Annual rapport 2015
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Summary

The Operating Room of the Future (FOR) is a research infrastructure facilitating research at St. Olav's Hospital HF. FOR is taking part in several research projects and many of them, but not all, are led by FOR. In the present report we have included some projects where FOR and our staff have represented a prerequisite for the completion of the project. In these cases we have included the project leader/supervisor in the mention.

The Operating Room of the Future is representing an excellent cooperation between St. Olav's Hospital HF, University Hospital of Trondheim and the Norwegian University of Science and Technology (NTNU), Trondheim, Norway. The tasks of the University Hospital is defined in the specialist health care act and include treatment of patients, teaching of patients and their relatives as well as teaching of health care personnel. Trondheim has a particular responsibility for research within the field of medical technology. From January first 2015 FOR became a department lead by the director of research, St. Olav's Hospital and as such also a part of the common research infrastructure of the hospital.

The principal activity at FOR is research to provide safer and better treatment, more efficient logistics and flexible architecture in the construction of new operating rooms. FOR has also become a centre of competence for the construction of operating rooms outside St. Olav's Hospital. An agreement with our industrial partners has made it possible for the Health Care Trust of Central Norway, St. Olav's Hospital and NTNU to promote research and development in central Norway. FOR has a close collaboration with National Centre for Advanced Laparoscopic Surgery (NSALK), SINTEF, NTNU Technology Transfer (TTO) and National Centre for Ultrasound and Image Guided Therapy. FOR is now a part of the national research infrastructure NorMIT (Norwegian centre for Minimally invasive Image guided Therapy and medical technologies) in cooperation with the Intervention Centre at the National Hospital, Oslo.

FOR is a multidisciplinary project and an arena for clinical research and development with focus on medical technology. Prototypes can be developed and tested in safe and controlled environments. FOR is set up to promote a close collaboration between clinicians, technologists, researchers and industrial partners. State of the art equipment is available at FOR.

FOR has now its basis in six operating rooms at the new St. Olav's Hospital; one at each of the operating departments. The FOR concept demonstrates synergy effects in letting representatives from various disciplines and medical specialities use equipment, areas and competence together. FOR has excellent facilities for research projects based on a multidisciplinary approach. Investigations are performed by PhD-candidates, scientists, students and clinicians. FOR with this technical equipment and design is perfect for teaching and education of students, doctors and nurses.

The operating rooms are equipped for image-guided minimally invasive therapy. During the first years the main focus was key-hole surgery of the abdomen (laparoscopic surgery) and endovascular therapy for diseases of the blood vessels. Minimally invasive therapy is now used in all surgical disciplines and FOR is including ENT, orthopaedic surgery, gynaecology and neurosurgery etc. Minimally invasive therapy is less traumatic than traditional open surgery and will become more and more important in the future.

New methods of teaching have been tested, and include transmission of images from the operating rooms with two-way communication. The educational part of the project will be continued. At FOR and NSALK several postgraduate courses for medical students are arranged annually.

FOR is taking part in the development of visualization and communication technology, which may be beneficial for diagnosis and treatment as well as for organisation of hospital units. Lecturing in the application of electro-medical equipment (EMU) has become a more important task for FOR.
St. Olav Hospital HF

St. Olav Hospital HF, University Hospital of Trondheim, is integrated with NTNU and owned by Central Norway Regional Health Authority RHF. Most institutions are located in the centre of Trondheim at Øya, Østmarka, Brøset and Lian. St. Olav Hospital has three district centres for psychiatry, two in Trondheim and one in Orkdal. Orkdal Hospital, New Røros Hospital and Hysnes Health Center are representing parts of the clinical activity at St. Olav Hospital.

St. Olav Hospital is the university hospital of Central-Norway with a population of 715 059 inhabitants, and local hospital for a population of 313 370 inhabitants per January first 2015. Through excellent cooperation with the local authorities and the primary health care we aim at optimal patient care.

Treatment of patients, teaching of patients and their relatives, as well as research and teaching of health care personnel are the main tasks of the hospital as defined in the specialist health care act. Our core values are integrity, equality, respect and co-determination, forming the background for our clinical activity and our students, colleagues and collaborators. St. Olav Hospital is integrated with the Norwegian University of Science and Technology, NTNU, and students, teachers and scientists are all playing important roles in the hospitals’ activity. Within teaching and research we are collaborating closely with several other institutions in central Norway. St. Olav Hospital has a special responsibility for research in our health region. As a university hospital we are actively contributing to the education of medical students as well as other health care professions, including medical specialist training in Central Norway.

In 2015 we had;

- 10411 employees
- 737 beds (somatic - and including Orkdal Hospital and Røros Hospital)
- 43 operating rooms (In addition: 5 ORs at Orkdal Hospital and 2 ORs at Røros Hospital)
- 436 072 somatic outpatient consultations
FOR, NorMIT and the future plans

FOR has been established as a brand for research and development at the integrated University Hospital of Trondheim. FOR is facilitating patient-oriented clinical research and innovation while we are developing the medical technology of tomorrow which then can be offered to the patients today.

National infrastructure for research
The collaboration with the Interventional Center at The National Hospital, Oslo University Hospital through the national infrastructure for research NorMIT, is now started after the inauguration took place in Trondheim in June 2014. “Norwegian center for minimally invasive Image guided Therapy and medical technologies” will strengthen Trondheim as the national headquarter of research in medical technology in Norway. I also hope that it will influence recruitment of professionals as well as scientists to our research group.

Innovation
St. Olavs Hospital will focus on product- and service innovation with the goal of improving the quality of treatment and safety for the patient. FOR will have an important role in our hospitals commitment for innovative solutions within minimally invasive therapy, logistics, work flow and organisation of high-tech diagnostics and treatment.

Competence
The potential within medical technology can be retrieved through cooperation between all those who are involved in the whole patient’s stay in hospital. A higher level of competence is required with focus on competence building to reach our goals on improved treatment with a minimum of complications, shorter stay in hospital, shorter convalescence and improved patient satisfaction. In addition we hope the treatment will be more cost-effective for the health care system as well as for the society as a whole.

Petter Aadahl
Director of Research
St. Olav’s Hospital
Photo: St. Olav Hospital
Dean of the Faculty of Medicine, NTNU, Bjørn I. Gustafsson

The development within medical technology during the last 50 years has been unique. Open surgery has to a great extent been replaced by minimally invasive techniques, giving better results and shorter rehabilitation. New systems for navigation, remote control and robotic surgery is opening up for a paradigm shift within surgical treatment. The technology is also becoming more important for teaching and training of personnel. This tendency is becoming more and more pronounced.

Increased standard of living and improved health has induced dramatic demographic changes in the society. People are living longer, but often with complex geriatric diseases. For the health care service to be sustainable in the future, we need new technological solutions and better training of students and health care personnel for optimal utilization of new medical knowledge. A multi-disciplinary approach and close collaboration between the health care system, academia and the industry is necessary to become successful.

The Operating Rooms of the Future (FOR) is an important contributor to achieve our goals. When FOR was established in 2005, it was the result of visionary innovation. Today, 11 years later we can confirm that this has been a very successful way of organizing a common research infrastructure and cooperation regarding medical technology and teaching in the integrated university hospital. Today we have six operating rooms for various operative specialties with priority and available time for scientific work. The fact that we are successful in the competition for external funding indicates that we were on the right track when establishing the center. We are also pleased with the good collaboration with other research institutions including technological research groups at NTNU, SINTEF and the Intervention Center at the National Hospital. This cooperation also includes national and international industry.

The infrastructure which now has been established at FOR is giving us unique opportunities to perform good clinical investigations which will improve patient treatment. In the future, FOR will contribute to innovation within the health care sector and should have a key role in national and international scientific collaboration.

In the years to come, FOR is going to be a spearhead at the integrated university hospital. There is no doubt that FOR is important if we are going to succeed within good clinical research and innovation in Central Norway.
Organization of the Operating Room of the Future

Overview of the FOR research infrastructure
Staff

Hans Olav Myhre
Emeritus professor of surgery

Jan Gunnar Skogås
Biomedical Engineer
Managing director, FOR

Torbjørn Dahl
Assistant professor
Scientific adviser
Chief, Department of Vascular Surgery

Ronald Mårvik
Assistant professor
Consultant surgeon
Department of Gastrointestinal surgery

Marianne Haugvold
Cand. Scient.
Project coordinator

Therese Marken
Surgical nurse
Project coordinator

Liv-Inger Stenstad
Radiographer/ Master student
Project coordinator

Geir Andre Pedersen
Radiographer / Master student
Project coordinator

Gabriel Kiss
Engineer / Researcher
NorMIT coordinator

Photo: St. Olavs Hospital
An important task for FOR is to improve the quality and quantity of clinical research. Therefore the scientific advisory board is going through all research protocols, giving advice to those who are doing projects under the direction of FOR. FOR has a special guideline for projects including the tasks of the scientific advisory board as well as a description how to make research protocols (Professor Per Farup). These documents are forming the basis for the collaboration between FOR and those who are conducting research projects there. In addition we are making separate agreements between FOR and the project leaders. In 2015 altogether 7 bachelor degrees and 3 PhD degrees were finished in collaboration with FOR. FOR will have several main subjects for medical students.

The scientific advisory board has the following members in the period 2009 - 2015:

- Assistant professor Torbjørn Dahl (leader)
- Professor Hans Olav Myhre
- Professor Jon Erik Grønbech
- Professor Olav Haraldseth
- Professor Toril N. Hernes
- Professor Per Farup
- Professor Olav Sellevold
- Assistant Professor Ivar Rossvoll
- Professor Ståle Nordgård
Highlights of 2015

NorMIT

NorMIT is a national collaboration; its main goal is to establish an infrastructure that will contribute to increased clinical and technological research. It will help to generate expertise and innovation, and thus lead to improved patient safety. Although the main focus of the infrastructure is image-guided minimally invasive therapy and medical technology, NorMIT will also perform research and development in other important areas such as logistics, workflow, communication, organization and transmission of high quality images.

The operating rooms that are part of NorMIT are in practice modern research laboratories that develop, test and adopt new technology, new treatments and new medications. Cooperation and division of labour will help the two units, in Oslo and Trondheim, become a single infrastructure for image guided treatment and medical technology. The research centers in Trondheim and Oslo represent two of the country’s strongest environments in their field, environments that have been important in the development of methods and technologies in this field also in an international perspective.

The Intervention Centre at Oslo University Hospital and the Operating Room of the Future at St. Olav’s Hospital have become a joint research and innovation infrastructure as a result of NorMIT, with two nodes - one in Oslo and one in Trondheim. The infrastructures in both Oslo and Trondheim are used as expected. This infrastructure will strengthen research in several areas of great strategic importance for Norway: medical technology, ICT, nanotechnology, translational research and health innovation.

The main focus in 2015 has been to invest substantial amounts in equipment for research purposes and this will be followed by further investments in the coming years in order to set up the project’s research infrastructure. Part of this work has been to start the development of a common navigation platform for image-guided therapy (the NorMIT navigation platform), which is a collaborative subproject between the Oslo and Trondheim environments. Efforts to develop a common navigation platform have been started and have advanced according to plan. An important partner for NorMIT is the "National Center for Ultrasound and image-guided therapy", which is a national competence center appointed by the Health Care Ministry. NorMIT has many potential users, and its main purpose is to enable an extensive national and international cooperation between academia, industry and various clinics.

