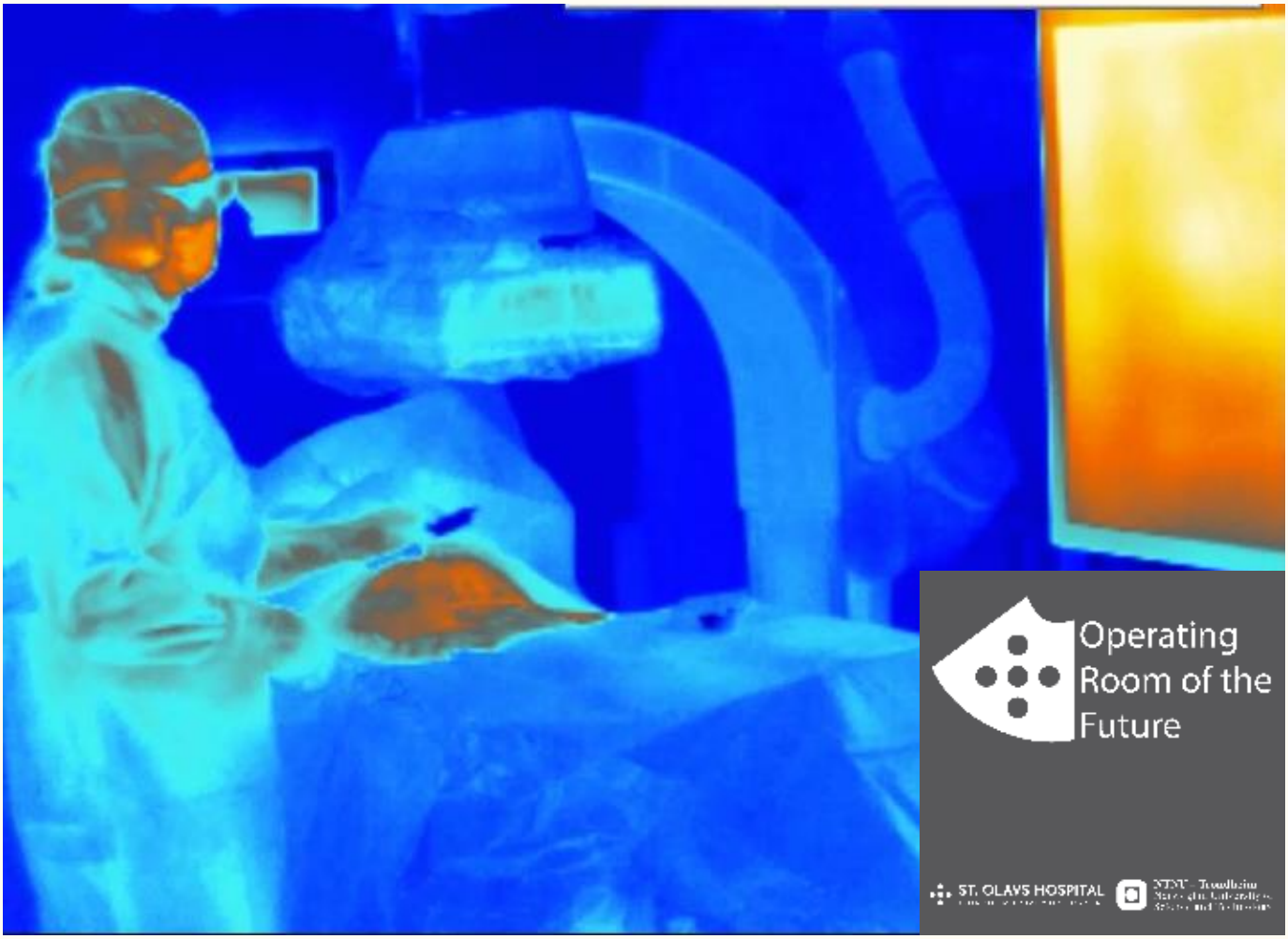
Annual report 2019
Operating Room of the Future



ST. OLAVS HOSPITAL
UNIVERSITETSSYKEHUSET I TRONDHEIM

NTNU | Norwegian University of Science and Technology

Frontpage photo: From a thermal plume camera taken at AHL-1F by Helena Kuivjõgi, a masterstudent at Department of Energy and Process Engineering, NTNU.

Preface

The Operating Room of the Future (FOR) is a collaboration between St. Olavs Hospital, University Hospital of Trondheim and the Norwegian University of Science and Technology (NTNU), Trondheim, Norway. FOR is a research infrastructure and an interdisciplinary arena that facilitates clinical research with emphasis on minimally invasive image guided patient care and medical technology within the surgical disciplines.

The infrastructure currently consists of 6 operating rooms at St. Olavs Hospital; one in each of the operating clinics. The operating rooms are built to develop, test and apply new technology and new treatment methods. Here, new prototypes can be developed and tested in safe and controlled environments. The infrastructure is approved for carrying out experimental surgery and has the necessary approvals and expertise.

NorMIT «Norwegian Center for Minimally Invasive Image Guided Therapy and Medical Technologies» as a common infrastructure and platform will bring us wider nationally and internationally. This platform was developed between FOR and the Intervention Center, OUS Rikshospitalet and supported by funding from the Norwegian Research Council. Both Western- and Nothern Norway Regional Health authority have now participated in this cooperation and are represented on the board. The purpose of the collaboration is to improve patient treatment and raise the quality and scope of research and innovation in such a way that it puts Norway on the map internationally. We are focusing on research and development based on the established infrastructure and research tools now available at the Intervention Center and FOR. Significant and important research equipment has been added to the infrastructure over the years.

FOR is taking part in several research projects and many of them, but not all, are led by FOR. In the present annual report we have included some projects where FOR and its staff has represented a prerequisite for the completion of the project. FOR is also set up to promote a close collaboration between clinicians, technologists, researchers and industrial partners who play a role in the development and innovation of the health care sector. This collaboration is reflected in the present annual report.

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 center of competence for the construction of operating rooms outside St. Olavs Hospital. We focus on architecture, material use, ergonomics, ICT solutions, logistics and health economics, so we can build more affordable and drive more rationally. It is important to do this in a systematic manner so that we get a lasting knowledge of different conditions at the operating departments.

The scientific advisory board at FOR is going through all projects to ensure that a good quality of the research is obtained.

Lecturing in the application of electro-medical equipment has become an important task for FOR. On behalf of the clinics FOR is organising courses and certification in the use of electro medical equipment. These courses are compulsory for all doctors in the FOR clinics and they are arranged via “Portal of competence” at St. Olavs Hospital.

A Lab for 3D-printing is established by FOR. The technology provides exciting opportunities for the development of implants, instruments and planning of complicated interventions. Technological developments in areas such as gene therapy, nanomedicine, artificial intelligence and ”big data” will have an impact on diagnostics and treatment in the future. These are areas that FOR is oriented towards through a multidisciplinary approach.

We want to thank all our collaborators for their contributions at FOR and NorMIT.

And we hope that you will enjoy our annual report of 2019!

Jan Gunnar Skogås
Head of department
Managing director
Photo: St. Olavs Hospital

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St.Olavs Hospital HF

St. Olavs Hospital HF, University Hospital of Trondheim, is integrated with NTNU and owned by Central-Norway Regional Health Authority RH. 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. The hospital covers psychiatry as well as somatic health care.

St.Olavs Hospital is running centers several places in Sør-Trøndelag County. In addition to the institutions in the center of Trondheim, hospital activity is taking place at:

- Orkdal hospital
- Røros hospital, Røros
- Departments of psychiatry at Østmarka and Brøset in Trondheim
- Three district centers for psychiatry; Orkdal DPS in Orkdal, Nidaros DPSand Tiller DPS in Trondheim
- Several psychiatry outpatient clinics for children and young patients in Sør-Trøndelag
- Department of psychiatry for children and youth at Lian
- Habilitation unit for adult patiens at Brøset, Trondheim
- Several outpatient clinics for psychiatry in Sør-Trøndelag

St.Olavs Hospital is the university clinic of Central Norway for a population of 731 931 inhabitants, and local hospital for a population of 324 282 per 01.01.19.

Our core values are integrity, equality, respect and co-determination, forming the background for our clinical activity and our students, colleagues and collaborators. St. Olavs Hospital is integrated with the Norwegian University of Science and Technology, NTNU, and students, teachers and scientists are representing natural parts of the hospitals` activity. Within teaching and research we are collaborating closely with several other institutions in central Norway.

In addition to the scientific activity, The University Hospital is responsible for the training of medical students and other health care professions. It is also responsible for the training of medical specialists in central Norway.

In 2019 we had:

- 10 657 employees
- 43 operating rooms at St. Olavs Hospital, Trondheim. In addition 5 operating rooms at Orkdal Hospital and 2 operating rooms at Røros hospital
- A total of 404 243 somatic outpatient consultations
- 1018 beds (somatic)

St. Olavs Hospital
Photo: Archive

An unresolved innovation potential from the research activity

Two interesting and relevant parliamentary reports are now on their way, - the parliamentary report for innovation in the public sector and the work relevance in education report. Operating Room of the Future responds to the need that both of these messages address: education that provides graduates with competence and knowledge relevant to the future and more innovation in the sector that contributes to both better and more efficient healthcare.

In Norway, research is being conducted for billions of NOK. A large part of the research takes place in close collaboration with the business and public community, where the knowledge from the research is transferred to the business and health sectors so that new products and services can be developed for better health services. But much of the research activity is also free independent research that has great potential for innovation and value creation that is never integrated into healthcare. It is not uncommon that it is precisely from some of these environments that radical innovations originate. So how can we ensure that more of the knowledge from research is actually used for better health services through new start-ups and health innovations?

In Norway, a review is underway of the instruments and support actions that will contribute to more innovation and value creation. Good infrastructures such as the Operation Room of the Future are one of several important tools for innovation and will also contribute to more relevant health education. The operating room of the future represents an important arena for revealing the potential for innovation and is a safe and secure infrastructure where students, researchers, business and health workers jointly can develop and test solutions based on the needs of the health service. In the health region, we are now also facing implementation of the Health Platform which will provide new opportunities for innovation and more efficient workflow. New drugs, methods of treatment and new technologies provide innumerable opportunities for development towards better quality of services as well as better efficiency. But we need better and more powerful tools and incentives to build more competence and capacity and to integrate innovation as an important part of the professional environments in the sector. The conditions and time for working with transforming innovation from research results must be improved and further developed. Tools to enable our employees to translate research results into specific products and services will be crucial in the future in order to unleash potential from the research. The review of the overall funding mechanisms and instruments in Norway must also include the development of new, better and more powerful instruments to unlock the potential for value creation and innovation from the research activity.

Therefore, through a close collaboration between St. Olavs Hospital and NTNU in "The Integrated University Hospital", the Operating Room of the Future represents an unique infrastructure for collaboration between different actors, for developing new competence and for translating knowledge from research into solutions and innovations based on the needs in healthcare. This is a powerful way of developing a Norwegian health industry and a better health service in Norway.

Toril Nagelhus Hernes
Pro-rector for innovation, NTNU
Professor of medical technology
Photo: NTNU

Operating Rooms of the Future

The Operation Room of the Future – FOR - contributes greatly to the continuous development of treatment and research at St. Olav's hospital and the Faculty of Medicine and Health Sciences at NTNU. Better and more functional surgical treatment and other services such treatment at distance where the patient cannot or should not come to the hospital are in focus. Together with researchers, innovators and industry; high-resolution visualization, holograms, robotics, artificial intelligence, and 3D printing has been adapted. FOR is a gateway to develop and test new technological solutions both in treatment of patients and in training of health professionals.

The ability to integrate advanced medical environment at St. Olavs Hospital with NTNU, SINTEF, the Innovation Center at OUS and commercial industrial partners is an important strength.

