

# Operating room of the future

St. Olavs Hospital HF, Department of Surgery

## Annual Report 2007



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# **Annual Report 2007**

## **Operating room of the future (ORF), Department of Surgery**

### *Summary*

The operating room of the future is a cooperation between St. Olavs Hospital HF, University Hospital of Trondheim and the Norwegian University of Science and Technology (NTNU), Trondheim, Norway. The day-to-day management is a responsibility shared between Department of Surgery and the Medical Faculty. Operating room of the future (ORF) is an arena for research and development with the operating rooms as unique “laboratories”, made to develop, test and apply new technology and new treatment modalities.

The tasks of a university hospital is legally defined in the “specialist health care act” and include treatment of patients, education of patients and relatives, research and teaching of health care personnel. ORF is working to fulfill these goals.

The most important focus of this project is research to provide safer and better patient treatment, more effective logistics and flexible architecture in the construction of operating rooms in new hospitals. ORF is also a centre of competence for construction of operating rooms outside St. Olavs Hospital. A unique agreement between our industrial collaborators has made it possible for the Health Care Authorities of Central-Norway, St. Olavs Hospital and NTNU to focus on research and development with special focus on image guided minimally invasive therapy. ORF has a close collaboration with the National Centre for Advanced Laparoscopic Surgery (NSALK), the research foundation SINTEF and the National Centre of Competence – 3D-ultrasound.

The project is multidisciplinary and an arena for clinical research and development of medical technology. Prototypes can be developed and tested in safe and controlled environments. ORF is made to promote a close collaboration between clinicians, technologists, researchers and industrial partners. The latest equipment available will be put to use at ORF.

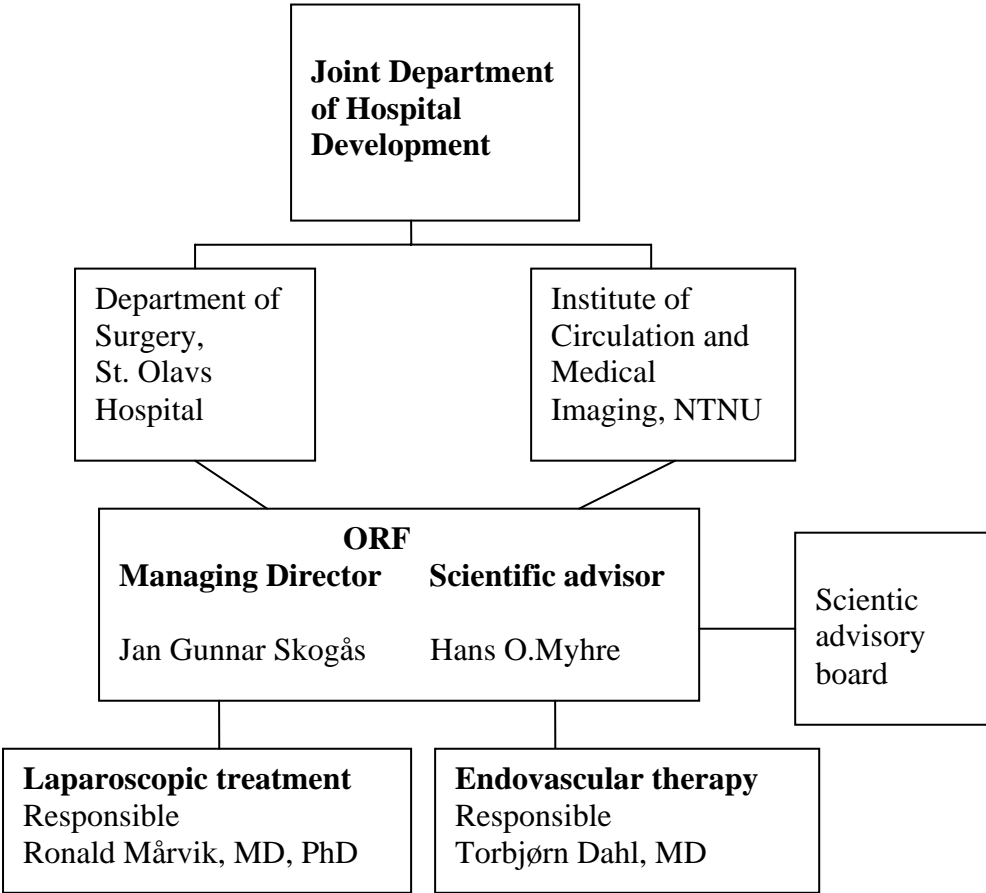
In the “National Plan of the Norwegian Health Authorities”, it is stated that Trondheim has a special responsibility for research within the field of medical technology.

The operating rooms are equipped for minimally invasive therapy. The major focus is on so-called key-hole surgery in the abdomen (laparoscopic surgery) and endovascular therapy of diseases in the blood vessels. Minimally invasive surgery is less traumatic than traditional surgery and will have a broader place in patient treatment in the future.

The concept of ORF also shows that different disciplines and medical specialists can use the equipment, the areas as well as the competence available. ORF has the facilities and logistics necessary to focus on research and projects which are based on a multidisciplinary approach. Studies are performed by PhD-candidates, scientists, students and clinicians. In addition, ORF with its technical equipment and design is perfect for teaching and educating students, doctors and nurses.

New methods for teaching have been tested and transmission of images from the operating room to the lecture room with bilateral communication has been used on several occasions. This has been perceived as a very valuable experience, and the intention is to develop this further, employing the excellent equipment and technological standard of the facility . At ORF and NSALK several courses are arranged annually, including courses compulsory for specialist candidates. ORF with the integrated surgical auditorium creates a unique environment for teaching during these courses. New projects and investigations have started in 2007 and several projects are on the planning stage.

**Organisation**



## ***The staff at ORF***

1 managing director

1 scientific advisor

1 responsible for medical technology

1 research nurse, endovascular therapy

1 research nurse, laparoscopic therapy

### **Other personnel resources connected to ORF:**

2 project leaders, one for endovascular and one for laparoscopic therapy, respectively

1 operating nurse, endovascular therapy

1 operating nurse, laparoscopic therapy

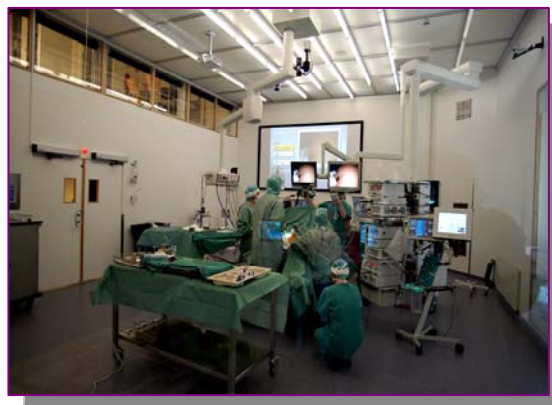
1 radiographer

1 radiologist

1 anaesthesia nurse

## ***Clinical activity***

**Altogether 175 operations were performed at ORF i 2007**



## ***Laparoscopic treatment***

A total of 92 operations have been performed at ORF for laparoscopy in 2007. This is an increase by over 30 operations compared to 2006. Most operations have been performed for morbid obesity; altogether 67 procedures. 56 of these received a gastric bypass operation (GBP). These patients are involved in a non-randomised trial where patients can choose between surgery and 18 weeks of conservative therapy including lifestyle modification. One aims for a 5-year follow-up. ORF, NSALK and Centre for Morbid Obesity are involved in a multicenter trial, investigating a new operative technique for morbid obesity, based on implantation of electrodes on the vagus nerve (VBLOC). Altogether four centres, in Mexico, Australia and Switzerland, are taking part in this investigation in addition to ORF/NSALK.

Custus X, a navigation instrument developed by SINTEF, has been used during several operations including adrenalectomies. The use of this navigation equipment is tested in a clinical multicenter study together with Medical Center, Utrecht, The Netherlands.

There have been several visitors at ORF, including participants in the European research project VECTOR, where NSALK and SINTEF are taking part.