Please visit normit.no for more information!
Newsletter from FOR

In October 2014, the first newsletter from FOR was available. It will be distributed every other month focusing on the FOR clinics including the activity at the FOR operating rooms. In each newsletter we will focus on one particular clinic.

So far the newsletters have been a great success showing the extent of the FOR activity. In 2015 a newsletter was distributed in March, May, June, October and December. We think this is a useful way to inform about the activities at FOR and hope you will enjoy it. To visit the newsletters please use this link:

http://www.stolav.no/no/Om-oss/Avdelinger/Fremtidens-operasjonsrom/Nyhetsbrev/130314/

Five newsletters were released in 2015 - in March, May, June, October and December
Three PhD theses with connection to FOR have been defended in 2015

Jordi Puig

Friday October 9th 2015, PhD fellow Jordi Puig defended his thesis “Art and Technology Perspectives on Brain Atlases”. The committee consisted of Pier Luigi Capucci (University of Plymouth) and Judith Redi (TU Delft), while NTNU was represented by Konstantinos Chorianopoulos (NTNU). Puigs supervisors were Andrew Perkis and Aud Sissel Hoel (both from NTNU).

Puigs work was a part of the multidiciplinary NFR-supported project Picturing the Brain: Perspectives on Neuroimaging (2010-2014), which was based on collaboration between Institute of Art and Media Science, NTNU, Centre for Quantifiable Quality of Service in Communication Systems (Q2S) at NTNU, Operating Rooms of the Future at St. Olavs Hospital (FOR), SINTEF and University of Oslo.

Vijayan Sinara

Sinara Vijayan, Institute of Circulation and Medical Imaging, NTNU defended her thesis “Improved image guidance for minimally invasive liver therapy – Image co-registration techniques” for the PhD degree in medical technology at The Medical Faculty, NTNU.

Professor Toril A. Nagelhus Hernes and director of research Thomas Langø have been her supervisors. Assistant professor Ronald Mårvik and assistant professor Ole Jakob Elle have been co-supervisors.

The dissertation took place November 6th 2015.

Erik Smistad

September 24th, Erik Smistad completed his trial lecture and thesis defence and was awarded the PhD degree. Adjunct Associate Professor Frank Lindseth has supervised his PhD work at the Algorithms, HPC, and Graphics (AHG) research group. Co-supervisors have been Associate Professor Anne C. Elster and Adjunct Professor Toril A. Nagelhus Hernes.
FOR network-meetings 2015

FOR’s network-meetings are arranged twice a year and were established in 2011 on request from FOR’s collaborating units. The meetings are an arena for FOR-contacts in the respective departments, but may include any collaborating partner. The purpose of these meetings is to promote research and development activities together with FOR and to exchange ideas and experience. The last couple of years, we have stimulated the various clinics which are cooperating with FOR, to host these meetings. The spring-meeting was arranged by Clinic of ENT Diseases, Oral Surgery and Eye Diseases on May 28th 2015.

Section leader Anne Lise Krogstad and the FOR contacts Mona Elisabeth Källman and Marit Furre Amundsen at The ENT Department had an excellent presentation on FOR-related research projects going on at the moment.

Wednesday December 2nd, the autumn-meeting was arranged by the Department of Neurosurgery. Professional development nurse Pål Sørensen gave an inspiring presentation about Department of Neurosurgery; how the department was organized, activity at the operating department, which technology was available at the department and research activity as well as publication policy. He completed the presentation by emphasizing the importance of research, development and innovation.

Photo: Marianne Haugvold, FOR
Activity at the FOR operating rooms

Surgical Clinic

Medical technology is becoming more and more important in the surgical treatment of patients and the Surgical Clinic is completely dependent upon the FOR operating room for endovascular treatment of aortic aneurysm and dissection. More patients are also treated with so-called advanced stent-grafting. As a result of this, we have more collaboration between radiologists and vascular surgeons. We have great expectations about the use of the “Angiosimulator” for planning of advanced procedures. This will be studied in a project together with the National Center of Competence for Ultrasound and Image Guided Therapy.

From the Department of Cardiology there is increasing activity regarding endovascular implantation of heart valves (TAVI) and there is already need for one more hybrid operating room. At the same time the increased activity is leading to challenges regarding maintenance and upgrading of the FOR operating room.

The activity within experimental surgery slowed down during a period when the animal laboratories were under reconstruction. Since this work is finished, the activity is now increasing again, and as a part of the NorMIT cooperation, scientists are coming from Oslo to do experimental procedures at our center in Trondheim. Within laparoscopic surgery, we are working with intraoperative ultrasound and instrument – navigation during surgery for liver metastases. Thoracoscopic resection of the esophagus is a well-established method. Thanks to the excellent collaboration with the Department of Anesthesiology and the Operating Department, we have been able to extend the working hours whereby we can use more time to develop new operating techniques.

There is a steady interest from the bachelor programs of nursing and radiography to do projects in cooperation with FOR.
Altogether 53 patients were treated, 28 women and 25 men. 48 had aortic stenosis while 5 were treated for degeneration of biologic aortic valve implant. 41 of the procedures were transfemoral and 12 transapical. 18 had implantation of balloon-expandable valve and 25 with self-expanding valve implant.

**TAVI 2015**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAVI</td>
<td>53</td>
</tr>
<tr>
<td>New stentgraft for AAA</td>
<td>58</td>
</tr>
<tr>
<td>Various vascular operations</td>
<td>44</td>
</tr>
<tr>
<td>Various other operations</td>
<td>15</td>
</tr>
<tr>
<td>Thoraco-abdominal stent-grafts w/ side branches</td>
<td>5</td>
</tr>
<tr>
<td>Combined procedures (open operation +PTA/stent)</td>
<td>42</td>
</tr>
<tr>
<td>PTA/stent</td>
<td>10</td>
</tr>
<tr>
<td>Various endovascular procedures (coiling etc.)</td>
<td>14</td>
</tr>
<tr>
<td>Removal of infected pacemaker</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>253</strong></td>
</tr>
</tbody>
</table>

Stent-graft operation at FOR operating Room, AH-1F
Photo: Liv-Inger Stenstad, FOR

AH-1F FOR Operating room: TAVI- operation
Photo: Liv-Inger Stenstad, FOR
There has been a high activity in this operating room. “Upper GI” had more than 100 laparoscopic and almost 100 endoscopic procedures. “Lower GI” had around 50 laparoscopic and 50 endoscopic procedures. In addition, the operating room was used for open surgery at Department of Gastroenterological Surgery, Department of Urology and Endocrine surgery.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laparoscopic appendectomy</td>
<td>6</td>
</tr>
<tr>
<td>Pancreatectomy/resection</td>
<td>7</td>
</tr>
<tr>
<td>Sigmoid resection</td>
<td>7</td>
</tr>
<tr>
<td>Gastric bypass</td>
<td>7</td>
</tr>
<tr>
<td>Choleysectectomy</td>
<td>6</td>
</tr>
<tr>
<td>Splenectomy</td>
<td>1</td>
</tr>
<tr>
<td>Paraesophageal hernia</td>
<td>10</td>
</tr>
<tr>
<td>Adrenalectomy</td>
<td>2</td>
</tr>
<tr>
<td>Hemicolecstomy</td>
<td>6</td>
</tr>
<tr>
<td>Total colectomy</td>
<td>8</td>
</tr>
<tr>
<td>Liver resection</td>
<td>6</td>
</tr>
<tr>
<td>Myotomy</td>
<td>4</td>
</tr>
<tr>
<td>Fundoplication</td>
<td>5</td>
</tr>
<tr>
<td>Rectal amputation/resection</td>
<td>16</td>
</tr>
<tr>
<td>Ventral hernia</td>
<td>7</td>
</tr>
<tr>
<td>Gastric resection</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>111</strong></td>
</tr>
</tbody>
</table>

FOR Operating room at Department of Gastroenterological Surgery
Photo: Gabriel Kiss, FOR
FOR activity in the Clinic for Medical Imaging

The Clinic for Medical Imaging has for many years contributed to the implementation of numerous studies and clinical treatments at the FOR operating room in the AHL building. This collaboration continued in 2015.

During the insertion of stent-grafts in the aorta, the interventional radiologist plays a central role and is closely interacting with the vascular surgeon. This is a good example of how modern medicine depends on good cooperation between various specialties in order to achieve a good outcome for the patients. In 2015, 51 stent grafts were placed electively in the abdominal aorta and an additional 8 as part of immediate emergency procedures. In the thoracic aorta 7 elective and 11 emergency stent graft procedures took place. In addition, 3 thoraco-abdominal grafts were placed, one of which was an emergency procedure.

In addition, vascular procedures in the pelvis and lower limbs have been performed in collaboration with vascular surgeons. In 2015, 44 such procedures were completed, where one combine the use of traditional open vascular surgery with stenting of vessels during the same session.

Doctors from the clinic are also involved in the planning of TAVI procedures.

Regarding research projects, personnel from the clinic have participated in experiments on phantom based navigation (completed), experiments in phantoms combined with image registration (ongoing) and animal experiments in pigs, with deploying of stents in the airways (completed).

Funding for an upgrade of the angio simulator has been confirmed. This facility is jointly owned by the Medical Simulation Center and several clinics at the hospital. The upgrade will enable us to conduct preoperative planning in a completely new way, more specifically by using the patient’s own CT examination and by virtual testing of the equipment before the procedure. In addition, one could train the operating team before the surgery in order to achieve a better cooperation. The use of this new simulation system will be evaluated and followed up in connection with a PhD work during 2016. It will be interesting to see how preoperative simulation will affect our processes in the future.

Edmund Søvik
Head of clinic / Chief Attending Physician
Clinic for Medical Imaging
Photo: St.Olavs Hospital

<table>
<thead>
<tr>
<th>Activity in the Clinic for Medical Imaging</th>
<th>FOR operating theater at AHL 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stent grafts in the abdominal aorta</td>
<td>51+ 8 emergencies</td>
</tr>
<tr>
<td>Stent grafts in the thoracic aorta</td>
<td>7 + 11 emergencies</td>
</tr>
<tr>
<td>Thoraco-abdominal stent grafts</td>
<td>2+ 1 emergencies</td>
</tr>
<tr>
<td>Combined intervention in the pelvis and lower extremities</td>
<td>44</td>
</tr>
<tr>
<td>TOTAL</td>
<td>124</td>
</tr>
</tbody>
</table>
FOR activity at the Department of Women and Children’s Diseases

At the Department of Women and Children’s Diseases we have a close collaboration with FOR and, our FOR operating room is the primary choice for all laparoscopic procedures. The equipment has been transferred from the “old” FOR operating department and includes EndoAlpha and HD camera. In addition we have a high-energy platform, Force Triad, which is tested intraoperatively to obtain haemostasis.

We have now established a new operating room located near our out-patient clinic. Thereby we have been able to increase the capacity without increasing the staff. The planning of this operating unit was done in close cooperation with FOR.

Robotic surgery has now become routine at our department. We are applying this technology both for general gynaecological operations as well as for cancer surgery. Thus, we can obtain a sufficient experience with this particular operating technique. Robotic surgery requires collaboration with the Department of Urology for optimal use of the capacity of the Da Vinci robot. Robotic surgery fits well into the FOR concept; it is high-tech, innovative and has a great potential for the future. We are looking forward to continue the present good cooperation with FOR and operating room personnel at The Department of Surgery regarding the application of robotics. In 2012 a second Da Vinci robot was achieved at Orkdal Hospital, indicating that this hospital is a significant part of the University Hospital. We are now doing robotic surgery 2-3 days per week; two days at St. Olavs Hospital and 1-2 days at Orkdal Hospital.