Development of business activities in cooperation between hospitals, universities and the private sector is high on the political agenda in Norway. For St. Olav's hospital and the Faculty of Medicine and Health Sciences, FOR is a key instrument for establishing such business cooperations.

Many have contributed to the development of FOR, but I would especially like to thank Professor Emeritus Hans Olav Myhre and Managing Director at FOR Jan Gunnar Skogås for a long-standing effort to build FOR.

Gunnar Morken
Director of Research, Innovation and Education
St. Olavs Hospital and
Faculty of Medicine and Health Sciences, NTNU
Photo: St. Olavs Hospital

Faculty of medicine and health sciences, NTNU

Health for a better world is the Faculty's vision and contribution to realizing NTNU's vision *Knowledge for a better world*. We aim to develop knowledge, skills and solutions that contribute to good health from a regional, national and global perspective.

Operating Room of the Future (FOR) is an arena for safe clinical innovations: for development of interdisciplinary competence, for translation of knowledge from research to practical clinical solutions, and for implementation and testing of technical solutions and prototypes in a safe and controlled environment. NTNU students are attracted by the dedicated cooperation at FOR between various research groups at NTNU and clinical expertise at St.Olavs hospital, and currently master students and ph.d.-candidates are engaged in FOR activities from several faculties at NTNU.

In Norway, there is currently a major restructuring of National Curriculum Regulations in health and welfare education in order to make our students more future-oriented (RETHOS). The faculty is specifically following up the learning outcomes where more innovative knowledge is in demand, and see great value in collaborating with other faculties at NTNU and with St.Olavs hospital as the integrated university hospital. "The candidate can contribute to innovation, innovation processes, service innovation, systematic work processes and continuous quality improvement", the national regulations state. In this regard, FOR has already contributed greatly by facilitating workshops with our student-innovation group DRIV.

Students, researchers and professors at NTNU are inspired by the FOR management, staff and research teams. FOR is contributing to health innovation and student innovation, which both are defined as important goals for MH-faculty and for NTNU.

The annual FOR seminar at Røros is a favorite venue to meet engaged and innovative researchers and health personnel, and to learn about current projects and trends. Hospital infections, robotics in orthopedic and vascular surgery, artificial intelligence and machine learning, digital twins, nano- and micro-bubbles for ultrasound-mediated drug delivery, navigation methods in surgery and 3D-printing as surgical tool are topics learned about in this very relaxed atmosphere. Such hot topics are well suited for further involvements by NTNU students, researchers and professors. NTNU also has an innovation infrastructure with innovation managers at many centers, faculties and departments which can assist FOR to find the right NTNU researchers and students for their needs.

The MH-faculty wants to congratulate FOR on 15 years of success and proven contributions to clinical-technical research and innovation.

In accordance with our vision *Health for a better world*, we recognize FOR as an important partner and we are looking forward to further cooperation

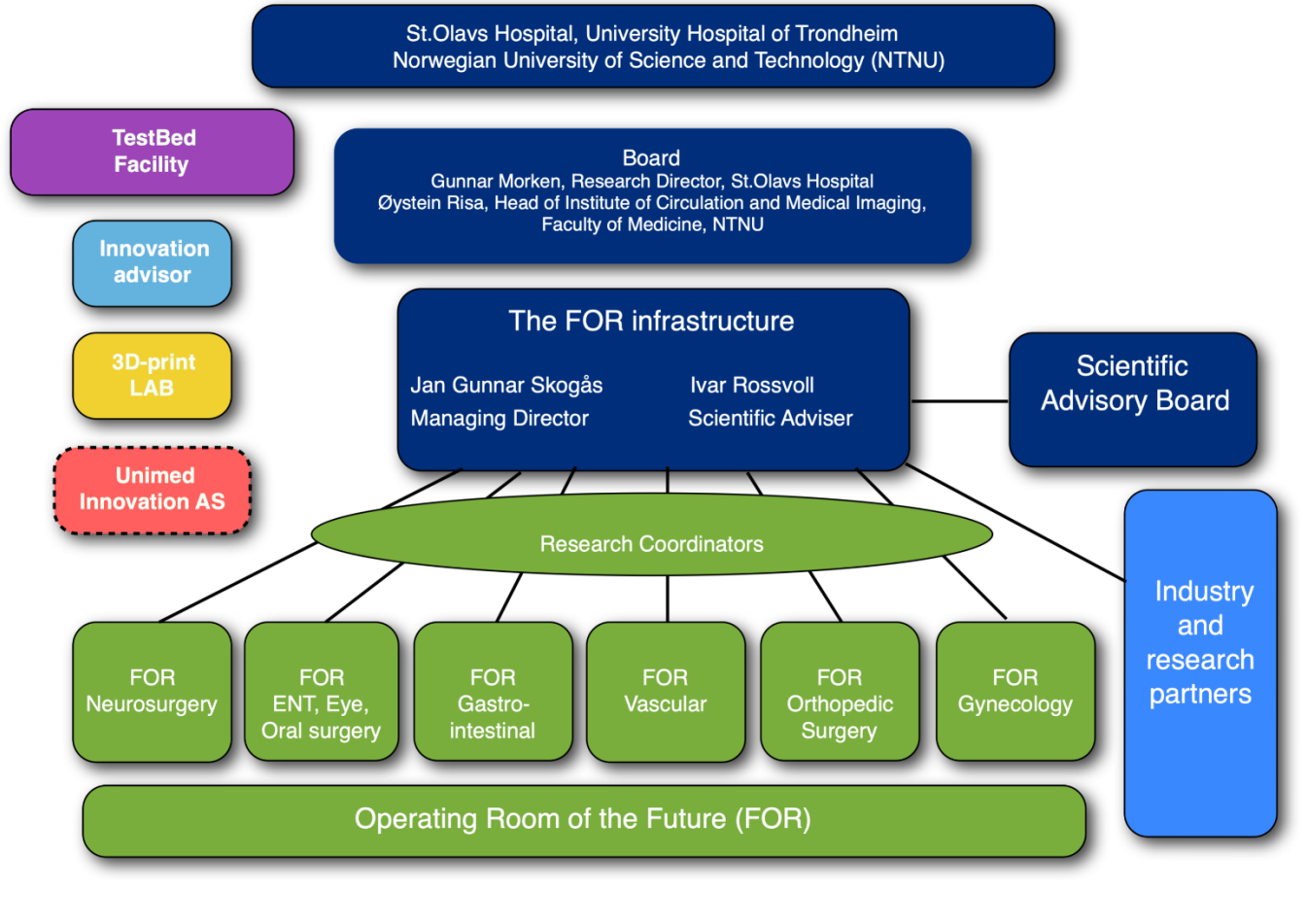
Björn I. Gustafsson
Dean, Professor

Brita Solveig Pukstad
Vice dean of innovation and ph.d.-education

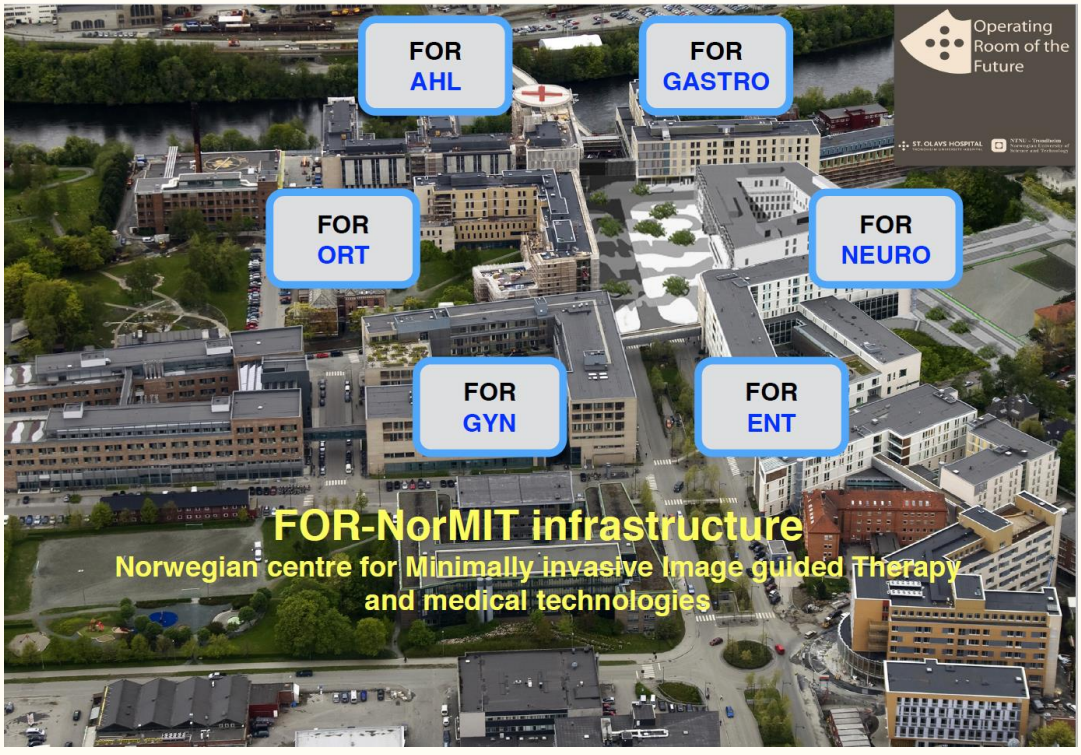
Øystein Risa
Head of dept. of circulation and medical Imaging

Photos: Geir Mogen/ NTNU

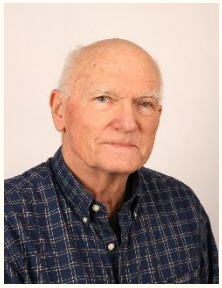
Organization of the Operating Room of the Future



Overview of the FOR research infrastructure



Staff



Hans Olav Myhre
Professor of surgery

Jan Gunnar Skogås
Managing Director

Ivar Rossvoll
Scientific adviser

Ronald Mårvik
Associate Professor

Frode Manstad- Hulaas
Associate Professor

Liv- Inger Stenstad
R&D coordinator

Jan- Magne Gjerde
R&D coordinator

Gabriel Kiss
Scientist, R&D coordinator

Marianne Haugvold
Advisor R&D

Guangyu Cao
Professor NTNU

Ingrid Granbo
R&D coordinator

Vigdis Schnell Husby
R&D coordinator

Alexander Moen
Innovation adviser

Geir Andre Pedersen
R&D coordinator

Photo: St. Olavs Hospital

Scientific advisory board

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 special guidelines 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.
FOR additionally contributes a great deal to students at the research line at The faculty of Medicine (NTNU), an offer for medical students who are interested in research and a possible future research career possibly parallel to clinical activities.

The scientific advisory board has the following members:

Assistant professor Ivar Rossvoll (leader)

Emeritus professor Hans Olav Myhre

Professor Per Farup

Professor Olav Haraldseth

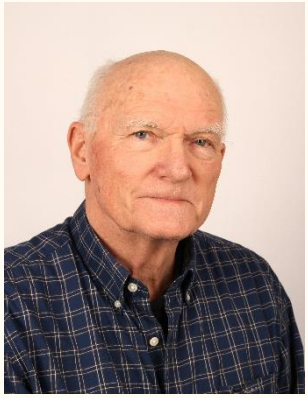
Professor Ståle Nordgård

Assistant professor Frode Manstad-Hulaas

Assistant professor Knut Haakon Stensæth

Research director Thomas Langø

Ivar Rossvoll
Scientific adviser
Photo: St. Olavs Hospital



Hans Olav Myhre
Professor of surgery
Photo: St. Olavs Hospital

Per G. Farup
Professor
Photo: Private

Olav Haraldseth
Professor
Photo: NTNU

Ståle Nordgård
Professor
Photo: NTNU

Frode Manstad-Hulaas
Associate Professor
Photo: St.Olavs Hospital

Knut Haakon Stensæth
Assistant professor
Photo: Private

Thomas Langø
Research director
Photo: SINTEF

Highlights of 2019

Dissertations 2019

PhD Amar Aganovic defended his thesis January 17th

As a part of the PhD study on "Control of airflow distribution methods enabling better indoor environment in health-care facilities" we investigated the impact of surgical lights on the velocity distribution and airborne contamination level in two operating rooms equipped with laminar airflow systems at the orthopaedic department of St.Olavs Hospital. The work was carried out in collaboration with Liv-Inger Stenstad and Jan Gunnar Skogås from FOR and under supervision of Guangyu Cao from the department of Energy and Process Engineering at NTNU. The study [1] showed that the wakes created behind the three differently shaped surgical lights were characterised by relatively high turbulence intensities and by velocities low enough for microbiological particles to deposit on critical surfaces such as wounds. This was confirmed in the same study by the occurrence of bacterial counts in the sterile field during mocked surgeries performed under surgical lights. An additional mock surgery that was performed without lights did not record a single bacteria count. The conclusion was that medical equipment such as surgical lights may impede the ventilation system's ability to clear contaminants from the sterile field. We are currently analysing the combined effect of surgical lights and the fluoroscopy imaging device on the airborne contamination in operating rooms with laminar airflow systems.