Several surgeons from Norway, Egypt and Japan have been visitors at ORF/NSALK for shorter periods. NSALK/ORF had in 2007 several visitors from Norway and other countries to observe Europe's first fully integrated digital operating room.

NSALK has three PhD-fellows at ORF at the moment.

The synergy between NSALK's simulator-based laboratory and ORF's interactive auditorium makes it possible for participants at courses and symposias to train on simulators and be present in the lecture room where they can observe procedures performed by laparoscopic/endoscopic technique. NSALK has in collaboration with Olympus developed a new operating light, which can replace regular operating lamps. The first prototypes are tested at NSALK's animal laboratory and will later be used at ORF.

**In 2007, 92 operations were performed at the laparoscopic operating room**

**Activity, laparoscopic surgery:**

<b>Operations 2007</b>	
Fundoplication	3
Cholecystectomy	4
Gastric bypass	56
Gastric sleeve	3
Vagus block	6
Reopr. VBLOC	2
Gastric reresection	2
Gastroscopy	2
Hernial repair	1
Diagnostic laparoscopy	1
Resection of duodenal polyp	1
Zenkers diverticulum	1
Diverticulectomy	1
Low anterior resection	1
Adrenalectomy	8
<b>Total</b>	<b>92</b>

## Endovascular treatment

Altogether 83 procedures have been performed at the endovascular room. Six of these were emergency cases. Operations for iliac-, abdominal- and thoracic aneurysms have been carried out. Furthermore, several combined procedures like balloon angioplasties/stenting have been performed together with endarterectomy or infrainguinal bypass.

Some radiological procedures have also been performed in this room. The main intent was to test the effect of upgrading of the Dyna-CT software.

As part of a research protocol, 3D-visualization with Dyna-CT was performed on elective operations for abdominal aortic aneurysms. This was done with informed consent by the patients. Dyna-CT was also performed in other operations as pilot investigations and studies for the testing of this specific treatment modality.

Dyna-CT was further used in phantom experiments, experimental surgery and testing of the navigation system for intravascular use.

### In 2007, 83 operations were performed in the endovascular operation room

#### Activity endovascular treatment:

<b>Elective operations / procedures 2007</b>		<b>Acute procedures</b>	
Thoracic stentgrafts	3	Thoracic aneurysms	2
Secondary procedures following thoracic stentgrafting	4	Abdominal aortic aneurysms	2
Abdominal stentgrafting	31	Thoracic aortic trauma	1
Secondary procedures after abdominal stentgrafting	6	Combined stentgraft/open operation in trauma of the groin	1
Stent brachiocephalic trunc	2	<b>Total acute</b>	<b>6</b>
Percutaneous procedures for endoleak	1	<b>Total number of endovascular procedures</b>	<b>83</b>
Carotid stenting	1		
Stentgraft for pseudoaneurysm	1		
Stentgraft /stent / angioplasty of the iliac arteries	18		
SNS (stimulation of the sacral nerves)	9		
Removal of venous port (paediatric)	1		
<b>Total elective procedures</b>	<b>77</b>		



## ***Other activities***

In addition to patient treatment, all operating rooms have been used as laboratories for various experimental investigations. Thus, the operating rooms are used in the testing and development of new medical technology, prototypes and new equipment. Some of this recently developed equipment has been applied in patient treatment in connection with PhD-projects.

SINTEF has used the operating rooms altogether 23 days for calibration and testing of their navigation system. Internally, and together with industrial collaborators, we have used our facilities for 90 days for the testing of technology systems, quality control, safety routines etc.

## ***Teaching***

ORF is a resource centre for future integration and implementation of new technology and instruments in the operating area. Several departments which have been built at St. Olavs Hospital during phase 1, as well as the planning in phase 2, are based on the knowledge which has been accumulated at ORF. Thus we have learnt how to implement new equipment and technology in our new integrated university hospital.

In 2007 there has been focus on phase 2 in the new hospital, especially with regard to infrastructure, architecture and technology in the new operating rooms.

## **Staff**

### **Education**

- Medical personnel affiliated to ORF are going through annual certification according to national regulations regarding use and maintenance of electromedical equipment § 13.
- We have certified some of the employees at ORF for the use of advanced medical technological equipment. They are going through courses to update their knowledge.
- The personnel at ORF are contributing in the teaching of personnel at other departments at St. Olavs Hospital as well as personnel from other institutions, focusing on clinical procedures, research and the application of medical technology.

- ORF had in 2007 visitors by personnel from other hospitals, e.g. the National hospital of Oslo, Aker University Hospital (Oslo), Østfold Hospital (Fredrikstad), Akershus University Hospital (AHUS), Aust-Agder county hospital (Arendal) and Nordland sentralsykehus (Bodø). We have therefore contributed to the dissemination of important information regarding new technology, methods and integration of minimally invasive surgery in ORF including the lecture room.
- ORF has contributed to the upstart of endovascular therapy of abdominal aortic aneurysms at Fredrikstad hospital. Personnel from this hospital have followed the operations at ORF and doctors from St. Olavs Hospital have assisted at procedures in Fredrikstad.
- During a course in simulator training, arranged by National Centre for Advanced Laparoscopic Surgery, ORF has been used as an arena for transmission of operative procedures and dissemination of information about integration of new equipment applied during these procedures.
- The personnel at ORF have during 2007 attended courses within leadership and research organisation.

## Students

- On a regular basis operative procedures have been transmitted to the lecture room in connection with teaching of medical students, nurses and radiography students as well as other professional groups at St. Olavs Hospital.
- Operating nurses and anaesthesia nurses have taken part in education and tutorial activity.
- Visitors from other hospitals have attended ORF and have been present during operations.
- Master students as well as PhD students at St. Olavs Hospital / NTNU / SINTEF have a good opportunity to see new medical technology and operations from the interactive surgical lecture room at ORF.

## Courses

May 2<sup>nd</sup>, 2007 – Course with topics within hygiene and patient safety for engineers and scientists arranged by ORF.

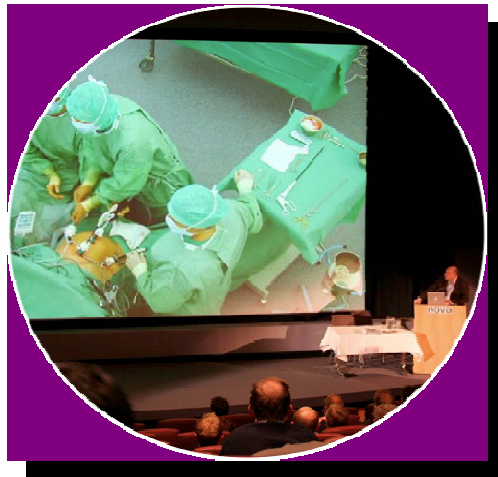
April 18<sup>th</sup> -19<sup>th</sup>, 2007 – National course in endovascular therapy, arranged by Department of Radiology and Department of Vascular Surgery.

## Conferences / other arrangements

August 27<sup>th</sup> -29<sup>th</sup> , 2007 - AMEE (The Association for Medical Education in Europe)  
ORF participated together with NSALK and SINTEF with a stand on the world congress of AMEE. This is an international conference in medical education and teaching, which was arranged at Trondheim Spektrum.

October 17<sup>th</sup> -20<sup>th</sup> , 2007 – Technoport 2007  
ORF was participating together with NSALK and SINTEF with a stand and with presentations on Technoport within the topic "health and technology", Trondheim Spektrum.

April 13<sup>th</sup> / August 30<sup>th</sup> – 31<sup>st</sup> / December 18<sup>th</sup> , 2007 – Seminars were arranged for employees, industrial partners, SINTEF Health and fellows connected to ORF.



