesia and analgesia 1999; 88 : 593-8.

13. Hirschberg H, Samset E.
Intraoperative image directed dye marking of tumour margins.
Minimally Invasive Neurosurgery 1999-09; 42: 123-7.

14. Djupesland PG, Qian W, Furlott H, Røtnes JS, Cole P, Zamel N.
Acoustic rhinometry: a study of transient and continuous noise techniques with nasal models.
The American Journal of Rhinology 1999; 13: 323-9.

15. Arafa OE, Pedersen TH, Fosse E, Svennevig JL, Geiran OR.
Vascular complications of the intraaortic balloon pump in patients undergoing open heart operations: 15 year experience.
Annals of Thoracic Surgery 1999; 67: 645-51.

16. Baksaas ST, Videm V, Fosse E, Karlsen H, Pedersen T, Mollnes TE, Hagve TA, Svennevig JL.
In vitro evaluation of new surface coatings for extracorporeal circulation.
Perfusion 1999; 14: 11-9.

2000

17. Videm V, Svennevig JL, Fosse E, Mohr B, Aasen AO.
Plasma endotoxin concentration during cardiac surgery may be related to atherosclerosis.
Perfusion 2000; 15: 421-6.

18. Skjeldal S, Lilleås F, Follerås G, Stenwig AE, Samset E, Tillung T, Fosse E.
Real time MRI-guided excision and cryo-treatment of osteoid osteoma in os ischii – a case report.
Acta Orthopaedica Scandinavica 2000; 71: 637-8.

19. Smedby Ø, Rostad H, Klaastad Ø, Lilleås F, Tillung T, Fosse E.
Functional imaging of the thoracic outlet syndrome in an open MR scanner.
European Radiology 2000; 10: 597-600.

20. Solheim BG, Rollag H, Svennevig JL, Arafa O, Fosse E, Bergerud U.
Viral safety of solvent/detergent-treated plasma.
Transfusion 2000: 84-90.

21. Storkson RH, Edwin B, Reiertsen O, Faerden AE, Sortland O, Rosseland A.
Gut perforation caused by biliary endoprothesis.
Endoscopy 2000; 32: 87-9.

22. Klaastad Ø, Lilleås FG, Røtnes JS, Breivik H, Fosse E.
A magnetic resonance imaging study of modifications to the infraclavicular brachial plexus block.
Anesthesia & Analgesia 2000; 91: 929-33.

23. Hol PK, Kvarstein G, Viken O, Smedby Ø, Tønnessen TI.
MRI-guided celiac plexus block.
Journal of magnetic resonance imaging 2000; 12: 562-4.

24. Fosse E, Hol PK, Samset E, Røtnes JS, Bjørnstad P, Lundblad R.
Integrating image-guidance into the cardiac operating room.
Minimal Invasive Therapy and allied technologies 2000; 9: 403-9.

25. Arafa OE, Geiran OR, Andersen K, Fosse E, Simonsen S, Svennevig JL.
Intraaortic balloon pumping for predominantly right ventricular failure after heart transplantation.
Annals of Thoracic Surgery 2000; 70: 1587-93.

2001

26. Edwin B, Ræder J, Trondsen E, Kaaresen R, Buanes T.
Outpatient laparoscopic adrenalectomy in patients with Conn's syndrome.
Surg Endosc 2001; 15: 589-91.

27. Samset E, Mala T, Edwin B, Gladhaug I, Søreide O, Fosse E.
Validation of estimated 3D temperature maps during hepatic cryo surgery.
Magetic Resonance Imaging 2001; 19: 715-21.

28. Samset E, Mala T, Ellingsen R, Gladhaug I, Søreide O, Fosse E.
Temperature measurement in soft tissue using a distributed fiber bragg grating sensor system.
Minimally Invasive Therapy and Allied Technologies 2001; 10: 89-93.

29. Mala T, Edwin B, Samset E, Gladhaug I, Hol PK, Fosse E, Mathisen Ø, Bergan AB, Søreide O.
Magnetic-resonance-guided percutaneous cryoablation of hepatic tumours.
Eur J Surgery 2001; 167: 610-7.

30. Mala T, Samset E, Aurdal L, Gladhaug I, Edwin B, Søreide O.
MRI estimated 3D temperature distribution in liver cryolesions: a study of cryolesion characteristics assumed necessary for ablation.
Cryobiology 2001; 43: 268-75.

31. Lærum F.
Demand for a new main speciality in image-guided therapy.
Computer Methods and Programs in Biomedicine 2001; 66 : 81-5.

32. Klaastad Ø, Smedby Ø.
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Director, Professor	**Terje Rootwelt**	Divison of Paediatrics
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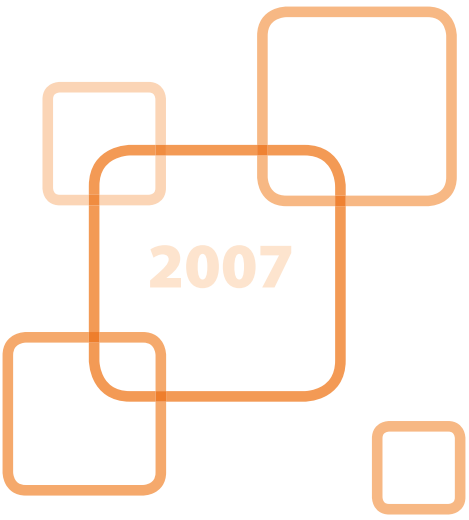
Professor	**Olav Haraldseth**	Faculty of Medicine, NTNU Trondheim
Professor	**Richard Blake**	Faculty of Info., Mathem. and Electr., NTNU, Trondheim
Professor	**Hans Olav Myhre**	St. Olavs Hospital, Trondheim
Ass. Professor	**Martin Biermann**	University of Bergen
Professor	**Torfinn Taxt**	University of Bergen
Consultant Surgeon	**Ulf Kongsgaard**	Dept. of Anaest., Montebello
Professor	**Petter Eldevik**	Tromsø University Hospital
Professor	**Kirsti Ytrehus**	Tromsø University Hospital
Professor	**Steinar Pedersen**	Tromsø University Hospital
Professor	**Arne Bakka**	University Hospital of Akershus
Professor	**Per Hj. Nakstad**	Ullevål University Hospital
Director, Professor	**Nils-Einar Kløw**	Ullevål University Hospital
Director	**Berit Mørland**	The Norwegian Health Services Research Centre
Dr. Philos	**Bjørn Anton Graff**	The Norwegian Health Services Research Centre
Coordinator	**Barbra Noodt**	Directorate for Health and Social Affairs



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