PhD Amar Aganovic delivered a brilliant lecture about his thesis January 17. The title of his PhD work is "Airflow Distribution for minimizing human exposure to airborne contaminants in healtcare facilities". The supervisor has been Prof. Guangyu Cao from the Department of Energy and Process Engineering. The co-supervisor was Professor Arsen K. Melikov from the Department of Civil Engineering, Technical University of Denmark. Opponents during the defense were Director Kim Hagström, Halton Oy, Finland, Professor Catherine Noakes, University of Leeds, UK and Professor Hans Martin Mathisen, NTNU.

From left: Managing director Kim Hagstrøm, Professor Catherine Noakes,
PhD Amar Aganovic, Professor Hans Martin Mathisen, Professor Guangyu Cao.
Photo: Liv-Inger Stenstad, FOR

Cecilie Våpenstad defended her thesis November 13th

The use and development of simulators has increased over the past ten years, partly because of the transition from open techniques to more complex minimally invasive techniques, but also because of increased focus among hospital management and the general population to get training without the risk of patients and a quality assurance of surgical skills. The potential for simulator-based training and assessment is far from being fully exploited today, and depends on further development, exploration and validation, as well as political and organizational goodwill. Cecilie Våpenstad's thesis is a contribution to the exploration and validation of simulator-based training and assessment.

Important questions that arise when using simulator-based training and assessment are whether simulator training can increase clinical skills, and whether simulators are able to demonstrate (test) clinical skills. The doctoral degree is based on five studies that looked at whether skills acquired on simulator were transferred to clinical skills (Article 4), on skills measured on simulator are equivalent to clinical skills (Articles 3 and 5), and what exists of simulator-based training for laparoscopic, endovascular and flexible gastroenterological endoscopy procedures (Article 2), and how surgeons experience simulated tactile feedback (Article 1).

Article 1: Våpenstad C, Hofstad EF, Langø T, Mårvik R, Chmarra MK (2013) Perceiving haptic feedback in virtual reality simulators. Surgical Endoscopy 27(7), 2391-2397.
Article 2: Våpenstad C, Buzink SN (2013) Procedural virtual reality simulation in minimally invasive surgery. Surgical Endoscopy 27(2), 364-377.
Article 3: Våpenstad C, Hofstad EF, Bø LE, Chmarra MK, Kuhry E, Johnsen G, Mårvik R, Langø T (2013) Limitations of haptic feedback devices on construct validity of the LapSim® virtual reality simulator. Surgical Endoscopy 27(4), 1386-1396.
Article 4: Våpenstad C, Hofstad EF, Bø LE, Kuhry E, Johnsen G, Mårvik R, Langø T, Hernes TN (2017) Lack of transfer of skills after virtual reality simulator training with haptic feedback. Minimally Invasive Therapy & Allied Technologies, 26(6), 346-354.
Article 5: Våpenstad C, Hofstad EF, Bernstein TE, Aadahl P, Johnsen G, Mårvik R (2019) Optimal Timing of Assessment Tasks Depending on Experience Level of Surgical Trainees - Minimally Invasive Therapy & Allied Technologies, 1-9.

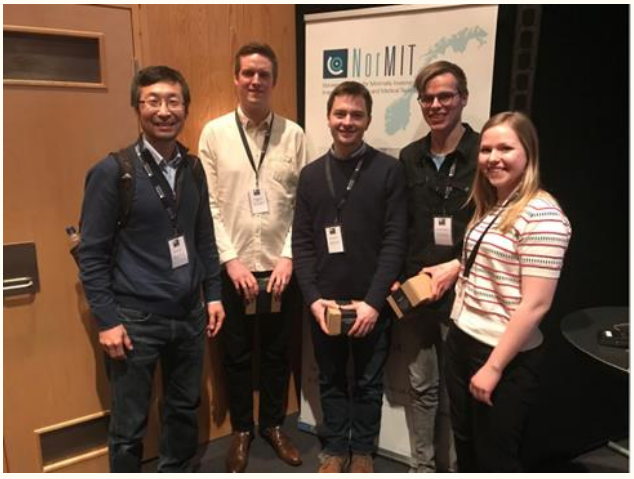
From left 3rd opponent Associate Professor Jan Pål Loennechen, NTNU, 1st opponent Professor Lars Konge, University of Copenhagen, the PhD candidate Cecilie Våpenstad, NTNU, 2nd opponent Researcher Sandrine Voros, Laboratoire TIMC-IMAG, Grenoble and Acting Dean Associate Professor Frode Manstad-Hulaas, NTNU. Photo: Private

The Annual Røros FOR seminar 2019

This year`s FOR seminar was traditionally held at Røros, in sparkling wonderful winter weather. It was a rich and exciting program as usual. This year, 78 participants had found their way to Røros to attend this annual event.

Thank you so much to all of you for pleasant days at Røros. The annual FOR seminars are important. It shows the variety of research and development within the surgical fields. At this year's seminar, the main focus of day 1 was air quality in operating rooms, and hospital infections with challenges in surgery. On day 2, the main theme was the future of medicine imaging, nanotechnology, gene therapy / cell therapy, 3D printing in medicine, augmented reality and how artificial intelligence shapes the future of patient care. We ended the day with another important topic; the conditions around health research and GDPR.

Photos: Jan-Magne Gjerde, FOR



Right: As a fun ending to dinner during the seminar, Hans Olav Myhre handed out something he chose to call the "FOR Prize 2018". The award went to Jan Gunnar Skogås.

Photo: Google

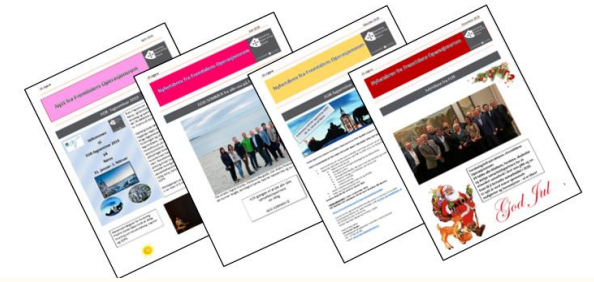
Left: Jan-Magne Gjerde, our expert on medical 3D printing, had made a great exhibition of some of his clinical work so far. One of the printers also demonstrated printing of a humerus during day 2

Under and left: Professor Guangyu Cao and his master's students, Anders Mostrøm Nilssen, Amar Aganovic (PhD), Christoffer Pedersen and Catharina Flatsetø. They come from the Department of Energy and Process Engineering at NTNU, and presented the lectures in the first session on day 1, which dealt with the various ventilation systems we have at the hospital and their impact on post-operative wound infections.

Newsletters from FOR

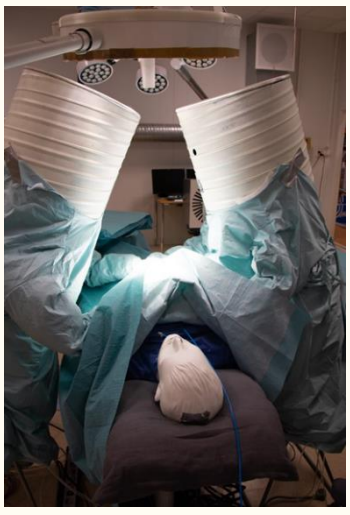
In October 2014 the first newsletter from FOR was available. So far the newsletters have been a great success. Three-four newsletters are distributed annually. They are focusing on the activity at the FOR infrastructure and are including visits at FOR, meetings, courses and information about scientific projects. We think this is a useful way of informing about FOR and hope you will enjoy it

If you would like to read the newsletters please visit this link: https://stolav.no/fag-og-forskning/kompetansetjenester-og-sentre/for

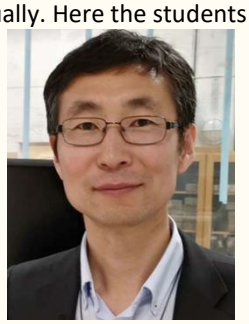


This year we have collected all the newsletters from October 2014 to December 2019 in one booklet.

Opening of a new OR- lab at NTNU



Trygve Magne Eikevik, Professor, Program Manager at Product Development and Production, Deputy Chair of the Department of Energy and Process Engineering and Jan Gunnar Skogås, Managing Director Operating Room of the Future, St. Olav's Hospital made the official opening. It is the Department of Energy and Process Engineering with Professor Guangyu Cao that is behind the construction of this operating room lab. It will mainly be used to study the ventilation systems found in hospitals, both mixed ventilation and LAF roofs, gradually. Here the students can work in a safe environment with their projects, simulating operations, and with the use of smoke machines and tracer gases to see the air currents and particles in the air.



The official Operating room of the future sign, which shows that there is a FOR operating room, was handed over by the managing director of FOR, Jan Gunnar Skogås. This makes the FOR operating room no seven in the series. This shows the good cooperation that FOR and the Department of Energy and Process Engineering have had since 2015, when the students started to study the ventilation systems in the FOR operating room at the departement of orthopedic surgery where there is LAF roof. Since then they have also studied the ventilation system in the FOR-operating room at AHL, where there is mixed ventilation.

Photos: NTNU/Maren Agdestein and Prof. Guangyu Cao

FOR – NorMIT 3D-printlab

"3D planning is now performed for all major reconstruction cases. This enables us to improve the quality of the treatment we give our patients. Greater predictability and shorter surgeries are also obtained with 3D-planning."

Nils Petter Fossland
Head of dep. Oral and Maxillofacial Surgery
St. Olavs Hospital
Photo: Private

"The cooperation with FOR has enabled a new method for planning and performing technical difficult surgical procedures…. In total, we have obtained an important tool that improves the quality of the treatment we can give our patients." Christian Øye, Consultant at department for pediatric Orthopedics at St Olav`s Hospital.

Christian Øye
Head of Section Children`s Orthopaedics, consultant; MD, PhD
St. Olavs Hospital
Photo: Private

2019 was the second year of operation for FOR-NorMIT 3D-print lab, and the activity in the lab is accelerating. Three departments are using this services on a regular basis as a tool for solving difficult clinical cases. Primarily the lab provide anatomical models for visualization and pre-operative planning of cases with challenging anatomy for the Orthopaedic- and Cranio-Maxillofacial department. Digital 3D-planning of surgery, and manufacturing of simple patient specific surgical guides can also be done at the lab.
The lab also provide patient matched boluses for radio-therapy treatment. These boluses help to improve the accuracy in treatment of cancer in the head/face region.
In addition to clinical work the lab is also a popular provider of models for research purposes. Among the deliveries are patient specific models of the aorta for research related to vascular intervention procedures, customized cranial plates for the department of neurosurgery, and several prototypes and phantoms for projects at SINTEF.
The lab is still in development. Workflow and procedures are being improved to obtain a more streamlined service. Whereas 2018 was mostly about spreading the word about 3D-printing to all departments at the hospital, 2019 has been more about prioritizing some applications to bring the service around. The optimization for these selected specialties will continue in 2020, before we plan a gradual expansion to provide clinical services for more specialties.