## Visitors at ORF

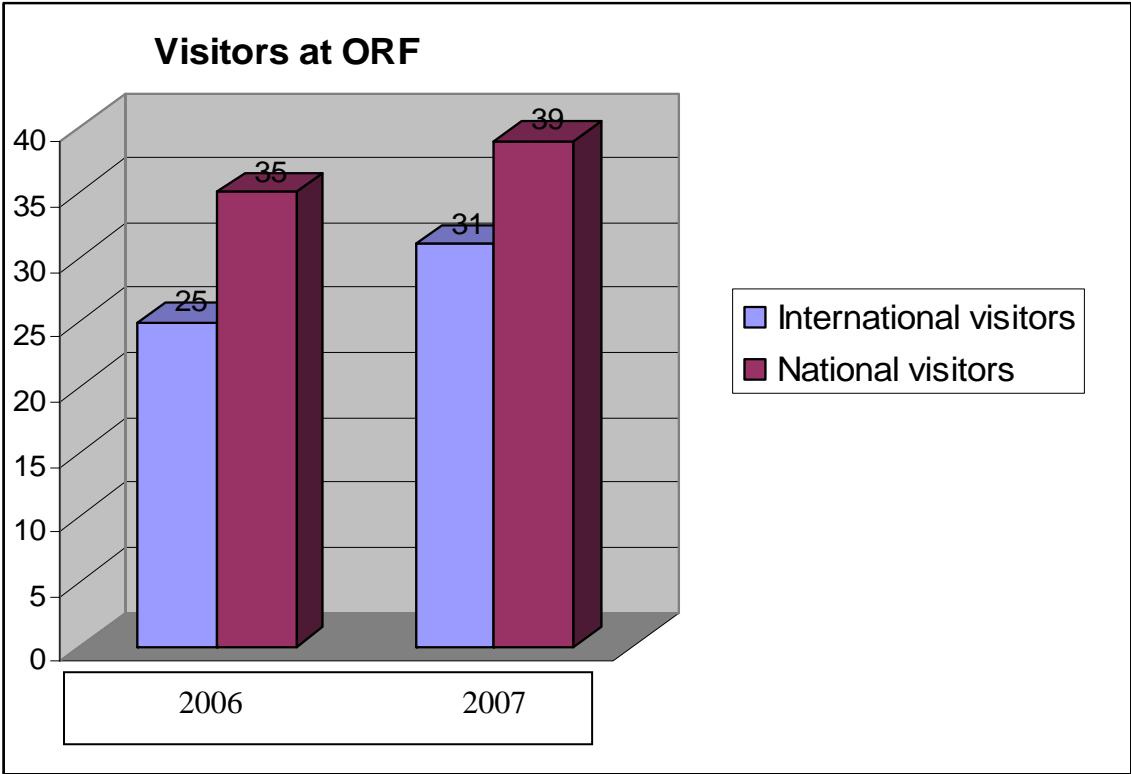
There is an increasing interest both from national and international groups to visit ORF. Altogether 70 groups visited ORF in 2007 and they included in total 450 persons. Fifty of these were medical students.

These visits have been supplemented by guiding in ORF, presentations, symposias and courses including transmission of operations to the lecture room. There were 31 international and 39 national visits at ORF. Twenty-six different countries have been represented. The groups have consisted of delegates from other hospitals, hospital planners, health care administrators, members of the Norwegian parliament and the government, architects, representatives from the industry, scientists and journalists. Medical students at NTNU and several other groups had lectures with transmission from the ORF.

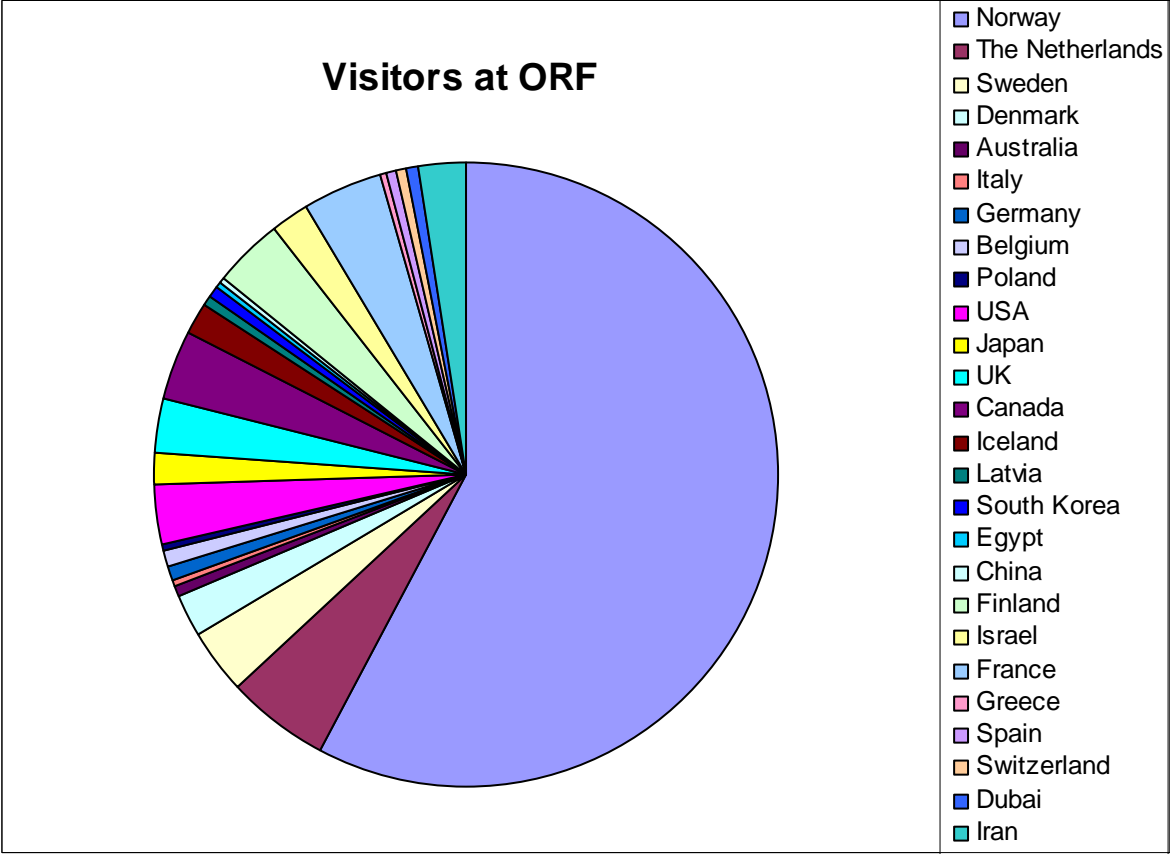
Also, there have been several internal groups from the Department of Hospital Development in Trondheim and St. Olavs Hospital. Most of these visits have included presentations by representatives from St. Olavs Hospital, NTNU and SINTEF.

Operating nurses, radiologists, anaesthesia nurses, anaesthetists, radiographers and surgeons from national and international hospitals have been visitors at ORF.