Research at our clinic has concentrated on ovarian cancer (tumour reductive surgery) and on operative technique applied during hysterectomy. All robot-assisted operations are recorded prospectively in a register. During the 3-year period ending October 2013 altogether 390 such operations had been performed. 50 % of them were carried out for malignant or premalignant conditions (e.g. carcinoma of the endometrium or cervix) and 50 % for benign conditions (hysterectomy for uterine haemorrhage, ovarian cysts, endometriosis, and genital descence).

Numbers for robotic surgery at our department for 2015:
- Total number of patients operated: 183. At St. Olav Hospital: 124 and Orkdal Hospital: 59.

We have obtained a shorter stay in hospital and less postoperative complications. With increasing experience, the operating time has been reduced and very few operations need conversion to open surgery. We are now conducting a research project exploring the importance of sentinel lymph nodes in cancer of the cervix and endometrium using a fluorescence camera connected to the Da Vinci robot.

FOR has been extremely useful for organizing the compulsory training and certification of our personnel in the application of electro-medical equipment. This is an important service to the operating clinics and is an excellent course whereby we are able to fulfil the requirements given by the health authorities.

We are pleased with the close cooperation with FOR and are looking forward to further cooperation.

Arne Sunde
Head of Clinic of Women and Children’s diseases
Photo: St. Olavs Hospital
### Operative activity FOR operating room 7
Department of Women and Children’s diseases 2015

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Maternity unit</td>
<td>45 patients</td>
</tr>
<tr>
<td>IVF</td>
<td>38 patients</td>
</tr>
<tr>
<td>Gyn Cancer</td>
<td>23 patients</td>
</tr>
<tr>
<td>Gyn General</td>
<td>443 patients</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>549 patients</td>
</tr>
</tbody>
</table>

FOR- Operating room of the futures at the Department of Women and Children’s diseases
Photo: Gabriel Kiss, FOR
The Department of Neurosurgery has one of the FOR operating rooms, which is facilitating a high scientific activity at our unit. The research at Department of Neurosurgery is carried out in close cooperation with “Centre of Competence for Ultrasound and Minimally Invasive Therapy”, a very important platform for our research activity. Our research has its background in clinical needs and is through a multidisciplinary approach, combining technological and clinical research. Less traumatic and safer treatment modalities are developed.

The most important research profile of the department is the application of 2D and navigated 3D ultrasound within image-guided minimally invasive neurosurgery. This technology has been applied to several areas including surgery of the pituitary gland, operations for brain tumors, arterio-venous malformations and hydrocephalus operations. Several of our projects are exploring the potential of 3D-ultrasound and navigation within these fields.

A new and exciting project in collaboration with FOR is the “Visualization project” - where new imaging technology including clinical images, is tested during minimally invasive surgery in a prototype operating room. Another research project is "Picturing the Brain: Perspectives on Neuroimaging" where new methods for visualization and imaging of the brain are explored. This project resulted in one PhD-degree at NTNU in 2015.

Together with the IO center - Center for Integrated Operations in the petroleum industry, NTNU, SINTEF and FOR, a case study was performed during the spring 2014 exploring how collaboration in a team might improve the way we work in an operating room, thereby leading to improved safety and effectivity. Observation and interviews of the operating team was also performed during the spring 2014. Two papers from this project were published during 2015.

In 2015 FOR assisted us with live-transmission in connection with the international course for neurosurgeons “ULTRASOUND IN NEUROSURGERY”. The transmission was made in full HD with two-way communication.

FOR has, on behalf of the clinic, arranged compulsory courses in the use of electro medical equipment (EMU). All doctors are trained in the use of electro medical equipment and the documentation is well established. These courses are fulfilling the demands within this area for all doctors at the department.

The research activity going on at the FOR operating room is integrated in the routine clinical work.

We are looking forward to continue this excellent collaboration with FOR in 2016.
## Operative activity at FOR operating room 3
Department of Neurosurgery 2015

<table>
<thead>
<tr>
<th>Operation</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Craniotomies/intracranial operations, vascular lesions and head trauma</td>
<td>62</td>
</tr>
<tr>
<td>Shunt operations</td>
<td>6</td>
</tr>
<tr>
<td>Operations on the spinal canal, spinal cord and nerve roots</td>
<td>221</td>
</tr>
<tr>
<td>Other operations:</td>
<td></td>
</tr>
<tr>
<td>• Spinal cord</td>
<td></td>
</tr>
<tr>
<td>• Nerve root</td>
<td></td>
</tr>
<tr>
<td>• Pain or dysfunksjon</td>
<td>33</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>322</strong></td>
</tr>
</tbody>
</table>

FOR operating room, Department of Neurosurgery
Photo: St. Olavs Hospital
FOR activity at the Clinic of Ear-Nose-Throat, Eye- and Maxillofacial Surgery

FOR is supporting the following important activities at our clinic:

1. Research with focus on innovation and technology. Important projects are “Ganglion. Sphenopalatinum/multiguide” and “Modelling of the upper airways in sleep apnea”. Both projects are representing innovation and multidisciplinary cooperation, in this case together with the technology-campus at NTNU and SINTEF.

2. Testing connected to purchasing of technological equipment. In 2015 FOR has facilitated testing of new equipment at all the departments of our clinic.

3. Excellent logistics for the treatment of patients. A part of this is the local quality-register for nose operations. The majority of these operations are taking place at the FOR operating room. We are planning standardization of other operative procedures and postoperative courses, and will start more quality registers connected to our operative activity.

4. Excellent audiovisual solutions for our teaching program. Image recording of tonsillectomy of outstanding quality was used at a compulsory course in ENT surgery of The Norwegian Medical Association.

We are looking forward to continue the excellent cooperation with FOR in 2016.

Mette Bratt
Chief of clinic
Photo: St. Olavs Hospital
### Operative activity at the FOR operating room 1
Department of ENT, Maxillofacial and Eye diseases in 2015

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional endoscopic sinus surgery (FESS)</td>
<td>85</td>
</tr>
<tr>
<td>Septal plasty</td>
<td>52</td>
</tr>
<tr>
<td>Concha plasty</td>
<td>17</td>
</tr>
<tr>
<td>Sialoscopy</td>
<td>6</td>
</tr>
<tr>
<td>Arthroscopy</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>172</strong></td>
</tr>
</tbody>
</table>
FOR activity at the Clinic for Orthopedic-, Rheumatology and Skin Diseases

The Clinic for Orthopedic, Rheumatologic and Skin Diseases is using the FOR research infrastructure for various projects. During the last two years several scientific projects have been facilitated through FOR. Fast track surgery has been the basis for four scientific articles and this work has received significant attention during recent years, also outside St. Olavs Hospital.

There is need for optimizing and upgrading of the technology at the FOR operating room to make it a good arena for further innovation within orthopedic surgery. In the near future, we will start a project where we will examine the air flow in operating rooms with a so-called LAF (Laminated air flow) system. Critical questions are: How should they be designed? How is the ergonomics in these operating rooms? And which factors are inducing turbulence of the air flow?

There is great need for the development of new treatment modalities and medical technology within orthopedic surgery. We are therefore planning more projects within research and development. During the last year, several scientific projects are on the planning stage, and FOR is an important infrastructure for these projects. Our clinic is using FOR for the compulsory training in the use of electro medical equipment for surgeons. FOR is arranging these courses and is organizing the training, including examination and approval on behalf of the clinic.

Jan Gunnar Skogås
Head of Clinic for Orthopedic,
Rheumatologic and Skin Diseases
Photo: St. Olavs Hospital
<table>
<thead>
<tr>
<th>Operation</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary hip prostheses</td>
<td>75</td>
</tr>
<tr>
<td>Revision of hip prostheses</td>
<td>40</td>
</tr>
<tr>
<td>Knee prostheses</td>
<td>152</td>
</tr>
<tr>
<td>Other operations</td>
<td>72</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>339</strong></td>
</tr>
</tbody>
</table>

Mainly total prostheses of the knee are included in the fast-track project.
Technology in the FOR - operating Room

Medical technology at FOR, 2015
The research infrastructure at the FOR operating rooms, has in 2015 been upgraded with new software and some hardware. In addition minor adjustments of the technology equipment has taken place.

FOR operating room, Cardiovascular Centre:
- Upgrading of software for ArtisZeego angiography laboratory, which is giving better and faster image processing and the possibility for new applications.
- Integration of ultrasound imaging in the visualization display and improvement of the user-interphase

FOR operating room at the Center for GI Surgery:
- 3D visualization of laparoscopic procedures.
- Upgrading of the software of the EndoAlpha – system and of the EXERA
- Implementation of high-energy platform for electro-surgery

At the FOR operating room at The Department of Neurosurgery:
- Upgrading of the display technology giving full access to HD and later 4K. These changes will lead to better display solutions for high resolution images with depth of field, good ergonomics and correct colour reproduction.

FOR operating room at the department of gynecology:
- Upgrading of the software of the EndoAlpha - system and of the EXERA
- Implementation of high-energy platform for electro-surgery

FOR operating room at the department of ENT:
- Software upgrading of OR-1
- Adjustment and improvement of the visualization plane
- Improvement of the internal communication axis as well as between MTU

Today we have two Da Vinci robots available at St. Olavs Hospital, one for urology and one for gynecology. The Departments of Urology and Gynecology have both excellent experience with the Da Vinci robot and several other surgical specialties are now interested in implementing this technology. Therefore, enough technology-time and operating room capacity is becoming a challenge. FOR is working together with the clinics to find a more permanent solution to these problems. Service and upgrading of both robots has taken place in 2015. One of the robots is a part of the NorMIT infrastructure.

We have further developed the fiber and IP-based communication for telemedicine via FOR, and new IP technology has been applied through the research net – Uninett. This has been used in communication from FOR to various destinations in Asia, Europe and USA. We have focused on further development of fiber-optic communication from the FOR operating rooms, making live transmission in full high definition possible. Since 4K soon will become available, we have already made prototypes for imaging and visualization with the possibility of live transmission.

We are cooperating with the Department of Medical Technology, MTA, HEMIT and Viju regarding optimisation of the ICT infrastructure. Today it is possible to make live transmissions from all six FOR operating rooms to the Knowledge Center.

In addition to clinical research, the operating rooms at FOR have been used for experimental investigations as well as laboratory studies. Navigation has been tested out in experimental neurosurgery, ENT, laparoscopy and in connection with endovascular procedures.

Development and testing of prototypes of medical technology and new equipment has been carried out in collaboration with various research groups and international industry. Employees at SINTEF and PhD-candidates have also used FOR operating rooms for calibration, testing and mounting of navigation equipment. Units from our own institution and industrial collaborators have used our research platform during 18 weeks for the testing of technological systems, quality control, safety control, upgrading and validation. Faster image processing and new applications have been tested in addition to integration of the ultrasound image in the visualization display, and improved user interface has been achieved.
FOR-NorMIT infrastructure

Three new ultrasound scanners were acquired as part of the NorMIT infrastructure. Two of them are from Verasonics, and are dedicated research scanners that provide unique opportunities to try out novel ultrasound imaging methods both for experimental and clinical use. The systems are suitable for research and allow users to make arbitrary imaging setups in a short time. Then the system sends the raw data (channel data) directly to a PC where it is stored and processed in real time. The high performance of the Verasonics system makes it possible to image with thousands of frames per second, at least a ten fold increase compared to previous results, and as such enabling the development of better methods for quantifying tissue deformation (elastography) and blood flow. In addition, a HIFU (High Intensity Focused Ultrasound) add-on was purchased that can be used for cancer treatment, was acquired.