Anatomical models for visualisation of pre-operative planning in orthopedics.
Left: Pre-bending of plates for a scapula fracture.
Right: Visualisation of complex fracture in distal femur.
Photos: Jan Magne Gjerde

Activity at the FOR operating Rooms

Surgical Clinic

FOR arranged a very successful seminar at Røros in January 2019, where we got information about particle counting and air quality studies for different types of ventilation in operating rooms. This contributes to the infection control work that is conducted in the surgical clinic. The projects also bring us back to the start of FOR, as the purpose among other things was to gather experience in building design of operating rooms for new hospitals.

Vascular surgeons and radiologists regularly use the FOR-operating room in the emergency center. The number of endovascular procedures for aneurysms is high and there are several and complex procedures for aneurysms involving the blood vessels of internal organs such as liver, intestine and kidneys.

TAVI operations goes on, and we notice that the X-ray installation is getting worn. There will probably be a need for replacements and renewals within a few years, and we hope that the industrial cooperation established by FOR will ensure modern and future oriented equipment when that time comes.

There has been somewhat less experimental studies on FOR 1, but the work on navigation and steerable catheters in vascular surgery continues in collaboration with the National Competence Service for ultrasound and image-guided treatment. FOR`s recently acquired expertise in 3D printing opens up new opportunities for studying navigation by producing anatomical models based on real patient data.

Simulator training with the entire operation team the day before endovascular surgery is perceived as very positive, and the tasks are defined in advance and make the team well prepared. However, it is still difficult to set objective goals for this, and preparation of the simulator with programming of the patient's CT data has been laborious for participating radiographs. The simulator has been in regular use, and provides opportunities for individual training and team training. The FOR-operating room in the Gastro Centre represents a large and good operating room for laparoscopic surgery. Technical problems have delayed the work of incorporating perioperative ultrasound images into the patient's CT images. Therefore, multimodal imaging is still being considered for laparoscopic treatment of liver metastases.

Birger H. Endreseth
Head of Surgical Clinic
Photo: St. Olavs Hospital

Operative activity FOR operating room AH- 1F Department of Surgery 2019	
TAVI	108
EVAR	76
Various vascular operations	41
Thoraco-abdominal stent-grafts w/ side branches	14
Combined procedures (open operation +PTA/stent)	77
Various endovascular procedures (coiling etc.)	12
Removal of infected pacemaker wires	19
Total	**347**
Experimental surgery and other research	10

Operative activity, FOR operating room 4 Department of surgery 2019	
Upper gastro	63
Middle gastro	161
Lower gastro	251
Total	**475**

Activity in the Department of Radiology and Nuclear Medicine associated to The Operating Room of the Future 2019.

Another year with high activity in the field of interventional radiology has passed by. The good collaboration with other departments in the hospital and the operating room of the future has been continued. It is very important to maintain and further develop the highly skilled level among our operators, and to secure that further innovations and research within the field of interventional radiology and vascular surgery takes place.

Research:

The collaboration between the Dept. of Radiology, Dept. of Surgery, The Medical Simulation Centre and The Operating Room of the Future has resulted in two articles in «Minimally Invasive Therapy & Allied Technologies», describing pre-operative training/planning before EVAR with the use of an angiosimulator (Mentice VIST). The first article was published in February 2020, and the second article was accepted for publication in the beginning of April 2020. The articles are titled «Influence of patient-specific rehearsal on operative metrics and technical sucess for endovascular aneurysm repair» and «Operators believe patient-specific rehearsal improve individual and team performance».

Erik Nypan ended the first part of his research project in 2018, and is now continuing with his Ph.d on the use of advanced catheter- and imageguided techniques in the aorta. The project is expected to produce several articles under the guidance of Reidar Brekken and Frode Manstad-Hulaas.

Håvard Ulsaker has been working on a project connected to NorMIT since the spring of 2018, using advanced catheters with electromagnetic tracer-technology to identify where to place wholes for sidebranches in a stentgraft. Reidar Brekken and Frode Manstad-Hulaas are supervisers in this project.

Clinical activity:

In 2019 17 thoracal stentgraft procedures were performed, 4 of these were done in an acute setting and in 6 patients the procedure was performed percutaneously. In addition, 11 thoracoabdominal stentgrafts were performed with side-branches and/or with fenestration, plus 67 «traditional» EVAR procedures. Out of these 67 EVAR procedures 7 were acute and 20 were performed percutaneously.

Through our good collaboration with the vascular surgeons we also made 10 stentgraft repairs and 56 combined procedures with open surgery and PTA/stent in the iliacs and the lower extremeties.

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

Activity that the Clinic for Medical Imaging has participated in at the FOR operating room at AHL 2019	
Stent grafts in the abdominal aorta	67 (7 emergencies)
Stent grafts in the thoracic aorta	17 (4 emergencies)
Thoraco-abdominal stent-grafts w/ side branches	11
Combined intervention in the pelvis and lower extremities	67
Total	**162**

FOR activity at the Department of Women`s Diseases

The Clinic of Women's Diseases has had a good cooperation with FOR over several years. At the FOR-operating room in the Clinic of Women's Diseases, mainly laparoscopic surgery is performed today. An Endo Alpha system has been installed including HD technology for imaging and visualization. Advanced platform for electro surgery with focus on vessel sealing is available. Gynecological department is active in robot surgery, and robot is currently used both for the operation of general gynecology patients and for gynecological cancer. The da Vinci robot at St. Olav's hospital was obtained through FOR. In 2012, a second da Vinci robot was placed at Orkdal Hospital - as a gift from the Norwegian Women`s Public Health Association. Gynecologists operate with the da Vinci robot two days a week at St.Olavs hospital and one to two days a week at Orkdal Hospital. Robot surgery is a good example of FOR activity; High-tech, innovative and has a great potential for the future. The department has conducted prospective studies related to ovarian cancer surgery (tumor reductive surgery) and surgical techniques in hysterectomies. Doctors at the department have recently concluded a prospective study on primary lymph nodes in endometrial and cervical cancer. Fluorescence camera attached to the da Vinci robot provides the opportunity to study this. FOR assists the clinic with the mandatory EMU certification of The Clinic of Women's Diseases. This is placed in the competence portal so that the individual doctor can follow his own plan for EMU training and follow up and when it is time for renewal.

In 2019 43 gynecological surgical procedures have been recorded using FOR-NorMIT technology. The recordings have been edited and post-processed in collaboration with the surgeon and will be used as teaching material to be released in connection with a textbook.

We look forward to continuing the good cooperation with FOR in 2020.

Kjell Åsmund Salvesen
Head of Clinic of Women's diseases
Photo: St. Olavs Hospital

Operative activity FOR operating room 7 Department of Women and Children's diseases 2019	
Maternity unit	18
Gyn Cancer	12
Gyn General	13
Total	**43**

FOR activity at the Department of Neurosurgery

Active clinical research is conducted at the FOR-NorMIT operating room at the Neurosurgical Clinic. The research at the department is carried out in collaboration with the "Norwegian National Advisory Unit for Ultrasound and Image-Guided Therapy". The research is directed by clinical needs and, through an interdisciplinary clinical and technological approach, a more optimal patient treatment is developed. The research activity at the FOR operating room at Neurosurgical Clinic is integrated with the daily operative activities.

The department's most important research profile is the use of 2D and navigated 3D ultrasound in image-guided minimally invasive neurosurgery. The technology is adapted to several applications, including pituitary surgery, brain tumor surgery, AVM operations and hydrocephalus surgery. Also in 2019, research related to 3D ultrasound navigation during the mentioned interventions has been conducted.

In addition, both the BrainLab Curve navigation system and the BK 5000 ultrasound scanner purchased by NorMIT are used for clinical research. In this way, the latest navigation software from BrainLab with built-in 3D ultrasound navigation support is available.

On behalf of the clinics, FOR has been given the task of arranging the compulsory courses in electromedical equipment (EMU course). Training and courses in electromedical equipment for doctors are well established and all surgeons receive continuous offers and invitations to courses that are systematically registered and documented under the auspices of FOR. These EMU courses fulfil the requirements for EMU training for all LIS doctors and surgeons.

The cooperation with FOR has been positive and we look forward to continuing this good cooperation in 2020.

Tomm Brostrup Müller
Head of the Department of Neurosurgery
Photo: Aleris

Operative activity at FOR operating room 3 Department of Neurosurgery 2019	
Craniotomies/intracranial operations, vascular lesions and head trauma	131
Shunt operations	14
Operations on the spinal canal, spinal cord	150
Other operations: • Nerve root • Pain or dysfunksjon	48
Total	**343**

FOR activity at the Clinic of Ear-Nose-Throat, Eye- and Maxillofacial Surgery

The FOR-operating room at Department of ENT is a modern operating room that incorporates high tech solutions, with special lighting and a cockpit solution. It is a popular place to work and is a central arena for tonsillectomy, and the use of navigation equipment. The advantages of the cockpit screen visualization system is studied and enables enhanced visibility and integration of patient data during advanced and navigated endoscopic procedures. The system is preferred for sugery with 4 hands/2 surgeons in particular.

Since the opening of the operating room in 2013, the FOR concept has focus on research projects within medical technology, good audiovisual solutions, testing of new technological equipment and good logistics around the patient. The establishment of the 3D print lab at FOR enables for a very close collaboration with several pre- and intraoperative applications.

We consider FOR an important team-builder and by facilitating cooperation and bringing together different disciplines it promotes creativity and innovation. We have experienced that FOR is responsible for a smooth cooperation with medical industry. Not least, we are pleased that our FOR contacts participate in the clinic's research committee and contribute with input and innovative ideas as well as information about opportunities within research support. We hope that this cooperation will evolve further.

Examples of ongoing projects where we have in close cooperation with FOR:

• Botox injections against the levator veli palatin muscle in patients with objective tinnitus caused by muscular myoclonia. The muscle is targeted with a navigated injection tool Multiguide based on preoperative integrated MRI and CT images. A pilot feasibility study is performed precluding a planned ph d project

• Injection of Botox against the sphenopalatine ganglion in patients with persistent idiopathic facial pain. This is a study of 30 patients where half get a placebo injection. There is a crossover after 6 months, patients undergo new injection round but the opposite substance to the initial injection in given, thus a total of 60 injections. The same navigation instrument is used

• Sialoscopy (tools for diagnosing tumors and stones in the salivary glands): Currently, ENT and the department of Maxillofacial surgery are is the only departments in Norway next to Stavanger that offers this minimally invasive method. We therefore receive patiens from the entire country. The number of examinations and treatments increased in 2019 to 54 from 27 the previous year

• A national project for improvement of results after tonsillectomy: ENT surgeons from the 6 hospitals with best results demonstrated surgical techniques for colleagues nationwide Educational videos from all procedures as basis for education of ENT doctors in Norway

We thank FOR for a good cooperation in 2019 and look forward to the continuation.

Marit Fagerli
Head of Clinic
Department of ENT, Maxillofacial and Eye diseases
Photo: Private

Operative activity at the FOR operating room 1 **Department of ENT, Maxillofacial and Eye diseases in 2020**	
Arthroscopy	47
Conchotomy	25
FESS - Functional endoscopic sinus surgery	45
Multi-guide injections	3
Neuro-navigation	22
Septal plasty	65
Sialoscopy	57
Other interventions	399
Total	**663**

FOR activity at the Clinic for Orthopedic-, Rheumatology and Skin Diseases

The Clinic for Orthopedic, Rheumatology and Skin Diseases uses the research infrastructure Operating room of the future, FOR. The FOR-operating room is used for example to major routine activities within prosthetic surgery.