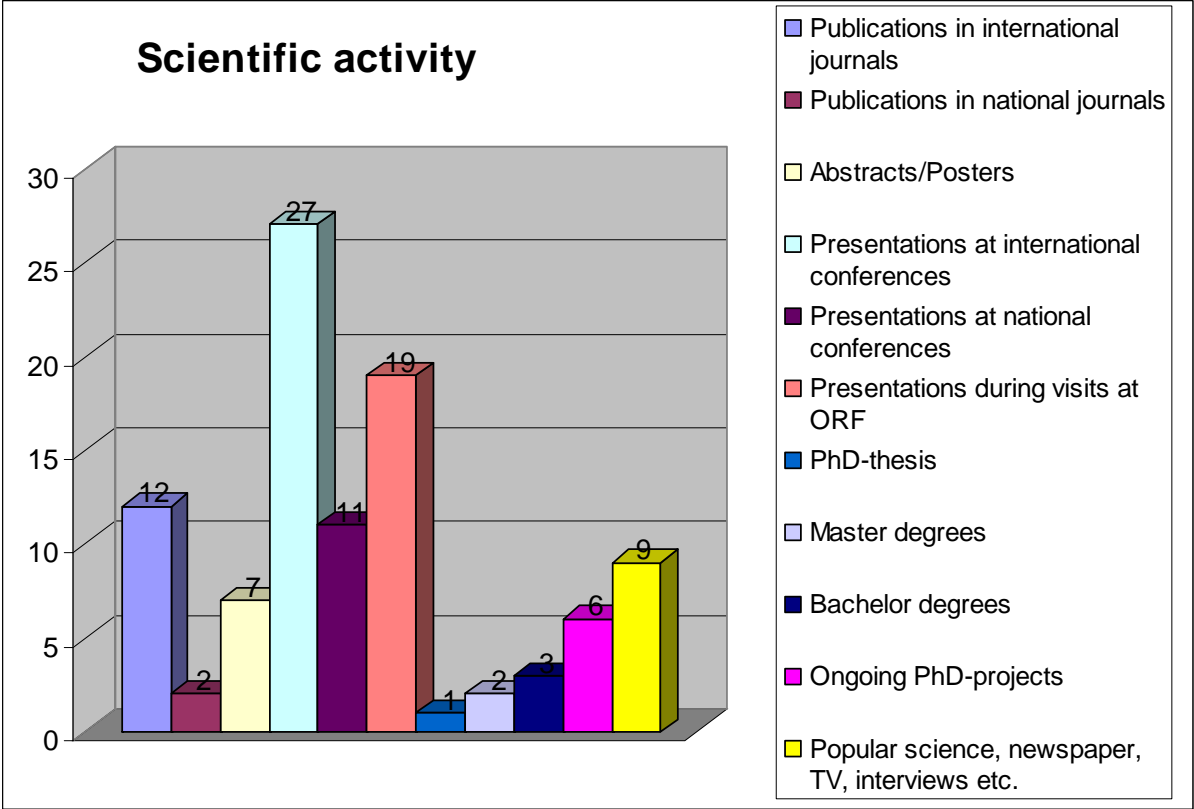
**Visitors at ORF 2006 and 2007 – national and international groups**



**Visitors at ORF 2007 – 26 different nationalities**



**Scientific activity 2007**



## ***Research and development***

### **New appointment**

Ronald Mårvik (responsible laparoscopic surgery) has been awarded a 20% appointment at the Medical Faculty 2007.

### **Supervision**

Hans Olav Myhre (scientific advisor) was in 2007 supervisor for two PhD candidates and opponent at a dissertation for one more PhD candidate. He also was member of the committee for evaluation of a position as professor in vascular surgery, Uppsala, Sweden.

### **National and international committees**

Ronald Mårvik was leader of the national working group responsible for the report “Preoperative evaluation and treatment of morbid obesity in the specialist health care”, November 2007.

Ronald Mårvik is a member of the Technology Committee and the NOTES - Committee in European Association of Endoscopic Surgery.

Hans O. Myhre was active in the foundation of the European Society for Nanomedicine in July 2007. The annual conference will be held 19-21 May 2008. See [www.esnam.org](http://www.esnam.org)

### **Projects finished in 2007**

#### **PhD-theses**

Torbjørn Dahl, MD

Defended his thesis June 19<sup>th</sup>, 2007, for the PhD in clinical medicine.

“Carotid artery stenosis – Diagnostic and therapeutic aspects”

Yunus Yavuz, MD, has finished his fellowship period and is working on his 4<sup>th</sup> paper for the thesis.

## Master degrees and diploma degrees

Nilsson L.

“Accuracy of electromagnetic tracked freehand laparoscopic 3D ultrasound”. Project thesis, 2007, KTH, Stockholm and SINTEF Medical Technology, Trondheim, 2007.

Lars Eirik Bø, Ultrasound simulator, in progress, 2007.

## Bachelor degrees

Three bachelor degrees have been made as collaboration between ORF and Sør-Trøndelag University College.

### Project 1

Siri Flack and Line Aune, Radiographers

“Concentration of bacteria in the Operating Room of the Future, room 1, St. Olavs Hospital”  
Sør-Trøndelag University College

### Project 2

Ragnhild M. Brunvoll and Tonje K.B. Bjerknesli, Bioengineers

“Concentration of bacteria in the Operating Room of the Future, room 2, St. Olavs Hospital”

### Project 3

Stine M. Gjendem, Wenche Hermstad, May Iren Melby, Radiographers

”Radiation doses and protection at ORF, room 1”

## PhD - programs

### Ongoing PhD programs

**Andreas Seim**, PhD (St. Olavs Hospital / SINTEF / Norwegian Research Foundation)

Andreas Seim has published 5 articles for his PhD-thesis focusing on logistics and patient flow. The PhD has been made in cooperation with Massachusetts General Hospital, Boston. The thesis will be available for evaluation in April 2008 with a planned dissertation in June.

**Frode Manstad-Hulaas**, PhD (medicine)

“Endovascular stentgraft implantation using navigation technology”

The project is focusing on the application of navigation during deployment of stentgrafts with sidebranches. We believe that the application of navigation and Dyna-CT during the procedures will make the operations safer. One of his articles is based on phantom studies and has been published. An experimental investigation on animals has started and finally a clinical study on the application of navigation during endovascular treatment of abdominal aneurysms is performed. A study regarding evaluation of 3D – 3D registration is on the planning stage.

**Håvard Nordgaard**, PhD (medicine)

”Ultrasound-based blood flow imaging for intraoperative control during cardiovascular surgery”. The project is using ultrasound transit-time flowmetry to control coronary artery bypass procedures and operations for carotid artery stenosis. One article on flowmetry during coronary artery bypass is published. One manuscript on the significance of pulsatile index is submitted for publication. Two more papers, one on carotid surgery and one on so-called “competing blood flow” are on the planning stage.

**Berit Brattheim**, PhD (health science)

”Selection of patients with AAA regarding evaluation of the indication for stentgrafting”. This work is performed in collaboration with Department for Electronic Health Record. A part of this study is identifying and describing the workflow when patients with AAA are evaluated preoperatively as to whether stentgrafting can be performed or not.

**Kari Ravn Eide**, PhD (health science)

”Intraoperative Dyna-CT during stentgraft implantation for abdominal aortic aneurysm”. Dyna-CT is a new technology where a C-arm of the angiography unit in the operating room is rotating. This provides CT-like images on the operating table. Our angiography laboratory is integrated with an operating room for open surgery. One paper has been published in Journal of Endovascular Therapy. A second study comparing Dyna-CT with MDCT evaluating the possibility for deployment of stentgrafts is submitted for publication. Further investigations on irradiation doses connected to the application of the Dyna-CT and the application of Dyna-CT in acute endovascular treatment is on the planning stage.

**Ole Vegard Solberg**, PhD (Medical technology)

”3D ultrasound reconstruction and fusion with preoperative images for improved diagnostics and image guided therapy”. Two articles have been published and the next part of the PhD-project has been started. Solberg’s PhD is performed in close collaboration with Center of competence, 3D-ultrasound.

**Reidar Brekken**, PhD (medical technology)

”Measurement of strain in the evaluation of abdominal aortic aneurysms (AAA)”  
The purpose is to measure strain in the aortic wall for the evaluation of rupture risk. One article about the methodology has been published. The next article is based on measurement of strain before and after endovascular treatment. This article has been submitted to Journal of Endovascular Therapy. Brekken’s PhD work is also performed in close cooperation with Center of competence, 3D-ultrasound.

## **Studies which is a part of a PhD**

**Tor Erik Evjemo**, PhD (sociology)

“Communication in a high-tech area”. A special design applied in this investigation is used to identify activities like cooperation, communication etc. The aim is to study cooperation in environments with a high degree of technological complexity. A part of the study is based on video recording of communication based on information in ORF. Interview of the employees has started up.

## PhD under planning

**Anna Aasgaard Rethy** startet 1<sup>st</sup> of January 2008 as a fellow at NTNU / St. Olavs Hospital / SINTEF Health. Her project is “3D-ultrasound and navigation in laparoscopic surgery”.