A FUS Instruments ultrasound scanner is available and can be used for animal experiments. It is currently used in a research project that aims to temporary open the blood-brain barrier with ultrasound waves. For some diseases, it may be beneficial to deliver drugs across this barrier in some regions of the brain. Early research shows that this process can be enabled by using focused ultrasound waves.

In addition the FOR-NorMIT infrastructure in Trondheim has a dedicated visualization lab and a media production system suitable for beginners. Mixing of live HD camera recordings, optical microscope images with the output of a navigation system for image-guided intervention can be done in the operating room. Additional features of the media production system include: capture of multiple live video sources, mix of sources using various visual templates, graphics and text overlay and storage of all input streams and of the final result with synchronized time stamps.
**Medicine and media technology**

Medicine and media technology has its source from the resource network AV Arena Norway at Operating Rooms of the future. FOR, St. Olavs Hospital has, since it started in 2005, had focus on the development of image guided surgery and image guided treatment in general. Digital media technology is important for the further development of this discipline. This sort of resource network is important to form a bridge between competence within digital media technology and health care, especially within training and cooperation and the establishment of projects to release medical and organizational benefits within the health care sector.

The portfolio of this resource network had in 2015 a strong focus on the improvement of health communication and telemedicine and to increase the capacity for innovation within the public sector. Collaboration with the oil industry is important to develop the telemedicine of the future.

FOR has an advantage since we have a strong focus on media technology and is used to collaborate with national and international industrial partners and research groups. The network is connected to strong clinical groups making it easier to collect transfer values between the various groups. Here FOR has an important role in the planning of operating rooms, including architecture and design with focus on infrastructure and medical technology.

Medicine and media technology is of importance for several fields and will strengthen our position as an important arena for research and innovation in the health care sector.
Telemedicine of the future - collaboration with the oil and gas industry

June first 2014, the project “The Future of Telemedicine in O&G” was completed. The project was based on a pre-project finished in 2013. Partners in this project were: Conoco Philips, Petrobras. IBM, St. Olavs Hospital represented with FOR and The Emergency Department, Medical Imaging Laboratory (MI lab), NTNU, Albert Einstein Hospital, and Center for Integrated Operations in the petroleum sector at NTNU/IFE/SINTEF.

The project is studying the work-flow within telemedicine today and is exploring the future potential for telemedicine. Thus, we are developing and demonstrating prototypes for new telemedical solutions. And we are investigating safety aspects as well as aspects of planning and implementation of new telemedical practice offshore. The project is developed together with representatives from Norwegian and Brazilian oil industry and will most likely influence telemedical solutions in the health care sector as well. One result of the project was introduction and demonstration of a “virtual examination room”. See illustration page 29.

It has been decided to continue the project in a phase 3. Here we are planning an upscaling of both development and demonstration of a prototype in 2015-2017. We are working continuously with the virtual examination room, which we believe will have synergy effects with the collaboration project on decision support within and between various levels of the health care system.

Operating Rooms of the Future is the leader of this project.

The Ekofisk platform. The nearest platform (with the helipad) is also the accommodation platform and includes an examination room. Photo: ConocoPhillips
Decision support and “seamless” sharing of medical information within and between the various levels of medical treatment.

The Operating Room of the Future received a grant from the Health Authorities of Central Norway to start a project on how to share medical information, and on collaboration for decision support within and between the levels of treatment in specialist- as well as in primary health care and pre hospital service. The project is founded on results of a project “Telemedicine of the future in oil and gas industry” which again is anchored in Center of Integrated Operations in the Petroleum Sector, NTNU and organized by FOR, St. Olavs Hospital. The project will demonstrate new applications of ICT technology and new work processes for decision support between the various levels of treatment. The primary health-care reports a satisfactory development of new medical technology which can be used for better diagnostic work and for treatment of patients. A good example is the pocket sized ultrasound machine Vscan. However there is need to improve the next step in the work process with simple solutions and systems for sharing medical information, and how cooperation and decision support can be achieved with a minimal response time while the quality of priorities and decisions are at the same time improved.

Today the primary health care has no “seamless” systems for sharing medical information in the decision support in and between levels of care. The routine today is the use of phone, telefax, e-mail, video and letters and the structure is rather fragmented.

Illustration: FOR

The director of interaction at St. Olav’s Hospital has expressed the need for the specialist health care to provide “packages” which could trigger decision support to the primary health care including prehospital service. Transmission of information while the patient is transferred between the different levels of care is representing a challenge for obtaining better patient treatment. Such decision support is important to maintain good quality of the treatment and is supporting the implementation of a “seamless” course for the patient. This will also improve documentation regarding who did what and when in the decision chain. Finally it will be an important tool for documentation of quality in the treatment.

Demonstrations have shown promising results. The ideas have matured to an extent that they can now be moved and transformed further by the needs of our regular health care system. St. Olav’s Hospital is in a good position to lead the development of forming future “packages” for decision support in our health care system and to become a reference center for the important commitment in ICT- development adopted by the Health Authorities of Central Norway.

The project has focus on defining the needs and to understand the work process on a detailed level. On this basis the aim is to form ICT solutions which will lead to new routines. The project started during the autumn 2014 and will continue throughout 2016.
The National strategy plan for ICT 2013-2020

The Operating Room of the future is mentioned in the national plan for ICT 2013 - 2022. The Norwegian government has a strategy for research and development within ICT focusing on important areas where they want to spend resources in the years to come.

ICT in combination with medical technology is becoming more and more widespread. To improve growth and formation of values we need strong ICT groups in Norway and we are dependent upon research and development within this area. Although much is going on internationally, we need our own national expertise within the field. The government has pointed at three focus areas of ICT research and development in the years to come:

- ICT of high international quality
- Business development
- Social challenges


Dissemination of knowledge

The Annual Røros FOR seminar 2015

The annual FOR seminar was arranged at the beautiful mining city of Røros.

We gathered 74 participants from St. Olavs Hospital, NTNU, SINTEF, industrial partners and exciting guest speakers, among others Ottar Tollan from Scandinavian Business Seating and Paal Brekke from the Norwegian Space Centre. The program was varied and interesting. Such gathering means a lot, and it is important to be able to meet at a different arena than you do on a daily basis.
Courses arranged by FOR

Arranged EMU-courses in 2015:

October 30th: Two-day course for Surgical Clinic:
- High energy equipment
- Endoscopy
- Irradiation protection and use of C-arm for fluoroscopy

Courses in the use of electro-medical equipment (EMU)
On behalf of the operating clinics FOR is conducting compulsory courses in the use of electro-medical equipment. In 1999 a new regulation regarding “Use and maintenance of electro-medical equipment” was passed. This regulation has its background in law on medical equipment from 1995. According to § 13 training and instruction in the application of such equipment is necessary because:

- Personnel who are going to use electro-medical equipment must have training and instruction in the application of such equipment.
- They should know potential side-effects connected to the application of electro-medical instruments and know how to prevent them.
- The training program must be systematic and include documentation.

The Systematic training program must include:

- Training when new equipment is introduced.
- Training of new employees.
- Maintenance of the knowledge achieved during this training program.

At present the training program including the documentation is well established at all operating clinics at St. Olavs Hospital. All surgeons, including surgeons in training as well as staff surgeons, are getting invitation to the courses as part of the continuing medical education.

Course in hospital hygiene
A course in hospital hygiene can now be followed at the electronic network “Kilden” of the hospital. It consists of 4 modules. After completion, documentation will be given by FOR that the course has been completed.
**Staff**

Medical personnel affiliated to FOR is going through annual certification in compliance with national regulations regarding use and maintenance of electro-medical equipment. All surgeons at St. Olavs Hospital are also going through courses on an annual basis regarding the use and maintenance of electro-medical equipment. The personnel at FOR is including so-called super-users having special focus on modern, advanced medical technology. They need to go through refreshing courses on a regular basis. The personnel at FOR is contributing to training of personnel from other departments at St. Olavs Hospital as well as personnel from institutions focusing on clinical procedures, research and application of medical technology. As an example, nurses working in the oil and gas industry had demonstration of the application of the pocket-sized ultrasound machine Vscan.

FOR has visitors from other hospitals in Norway and has thereby been giving information about new technology and methods. Organization and design of operating rooms have been among the most important focus areas.

During a course in simulator training arranged by the National Centre for Advanced Laparoscopic Surgery, FOR has been used as an arena for transmission of operative procedures and for dissemination of information about integration of new equipment applied during these procedures. The personnel at FOR has during the last year been participating in courses in leadership, scientific work and professional development.

**Students**

Since 2005 FOR has had excellent cooperation with University College of Sør-Trøndelag (HiST). On a regular basis we had presentations for students at the Department of Health and Social Work, for operating room nurses and anaesthesia nurses as well as radiography students and students within bio-engineering. This has resulted in several bachelor degrees, which have been performed as a cooperation with FOR in our operating rooms. FOR is also taking care of teaching the use of electro-medical equipment for several of these students.

Master students as well as PhD students at St. Olavs Hospital/NTNU/SINTEF have a good opportunity to experience new medical technology and operations from the interactive lecture room at FOR where they also learn about opportunities in research.

**Other courses arranged by FOR**

February 3rd: Course for bachelor students in radiography, HIST - LIS and MH

February 24th: Course for bachelor students, Bioengineering, HIST - TM

March 13th: One day course for master students in clinical health science “Overweight and health”. Live-transmission from FOR operating room gastro, LIS

**Visits at FOR**

April 23th: Visitors from Østfold Hospital, Fredrikstad at the hybrid operating room AHL-1F. Guiding and information by AØ,TD and LIS

June 18th: Visit from Østersund Hospital, Sweden. Presentation and visit at the FOR operating room at the Department of ENT. MH and JGS

July 1st: Visit from Lithuania, Kaunas University Clinic and Mr. Vidar Liverød. Presentation about FOR by JGS and visit to AHL, ENT and NSALK. LIS and JGS

September 25th: Tine Kapur, Executive Director of Image Guided Therapy at the Department of Radiology, Brigham and Women’s Hospital and Harvard Medical School and Dr. Wolfgang Wein, Technische Universität, Munich. Presentation by Frode Manstad-Hulaas and MH. Visit at FOR Operating Room for vascular surgery.

September 28th and 29th: Visitors from Sony corporation, Tokyo: Masayuki Kobuna, Senior Manager, Vision Presenter and Medical Solutions, Yasuhiro Suga, Project Manager Vision Presenter, Kazuhiro Takaoka, Manager Vision Presenter, Gary Cox, Product Manager Vision Presenter UK. Topic for the visit: Upgrading of the Visualization project, medical imaging and visualization. JGS
Visitors from Hospital in Østersund, Sweden
Photo: Marianne Haugvold, FOR

Visitors from Østfold Hospital, Fredrikstad
Photo: Liv-Inger Stenstad, FOR

Visitors from Kaunas University Hospital in Lithuania
Photo: Liv-Inger Stenstad, FOR

Tina Kapur, PhD, Executive Director, Image Guided Therapy.
Department of Radiology Brigham and Women’s Hospital,
Harvard Medical School, Boston and
Dr. Wolfgang Wein TUM Technische Universität München.
Photo: Marianne Haugvold, FOR
Experimental surgery

All FOR operating rooms are authorised for experimental surgery including animal research. Such experimental procedures can be ordered at FOR who will then organize them. This arrangement is well established among clinicians and scientists. We have a “package” where FOR is organizing and planning the animal experiments in collaboration with Department of Comparative Medicine (AKM). FOR has trained and authorized personnel assisting during the whole process.