The operating room is equipped with LAF ceiling. An important work that has been going on since 2015 is to investigate how different devices, such as the operation lamps, affect turbulence in the airflow under the laminar airflow (LAF) roof. In 2019, students from the Department of Energy and Process Engineering at NTNU also studied the thermal comfort of the staff, how heat in the operating room can affect the surgeons.

Radiation protection is also important for personel who use radiation during surgery. As a project, 22 selected orthopedics who may be exposed to scattered radiation, should carry dosimeters for a year to determine whether this should be a permanent solution. FOR helps the Section of radiation control with this project.

We hope that the technology in the FOR-operating room at our clinic will be optimized and improved emerging as a good innovation arena for further development of the orthopedic area. Development of new treatment methods and medical technology is of great importance in the field of orthopedics. Over the past few years, several different research and development projects have been reported; indicating that FOR is a useful infrastructure.

FOR, on behalf of the clinics, is leading the mandatory training and checkout of electro medical equipment for the surgeons and LIS. FOR is arranging the courses and manages this registry through the competence portal.

Vigleik Jessen
Head of Clinic for Orthopedic,
Rheumatologic and Skin Diseases
Photo: St. Olavs Hospital

Operative activity FOR operating room 8 Clinic of Orthopedic Surgery 2019	
Primary hip prostheses	61
Revision of hip prostheses	60
Knee prostheses	203
Other operations	25
Total	**349**
Research days	11 days
Mainly total prostheses of the knee are included in the fast-track project	

Medical Technology and Information Technology FOR-NorMIT

FOR is featured in the National ICT Strategy Plan for 2013-2020, and the Government's ICT research and development strategy is defining areas for ICT research and development in the future and signals how the government wishes to prioritize public resources allocated for research and development in ICT.
Link to National Strategy - ICT - Research and Development.
http://www.regjeringen.no/nb/dep/fad/dok/rapporter_planer/planer/2013/strategi-ikt-forskning.html?id=734430

The pace of digitization challenges us massively. Technology companies and developers identify the health sector as a major focus area for innovation. The society's expectations that the health sector will become more modern and technology-based will be strengthened in the years to come. Employees will expect the health service to be ahead of the development of using new therapies and technology. Younger people are raised with extensive use of internet-based «items». The proportion of people gathering and sharing information both at work and in leisure time from their networks will increase for each year. The community will therefore become more network-based by 2035. Both employees and patients will expect that necessary information and answers "always" are available. This requires that we change the way we are organized and work.

Medical technology and information technology gives us new opportunities to improve our knowledge base through an explosive growth in available data. Future analysis platforms will provide integrated patient data, including data from MTU, and will provide a better and more accessible basis for own research. Using Big Data, strategies can be developed to prevent disease and to provide better treatment. The development in technology and medicine will provide a good basis for research with available and integrated data. It is important to ensure that research results and new innovative solutions are implemented and that they form the basis for a knowledge-based and future-oriented health service.

FOR-NORMIT with its unique relation to technical competence environments by for example NTNU, SINTEF and international research and industrial environments, have an outstanding opportunity to take advantage of clinic-initiated development to a greater extent as technology evolves. There will be a standardization and coordinated development / innovation throughout the health service. In this work, patient needs and requirements, as well as clinic-initiated innovation, should be considered and new measures evaluated through research.

FOR-NorMIT is an established research infrastructure at the University Hospital in collaboration with NTNU. Under the auspices of FOR-NorMIT, different professional environments can try out new technology in a safe way. The NorMIT initiative emphasizes that FOR is a research infrastructure that will benefit the entire health region - and beyond it, nationally and internationally. It is interesting for the health care companies that there will be a lot of new technology that requires testing in clinical practice. It is also likely that rational in the future that some heavy technological investments are concentrated to make the most out of the resources.

Through co-operation with environments and forums where development in the future is a topic, FOR-NORMIT can capture trends / new technologies at an early stage.
Examples are:
- Nanotechnology
- Biotechnology (Gene therapy / diagnostics)
- IT revolution that will continue (Big Data)
- Neurotechnology
- Quantumtechnology

Several conditions that previously had to be treated at larger clinics, can eventually be taken care of at the local hospital level. There will be more technological equipment in the operating rooms. Operation of this requires considerable training. Engineers get a more important role. There will be a centralization of the most complicated interventions. Other conditions that do not require extensive multidisciplinary collaboration including several different specialists can be done at the local hospital level. Analysis and interaction technology can provide very good opportunities for comprehensive innovation in mental health care.

The trend towards 2035 will be more personalized medicine, technology that enables even more decentralized treatment, as well as better utilization of health data from various sources. Consequences of this may be that with more accessible research data, time interval from research to results will be shortened and clinical practice may become even more adaptable.

Advanced digital image processing and large data power provide new ways of visualization and image production with higher information value with ever better resolution and shorter recording time. Development on equipment and software increases diagnostic precision combined with lower amount of ionizing radiation. Other non-ionizing diagnostic equipment is getting new applications. Both 3D printing and holography provide better possibilities for modelling and simulation. Large volumes of diagnostics and reprocessing of data for new image representations are available in commercial software. Therefore, it is important that such systems are integrated so that documentation is included in the patient's chart directly.

Navigation with electromagnetic tracking system in the vascular system is in development. The effect is reducing the use of radiation and is time saving. You depend on good visualization in the treatment situation. The development in MR spectroscopy could replace the need for biopsy in many situations. Intervention radiology improves and utilizes several imaging modalities and combinations of them for increasing precision with many treatment technologies, such as thermal-, radio frequency-, microwave- and laser. Future focus will be even more use of high-resolution camera systems and visualization equipment combined with 3D ultrasound and radar technology will make use of holograms and hololens in hybrid operating rooms.

Medical robots are already being used and medical personnel and robots are expected to work even closer together in the near future. Medical robots can improve surgical precision, medicine production, laboratory analysis, logistics and cleaning tasks, including desinfection of hospital rooms and surgical rooms. Used correctly the most important effect is release of health personnel time spent on routine tasks. Robotization will also be able to streamline administrative and technical tasks in the health services. Many argue that anything that can be robotized if labor costs exceed investment and operating costs with the robotization.

Robotic parts attached to the body can speed up rehabilitation of injured patients or allow people with paralysis to walk again. Robots come in all sizes and shapes, today's miniature robots are in millimeters of magnitude. These robots can be swallowed and allow for less invasive surgical procedures and targeted drug delivery. However, it is expected that nano-size robots will be developed and these can be placed in the bloodstream. They can be used to repair damaged cells or to help the body fight infection. Human contact will nevertheless be the core of good patient care. The development plans should include how medical personnel and robots can work together, and how patients can best adapt to the presence of a robot in the healthcare sector.

Artificial intelligence (AI). The data produced daily in the clinic and stored digitally in PACS systems doubles every other year. The vast amount of information makes it impossible for healthcare professionals to keep up with all that is stored or to use this information in daily practice. However, artificial intelligencebased (AI) tools can help to keep track of and extract relevant information from the database and adapt it to the particular situation they face. AI in medical education will improve the learning process and enable the students to have a much wider experience than they encounter in the traditional period of stay at the clinic. It is expected that AI will have a beneficial effect in all areas of the health sector. Patient logistics, treatment planning, drug development or surgical procedures can all benefit from using AI, using intelligent medical information systems and devices. Access to large data will allow more accurate decision making and targeted medication. The decision on treatment and medication will be tailored for each patient and based on the outcome of those with a similar medical history. AI will enable to establish a correlation between a disease and genetic information, medical records or DNA mutations. These new developments will also require the public to be informed and accustomed to AI. Furthermore, a new set of ethical standards must be developed to update existing guidelines and ensure that AI is used appropriately in the healthcare sector.

FOR-NorMIT infrastructure

In 2019, the NorMIT infrastructure was used extensively by 143 users in Trondheim and Oslo, with 100 different projects benefitting from the NorMIT infrastructure. At the Trondheim node 10 PhD are ongoing while 2 PhD have defended their thesis in 2019. Six master candidates and 4 bachelor students were involved in research collaborations with FOR-NorMIT. Overall 32 articles, 36 national presentations and 14 international presentations were based on NorMIT related work. NorMIT IGT is a sub-project of NorMIT and is managed by the Intervention Center. A common NorMIT Navigation platform for image-guided treatment (NorMIT IGT) will be developed through the integration of the NorMIT Plan from the Intervention Center and NorMIT-Nav from SINTEF and where new software modules are developed for this common

platform. In 2019, a first integration between these modules has been developed, and the entire pipeline from CT / MR images of the patient, through segmentation and resection planning in the NorMIT plan transferred to NorMIT-Nav as a navigation map. At normit.no you can now download the software for free. NorMIT has repeatedly been in the forefront in lectures, seminars, workshops and information about the project and how it can be used in research projects has been presented.

At the Future Operation Room, the following equipment is available at NorMIT:

- Brainlab optical and magnetic system
- DaVinci minimal invasive surgery system
- FUS instrument's ultrasound system
- Medical visualization equipment
- Tricaster video editing system
- Siemens Artis Zeego C-arm
- Verasonic's ultrasonic devices (with HIFU option)
- Hydrophone Scanning system; for quality control of ultrasonic probes
- Ultrasound bronchoscopy equipment (EBUS)
- Intraoperative ultrasound (BK5000)

An overview of all equipment that can be booked at FOR-NorMIT is available at www.normit.no

Our partners have used the NorMIT equipment park extensively. Below we present some of the technical development projects that have used NorMIT equipment.

At NTNU Department of Circulation and Medical Imaging, the Verasonics ultrasound machines are used in various projects related to cardiovascular imaging. "High frame rate vector-Doppler imaging for cardiovascular disease", by Ingvild Kinn Ekroll, and Jørgen Avdal is one example of a paper on this project, now approved for the IEEE International ultrasound symposium. Furthermore, it is used in projects related to imaging of blood flow "High frame rate cardiac color flow imaging", Alessandro Ramalli and Lasse Løvstakken. Here too, a paper was presented at the IEEE International ultrasound symposium.

Users of the infrastructure	**2019**
Total number of users	143
Total number of internal users (Users employed by the host institutions)	68
Total number of external users (Users not employed by the host institutions)	75
Number of students (6 Master,12 Bachelor)	16
Number of PhD students	54
Number of scientists (permanent employment, post doc etc.)	50
Number of users from industry	24
Type of projects (funding) where the infrastructure has been used	**2019**
Total number of projects	100
Number of projects with international funding (EU, Nordic etc.)	5
Number of projects with external national funding	53
Number of projects funded by the host institution (e.g. via the basic budget)	33
Number of projects funded by the industry	9

Catharina Davies at NTNU, department of Physics, reports about the NorMIT ultrasound infrastructure from FUS instruments. Autumn 2018 and spring 2019, the FUS instruments device has been used by PhD fellow Stein- Martin Fagerland to treat spontaneous prostate tumors in mice. The mice were injected with nanoparticles with the cytotoxic cabazitaxel and the microbubble sonovue and prostate received ultrasound treatment. We have previously done similar research with tumors that grow subcutaneously and had very good results. Therefore, we wanted to proceed with a more clinically relevant tumor model.

Bjørn Angelsen reports that at NTNU ISB, they have used the NorMIT infrastructure called SURF Technology in the PhD for Johannes Kvam. He defended his thesis on May 6 with a thesis showing new and interesting methods for tissue characterization by the two-frequency method. In this connection, Johannes and others have developed a lot of new sound waves for the ultrasound scanner, which is available for future projects. The support from NorMIT has been and will be important for this activity.

Newsletters

The first edition of the NorMIT newsletter was published in October 2017 and presented the latest news and research results based on NorMIT equipment. In 2019, 3 editions were produced that reflect some of the activity of NorMIT.

You can read the newsletters here: http://normit.no/en/

Courses arranged by FOR

EMU-courses arranged in 2019:

8th of May: EMU-course for ENT/ Maxillofacial/ eye:

- High energy equipment
- Endoscopy
- Irradiation protection and use of C-arm for fluoroscopy

10th and 17th of September: EMU-course for neurosurgeons:

- 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.