## Studies / projects / national and international collaboration

- We have established a good cooperation between our most important industrial partners, like SONY, Siemens and Olympus. Agreements have also been made with Covidien and Medistim.
- ORF has a close collaboration with Sør-Trøndelag University College (HIST). The medical faculty (NTNU), NSALK (National Centre for Advanced Laparoscopic Surgery), SINTEF Health and National centre of competence - 3D ultrasound.
- Comparison between surgery (gastric bypass) with lifestyle modification in patients with morbid obesity. A 5-year investigation organized by Centre for Morbid Obesity, St. Olavs Hospital. The patients selected for surgery are treated at ORF.
- Navigation and Dyna CT during operations for anal incontinence. The pilot investigation was finished in 2007 and this study is continuing. More patients are included in this project where the aim is to implant electrodes for stimulation of the nerves to the anal sphincter. Responsible: Astrid Rydning, MD, PhD, St. Olavs Hospital.
- Training prior to gastric bypass. Tissue samples are taken during gastric bypass operation. This is a cooperation between NTNU and Centre for Morbid Obesity, St. Olavs Hospital. Responsible: Thomas Stølan, NTNU.
- Collaboration with University of Tübingen, Germany. The project is to develop an ergonomic handle for use during laparoscopic surgery. In 2007 NSALK was testing a new ergonomic laparoscopic instrument, ErgoGrip.
- University Hospital of Barcelona. Collaboration regarding the application of Olympus' data technology in the operating room.
- EAES (European Association of Endoscopic Surgery): Participant in the NOTES-group.
- University of Krakow. The intention is to collaborate on a EU-project within flexible endoscopy.
- Independent Public Medical Care Unit Military Hospital, Szczecin. Application for EU sources regarding training.

- Montsouris University Hospital, Paris. Visit Prof. Brice Gayet, Laparoscopic liver surgery.
- Steinberg University, Berlin, Visiting Prof. Marc Schurr, Animal study regarding VECTOR and a new anti reflux prosthesis.
- National Cancer Center, Tokyo. Visiting Prof. Gotouda endoscopic submucosal resection.
- In connection with the application of navigation in laparoscopic surgery cooperation was established between Mesos Medical Center, Utrecht, The Netherlands. We have signed a protocol regarding research collaboration including a multicentre study.
- Electromagnet positioning in the operating room. We have collected data in ORF to investigate the potential and the accuracy of electromagnetic positioning and orientation in several operating rooms. Special instruments are used to study the influence on these measurements. One scientific paper is describing the results from these first investigations. The conclusion is that electromagnetic positioning is possible. We proceed with development and testing of the method, both in intravascular navigation and in 3D laparoscopic ultrasound.
- 3D ultrasound in laparoscopic surgery. A solution based on micropositioning and flexible ultrasound probes is integrated in the navigation system CustusX. The ultrasound solution has so far been tested in the laboratory to investigate the accuracy of the system. The applicability of this technical solution will be tested in experimental investigations in 2008. The plan is to visualize several structures during the experimental investigations and then to compare with Dyna CT images performed simultaneously on the operating table. This project forms the basis of master degrees and one PhD.
- High resolution (HD) video in laparoscopic surgery. We are collecting images from HD and standard video (SD) during laparoscopy in experimental surgery. The image quality will be investigated and compared. The method is based on one large trocar opening where both types of endoscopes are focused on the same organ. Images are collected from the same angle and the same distance from the organ. Afterwards a comparison is based on the evaluation by several observers blinded to what is HD and what is SD.
- Possible complications due to positioning on the operating table in patients undergoing laparoscopic gastric bypass operation. The data have been collected and an article is under publication. Responsible: Anne Karin Wik, RN, ORF.
- Olympus has developed a prototype of operating light which can replace traditional lamps. This is a development project between ORF and Olympus.
- Siemens has developed the prototype for an operating light which can be used during endovascular therapy. The lamp has been tested out 2007 during endovascular and vascular procedures. A report has been delivered to Siemens AG. .

- Regarding visualisation of clinical imaging a collaboration has been made between Sony Corporation, Kano M, Liverød V and Skogås JG, where the goal is to form a protocol for an investigation where the application of holograms and 3D display in the operating room will be tested. This is a promising project first and foremost for the application within teaching.
- Measurement of air quality in the ORF  
A collaboration between St. Olavs Hospital, ORF and Sør-Trøndelag University College. The project has received economic support from Central Norway Regional Health Authorities. Results from previous measurements and student projects regarding the air quality at ORF form the basis of this project. In the project, air quality has been measured at operating rooms, which are now used in phase 1 of our new hospital, and one operating room in the old operating department. The aim is to investigate which factors could influence the air quality like ventilation, personnel, equipment in the OR's etc. Our experience will be reported to the Department of Hospital Development and will also form the basis for construction of operating rooms in phase 2.
- We have cooperation with Technische Universität München about recording of pre- and intraoperative CT-images. This is part of Frode Manstad-Hulaas' PhD-work. He is cooperating with Sefanie Demirci who is a fellow at CAMPAR (Chair for Computer Aided Medical Procedures & Augmented Reality), Fakultät für Informatik. Siemens Medical Solutions is also involved in this cooperation.
- There is a cooperation regarding the implementation of an electromagnetic sensor in a guide wire. This is also involving PhD candidate Frode Manstad-Hulaas, who is cooperating with Lucian Gruionu, who is assistant professor at Advanced Engineering Group, University of Craiova, Romania and Professor Kevin Cleary, The Imaging Science and Information Systems (ISIS) Center, Georgetown University Medical Centre.



- We have established good cooperation with MGH (Massachusetts General Hospital), Boston regarding logistics. One of our PhD candidates has been working at MGH. This cooperation will be continued in the future.

- NSALK is represented with Ronald Mårvik who is a member of the Technology Committee of EAES, which has an annual European symposium. Through this membership ORF is used as an arena to demonstrate new technology.
- The EU project VECTOR (Versatile Endoscopic Capsule for gastrointestinal Tumor recognition and therapy) is a project involving 18 centres, including SINTEF and clinicians at St. Olavs Hospital through SMIT (Society for Medical Innovation and Technology). The project included micro-technology for detection of malignancies in the gastrointestinal tract. The project was started in September 2006 and will run for 4 years. ORF will be an arena for testing of prototypes during this period. The project has a meeting each year, where all participants are going through status and future plans. The meeting for 2007, which was a preparation for the evaluation of the project in Brussels, was held in ORF, Trondheim. With 40 participants in the lecture room this was one of the major seminars at our unit. We received several positive comments from departments in the VECTOR project after this meeting regarding the medical technology and the competence at ORF.
- We have established a cooperation between NSALK / ORF and AV Arena Norway through Midgaard Medialab, NTNU. The main goal for AV Arena Norway is to strengthen Norway as an international leading base of knowledge within new digital medias. The focus is industry and innovation. Midgaard Medialab has been involved in HD transmission to NOVA cinema in connection with conferences. In 2008 we plan a transmission from ORF to Yonsei University Hospital, Korea, and an agreement has been worked out with this hospital through NTNU.

## **Publications**

### **Endovascular therapy:**

#### **Articles in scientific journals with referee:**

Norgren L, Myhre HO. Arteriell insuffisiens i beina. Tidsskr Nor Lægeforen, 2007; 127: 2123

F. Manstad-Hulaas, S. Ommedal, G.A. Tangen, P. Aadahl, T.N. Hernes  
Side-Branched AAA Stent Graft Insertion Using Navigation Technology: A Phantom Study.  
Eur Surg Res 2007;39:364-371

Eide KR, Ødegård A, Myhre HO, Haraldseth O. Initial observations in EVAR using Dyna-CT. J Endovasc Ther 2007; 14: 50-53.