Personnel who is planning or taking part in animal experiments must go through courses in animal experiments approved by the Norwegian Food Safety Authority. An important part of this course is to understand laws and regulations connected with the use of animals in medical experiments. The regulation regarding animal experiments assumes that all persons planning or performing such experiments should have passed the courses and be registered in the electronic system (FOTS) of the board for animal research. Both the responsible scientist and his co-workers involved in the practical performance of the experiments, including those who are taking care of the animals, should be included in the registration and have documentation that they have passed the course in animal experiments, category C.

Because AKM was closed for much of the year due to refurbishment there was no animal testing in 2015.

Research cooperation

National and international collaborating partners

SINTEF is FORs most important national research partner. Most of this collaboration is concentrated around “National Center of Competence for Ultrasound and Image Guided Treatment”.

Together with The Intervention Center at The National Hospital (IVS), FOR has established the national research infrastructure “NorMIT”- Norwegian Center for Minimally invasive Image guided Therapy and medical technologies.

FOR has an excellent cooperation with NTNU and The University College of Sør-Trøndelag, HIST. 57 students from this institution have finish their bachelor-or master degree at FOR.

FOR has also good cooperation with industrial partners like Sony, Medtronic, Covidien, Brainlab, Intuitive, Siemens, Stryker, IBM, ConocoPhilips, Total, Olympus, Bioventus, Smith &Nephew, Karl Storz, Brainlab and Covidien. Routines for such collaboration have been established with the assistance of legal expertise within the field.

FOR has an excellent cooperation with Vanderbilt University Medical Center, TN, USA. This hospital is organized in a similar way as St. Olavs Hospital. We are running research projects on how new treatment modalities could influence technological solutions. We are also looking for cooperation on the use of ICT in the operating rooms to optimize organization and patient flow. In 2015 we developed further the cooperation with Albert Einstein Hospital in Sao Paulo, Brazil regarding telemedicine and decentralization of specialist health care. FOR is also cooperating with Massachusetts General Hospital, Boston, Operating Room of the Future, Tubingen, Germany and research groups at Krakow University Hospital, Poland. Cooperation has further been established with Yonsei University Health Center, Korea. Focus areas are here the health of the aging population, the intelligent hospital and transmission of high quality medical images. FOR has collaboration with organizations like EAES (European Association for Endoscopic Surgery) and SMIT (Society for Minimally Invasive Therapy).
Research and development in cooperation with SINTEF
National Center of Competence for Ultrasound

Operating Room of the Future is an arena and infrastructure for several ongoing research projects. Several of the main activities during 2015 have been done in cooperation with National Centre of Competence for Ultrasound and Image Guided Therapy (www.USIGT.org). SINTEF is an important research collaborator for FOR and USIGT. This center of competence is a national service established by the Department of Health and Human Services. The center is using FOR as an arena for several clinical and technological research projects on medical technology, prototyping and clinical testing of new solutions to improve patient treatment. In 2015, 10 ongoing PhD-projects were running and 2 were finished. Often, an engineer and a clinician are working on a PhD, investigating a problem from their individual viewpoint. 27 scientific papers in peer reviewed journals were published in 2015 and several of these studies used FOR/St. Olavs Hospital as their infrastructure.

Through user-controlled projects supported by the Norwegian Research Council and EU, USIGT has been an important platform for innovation and cooperation with the industry. The competence center has a broad national and international network and important activities connected to the development and dissemination of knowledge. Through participation in several EU projects (VECTOR, IIiOS Marie Curie initial training network, 3MICRON, FUSIMO, MISTELA, RASimAs, TRANS-FUSIMO) we have “imported” competence from international groups and have also contributed with competence both nationally and internationally.

Research at this center of competence includes image guided minimally invasive surgery within vascular surgery, neurosurgery and laparoscopic surgery, pulmonary medicine and Ear-Nose and Throat diseases. In addition to the use of ultrasound, navigation has become an important research topic. The navigation system Custus X has been developed by SINTEF. The purpose is to improve accuracy of the diagnostic work. This platform will now be published nationally and internationally as an Open Source Platform through the NorMIT cooperation. Custom-designed versions for clinical use are available. As an example the Fraximus – project is making and distributing a program package free of charge for support during bronchoscopy and better diagnostics of pulmonary lesions.

The activity at the National Centre for Competence for Ultrasound and Image-guided treatment is a good example how Operating Room of the Future can support research, development and testing of new technology and thereby contribute to strengthen national and international cooperation. In addition, FOR is contributing with dissemination of knowledge through courses and publication of popular science in close cooperation with SINTEF. SINTEF is also contributing significantly through its basic research grant for strategic commitments to develop new technologies within minimally invasive therapy.

Illustrations showing the use of the Navigation platform CustusX. Below: Laparoscopic surgery. Above: Bronchoscopy at FOR
Photo: SINTEF Media

Thomas Langøe
Head of Research, Department of Medical Technology, SINTEF
Photo: SINTEF Media
In 2015 the national infrastructure NorMIT is well established

Institute of Circulation and Medical Imaging has a special responsibility to promote the cooperation between NTNU and St. Olav’s hospital through Operating Rooms of the Future. Support and excellent infrastructure for research and innovation is mandatory for clinicians to use research for the improvement of their own expertise.

The establishment of NorMIT as a national infrastructure in 2014 represented a milestone for FOR. Now, in 2015 the possibilities are now excellent to do patient-oriented clinical research through national and international cooperation. A good infrastructure is important to obtain good quality within research and teaching, as it is within patient treatment. An active scientist must easily be kept up to date with the latest results within his field and thus achieve important knowledge through own research, by reading of scientific articles and by being active in debates taking place in research networks and during conferences. For a scientist import and export of new knowledge is a continuous process. And it is important that Norwegian patients are getting the benefit of this knowledge. Therefore, the Operating Rooms of the Future is just as important for the patients as for the health care personnel.

Toril A. Nagelhus Hernes, Professor of medical technology, Leader of Institute of Circulation and Medical Imaging, DMF, NTNU

Photo: NTNU
FOR in the future

FOR has been running since 2005 and continued in 2010 in the new hospital with focus on all operating clinics using image guided minimally invasive treatment. Altogether we have six operating rooms with a modern AV-ICT structure. Thus it is possible to make live transmissions and interactive communication in full high-definition (HD) while 4K will soon be available. The most important motivation for continuing FOR in the new hospital is to form a basis for good clinical research, but also to have a center of competence for the building and organization of operating departments. Image guided minimally invasive treatment is one of the most important fields of innovation within the specialist health care system. Such procedures are important to give a less traumatic and more efficient treatment of the patients. It may lead to shorter convalescence, reduced need for intensive care, less complications and often better results of the treatment. Several surgical procedures can now be performed as day surgery and the patient will need shorter time to get back to everyday activities and work. The elderly part of the population is increasing and open surgery in elderly patients may include certain challenges. Thus the risk of complications is higher than in younger patients and the convalescence is generally longer. Whenever the situation allows it, minimally invasive therapy may be the preferred treatment modality in elderly patients.

Today several new hospitals are on the planning stage in Norway as well as in other European countries. Operating rooms are the most expensive part of the hospital and the operating departments are expensive to run. We want to gain experience and to be leading within this field, thereby optimizing the result of the investments. We will focus on architecture, use of materials, ergonomics, ICT solutions, logistics and health economy and we hope to be able to build operating rooms at a lower cost and to organize them more efficiently. It is important to do this in a systematic way, getting solid knowledge about operating departments. There is need to do testing of new equipment and new techniques in a systematic way. FOR will continue to support this through the formation of contracts, the accomplishment and the evaluation of the projects.

Imaging and visualization of medical images is of utmost importance for minimally invasive therapy. We are also planning a new FOR operating room at the Department of Pulmonary Medicine where research and development of navigation and image guided procedures is important. We want to refine and develop further the technique and to expand the indications for navigation in pulmonary medicine. In ENT-surgery navigation technology is now well established. Our PhD-candidates are financed through external funding. This has made it possible to obtain a good scientific activity in spite of a small annual budget. FOR has targeted 1-2 PhD-degrees and one master degree per year. In the near future there will be an increasing demand for scientific work, which forms the basis of master degrees, and FOR can be a good platform for this work.

In 2015 FOR has developed, established and implemented a teaching system within the use of electro-medical equipment for all doctors in surgical disciplines at St. Olavs Hospital. Focus areas are the application of high-energy technology, application of C-arms and x-ray protection. Hospital hygiene is also included in the program. Our plan is to develop courses using digital learning. One advantage is that the students then can use this material any time. In collaboration with “at work” we have developed digital based interactive reports. This is a prototype of a completely new type of course registration and approval. The system can be integrated with other systems. Through the health academy of Regional Health Trust, collaboration has been established in order to expand this arrangement to other hospitals within Central Norway.

FOR has close collaboration with several other institutions like international industrial companies, clinical departments, and technological groups. Our closest collaborators are The Medical Faculty, NTNU and SINTEF, Department of Medical Technology/Health. Other important collaborators are “Center of Competence for Ultrasound and Image Guided Therapy”, “National Center for Advanced Laparoscopic Surgery”, University College of Sør-Trøndelag (HiST), NTNU Technology Transfer (TTO) and Center for Interdisciplinary Research in Space (CIRIS). It is important to take care of the synergy effects of this cooperation in the years ahead. The collaboration with SINTEF on navigation technology is continuing, and we have great expectation regarding the application of steerable wires and catheters in endovascular treatment. Navigation in pulmonary medicine has been mentioned. Robotic surgery is another field where FOR is involved. We are also working with new techniques for treatment of patients with morbid obesity. We are looking forward to further collaboration with the Clinic for Medical Imaging, and will focus on surveillance of patients treated for aortic aneurysm by stent grafting, using ultrasound technology.
FOR is and has been an internationally preferred partner for research collaboration, especially within imaging and visualization technology for application in minimally invasive therapy. We want to strengthen the international collaboration. So far we have concentrated on Massachusetts General Hospital, Boston, Operating Rooms of the future in Tübingen and research groups at Krakow university hospital, Poland. We are also cooperating with Vanderbilt University Medical Center, Nashville, TN. FOR is also cooperating with organizations like EAES and SMIT. Finally we have established cooperation with Yonsei University Health System, Seoul, Korea.

Our goal is that FOR should be a research infrastructure of excellent international quality. Quantity as well as quality of research relevant for FOR should be improved. And FOR should be at the international forefront in image guided minimally invasive treatment. Today FOR is involved in research projects and quality improvement programs in such treatment within most surgical disciplines.

St. Olavs hospital and FOR are international pioneering actors in the intercept between digital media technological industry and development of new technology and new applications in minimally invasive therapy. FOR is today leading development projects on quality improvement and minimally invasive therapy within all surgical disciplines and is well suited for such innovation and development. Thus, FOR has contributed to set standards for minimally invasive treatment in an international context.

The infrastructure-project NorMIT (Norwegian Center for Minimally Invasive Image guided Therapy and Medical Technologies) is a research platform that promote new contacts nationally and internationally. This platform has been developed together with The Intervention Center at The National Hospital with economic support from The Norwegian Research Council. The aim is to improve patient treatment and to strengthen research and innovation putting Norway on the map from an international point of view. We are pleased to get this opportunity together with The Intervention Center and our other collaborators. In 2015 we have mainly focused on the establishment of the structure.