Competence portal
All courses in the use of electromechanical equipment and infection protection are now assigned to the individual doctor and LIS in the competence portal.

Everyone can now see which courses are valid and what courses need to be renewed. When you click on the course in the competence portal, you will automatically come to the course in the learning portal, if it is an e-learning course.
Initially, this applies to the courses in infection protection. High-energy devices and endoscopy, as well as the use of C-arm are still based on classroom teaching.

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. Olav's 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.
FOR has through visits and visitors from other hospitals in Norway helped to provide important information and training on new technologies, methods and integration of laparoscopic / endoscopic surgery. Organization and design of operating rooms has also been the subject. At the simulator course organized by the National Center for Advanced Laparoscopic Surgery (NSALK), FOR has been used as a venue for transmission of operating procedures and information on the integration of new equipment.

Experimental surgery

All FOR operating rooms are authorized 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.

Research Collaborations - National and international partners

Together with the Intervention Center (IVS) at Oslo University Hospital, FOR has established the national research infrastructure, NorMIT; Norwegian center for Minimally invasive Image guided Therapy and medical technologies, which now has its infrastructure in place with several ongoing projects. The NorMIT infrastructure is available both nationally and internationally. During 2019 we have concentrated on cooperation with partners in our own health region; Nord Trøndelag county, the health register HUNT and Møre and Romsdal county where the FOR-NorMIT infrastructure is available and where new research projects have been established.

SINTEF is one of FOR’s most important collaboration partners. The cooperation is among other things built around the”National Center of competence for Ultrasound and Image Guided Therapy”. FOR has also a very good collaboration with NTNU through the MH faculty, at the Department of Circulation and Medical Imaging, Department of Energy and Process Engineering, Department of Design, Department of Mathematical Sciences, Department of Electronic Systems and the Department of Technical Cybernetics and the AI lab. The students at the Faculty of Health Sciences at NTNU use the FOR infrastructure for projects related to their bachelor’s and master’s degree in collaboration with FOR. Various competence centers such as the ”National Center of competence for Ultrasound and Image Guided Therapy” and the ”National Center for Advanced Laparoscopic Surgery”, NTNU Technology Transfer (TTO), Center for Interdisciplinary Research in Space (CIRiS) are important partners, and it is important to maintain the synergy effect of this collaboration.
Furthermore, FOR has a good cooperation with a number of industrial partners: Sony, Medtronic, Brainlab, Intuitive, Siemens, Stryker, Karl Storz, IBM, Apple, ConocoPhillips, Total, Olympus, and Smith & Nephew. Good practice and guidelines for collaboration with industrial partners have been developed together with experts in this area.

FOR has an established joint research projects with several international partners such as Vanderbilt University Medical Center in Nashville, TN, USA. Together we investigate what is the impact of new treatment modalities on technological solutions and decisions made in the operating room. We also want to collaborate on efficient use of ICT in the operating rooms in order to optimize workflow and patient flow. We also work with Albert Einstein Hospital in Sao Paulo and UFF Universidade Federal Fluminense in Brazil, mainly focusing on telemedicine and”decentralization of specialist healthcare services”.

There are several other international partners who wish to cooperate with FOR. So far, we have focused on establishing research collaboration with the Massachusetts General Hospital in Boston, the Operating Room of the Future in Tubingen and research groups at Krakow University Hospital in Poland. A collaboration with the Yonsei University Health System, Seoul, Korea has also been established. Handling of the increasing number of elderly patients, the intelligent hospital and the transmission of high quality medical information are some of the projects that have been initiated, and which we want to focus on in the next few years. FOR also collaborates with organizations such as the European Association for Endoscopic Surgery (EAES), the Society for Minimally Invasive Therapy (SMIT) and Technoport in Trondheim.

Research and development in cooperation with SINTEF

Norwegian national center of competence for ultrasound and image guide therapy

The Operating Room of the Future (FOR) is the arena and infrastructure provider for several ongoing research projects, including projects at the national advisory unit for ultrasound and image-guided therapy (www.USIGT.org). SINTEF is a key research partner in USIGT and in FOR. Thomas Langø at SINTEF has a coordinator position at St. Olav's hospital related to USIGT. One of the most important activities in 2019 was linked to the projects within the national USIGT center, which appointed by the Ministry of Health and Care Services. USIGT carries out many of the projects in FOR, i.e. using it as an arena for a number of clinical and technological research, development and innovation projects, ranging from technology development, prototyping and clinical trials / studies of new solutions to improve patient care. In 2019 there were 12 PhD projects in progress and 6 ongoing Postdoc research projects in USIGT, both clinical and technological. About half of these have a workplace at SINTEF, having a shared position between SINTEF and NTNU. Often, a technologist and a clinician are working together on PhD projects related to the same clinical application, illuminating the problem from both a clinical and a technological perspective. There were published about 30 scientific papers with peer review at USIGT in 2019, some from projects conducted at FOR, St.Olavs hospital.

Through several user-driven projects supported by the Research Council and EU, the USIGT advisory unit has been an important competence environment for innovation and industrial cooperation. The center has a broad national and international network and extensive activity related to the development and dissemination of expertise and knowledge, one of the core tasks of the service. Through participation in several EU projects like VECTOR, IIIOS, FUSIMO, MISTELA, RASIMAS, TRANS-FUSIMO, HiPerNav, and the recently awarded project MEDITATE EID (European Industrial Doctorate), important expertise from international academic environments has been "imported", while at the same time generating and contributing to the spread of local expertise both nationally and internationally. St. Olav's hospital at FOR and SINTEF have applied for a new ITN EU project, ORConnect, in January 2020, in collaboration with 10 other European research groups.

The advisory unit USIGT focuses on ultrasound and image-guided minimally invasive therapy with areas of interest related to vascular surgery, endovascular treatment, neurosurgery, laparoscopic and flexible endoscopic surgery, pulmonary medicine and radiology/urology. In addition to the use of ultrasound, navigation, visualization, and decision support are also important fields of research in the USIGT center. A software infrastructure, the CustusX research platform, developed and maintained by SINTEF, is available as an open source package (www.CustusX.org) to the research community in the field of research that USIGT operates. Through collaboration in NorMIT with the Interventional Centre at the National hospital in Oslo, we are expanding this intraoperative navigation platform with planning tools (www.normit.no). The purpose is to make the diagnosis better and the treatment safer. These platforms will now be disseminated nationally through the NorMIT infrastructure project and internationally as an open source platform in the form of customized versions for clinical applications. An example of the latter is Fraxinus (based on CustusX), a project that will create and distribute a free software package for bronchoscopy guidance (particularly planning) and thus making the diagnosis of lung lesions more robust with the ambition of a higher success rate in sampling suspicious lesions in the peripheral parts of the lungs.

The activity of the national advisory unit is a good example of how the future operating space can support research, development and testing of new technology and methods, while strengthening national and international cooperation. In addition, FOR contributes with expertise related to courses and publishing popular science articles in close cooperation with SINTEF. SINTEF also brings considerable expertise into the collaboration and utilizes its basic funding for strategic efforts to develop new technology for minimally invasive surgery / therapy.

Thomas Langø
Head of Research, Department of Medical Technology, SINTEF
Photo: SINTEF

Scientific production

PhD degrees - completed in 2019

Amar Aganovic defended his thesis in January 17th
Cecilie Våpenstad defended her thesis November 13th

Their work has been discussed in the chapter “Highlights”

Amar Aganovic
Photo: Private

Cecilie Våpenstad
Photo: Private

Master degrees - finished in 2019

Anders Johannesen
Affine Alignment of Ultrasound
Volumes Using Deep Learning
Master’s thesis in Cybernetics and Robotics
Supervisor: Gabriel Kiss, Hans Torp
June 2019

Norwegian University of Science and Technology
Faculty of Information Technology and Electrical Engineering
Department of Engineering Cybernetics

This thesis explores the possibilities of deep learning based image registration of 3D ultrasound volumes. Two models for affine transformation of a moving image in reference to a target image is being compared. The first model is inspired by the affine transformation framework proposed by de Voss et al. (2019). This model passes the full ultrasound image directly through a deep learning network to predict the optimal affine transformation matrix that maximizes the Normalized Cross-Correlation (NCC) similarity measure. The second model proposed in this thesis is inspired by the framework for Large Deformation Diffeomorphic Metric Mapping (LDDMM) developed by Yang et al. (2017). This model divides the 3D image into multiple smaller patches of uniform size before passing them through a deep learning network for transformation matrix prediction. The change in NCC between the moving and target image before and after transformation, is being used as a metric for performance of the two models.

Christoffer Pedersen

Studies have shown that it is possible to get less than 10 bacteria cubic meters of air (referred to as ultra-clean requirements (10CFU / m3)) in operating rooms equipped with mixing ventilation. However, variations in measured CFU level exist between operations, leading to uncertainty about how consistent mixed ventilation manages to meet the ultra-clean requirement. Studies have suggested that the activity level of the surgical staff is an important factor affecting the bacterial level in the air, but few studies have quantified this hypothesis.

Autumn and spring semester 2019 I wrote a project and a master's thesis in collaboration with the operating room of the Future. The aim of the thesis was to analyze the conditions that must be present in an operating room equipped with mixing ventilation in order for the ultra-clean requirement to be met, and in our task the focus was on activity level. We arranged standardized mock surgeries in the FOR operating room at AHL, which is equipped with mixing ventilation, and performed bacterial measurements of the air at different activity levels on the operating staff.

The measurements from 5 mock surgeries showed an average bacterial level of 12.9 CFU / m3, with a standard variation of 6, when the operating personnel were active. When the operating staff was at rest, the bacterial level was 2.5CFU / m3.

The results indicate that activity level is an important factor in keeping a low bacterial level in the air during surgery. An operating room equipped with mixing ventilation can fairly consistently meet the ultra-clean requirement if the right conditions are present. However each operation can differ somewhat from the requirement, even if the right conditions are present.
Supervisor: Prof. Guangyu Cao

Photo: Private

Helena Kuivjõgi

In healthcare facilities and hospital environment, it is essential to ensure a certain thermal comfort level for all occupants. Unsatisfactory thermal conditions in operating rooms (ORs) might influence the performance of surgical staff and increase the risk of developing surgical site infections (SSIs).

During my exchange semester spring 2019 in Norwegian University of Science and Technology (NTNU) I completed my master thesis in collaboration with the Operating Room of the Future with the support of Liv-Inger Stenstad and Jan-Gunnar Skogås. My supervisor was professor Guangyu Cao from the Department of Energy and Process Engineering at NTNU.

The purpose was to investigate the thermal comfort level of patient and surgical staff in operating rooms at St. Olavs Hospital and give the suggestions for improvement. The main work of this master thesis has been performed in two ORs with LAF ventilation ("Stue 8" at "Bevegelsessenteret") and in mixing ventilation ("Stue 1" at "AHL-senteret") solution. This study includes measurements and survey in both operating rooms. Measurements shows, that in the mixing ventilation OR, the air temperature and air velocity are comfortable for patient, but uncomfortable for surgeon and assistant nurse (warm). In contrast, in LAF OR, the air temperature and air velocity are comfortable for surgical staff, but may be uncomfortable for patient (higher velocity feels cold).

Based on survey results there is an acceptable thermal comfort level on surgical staff in the operating room with LAF, but in the OR with mixing ventilation the occupants feel in some cases cold (clean zone nurse) and in some cases extremely warm (surgeons). The results show that the thermal comfort level varies greatly from surgeons to patient in different operating room, therefore this should get more attention in hospitals. Supervisor: Prof. Guangyu Cao
Photo: Private

Minchao Fan

I am very honored to collaborate with the Future Operating Room to finish my master thesis project about developing a comprehensive evaluation framework on the suitability of different ventilation strategies for existing operating rooms at hospitals.