Berge C, Haug ES, Romundstad PR, Lange C, Myhre HO. Infrarenal abdominal aortic aneurysm repair. Time-trends and results during a 20-year period. World J Surg 2007; 3: 1682-6

Brattli OS, Nystuen K, Sæther OD, Aadahl P, Grønbech JE, Myhre HO. Regional distribution of blood flow during proximal aortic cross-clamping. An experimental study using coloured microspheres. Scand J Clin Lab Invest 2007; 67: 526-535

Dahl T, Cederin B, Myhre HO, Indredavik B. The prevalence of carotid artery stenosis in an unselected hospitalized stroke population. Accepted Int Angiol Sept07

Seim AR, Fagerhaug T, Ryen SM, Curran P, Sæther OD, Myhre HO, Sandberg, WS. Causes of cancellations on day of surgery at two major university hospitals. In preparation

Berge C, Haug ES, Romundstad PR, Lange C, Myhre HO. Infrarenal abdominal aortic aneurysm repair. Early and long-term survival. Accepted Scand Cardiovasc J 2007

Brekken R, Dahl T, Hernes TAN, Myhre HO. Reduced strain in abdominal aortic aneurysm after endovascular repair. Submitted J Endovasc Ther

### **Presentations at international conferences:**

Myhre HO. Aortic Dissections. ESVS Revision Course at the Annual Meeting of European Society for Vascular Surgery, Madrid 20.09.07.

Myhre HO, Ødegård A, Eide KR, Skogås JG. 17th European Chapter of the International Union of Angiology. How should we build operating rooms for treatment of vascular diseases? Cyprus, April 25-28, 2007.

### **Presentations at national conferences:**

Ødegård A. Moderne bildeutredning og terapeutiske muligheter ved sirkulasjonssvikt i underekstremitetene. Høstmøtet, Norsk Radiologisk Forening, Nov. 2007

Manstad-Hulaas, F: Bildestyrt navigert implantering av stentgraft. Norsk forening for automatikk (NFA) Medisinsk teknologi, september 2007

### **Abstracts:**

Brekken R, Kaspersen JH, Tangen GA, Dahl T, Hernes TAN, Myhre HO. A 3D visualization of strain in abdominal aortic aneurysms based on navigated ultrasound imaging. SPIE-Medical Imaging febr. 07

Myhre HO, Ødegård A, Eide KR, Skogås JG. How should we build operating rooms for treatment of vascular diseases? EUROCHAPTER & MLAVS Congress 2007, Cyprus, April 25-28, 2007.

Altreuther M, Aasgaard F, Lange C. Stentgraftbehandling av korallplakk i thoracalaorta etter residiverende embolier. Norsk Kirurgisk Forening – Vitenskapelige forhandlinger – Høstmøte okt 2007.

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### **Posters:**

Nordgaard H. The reliability of “pulsatility index” for evaluation of peripheral resistance. Poster presented ISMICS, Roma, June 2007.

### **Laparoscopic surgery:**

#### **Articles in international scientific journals with referee:**

Langø T, Tangen GA, Mårvik R, Ystgaard B, Yavuz Y, Kaspersen JH, Solberg OV, Hernes TAN. Navigation in laparoscopy – Prototype research platform for improved image-guided surgery. Accepted for publication in Minim Invasive Ther Allied Technol (MITAT), 2007.

Solberg OV, Lindseth F, Torp H, Blake RE, Hernes TAN. Freehand 3D ultrasound reconstruction algorithms - A review. *Ultrasound Med Biol*, 33:7:991-1009, 2007.

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#### **Presentations at national scientific conferences:**

Langø T, Tangen GA, Solberg OV, Hernes TAN, Mårvik R. Navigasjon og visualisering av medisinske data i minimal invasiv terapi. Invited presentation at MedFys 2007, Bergen, Norway, March 20, 2007.

Johnsen G: Foredrag på Midt-Norsk gastroenterologisk Forenings møte, Trondheim 01.12.07. Tittel: "Bariatrisk Kirurgi". Samme foredrag på FOR sin fagsamling 18.12.07.

### **Presentations at international scientific conferences:**

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Langø T. New imaging in new operating theatres. Trondheim Study Tour for German, Russian, and Danish hospital management and cancer care groups. St. Olavs Hospital, FOR, January 25, 2007.

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Skogaas JG, Are cold light sources really cold? June 2007: ACMI and Boston University, USA.

Hernes TAN. Today and future use of MR, ultrasound and CT for improved diagnostics, treatment guidance and follow up of patients. Invited lecture at the first Dutch Biomedical Conference, 18-20 January 2007.

Rydning A, Langø T, Tangen GA, Mårvik R. Three dimensional CT imaging in Sacral Nerve Stimulation. Oral presentation at the European Society of Coloproctology (ESCP), Malta, September 26-29, 2007.

Mårvik.R The future of TEM. European Surgery Forum. Mallorca 23. Juni-07

### **General ORF**

#### **Article in national journal:**

Mårvik R, Langø T, Skogås JG, Kjøsnes B. Kommunikasjon og læring i Fremtidens operasjonsrom. HMT nr.4, sept 2007.

### **Oral presentations at international conferences:**

Mårvik R, Langø T, Ystgaard B, Hernes TN. Future Operating Rooms in Trondheim. Oral presentation at the 19th annual SMIT (Society for Medical Innovation & Technology) congress, Sendai, Japan, 20-22 November 2007.

Mårvik R, Hospital IT "Future operating room". Seminar on Korea – Norway Business Cooperation. Seoul, Korea, mai 2007.

Mårvik R. Future Operating Rooms in Trondheim and Navigation in laparoscopic surgery. Oral presentation at Asian Endoscopic Society, Hyderabad, India. December 2007.

Skogås JG. Marmaris University Hospital, Istanbul. Boston University Hospital, Boston, USA. Valleylab Boulder Colorado, USA  
Workshop Medisin IT og medieteknolog, NTNU Midgard Media Lab v/AV Arena Norway  
23. november 2007, Oslo

Skogaas JG, Future Operating Room in Trondheim, St.Olavs Hospital, Norway. Project and development. February 2007: Valleylab, Bolder, Colorado, USA

Skogaas JG, The structure and logistics in the Future Operating Room in Trondheim, St.Olavs Hospital, Norway. May 2007: Marmaris University, Istanbul.

Skogaas JG, The modern AV-ICT and challenge of Visible Light in PACS, Athens Conference, May 2006, Trondheim, Norway.

Skogaas JG, Future Operating Room in Trondheim, St.Olavs Hospital, Norway. Project and development. June 2007: Boston University, USA.

Myhre HO, Presentation of FOR. Visit to Siemens AG Medical Solution, March 2007, Forchheim, Tyskland.

Ødegård A, Presentation of Dyna CT projects FOR. Visit to Siemens AG Medical Solution, March 2007, Forchheim, Tyskland.

Mårvik.R The Future OR and Navigation Technology. Yonsei Hospital, South-Korea. 8. – 13. May-07

Mårvik R. The New St. Olavs Hospital. Introduction Norwegian to Norwegian Hospitals and their visions. Yonsei Hospital, South-Korea. 8. – 13 May-07

Mårvik R. Future OR in Trondheim and navigation in laparoscopic surgery. One day symposium on endoscopic operating rooms in new hospitals. Kristiansand, 14. June 2007.

Mårvik.R The future OR at St.Olavs Hospital. Marmaris University Hospital, Istanbul, 25.June-07

Mårvik.R et al. Organization of The Future OR. EAES Congress. Athens 4.July 2007

Mårvik R, et al. Navigation Technology in The Future Operating Room. Invited lecture at 63<sup>rd</sup> Congress of the Association of Polish Surgeons. Poznan, Poland, September 12-15, 2007.

Mårvik.R The OR of the Furure. Invited speaker at the European Surgical Society. Krakow December 1<sup>st</sup>, 2007

### **Presentations at national conferences / local conferences:**

Skogås JG, Fremtidens Operasjonsrom med fokus på moderne medisinsk teknologi. Medisinsk Teknisk Forening, MTF, symposium mars 2007

Skogås JG, Moderne AV-IKT i fremtidens operasjonsrom og R&D innen minimal invasive teknikker. Workshop Helse, Medisin og medieteknologi. AV Arena Norway, Midgard Medialab, NTNU. Oslo november 2007

Skogås JG. Teknologiske sider ved rigide endoskopiske prosedyrer, ”pitfalls” og service. Temadag for Sterilsentralledere, Helse Midt-Norge. Desember 2007.

Aasland J: Fremtidens operasjonsrom - prosjekterfaringer så langt. Midt-Norsk karkirurgisk møte, Trondheim desember 2007.