Jan Gunnar Skogås
Managing director, FOR
Photo: Private
Scientific Work
PhD theses completed in 2015

Jordi Puig

On Friday 9th October 2015 Jordi Puig defended his doctoral thesis "Art and Technology Perspectives on Brain Atlases". The opponents were Pier Luigi Capucci (University of Plymouth) and Judith Redi (TU Delft), and the internal committee member was Konstantinos Chorianopoulos (NTNU). Puigs supervisors were Andrew Perkis and Aud Sissel Hoel (both at NTNU). Puigs project was affiliated with the interdisciplinary NFR project Picturing the Brain: Perspectives on neuroimaging (2010-2014), which consisted of a collaboration between the Department of Art and Media Studies at NTNU, Centre for Quantifiable Quality of Service in Communication Systems (Q2S) at NTNU, ORF (FOR) at St. Olavs Hospital, SINTEF and University of Oslo.

Erik Smistad

On 24th September, Erik Smistad completed his trial lecture and thesis defense and was awarded the PhD degree. Adjunct Professor Associate Frank Lindseth has supervised his PhD work at the Algorithms, HPC, and Graphics (AHG) research group. Co-supervisors have been Associate Professor Anne C. Elster and Adjunct Professor Toril A. Nagelhus Hernes.

Vijayan Sinara

Sinar Vijayan, Department of Circulation and Medical Imaging, defending her thesis "Improved image guidance for minimally invasive liver therapy - Image co-registration techniques" in defense of the PhD degree in medical technology at the Faculty of Medicine, NTNU. The candidate's supervisor has been Head of Department Toril A. Nagelhus Hernes and research director Thomas Langø. Adjunct Ronald Mårvik and Associate Ole Jacob Elle has been co-supervisors. Dissertation 6th November 2015.

PhD - ongoing

Cecilie Våpenstad
"Tools and methods for skills training in minimal invasive surgery – using simulators, ultrasound and navigation.”
Technological PhD candidate.
Evaluating how simulation and the use of simulators can improve surgical skill and surgical team work. The aim is also to develop tools for using navigation and ultrasound. Supervisors: Toril A. Nagelhus Hernes, Ronald Mårvik and Petter Aadahl

Geir Arne Tangen
"Enhanced Minimally Invasive Therapy".
Technological PhD candidate.
In 2015 he worked on the development / testing of steerable catheters integrated with navigation technology for endovascular procedures. They also conducted a study to examine the method that ensures more accurate correlation between image information from CT and blood vessel anatomy by guiding catheter procedures. This can be used to simplify the integration of navigation technologies in endovascular procedures and ensure more accurate maneuvering of catheter and guidewire in complex anatomy. Supervisors: Toril A. Nagelhus Hernes and Petter Aadahl

Rita Elmkvist-Nilsen
"Mapping Brain Plasticity"
Rita Elmkvist-Nilsen's PhD project examines the formative role of newer image mediating technologies play as knowledge producing, diagnostic and therapeutic tools in neuroscientific research practice. The project focuses on newer approaches in cognitive neuroscience that regard the brain as an adaptive and dynamic body with plastic potential and actualize through diffractive reading later human scientific perspectives on human perception and cognition as bodily anchored, relational, situated, action oriented, and shaped by technological Mediations. Supervisors: Aud Sissel Hoel and Anne Beaulieu
**Daniel Fossum Bratbak**

“Sphenopalatina prosjektet”
The project includes development of a new optical navigated tool for use with targeted injections and samplings. Tool "Multi Guide" is patented and developed in cooperation with NTNU TTO and medical department, MTA. Developing of prototype number 2 is soon finished.

In the use of Multi Guide enters into an intervention study to explore the effect of targeted blocking ganglion sphenopalatinum in pterygopalatine fossa with botulinum toxin in primary headaches. The project is a collaboration with neurological and radiological department.

Besides this, a continuous safety study with the prototype is going on. This includes both therapeutic injections, but also navigated biopsies of tumors in the head or neck area transcutaneously, transnasal and transoral. In all, 73 interventions were conducted at the end of the year. The procedures are performed under general anesthesia and local at ORF.

Pilot study is conducted on Botox blockade of ggl. sphenopalatinum in patients with therapy-resistant cluster headache (10 patients) where the results are being published. A similar study in patients with migraine performed.

EU application for a multi-center study on injection treatment of migraine at 8 centers in Europe is pending. The development of several varieties of Multi Guide proceeding, including sterile disposable components that enable multiple subsequent injections.

The project has its own website: [www.multiguide.no](http://www.multiguide.no)

Coaching Neuro; Erling Tronvik and ENT; Ståle Nordgård

**MultiGuide/Sphenopalatina project** - Prototype 2 awaiting approval.
- Multi Guide - A safety study.
- 73 patients with tumors of p-cyt - needle, abscesses and blockades with botox.
- Botox blockade of ggl. sphenopalatinum by cluster headaches. A pilot study, 10 patients.

**Kent Are Jamtøy**

“Botulinum toxin type A blockade of sphenopalatine ganglion in chronic rhinosinusitis with nasal polyposis”.

Injections against ggl. sphenopalatina with Multi Guide in 10 patients with intractable polyposis. Project, presented the clinic’s FU.


**Mads Moxness**

“Modeling of obstructive sleep apnea by Fluid - Structure Interaction in the Upper Airways”.

The Research Council has allocated 10 million. Enough for a research project between DMF, Faculty of Engineering Science and Technology and SINTEF to develop a 3D model and a computer simulation of the conditions in the upper airway in patients with obstructive sleep apnea before and after nose surgery. The model will be based on CT and MR images and airway measurements in patients. In one part of the project, 25 patients are operated at ORF and results correlated between measurements postoperatively in patients and results from the model.

The goal is to find general principles for the impact of nasal surgery on OSAS and the ability to predict the outcome in the individual patient.

- Simulating changes in upper airway by nasal operations on patients with OSAS
- Medical mission: Operate at least 25 pas - MR / CT before / after
- Separate research in patients with OSAS
- Results of surgery and epidemiology

The project period is three years and is a PhD project for Mads Moxness.

Supervisor ENT: Ståle Nordgård

The project starts in 2017 and also includes 2 PhD at IVT and dissertations about validating data model.

CT and MRI of the first pilot patient is taken and first operation 23.01.15, 15 patients were included and operated.

The project has its own website [www.osas.no](http://www.osas.no)

Article:

Moxness MH, Nordgård S.

An observational cohort study of the effects of septoplasty with or without inferior turbinate reduction in patients with obstructive sleep apnea.


2 articles about structural and functional aspects in noses patients with OSAS vs. control patients while writing (n = 200)
Camilla Berge
“Abdominal aortic aneurysm repair
Factors influencing early and late mortality”
Clinical PhD candidate
The thesis deals with factors affecting early and long term mortality after surgery for abdominal aortic aneurysm. It includes both open surgery and endovascular treatment. In particular, the focus is on female patients. They have higher mortality during surgery for rupture than men. And aneurysm ruptured at lower diameter in women than in men.
Long term survival improved generally over time. Accompanying conditions like cerebrovascular disease, diabetes, COPD and renal failure affected long-term survival in a negative direction. Female patients had more autoimmune diseases than men. But there was otherwise no differences in morbidity or incidence of postoperative complications that could explain the higher early mortality in women.
Patients with elevated white blood cell count preoperatively had generally higher mortality than those who had normal white blood cell count.
Supervisors: Torbjørn Dahl and Anne Irene Hagen

Anna Rethy
“Navigated 3D laparoscopic ultrasound in treatment of liver tumours.”
Clinical PhD candidate.
Rethy investigates the use of laparoscopic ultrasound in primary tumors and metastases in the liver. She has also studied position changes in solid bodies by establishing air in the abdominal cavity for laparoscopic surgery, and how navigation technology can then be used as well. In addition, she has worked with multimodal live models to simulate tumors and test multimodal imaging and training with laparoscopy and navigational instruments.
Supervisors: Ronald Mårvik and Thomas Langø

Technological PhD candidate, NTNU, IIIOS project, ITN EU.

Páll Jens Reynisson
Multimodal image fusion in minimally invasive interventions.

Lars Eirik Bø
Image-guided spine surgery.
Technological PhD candidate.

Hanne Sorger
Development of navigated ultrasound in bronchoscopy.
Clinical PhD candidate.

Mohammad Mehdi
Medical Image Visualization.
Technological PhD candidate.

Research Program for medical students

Erik Nypan
Three-dimensional visualization and navigation of endovascular procedures
The project deals with navigation systems for use in endovascular navigation, especially considering the aorta. The goal is to compare navigation systems iPILOT (Siemens) and CustusX (SINTEF) for endovascular use. The first part of the project compares the accuracy of registration algorithms used by navigation systems. The algorithms used to pair preoperative data with intraoperative data. Data for phantom is collected and during the fall and spring patient data should also be collected. In the last part of the project it is planned to conduct animal studies on pigs. It will then look at navigation systems in a clinical setting by looking at how easy they are to use, the use of contrast medium, the total radiation dose etc. The project is conducted at the FOR operating room in the AHL."
Supervisor: Frode Manstad-Hulaas and Reidar Brekken

Erik Nypan
Photo: Private
Post doc. – ongoing

Heidi Gilstad
“Health communication in a digital everyday situation”

In spite the fact that adequate information is a patients’ right in today’s health care system, the number of complaints about insufficient information is steadily increasing. Therefore information and communication need to be improved. The aim of the investigation is to accumulate knowledge about communication practice from the patient is admitted to hospital and until the treatment is completed. The experience from patients and health care workers will be investigated. Data from field investigations, interviews, written patients records etc. in a major Norwegian hospital will form the basis for the investigation.

Håkon Olav Leira

Håkon Olav Leira has a 50 % postdoc position for 6 years at ISB, DMF, and NTNU. He is also a consultant at the department of pulmonary medicine. His main research topic is on bronchial carcinoma, especially navigation combined with bronchoscopy. This is a part of USIGT, FOR and NorMIT. He is also active in the planning of the new FOR operating room at the department of pulmonary medicine.
Ongoing master project

Postoperative wound infections.
An observational study at St. Olavs Hospital, Department Røros Hospital

Lise Hagen

Infections generated by the health care system are inducing significant costs for the health institution and for the society as a whole. And postoperative wound infections are generating the largest costs. It has been calculated that infection in an operated area is representing half of extra days in hospital and almost half of the extra costs induced by infection in the health care system. For the individual patient postoperative infections could represent significant complications: longer stay in hospital, antibiotics with the risk of developing antibiotic resistance, decreased function and in the worst cases there is also a certain mortality following serious infection. In addition to this there are economic consequences like sick leave compensation, loss of production and decreased income for the society.

The stay in hospital following surgical procedures has decreased, and we see more use of day surgery and outpatient treatment. For patients leaving the hospital shortly after surgical treatment there is no systematic follow-up which is recording postoperative infection. The patients are not routinely scheduled for a visit to the hospital to check for postoperative infection. Superficial wound infections are usually treated by the primary physician. Therefore there is a risk that some infections are not recorded in our system. Reliable information about the incidence of postoperative wound infection is dependent upon active surveillance and systematic recording. Otherwise there is a risk of underestimation of the problem.

At Røros Hospital, the main surgical activity is elective orthopedic operations. Most patients are operated on a day surgery basis. So far we do not have exact information about postoperative infection after day surgery, since we do not have a systematic recording of the problem. There is also scarce information about postoperative infections after day surgery in the literature.