A suitable ventilation system in operating theatre should use relatively less investment and energy consumption to create an environment which perfectly meets the standard requirements of clean room, at the same time ensure the staffs' and patients' comfort. In the evaluation framework, evaluation indices were determined from the aspects of ventilation effectiveness (sub-indicators: bacteria and particle concentration, temperature and relative humidity), energy consumption as well as users' satisfaction (sub-indicators were thermal comfort and noise level) and the major aspects were given weights 0.49, 0.35 and 0.16, respectively based on expert survey and analytic hierarchy process method. Through the combination of weights and the corresponding index values from the measurements during mock surgeries, the fuzzy comprehensive evaluation method was used to obtain the final comments of the degree of membership of the object to be evaluated as "unsuitable, tolerable and suitable". This evaluation framework is flexible since more evaluation indicators can be added, such as lifecycle cost and environmental influence; the evaluation criteria of the indicators can also be adjusted according to the applied countries or regions.

Two operating rooms with laminar air flow and mixing ventilation at St. Olavs Hospital were evaluated respectively. The evaluation results showed that both operating rooms could provide clean and temperature-appropriate operating environment, while operating room with mixing ventilation had more dissatisfaction vote in thermal comfort and the electricity consumption was at the level a little bit above median value of all the operating rooms. Therefore, the case operating room with mixing ventilation was evaluated less suitable than the one with laminar air flow system. From the evaluation results and energy calculation, we may suggest that design and selection of the ventilation system for operating rooms should focus on appropriate air volume on the basis of meeting the demand of safety, then make rational use of the heat recovery technology as well as setback strategy. Regularly test the air cleanliness, temperature, humidity and noise in the operating theatres and keep tracking the feelings of the operating team members to provide the basis for possible system adjustment.
Supervisor: Prof. Guangyu Cao
Photo: Private

Torjus Haukom

Basal Strain Estimation in Transesophageal Echocardiography using Unsupervised Deep Learning
Master's thesis in Electronics Systems Design and Innovation
Supervisor: Gabriel Hanssen Kiss and Ilangko Balasingham
June 2019
Norwegian University of Science and Technology
Faculty of Information Technology and Electrical Engineering
Department of Electronic Systems

This thesis aims to contribute towards the full automation of perioperative echocardiographic monitoring through investigating the feasibility of fast, automatic longitudinal strain estimation in the basal segments from unselected 4-chamber, 2-chamber, and longaxis TEE images using unsupervised deep learning methods. A strain estimation pipeline is proposed, composed of two major components: myocardial landmark detection and frame-to-frame displacement estimation. Using the estimated displacements, the detected landmarks can be tracked through the cardiac cycle and used to estimate strain. The landmark detection algorithm assumes known mitral annulus location and employs a series of filtering operations to highlight a suitable landmark in the myocardial segment below it. The displacements are estimated using a fully convolutional neural network (CNN) and cubic B-spline interpolation, inspired by recent work in image registration. The CNN is trained in an unsupervised manner, removing the need for manual annotation of the ground truth, and estimates a low-resolution displacement field. This low-resolution field is then interpolated to produce a dense displacement field describing the motion of each individual pixel between two consecutive frames.

Photo: Private

Trym Nordal

Automatic Detection of Mitral Annular Plane Systolic Excursion from Transesophageal Echocardiography Using Deep Learning
Master's thesis in Cybernetics and Robotics
Supervisor: Lasse Løvstakken, Gabriel Hanssen Kiss
June 2019
Norwegian University of Science and Technology
Faculty of Information Technology and Electrical Engineering
Department of Engineering Cybernetics

The study presented in this thesis is based on the hypothesis that perioperative monitoring and assessment of cardiac function from TEE can be automated by utilizing the power of deep learning. A pipeline for automatic detection of the global systolic functional parameter MAPSE (mitral annular plane systolic excursion) has been proposed, implemented and tested against clinical measurements from St. Olav's University hospital, Trondheim, Norway. The pipeline consists of a convolutional neural network (CNN) for detection of a set of mitral landmarks in two-dimensional TEE B-mode recordings of the left ventricle, and necessary post processing components in order to get a final MAPSE estimate. The CNN landmark detector has been trained with 131 two-chamber and four-chamber recordings.

Photo: Private

Bachelor degrees – completed in 2019

Faculty of Medicine and health sciences, NTNU
Bachelor`s degree program Nursing

Tuva Kristiansen
"Information dissemination and management of mental reactions in spontaneous abortion" Introduction:

Kine Maaø
"Nurse`s care of women`s psychological reactions by spontaneous abortion"

Morten Sildnes Andersen
"Spontaneous for me, everyday for you. How can nurses through increasing follow-up improve the patient experience in women who have undergone miscarriage?"

Orsika Swahn
«Hidden grief: emotional support during and after Miscarriage»

From left. Marianne Haugvold (FOR), Tuva Kristiansen (NTNU), Morten Sildnes Andersen (NTNU), Beate Andre (NTNU), Kine Maaø (NTNU), Oriska Swahn (NTNU) and Jan Gunnar Skogås (FOR).
Photo: FOR

Postdoctoral staff affiliated with FOR

Hanne Sorger – Advanced navigation during bronchoscopy

When a patient comes to the Pulmonary ward with a recently discovered abnormal "shadow" on chest x-ray, it is our job to find out whether or not this is lung cancer. We also want to know the stage of the disease, ie. whether the disease has spread to other organs. Most patients will be offered a bronchoscopy, a video assisted investigative procedure of the lung. It can however be difficult to locate the tumor or obtain adequate diagnostic material by bronchoscopy. Therefore, we have developed a navigation system for the lungs which allows a more targeted bronchoscopy, where CT images of the patient´s lungs become a map or a coordinate system in which we maneuver our investigative tool- the bronchoscope. When inside the lungs, we are guided by the GPS-like technology to the position of the tumor and can direct our sampling procedures at the right spot immediately. We are also working on implementing ultrasound images into our navigated bronchoscopy, which will allow us to investigate whether the cancer has spread to lymph nodes positioned near the airways. We could by doing so not only provide the diagnosis, but also determine whether or not the patient is eligible for curative treatment.
Photo: Private

Håkon Olav Leira, Postdoc ISB, NTNU

Håkon Olav Leira, consultant at the Department of pulmanory diseases, St. Olav's hospital and assistant professor at ISB, NTNU. Together with Thomas Langø leading the LUNA research group, developing new medical technology for lung cancer diagnostics and treatment, as part of USIGT, FOR and NorMIT.

In LUNA, they develop advanced medico-technical solutions for lung cancer, from machine-learning image diagnostics to full scale image guided minimally invasive tumour diagnostics.

Small lung tumors can be difficult to find when you want to sample them. The reason for this is that the airways in the lungs have myriads of small branches, and it's easy to get lost when you try to control equipment down to the tumor. They are developing a tracking system that remind you of the GPS systems used in cars. As a map they use the patient's own CT images. From 2018 we have started a European cooperation with centers in the Netherlands and Ireland, and the purpose is to develop a complete navigation system for the lungs.

This was presented in Adresseavisen (https: //www.adressa.no/pluss/ nyheter/2018/02/26/Slik-vil-kreftlegene-finne-skumle-lungesvulster-16158295.ece) and Gemini (https: //gemini.no/2018/02/ teknologiutvikling-gir-nytt-hap-pasienter-lungekreft/).

Håkon Olav Leira
Photo: FOR

Erik Smistad, Postdoc ISB, NTNU / Researcher SINTEF

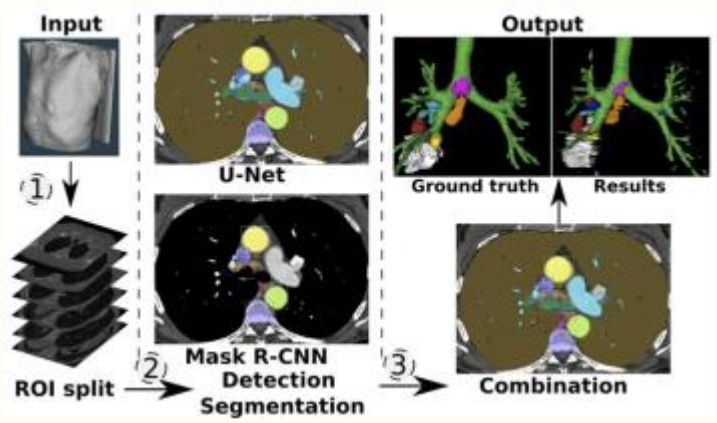
Erik Smistad is working mostly with automatic image analysis of ultrasound, MR and CT images.
Finding structures such as blood vessels, nerves and tumors in images automatically in real-time can be useful in many applications such as diagnosis, pre-operative planning and ultrasound and intra-operative guidance. His main research interests includes: image segmentation, machine learning and neural networks, parallel and GPU processing and ultrasound.

Erik Smistad
Photo: NTNU

David Bouget, NTNU (ISB/CIUS)

Project title: 3D CT imaging for automatic detection of lymph nodes.

To perform diagnostic and to choose the right treatment for lung cancer, it is important to detect lymph nodes in the mediastinum and identify their exact specific anatomical location. While the primary tumor is usually easy to identify in the lungs, finding out if the cancer has spread to nearby lymph nodes is more challenging. Therefore, the goal of this project is to develop methods for improving the automatic detection of the lymph nodes from 3D CT images. For this, we propose a combination of deep learning networks for performing concurrent pixelwise segmentation of fifteen different anatomical structures and instance detection of the lymph nodes. The segmentation knowledge of all other anatomical structures is necessary for performing lymph node station assignment. The result, planned to be forwarded to the surgical team, is an overview of identified lymph nodes with centroid position and full-extent segmentation. A first prototype of the software has been developed and validated on CT data from 15 patients for the task of lymph node detection. Preliminary results show that the algorithm can detect all relevant lymph nodes.



Lymphnode detection
Photo: Private

David Bouget
Photo: NTNU

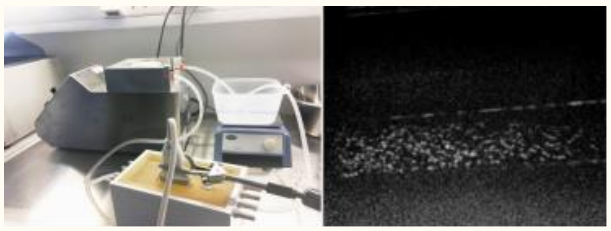
Sébastien Muller, NTNU / INM / SINTEF

Project Title: MultiGuide; Development and Safety.
The main focus is implementation of feasibility and usability (human-machine interaction) studies for quality assurance and documentation of the operating procedures. An automatic detection of surgical phases based on machine learning has been completed and published. Technical validation of the new display device being developed for the MultiGuide is on its way with a special focus on navigation accuracy related to different elements of the navigation system (hardware and software). Furthermore, the clinical validation for each application is carried out in close cooperation with clinicians. For each clinical study, the postdoc will be responsible for registration of adverse device effects (ADEs). This is harmful events that occur due to error or lack of procedures, software or the medical device (MultiGuide). These registrations will be based on ”Clinical investigation of medical devices for human subjects - Good clinical practice, ISO 14155». Such registration is necessary for future CE marking of the MultiGuide.

Sébastien Muller
Photo: SINTEF

Sigrid Berg and Rune Hansen, NTNU / SINTEF
Project title: Imaging of ultrasound contrast bubbles at high frequencies.

Microbubbles, consisting of thin lipid shell and gas core, are used in the clinic to provide better images of microcirculation in echocardiography and cancer diagnostics. With clinically available ultrasonic machines, bubbles can be depicted at relatively low frequencies (2-5 MHz) and low pressure (MI = 0.1). At high frequencies, one must typically use higher pressures to activate bubbles, and thus it will no longer be possible to suppress the signal from the tissue in a satisfactory manner. We have been working on implementing a new method for depicting bubbles at high frequencies on the research scanner Verasonics (NorMIT). By combining high frequency imaging pulses with low-frequency manipulation pulses, we achieve both a high signal from the bubbles and a good suppression of the tissue. The method is patented and has been implemented on linear transducers with frequencies from 5 to 25 MHz, this includes transducers from Verasonics, GE and Visualsonics. When methods for imaging bubbles are developed, it is important to have validated information about the pressures and frequencies of the transducer transmits. To characterize transducers we have used NorMIT's Onda AIMS III system.