Myhre HO. 30 års utvikling av karkirurgien mot Fremtidens operasjonsrom. Jubileumsseminar Ultralydgruppen ISB, 14. sept., St. Olavs Hospital.

Myhre HO. Fremtidens operasjonsrom (FOR), St. Olavs Hospital, en arena for innovasjon og forskning i samarbeid med store internasjonale aktører som Olympus, Siemens, Sony, Tyco og MediStim. Hvordan utnytte denne fasiliteten for flere norske bedrifter, både som utviklingsarena og ifm profilering internasjonalt? Technoport, Trondheim, 17.-20. okt. 07

### **Presentations at visits, courses and conferences at ORF:**

Skogås JG. Future Operating Room in Trondheim, St.Olavs Hospital, Norway. Project and development. Besøk av Den Norske Guideforening, mars 2007

Myhre HO. Fremtidens operasjonsrom. Besøk fra Spartanburg Hospital og Department of Defence, US, i regi av SINTEF, oktober 2007.

Skogås JG. Moderene AV-IKT i medisinsk teknologi ved FOR, St.Olavs Hospital, Besøk av IKT-personell, april 2007

Skogås JG. Future Operating Room in Trondheim, St.Olavs Hospital, Norway. Project and development. Besøk av Mail Business Newspaper, Seoul, Korea og Norsk Forskningsråd, april 2007

Liverød V, Skogås JG. AV-IKT og Sony PACS, kurs for superbrukere ved KB, Nevro og FOR, april 2007.

Skogås JG. Future Operating Room in Trondheim, St.Olavs Hospital, Norway. Project and development. Besøk av klinikere og teknologer fra Japan, januar 2007.

Skogås JG. Forhold rundt medisinsk teknisk utstyr, kurs i hygiene og pasientsikkerhet for teknologer / forskere i regi av FOR, mai 2007

Langø T. New imaging in new operating theatres. Trondheim Study Tour for German, Russian, and Danish hospital management and cancer care groups. St. Olavs Hospital, FOR, January 25, 2007.

Skogås JG. Future Operating Room in Trondheim, St.Olavs Hospital, Norway. Project and development, modern AV-ICT. Besøk fra universitetssykehuset, Kairo, Egypt, mai 2007

Myhre HO. Fremtidens operasjonsrom. Besøk av Arbeiderpartiets strategikomité 23.11.07

Skogås JG. Endoskopets teknologi, kliniske forhold og høyenergetisk teknologi. Kurs for operasjonssykepleiere under utdanning, HIST, St. Olavs Hospital, februar 2007.

Skogås JG. Moderne AV-IKT i medisinsk teknologi ved FOR, St.Olavs Hospital, Besøk av KITH og sykehusplanleggere ifbm BF2, mai 2007

Skogås JG. Future Operating Room in Trondheim, St.Olavs Hospital, Norway. Project and development, modern AV-ICT. Besøk av flere universitetssykehuset, Frankrike og Israel, juni 2007

Skogås JG. Future Operating Room in Trondheim, St.Olavs Hospital, Norway. Project and development, modern AV-ICT. Besøk av VECTOR-prosjektet, flere EU-land, okt 2007

Sæther OD, Skogås JG, Mårvik R. Future Operating Room in Trondheim, St.Olavs Hospital, Norway. Project and development, modern AV-ICT, and MIS. Besøk av Norske Utenriksdepartement, ambasderåder og Adm.dir, Access Mid-Norway, nov 2007

Skogås JG. Future Operating Room in Trondheim, St.Olavs Hospital, Norway. Project and development, modern AV-ICT. Besøk av sykehusplanleggere, IKT fra Dubai og Canada, november 2007

Myhre HO. Fremtidens operasjonsrom i Trondheim. Besøk fra Nederland (HBMN) 080207.

Myhre HO. Fremtidens operasjonsrom i Trondheim. Besøk fra Island og Canada (HBMN) 060307.

Myhre HO (Ødegård A, Manstad-Hulaas F, Skogås JG), FOR, besøkte Siemens, Forchheim, Tyskland, 21.03.07

## **Popular science in newspapers and magazines:**

"Pillen som kan fjernstyres i tarmene dine" VECTOR EU-prosjektet, Adresseavisen, 25.10.2007.

"Kommunikasjon og læring i Fremtidens operasjonsrom", HMT nr.4 – 2007, s.22-25.

"Livreddende behandling ved Fremtidens operasjonsrom" Pulsen nr.4 – 2007.

"FOR opererer inn i framtida", Pulsen nr 4/07.

"Reddet av fremtidens operasjonsrom", Byavisa nr 50/07.

"Pillen som kan fjernstyres i tarmene dine". Artikkel i Adresseavisen, 25.10. 2007. Artikkel i forbindelse med EU møte i VECTOR prosjektet i Trondheim. (Naterstad S)

"Reddet av fremtidens operasjonsrom". Artikkel i Byavisa, 18.12.07 (Lein K, Myhr OR)

## **Publication on the internet:**

"Medisinsk link til Korea - sylskarpe TV-bilder fra operasjoner på St. Olavs skal sendes direkte til medisinstudenter i Sør-Korea, og vårt lokale medisinmiljø skal lære effektiv sykehusdrift av koreanerne"

[http://www.universitetsavisa.no/ua\\_lesmer.php?kategori=nyheter&dokid=4756932a64a1d0.49977757](http://www.universitetsavisa.no/ua_lesmer.php?kategori=nyheter&dokid=4756932a64a1d0.49977757)

## **Interviews / popular science:**

NRK P1. Norgesglasset. Intervju med Ronald Mårvik om VECTOR på bakgrunn av oppslag i Adresseavisen den 25. oktober 2007.

## **Prizes**

Svein Tønseth, SINTEF Media ble tildelt pris for beste artikkel 2006 i kategorien "norsk bedriftsblad" i regi av Norsk kommunikasjonsforening. Artikkelen "Med GPS i blodåra" stod i GEMINI nr.4- 2006. Artikkelen beskriver forskning som er sterkt tilknyttet FOR. Mars, 2007.

## **Participation in exhibitions and demonstrations**

MedTek-dagen 2007. 27. september 2007, Trondheim. "Navigasjonssystem for bildestyrt kirurgi". Arrangør: NTNU.

Årsmøte, Nasjonalt Kunnskapssenter for Helsetjenesten. 13. september 2007, Trondheim. "Nasjonalt kompetansesenter for 3D ultralyd i kirurgi". Arrangør: Nasjonalt Kunnskapssenter for Helsetjenesten, Sosial- og Helsedirektoratet.

Technoport 2007. 19-22. Oktober 2007. "Future Operating Room". Arrangør: Technoport.

Forskningsdagene 2007 - Researchers Night. 28. september 2007, Trondheim.  
"Kikkhullskirurgi - GPS for kirurger". Arrangør: NTNU - EU prosjekt "Researchers in Europe".

AMEE 2007. 25-29. August 2007, Trondheim. "Future Operating Room". Arrangør : AMEE - The Association for Medical Education in Europe.

## ***New medical technology at ORF***

- Upgrading of EndoAlpha, laparoscopy
- Development of wireless communications between videosource and visual display
- Upgrading of Dyna CT with software.
- New Leonardo-workstation for the Dyna CT
- Installation of prototype for operating light in connection with Dyna CT
- Upgrading of flat screens for laparoscopic procedures OR2, upgraded to full HD 1920 x 1080 input
- Further development of HD/SDI interface from OR1 or OR2 compatible with the Sony-HD-structure. This makes it possible to send HD formats from ORF in connection with video conferences using fibre-optic technology. Upgrading of video signals from OR1 makes it possible to show angiographic images and images from the Leonardo workstation in HD. This can then be transferred from ORF via fibre-optic connection.
- Radiology images can be shown in full HD.
- Upgrading and replacement of flat screens in the lecture room and further development of HD.
- Installed fibre-optic connection and technology from Network Electronics for ORF as a cooperation with Midgard Medialab.
- Performed live transmission using HD from the operating room to Nova cinema i connection with the 10 year anniversary of NSALK
- Upgrading of servers and network structure in the Sony infrastructure, AV/IKT.
- All touchpanels have been reprogrammed, which makes it compatible with all types of hardware.
- Implementing of a new platform for diathermy and ligasure.
- Installed MAC-computer for research within vascular surgery.