The aim of this master-project is to investigate how many of the patients are getting wound infection following day surgery at St. Olavs Hospital, Department Røros Hospital. The investigation will include 600 patients who will be interviewed by a phone call 30 days after surgery. We will also investigate various risk factors for infection in this patient population.

Relevant data have already been recorded and we are now analyzing the data which will be reported. It is our hope that this could form the basis for further quality improvement work at the department.
Operation planning at The Department of Orthopedic Surgery

Marthe Siren Anvik, Mikkel Treu Os og Jon Erik Medhus
We want to plan the start and sequence of operations at the orthopedic OR for one day. Various elements like duration of surgery and anesthesia as well as the number of emergencies are included in the project. The various factors will be analyzed from operations which took place during the period 2006-2016. We have investigated how factors like type of operation, the individual surgeon and time of the day might influence the possibility for proper planning. By computed programs and mathematical modelling we will define the best operating schedule, and compare it with the routines at St. Olav's Hospital today.

Distribution of operating rooms, sequence of operations and time for start of operations with different operating time when surgeons are working in more than one OR.
Jacob Nyman
Successful planning of operations is mandatory for effective and safe treatment of the patients. In case the chief surgeon only needs to be present during the critical and most demanding part of the procedure, it is a possibility that he or she can do surgery parallel in more than one operating room. This model has been used in e.g. the US. In this way the work becomes more effective. We are making a mathematical model forming the basis for a detailed operating plan with surgeons working in several operating rooms. The model is taking into consideration that there is variation in the operating time, based on the experience from Department of Orthopedic Surgery. Based on relevant literature, results of our modelling and interview of personnel at the operating department, we will give our recommendations on how the department might use the operating rooms and the OR personnel more efficiently. This includes methods for better estimation of operating time, increased awareness connected to evaluation of planned and finished time schedules, and possible advantages with letting surgeons operate parallel in more than one operating room.

Information to patients prior to radiological examinations
Liv-Inger Stenstad
In this project, I have studied information sent to patients prior to defecography. Although this examination is performed in a limited number in Norway, the information which is sent to the patients varies considerably. I wanted to find out what sort of information the patients preferred. Do they want detailed information or just a short summary sent to them by mail? This is a qualitative study where patients from St. Olav's Hospital and The National Hospital were included.
Student project

Kjetil Lund

"Electromagnetic Navigation vs. Fluoroscopy in Aortic Endovascular Procedures - a Phantom Study". This project was finished during the autumn 2015 with Frode Manstad-Hulaas as main supervisor and Geir Arne Tangen as co-supervisor. The project investigated the use of electromagnetic navigation compared to traditional fluoroscopy during simulated endovascular instrument navigation. The investigation was carried out at FOR, using a phantom of the abdominal aorta with renal arteries.

The navigation system is combining pre-and/or intraoperative image data sets with electromagnetic position recordings of endovascular instruments. Thereby a 3D real time visualization of the instruments’ position and orientation in the vessel is obtained. By using electromagnetic navigation, the use of intravenous contrast injection is avoided and the total dose of irradiation is reduced.

Five “Operators” with different experience took part in the investigation. A total of 120 cannulations of the renal arteries of the phantom were performed; 60 with each technique. The conclusion is that electromagnetic navigation was of sufficient quality for guiding of endovascular interventions. This technique might be useful in cases with complex anatomy and whenever the dose of contrast material should be minimized.

Bachelor degrees 2015

Biomedical laboratory scientist, HiST
Microbiological testing of microorganisms resistant to antibiotics on equipment and inventory at departments of Orkdal Hospital.
Candidates: Tonje Brunes and Nora Rosvoll Finstad.

Department of Radiography, HiST
“Mapping of irradiation doses at the eye lenses of orthopaedic surgeons at the emergency operating rooms, St. Olavs Hospital”. Candidates: Nora Bråtteng Olsen, Lisa Lange and Kristin Johnsen Wirum.

Department of Radiography, HiST
“Effective dose to personnel and dose-rates from patients during PET examinations with use of 18F Fluorodeosyglucose”. Candidates: Carl Petter Kulseng and John Christoffer Sandstrøm.
Other Projects

An important part of the mandate of The Operating Room of the Future is to develop and promote research and development projects in the intersection between scientists, health care personnel and industry. The aim is to create new and original knowledge with new solutions which are useful for the patients. We are in the intersection between science and innovation – between creation of new knowledge and new solutions and their application in daily clinical practice.

The collaboration with various clinical disciplines is important to make sure those new solutions, methods, processes and new knowledge is introduced in clinical routine. We have our own infrastructure for the testing of new medical technology and new treatment modalities to create and maintain the bridge between new knowledge and well known routine. FOR has an extensive collaboration with national and international industry through research and development projects. This cooperation is important for introduction and use of new knowledge in clinical practice.

By establishing NorMIT the Norwegian Research Council is emphasizing that Operating Room of the Future has methods and systems for effective collaboration with the industry and clinical groups to create and apply of new knowledge. The Norwegian Research council as well as EU’s frame programs for research and development is emphasizing that practical application of results of research is becoming an important criterion for success in financing projects. We regard funding of the NorMIT project, which is now well established, as recognition of our focus on innovation. It will also represent an important basis for our strategic commitment in new international research and development projects. In an international perspective we experience great interest in our work and that we are attractive as collaborators within EU’s framework programs for research and development.

In 2015, Operating Room of the future had collaboration with several international companies like Sony, Medtronic Covidien, Brainlab, Intuitive, Siemens, Stryker, Karl Storz, IBM, ConocoPhillips, Total, Olympus, Bioventus and Smith & Nephew. Furthermore we have an excellent cooperation with national and international research groups.

Quality register for ENT surgery and “Fast track”

In January 2012 a quality and research register was established for patients who had undergone endoscopic sinus surgery. Quality of life was measured preoperatively and at 6 months postoperatively. All endoscopic and open operations were recorded consecutively. At the end of 2015 altogether 750 patients had been included in the register. St. Olavs Hospital has now the responsibility for the national register for tonsillar surgery.

Planned presentations:
2 abstracts at the Annual national scientific meeting for ENT surgery
1 scientific article has been submitted
1 PhD is planned

Fast-track in this connection means a standardized course for certain groups of patients who are going to have nose-sinus surgery. It includes teaching of patients, direct booking of appointments and organization of work to obtain a treatment that is effective and cost-effective for the society as a whole.

Sialoscopy-an aid in the diagnosis of tumors of the salivary glands

Sialoscopy is an examination where the ducts of the salivary glands can be inspected by a flexible instrument. This project is investigating the use of this examination in the diagnosis of conditions like concrements, tumors and other diseases of the salivary glands. Sialoscopy will be compared with other diagnostic methods including MRI. The project is in the planning phase with testing of the equipment. New sialoscopic equipment and a rack for the testing have been acquired. A quality register will be established in 2016.
**Balloon sinoplasty for chronic rhinosinusitis**

We are testing equipment for balloon dilatation of the orifice of the frontal and maxillary sinus for minimally invasive reestablishment of drainage from the sinuses. The method is used in selected patients where the drainage has been blocked by chronic rhino-sinusitis. So far 15 patients have been included in the investigation. A study on the quality of life after balloon dilatation is running. This work is continuation of the master thesis of Marit Amundsen Furre.

Leader of the project: Assistant Professor Vegard Bugten.

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**Case study, ORF - IO**

Clinic of Neurosurgery, Røros Hospital and FOR.

This project is a comparative study where we are learning from other fields. With the background from similar studies with onshore rig teams we made an investigation of technology-supported interpretation and collaboration in a surgical team at St. Olavs Hospital. By identifying core characteristics and - conditions for these teams, we could focus on important factors that must be taken into consideration when establishing geographically distributed arenas for collaboration as in the petroleum sector and in the health care sector.

We observed that an important success factor in the operating room was to create a meaningful image of the future. This means that all those working in or in relation to the operating rooms had the same interpretation of the information given to them. This gives a good background for the understanding of what is going on the next seconds, minutes, hours and days.

Another important finding is that the separation of work processes between interpretation, decision and execution, which usually forms the basis for the creation of work processes in geographically and professionally distributed settings, may be demanding. Our study of surgical teams is supplementing observations from the petroleum industry and is forming a basis for the understanding of interpretation, decision making and execution as non-discrete activities without sharp borders between them. The investigation was completed in 2015.

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**TPO-150 investigation. Use of depot-opioid as pre-and postoperative pain medication in primary knee arthroplasty**

This is a double blind randomized controlled study comparing Tapentadol with Oxycodon and placebo. The study is a part of investigations where the aim is to obtain the best pain medication following these operations. The investigation has started and will probably run until mid-2017. Follow up of the patients is organized at the patients’ home and report about the effect of the medication is made via i-pad. Testing of this type of follow up is done and indicates that it can be used for other patient groups as well.

Project leader: Torbjørn Rian, Consultant Anesthesiologist, St. Olavs Hospital
Posters 2015
Autumn Conference in microbiology in 2015, 15th-16th of October

“Microbiological testing for the presence of multiresistant bacteria in patient close equipment and inventory at Orkdal hospital.”

Augusta Irene Kvam (picture below), Tonje Brunnes, Nora Rosvoll Finstad, Torun Gresdal Rønning, Anita Wang Børseth, Nina Hassel and Operating Room of the Future

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**Drewes C, Sagberg LM, Jakola AS, Solheim O.**
Does brain tumor laterality affect patient-reported quality of life?
Poster at the Annual meeting of EANS, Madrid, October 18-21, 2015

**Sagberg LM, Drewes C, Jakola AS, Solheim O.**
Prediction of postoperative functional level after brain tumour surgery.
Poster at the Annual meeting of EANS, Madrid, October 18-21, 2015

Surgery for lumbar spinal stenosis in octo- and nonagenarians: A multicenter observational study.
Poster at the Annual meeting of EANS, Madrid, October 18-21, 2015

Does daily tobacco smoking affect outcomes after microdecompression for degenerative central lumbar spinal stenosis?
Poster at the Annual meeting of EANS, Madrid, October 18-21, 2015

The risk of getting worse: Predictors of deterioration after decompressive surgery for lumbar spinal stenosis
Poster at the Annual meeting of EANS, Madrid, October 18-21, 2015
Haavik K T

Rosness R, Evjemo T E, Haavik T, Wærø I
Prospective sensemaking in the operating theatre. Cognition, Technology & Work, 18(1), 53-69

Solheim O, Johansen TF, Cappelen J, Unsgård G, Selbekk T.
Transsellar Ultrasound in Pituitary Surgery With a Designated Probe: Early Experiences. Neurosurgery. 2015 Nov 5. [Epub ahead of print]

Sagberg LM, Solheim O, Jakola AS.