Replacement and upgrading of new technology in 2007 had a value of NOK 1 700 000,-. However, these costs were covered by our industrial collaborators through the research agreements.

## ***Economy / results***

In NOK 1000

	<b>Account 2007</b>	<b>Transferred to 2008</b>
Disposable equipment	61	
Salaries	1 645	
Technical equipment	103	
Other costs	281	
Overhead 15%	314	
<b>Total costs</b>	<b>2 404</b>	
<b>Research grants 2007</b>	<b>2 500</b>	
<b>Result 2007</b>	<b>97</b>	
<b>Positive balance transferred to 2008</b>		<b>97</b>

## ***Future plans for ORF in the new hospital***

After discussions with authorities from St. Olavs hospital and the Medical Faculty we are now planning the continuation of ORF in the new structure of our hospital. ORF will have an organization similar to what we have today, but the activity will be decentralized. The most important goal for continuation of ORF in the new hospital structure is to form a basis for good clinical research. However, it is also important to be a centre of competence for construction and management of operating departments. In Norway, as well as in other European countries, a significant number of new hospitals are under construction. Operating departments are expensive to build and are costly to run. The experience is that soon after these constructions have been finished, expensive secondary reconstructions become necessary as the technology is developing. We want to minimize this problem and will therefore focus on architecture, materials, ergonomics, IT, logistics and health economy. In this way we hope to obtain lower construction costs and more efficient management on a daily basis. It is important to evaluate these factors systematically to obtain evidence-based knowledge as far as possible regarding management of operating departments.

In ORF we have a close cooperation between several important institutions. This includes industrial companies, clinical departments and technology institutions. The most important participants are St. Olavs Hospital, The medical faculty, NTNU and SINTEF Health. Centres of competence like “Centre of competence - 3D-ultrasound” and ”National Centre for Advanced Laparoscopic Surgery” as well as Sør-Trøndelag University College are important collaborators and it is of great importance to further develop the synergy of this cooperation.

One of our main goals is to strengthen our international cooperation. We have been in contact with several international institutions regarding cooperation at ORF. So far we have concentrated on the cooperation regarding logistics with Massachusetts General Hospital, Boston, Future operating room, Tübingen, Germany and research groups at University Hospital, Krakow, Poland. Furthermore ORF has cooperation with organisations like EAES, SMIT and registers like EUROSTAR, an international register for endovascular procedures. If our economy and the number of supervisors had made possible, we could have had more international fellows at ORF. However, we feel that we must take care of those who already are working on projects at our institution. The fellows are externally financed. This has made it possible to maintain a good scientific activity in spite of a low annual budget. ORF has realistic and moderate goals since we aim at finishing one PhD and one Master degree annually.

Regarding research projects we work with the possibility of refining and extend the indication for stentgrafting for patients with aneurysmal disease, aortic dissection and arterial trauma. This means that we to a greater extent want to use stentgraft with sidebranches to the renal and visceral arteries. One project is exploring the possibility of using navigation to facilitate the application of this technique. We also want to treat more patients with ruptured abdominal aneurysms with endovascular technique. This project will be performed in cooperation with the Department of Anaesthesia and the Department of Radiology. The testing of the Dyna-CT imaging modality is also a PhD-project.

Within the field of laparoscopic surgery we will focus on the application on navigation and make such procedures safer. We are exploring new techniques for the treatment of morbid obesity. An interesting principle is to use pacemaker for stimulation of the vagus nerve in

these patients. This is an international multicentre study. Navigation can be used within most fields of surgery. In one project we use this technology for treatment of anal incontinence. Within orthopaedic surgery the technology is applied in knee surgery and operations at the vertebrae. New research projects will be started in 2008.

The synergy between NSALK and ORF makes it possible to give excellent courses for surgeons, operating nurses, medical students and engineers working with medical technology. Our training laboratory is at the moment under reconstruction and will be equipped with 10 new data simulators and 6 new laparoscopic racks. In addition we will have flexible scopes for training in a new endoscopic method; Natural Orifice Transluminal Endoscopic Surgery (NOTES).

The regional broadband network will make the training effective and will facilitate two-way communication between St. Olavs Hospital and other hospitals in our region. In this way we can supervise at courses by looking at transferred images, and simultaneously they can, if necessary, lead the data simulator from their own office. When our new training laboratory is finished, we will have the possibility of making courses for about 40 participants. The new multimedia network between ORF and NSALK will give the possibility to see all the procedures made at ORF while they can be transferred via broadband network to other European centres. At the time ORF has, in cooperation with Midgaard medialab, NTNU, received wavelength Unnett's research network for transferral of bilateral live-operations in cooperation with Yonsei Hospital, Seoul, South-Korea.

NSALK has made a strategy plan for 2008-2013 describing visions and goals for these years. NSALK is planning scientific studies of simulator training. NSALK/ORF have also taken the initiative to develop a new laparoscopic instrument which has been patented and will be commercialized through the company Surgitec Norway AS, Trondheim. The first instruments will be tested in animals in 2008. The University of Tübingen has also been taking part in the testing of this equipment.

Courses as well as teaching of medical students and specialist candidates are an important task for ORF. We need resources for simulators within several surgical disciplines. In addition to laparoscopic surgery this includes endovascular therapy, orthopaedic surgery etc. Within laparoscopic surgery the establishment of 8 laparoscopic simulators and 4 simulators for flexible endoscopy has already been mentioned. However, it is necessary to use simulators also in the teaching of surgeons, radiologists, cardiologists, orthopaedic surgeons etc. We have the possibility of cooperating with Royal College of Surgeons on these matters. Royal College has recently used significant economic resources on simulator training. Since there is less experience per resident in the operating room, simulator training will have a much more important place within all specialities where technical skill is required. We plan to establish a cooperation between various departments and clinics at St. Olavs Hospital and especially the Simulator Centre at St. Olavs Hospital/NTNU. Telemedical transmissions are an important part in the teaching of specialist candidates. High-definition solutions make it possible to observe details much better than when being present in the operating field. Such transmissions are extremely important as a supplement to conferences and courses.

For many years we have planned to use holograms and other advanced methods for visualization in the operation room, both as a diagnostic tool and as an adjunct in connection with operations. This could be of great importance in the teaching situation. Our collaborating partners at ORF have made these aspects possible in the near future.

ORF is based in the clinical and technological research groups in Trondheim where SINTEF is one of our most important partners. Innovation is an important goal for ORF. This could lead to establishment of a new industry connected to products which is a result of the research going on at ORF.

In ORF we focus on a good multidisciplinary cooperation, the collaboration with industrial partners and the unique research agreements which have been achieved with them. Furthermore, we have developed competence for accomplishment of projects, quality assurance, research projects through the Scientific Advisory Board. We have also knowledge regarding building and administration of high-tech facility, which an operating department is. An important argument for continuation of ORF is that our unit will take care of the education in application of electro-medical equipment for all clinics at St. Olavs Hospital. It will be a challenge to develop this project in a decentralised model, but we have plans how this can be achieved. An important aspect is to continue the solution with the research environments where we can accomplish research, teaching, innovation and development together with our industrial collaborators.

ORF has so far focused on minimally invasive therapy like laparoscopic surgery and endovascular treatment of diseases in blood vessels. Through our contacts in the recently established European Society for Nanomedicine new principles for treatment will also include surgical specialities. It is our aim to plan for the future where molecular biology and genetic technology will be used to a greater extent and replace the traditional open surgery.

Trondheim, March 2008



Jan Gunnar Skogås  
Managing Director, ORF



Hans Olav Myhre  
Scientific advisor, ORF



Torbjørn Dahl  
Responsible for endovascular therapy



Ronald Mårvik  
Responsible for laparoscopic surgery

## Collaborators from medical companies



## Research collaboration



[www.stolav.no/for](http://www.stolav.no/for)