Airway segmentation and centerline extraction from thoracic CT – comparison of four methods. Accepted for publication PLOS ONE, Nov 2015

CustusX: an open-source research platform for image-guided therapy. Int J Comput Assist Radiol Surg. 2015; Sep 26, Epub ahead of print

Sorger H, Hofstad EF, Amundsen T, Langø T, Leira HO

Sorger H, Hofstad EF, Amundsen T, Lango T, Leira HO
Endobronchial ultrasound visualization (3D-EBUS) - A novel navigation system for multimodal image-guided intervention
Presentation at the 3rd European Congress for Bronchology and Interventional Pulmonology (ECBIP). 23-25 April, 2015, Barcelona, Spain

Learning EBUS-TBNA – A 6-years experience at a single institution. ERS
ERS Sept 26.-30.09.2015, Amsterdam, Nederland. Eur Resp Journal; 46 (suppl 59): PA 317

Sorger H, Hofstad EF, Amundsen T, Lango T, Leira HO
Endobronchial ultrasound visualization (3D-EBUS) - A novel navigation system for multimodal image-guided intervention
CARS 29th Int. conference for computer assisted radiology and surgery, Barcelona, June 24-27, 2015


Reinertsen I, Wein W, Lindseth F, Jakola AS, Gulati S. CT-to-Ultrasound registration for placement of ventricular catheters. CARS 29th Int. conference for computer assisted radiology and surgery, Barcelona, June 24-27, 2015

Unsgård G. Methodology and results by operating (asleep) low grade glioma patients with 3D US guidance and navigated CUSA. Invited lecture, 5th Bi-annual Meeting of Intraoperative Imaging Society (IOIS), New Delhi, India, February 12-15, 2015


Unsgård G. AVM patients operated by assisted 3D US (Doppler) angiography; methodology and results. Invited lecture, 5th Bi-annual Meeting of Intraoperative Imaging Society (IOIS), New Delhi, India, February 12-15, 2015

Dragland Å. Presisjonsskyter Botox inn i «migrenesenter». http://gemini.no/2015/10/presisjonsskyter-botox-inn-i-migrenesenter/ Artikkel i Gemini, 06.10.2015


Meland S. Hjernesimulator for å lære ultralyd. Artikkel i Adresseavisen, 4. juni 2015

Egge J H. Valfarter til Norge for å lære hjernekirurgi. Artikkel på nrk.no, 4. juni 2015


Egge H. Lærer å forstå ultralyd med app. Artikkel i GEMINI.no, 10. juni 2015

Egge H. Interpreting ultrasasound images using an app. Artikkel i GEMINI.no, 15. juni 2015

Pedersen GA, Stenstad LI, Landmark A, Brattheim B. Information Given To Patients Undergoing Nuclear Medicine Procedures. 2015: CEUR Workshop Proceedings ( ISSN 1613-0073)


World Neurosurg 2015 May;83(5):673-8. Epub 2015 feb 3 PMID: 25655686

Jakola AS, Senft C, Unsgaard G, Solheim O
Surgical management of eloquent supratentorial low-grade gliomas with special emphasis on intraoperative imaging.

Golebiowski A, Drewes C, Gulati S, Jakola AS, Solheim O

Moxness MH, Nordgård S.

“Pilot study of sphenopalatine injection of onabotulinumtoxinA for the treatment of intractable chronic cluster headache”.
Bratbak DF, Nordgård S, Stovner LJ, Linde M, Folvik M, Bugten V, Tronvik E.

Torgeir K. Haavik
DOI 10.1007/s10111-015-0353-z discussion 240. Epub 2014 des 2
Acta Neurochir (Wien) 2015 Feb;157(2):235-40; PMID: 25435394

CTW Cognition, Technology & Work
Keep your coats on: augmented reality and sensework in surgery and surgical telemedicine

CTW Cognition, Technology & Work
Prospective sensemaking in the operating theatre
Ragnar Rosness, Tor Erik Evjemo, Torgeir Haavik & Irene Wærø
ISSN 1435-5558, Cogn Tech Work DOI 10.1007/s10111-015-0346-y

Kulseng CPS, Sandstrøm, JC.
Effective Doses To Staff And Dose Rates Emitted From Patients Undergoing Positron Emission Tomography Utilizing ¹⁸F-Fluorodeoxglucose. 2015, Radiography Open 2015, vol 2. ISSN: 238

FOR-related lectures

Selbekk T
Intraoperative image guidance with 3D ultrasound in brain surgery.
MedIm conference, Fornebu, Nov. 16-17, 2015

Surgical management and survival in low-grade gliomas: an updated analysis.
Lecture at the Annual meeting of EANS, Madrid, October 18-21, 2015

Stakkevold KR, Dahl T.
Behandling av aortadisseksjon type B på St.Olavs Hospital.
Høstmøtet i Norsk kirurgisk forening, Oslo 22.10.15

Dahl T, Semshaug D, Svengaard S, Rømo R.
Hvor blir det av tida på operasjonsstua?
Vintermøtet i Norsk karkirurgisk forening, Trysil

Solheim O
Surgical strategies in low grade gliomas.
Invited lecture at Fourth Annual World Course in Neurosurgical Oncology, London 8-12 July 2015
Langø T
Imaging modalities for flexible endoscopes.
Annual congress of the European Association for
Endoscopic Surgery (EAES), Bucharest, Romania, 3-6 June, 2015

Langø T
State of the art - intra-operative imaging for surgery
Annual congress of the European Association for
Endoscopic Surgery (EAES), Bucharest, Romania, 3-6 June, 2015

Gulati F
Three-dimensional Ultrasound-Guided Placement of
Ventricular Catheters.
Oral lecture, 5th Bi-annual Meeting of Intraoperative
Imaging Society (IOIS), New Dehli, India, February 12-15, 2015

Unsgård G
Ultrasound in Neurosurgery
Invited lecture at Norske Universitetssenteret in St.
Petersburg. April 2015

Solheim O
Surgical strategies in low grade gliomas.
Invited lecture at Fourth Annual World Course in
Neurosurgical Oncology, London 8-12 July 2015

Mårvik R
Foredrag om kompetansetjenesten i Trondheim for leger
og forskere i Tromsø
Mai 2015

Leira H O
Foredrag "Multimodal Image Guided EBUS"
Bronkoskopi Forum, Nasjonalt og Skandinavisk
bronkoskopimøte, UiO, Rikshospitalet, 09.04.15

Amundsen T
“Nasjonale guidelines (NLCG) for mediastinal staging av
lungekreft med EBUS”
Bronkoskopi Forum, Nasjonalt og Skandinavisk
bronkoskopimøte, UiO, Rikshospitalet, 09.04.15

Sørhaug S (Leira H, Amundsen T)
Foredrag “Å lære EBUS – Et 6års materiale fra
Trondheim, St. Olavs Hospital.
Bronkoskopi Forum, Nasjonalt og Skandinavisk
bronkoskopimøte, UiO, Rikshospitalet, 09.04.15

Leira H O
“Navigation systems for bronchoscopy”
Nordic Lung congress, Oslo 13.6.2015

Dahl T, Ødegård A.
Åpen eller kateterbasert behandling i karkirurgi – går
radiologene og karkirurgene i Trondheim sammen eller
hver til sitt? Kirurgen 2015;2:48-4

Individual lectures/ presentations at conference

22.01 - FOR-Fagseminar 2015 - FOR i dag. Jan Gunnar
Skogås
22.01 - FOR-Fagseminar 2015 - Medisinsk Visualisering
og avbildningsteknologi. Jan Gunnar Skogås
23.01 - FOR-Fagseminar 2015 - En
Forskningskoordinatørskvartskvarta med blikk for:
PET, NUKMED, FOR, RSNA. Geir A. Pedersen
18.03 – Hemt konferansen 2015 – IKT for liv og helse
«Fremtidens Operasjonsrom - Nye behandlingsmetoder
og ny medisinsk teknologi». Jan Gunnar Skogås
26.03 - Fagdag for radiografutdanningen. Gjesteforedrag
«Nyhet fra Fremtidens Operasjonsrom, teknologiens
utvikling». Jan Gunnar Skogås
24.04 - Presentasjon av Fremtidens Operasjonsrom, som
infrastruktur og organisering.
Sykehuset Østfold, Fredrikstad. Jan Gunnar Skogås
11.05 - Foredrag på Den 46th R3-nordic Symposium,
Thon Hotel Arena, Lillestrøm. Hvordan påvirker
medisinsk teknologi renhet i operasjonsstuen?
Utviklingen av nye behandlingsmetoder og teknologi.
Jan Gunnar Skogås
21.05 - Operating Room of the Future, research
infrastructure within minimally invasive treatment and
medical technology at St. Olavs Hospital.
Hans Olav Myhre
27.05 - Foredrag på NKKF Jubileumskonferanse,
“Høyddepunkt i norsk karkirurgi”. Hans O. Myhre
24.04 - Presentasjon av nye prosjekter i FOR, på FOR
nettverksmøte. Jan Gunnar Skogås.
28.05 - Presentasjon av FOR, prosjekter og infrastruktur, for en delegasjon fra Namsos Sykehus (Serviceklinikken (eiendom, mta, kjøkken, kontor, forsyning/innkjøp) og Medisinsk serviceklinikk (lab, røntgen / bildediagnostikk, steril forsyning). Jan Gunnar Skogås.


23.06 - Medical imaging and visualization within the minimally invasive treatment methods. Sony Corporation Atsugi, Japan. Jan Gunnar Skogås.

01.07 - Lecture, Kaunas University Hospital ifbm. Visit St.Olavs Hospital. Medical technology and operating theaters. Hybrid vs current solutions. Jan Gunnar Skogås.

08.09 - Forskningsseminar, Brekstad, Hovde gård. Presentasjon av FOR infrastruktur. Jan Gunnar Skogås.

08.09 - Forskningsseminar, Brekstad, Hovde gård. Forskningskoordinator i klinikk, Eksempler og erfaringer fra FOR. Liv- Inger Stenstad.

22.09 - Foredrag for radiografutdanningen. FOR-infrastruktur og hva FOR kan gjøre for bachelorstudentene. Liv- Inger Stenstad.

23.09 – USART summer school - Barcelona, Spain – 3D visualization and image fusion. Gabriel Kiss

25.09 – Besøk av Tine Kapur, Executive Director of Image Guided Therapy in the Department of Radiology at Brigham and Women’s Hospital and Harvard Medical School, og Dr. Wolfgang Wein, Technische Universität, Munchen. Foredrag om FOR ved Frode Manstad-Hulaas. Omvisning FOR stue Kar. Marianne Haugvold.


30.09 – Foredrag i forbindelse med Basalkurs, laparoskopisk kirurgi NSALK, DNLF. Laparoskopets teknologi, sikkerhet ved bruk av HF-strøm. Jan Gunnar Skogås.


27.10 – Keynote PAHI 2015 - Elgin, Scotland – Operating room of the future. Gabriel Kiss


05.11 – NFA Norsk Forening for Automatisering, konferanse Oslo. Medisinsk Teknologi og nye behandlingsmetoder, bildeveiledet og behovet for beslutningsstøtte. Jan Gunnar Skogås


Live transmission FOR

In connection with the “7th International Training course - 3D Ultrasound and neuro navigation » 4.-5. June - organized by the Centre for Ultrasound and image-guided therapy St. Olav Hospital, NTNU and SINTEF - carried out a successful live transmissions from the FOR operating room to the auditorium both days. Here is image from the transfer where clinic chief Unsgård from FOR operating room is talking to the participants who are present in NA.

FOR in the media

- Adressa 05.06.15 – Coverage in connection with the 7th international training course: Ultrasound in neurosurgery

- Schrödingers Katt – Footage from the Operating Room of the Future ENT. “Wisdom teeth inconvenience”. Broadcasted on television November 12th – link - https://tv.nrk.no/serie/schrodingers-katt/DMPV73001915/12-11-2015#t=23m30s


Participation in conferences

- Instituttseminar Institutt for sirkulasjon og bilde, ISB. 15.10.14

- FOR- Fagseminar Røros22 -23.01

- Hemitkonferansen. 18.03

- 13.03 – Masterdag
  Videoverføring Gastro, Gastric sleeve