To the left: Lab setup for optimization of imaging methods of microbubbles. The bubbles are pumped from a plastic tank and through one flow channel in a tissue-smoothing material. To the right: Example of ultrasound recording from flow model, were you can see strong signal from bubbles flowing through the channel and weak signal from the material around.

Sigrid Berg
Photo: NTNU

Rune Hansen
Photo: SINTEF

PhD degrees – Ongoing

Kent Are Jamtøy
Project title: Botulinum toxin type A blocked by sphenopalatin ganglion in chronic pain and inflammatory conditions of the craniofacial region.

Innomet is a research group based at St. Olav's hospital and the Norwegian University of Science and Technology (NTNU) in Trondheim. A new method of blocking ganglion sphenopalatinum (SPG) with botulinum toxin type A (BTA) has been developed. This is done using a navigation-based instrument (MultiGuide) to ensure accurate deposition of BTA. The method is performed in 10 patients with headache pains with transnasal access under the anesthesia of the endoscopic block of the sphenpalatine ganglion in intractable cluster headache. A pilot study on chronic migraine has also been published, where the injection is done with lateral access (through the cheek). This study also shows acceptable side effects and good potential for effect. In addition, there is also a pilot study on the injection of botulinum toxin against SPG by trigeminus neuralgia. In this PhD project, Jamtøy will inject botulinum toxin against SPG from chronic rhinosinusitis with nasal polyps and atypical facial pain. Jamtøy plans to complete his research with a 50% position over 6 years.

Kent Are Jamtøy
Photo: NTNU

Javier Pérez de Frutos

"Intraoperative registration techniques for improved ultrasound based navigation in laparoscopic soft tissue surgery." Technological PhD linked to the HiPerNav EU project (ITN). SINTEF/NTNU/IDI.
One-click registration method Lab study of the feasibility of the one-click registration method, implemented in the foundations of NorMIT-navigation software, before doing clinical tests.

Assessment of tracking systems target registration error. This study aims to assess the performance of optical and electromagnetic tracking systems in terms of target registration error. For this, both tracking systems where tested in a real OR environment using a phantom made specifically for such tests. This study was carried out as a collaboration between The Intervention Center in Oslo and SINTEF Medical Technology research group.

In 2019 he got to present his current research line in the SMIT 2019 conference, at Heilbronn, Germany. The title was: Deep deformation Map Regressor (https://smit2019.smart-abstract.com/sessionplanner/#/persons/68360).

Javier Pérez de Frutos
Photo: SINTEF

Geir Arne Tangen

"Enhanced Minimally Invasive Therapy". Technological PhD candidate.
The purpose of the project is development and testing of methods for integration of navigation technology in endovascular procedures. This involves accurate match between image information presented to the operator and catheter/guidewire movements inside patient vascular anatomy.

Supervisors: Petter Aadahl and Toril A. Nagelhus Hernes

Geir Arne Tangen
Photo: SINTEF

Rita Elmkvist-Nilsen

"Mapping Brain Plasticity"
Rita Elmkvist-Nilsen's PhD project examines the formative role of newer imaging technologies playing as knowledge-producing, diagnostic and therapeutic tools in neuroscience research practice. The project addresses newer approaches in cognitive neuroscience that considers the brain as an adaptive and dynamic body of plastic potential and, through diffractive reading, actualizes recent human-scientific perspectives on human perception and cognition as bodily rooted, relational, situational, action-oriented and shaped by technological medias.
Supervisors: Aud Sissel Hoel and Anne Beaulieu

Rita Elmkvist-Nilsen
Photo: NTNU

Yixian Zhang

My name is Yixian Zhang, a visitor Ph.d candidate of NTNU. My research topic is “Simulation and experiment on control of microbial aerosol transmission under different ventilation strategies for operating rooms”. During the measurement in St. Olavs Hospital, I participated in the mock surgeries in the cardiopulmonary operating room with mixing ventilation system and the orthopaedic operating room with laminar ventilation system. The mock surgery can be divided into three main phases: 1) incision (0-50 minutes); 2) joint replacement (50-83 minutes); 3) wound suture (83-120 minutes). In addition, non-activity of 20 minutes phase was added before the start of the mock surgery to see the difference in CFU（Colony Forming Units）levels of activity compared with non-activity surgical team. Comparing the CFU levels of suspended bacteria and sedimentation bacteria at different phases, I studied the effect of surgical staff activities and ventilation on the number of bacteria during operation. Besides, in order to set boundary conditions for the simulation, the following parameters were tested: surface temperature of maintenance structure, heating device and human body, velocity of diffusers. Thanks for the cooperation of St. Olavs Hospital and NTNU, and I learned a lot from the measurement in St. Olavs Hospital.

Supervisor: prof. Guangyu Cao

Yixian Zhang
Photo: Private

Kai Xu

Indoor environment parameters collecting:

In order to study and compare the indoor environment in Operating room with laminar airflow and mixing ventilation, we install a wireless data acquisition instrument to get the important data about half a year at St. Olavs Hospital.

Different hospital building energy consumption prediction using machine learning.

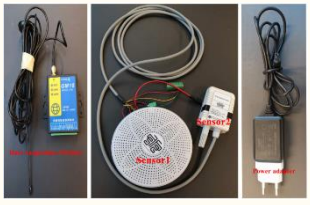
The Hospital energy consumption dataset download from the St.Olavs Hospital Siemens Navigator Platform (2018.12 - 2019.12);

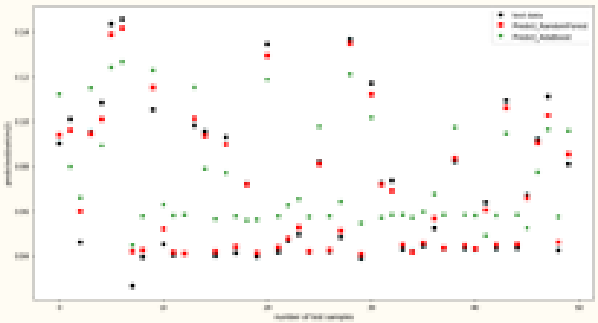
The weather dataset downloads from the Norsk klimaservicesenter with 5 parameters including Temperature (℃), Relative humidity (%), Windspeed (m/s), Global radiation (W/m2) and Longwave radiation (W/m2), choosing from the weather station at Voll (SN68860) and Gloshaugen (SN68173). Using Python toolkits (Pandas, Sk-learn, Matplotlib et.al) the research aim

- build a predict model between Hospital energy consumption and weather data.
- evaluate the predict model of St.Olavs hospital energy consumption.

Using two regression prediction models, AdaBoost and Random Forest respectively.Select the Labsenteret building in St. Olavs Hospital and Pick up the daily mean air temperature was the most important factor with a feature importance close to 80% and the evaluation index R2 close to 0.98. The comparison between the real energy data (test data) and the prediction data see in the figure below. Random Forest regression shows a better prediction results and can be used to predict the future energy consumption in different building. Supervisor: Prof. Guangyu Cao

Photos: Private





Erik Nypan

Three-Dimensional Visualization and Navigation in Endovascular Procedures

Abdominal aortic aneurysm (AAA) can be treated minimally invasive by endovascular stent graft insertion. Endovascular treatment is not possible for all aneurysms depending on anatomy, but more advanced stent grafts allowing fenestrations or branches through the graft is becoming increasingly prevalent. The aim of this project is to facilitate better and easier endovascular navigation in endovascular aortic procedures, potentially leading to more patients being treated by endovascular methods as well as a reduction in x-ray radiation and use of contrast media, which can be toxic to the kidney. The project has several sub studies, and consists of studies conducted on phantoms, animal models and in patients. An integral part of the project is to study the feasibility of combining preoperative imaging to the patient on the operating table with the use of non-ionizing electromagnetic tracking. With the help of position sensors integrated into instruments, it is possible to record position data inside the patient. The position data may then be registered to the preoperative imaging and can be used for navigation. In 2020, together with medical student Håvard Ulsaker, I will also study if patient specific 3D printed models can be used to study deformation that occur during the procedure.

Main supervisor: Frode Manstad-Hulaas
Assistant supervisor: Reidar Brekken

Photo: Private

Andrea Teatini

Andrea Teatini, MSc, was born in Monza, Italy in 1992. He received the BSc in Biomedical Engineering from the Politecnico of Milan, Italy, in 2014 and the MSc in Biomedical Engineering in Delft University of Technology, The Netherlands, in 2016, specializing in both Biomechatronics and Medical Instruments. He is currently pursuing the Ph.D. degree from the University of Oslo, Norway based on his work conducted at Oslo University Hospital, Norway. Andrea is part of the HiPerNav Marie-Curie ITN project, which aims to improve limitation of soft tissue surgical navigation and is also actively collaborating within the HoloCare project, which works on use of HoloLens headsets for medical applications. His research interests include the development of medical technology, especially within the fields of Image-guided surgery, Medical Imaging, Medical Instrument Design, Image Processing and Computer Vision applications.
Supervisor: Thomas Langø

Photo: Private

Andreas Østvik

Project title: Automatic analysis of medical ultrasound using machine learning

The goal of the PhD project is to utilize and further develop machine learning methods to improve state-of-the-art solutions in the field of ultrasound image analysis and visualization. More specifically, research is conducted on automating pipelines for clinical measurements in echocardiography, with motivation of improving robustness and workflow. This involves classification of images, quality assurance, semantic segmentation and landmark extraction, as well as integrating these components for quantitative measurements.
Supervisor: Thomas Langø

Photo: Private

Arne Kildahl- Andersen

PET and advanced ultrasound in navigated bronchoscopy
The project is part of the activity in the research group LUNA –Lung Navigation (part of the National Competence Center for ultrasound and image-guided treatment) which is a collaboration between SINTEF, NTNU and St. Olav's hospital. The group has long track record with electromagnetic navigation integrated in the bronchoscope. Together with the project group, Arne will continue to work on ultrasound bronchoscopy integrated with electromagnetic navigation and PET-CT. A clinical trial of Fraxinus, a navigation software for virtual bronchoscopy will be performed. In addition, Arne will explore the possibilities for improved diagnostics of peripheral lung tumors by combining ultrasound and navigation. Additionally, Arne has been involved in testing Hololens based visualization during bronchoscopic procedures. Both phantom tests as well as a pilot study on one patient have been carried out.
Main supervisor: Håkon Olav Leira

Photo: Private

Jakub Wladyslaw Dziedzic

As a PhD Candidate of the Department of Energy and Process Engineering, I have developed a methodology to motion capture occupant indoor activities. The development scope was to track energy-related activities, but due to robustness of the proposed method, it was possible to implement it in different fields of research.
We have managed to conduct series of experiments in surgical rooms with mixed and laminar ventilation. The goal of the research was to investigate the influence of surgeons and nurses on a spread of bacterial contamination. Conducting this investigation required usage of the motion capture technique and passive CFU sampling. The developed methodology was responsible for capturing the surgical staff spatial displacement and their activity. The preliminary results of research have highlighted critical issues influencing the contamination rate of surgical rooms with mixed ventilation.
Supervisor: Prof. Guangyu Cao

Photo: NTNU

Masab Khalid Annaqeeb

Title: Simulation of Energy/related Occupant Behavior in Buildings
The focus of the doctoral research work is on developing occupant behavior (OB) models, to be used in building simulation. In order to improve the understanding of OB, its drivers and influencing factors, the models will be developed in different domains, taking into account the multidisciplinary aspect of OB. To achieve that, the work includes collection of behavioral data with regards to the occupant's surrounding layouts, movement, social influences, and energy-use habits.
Supervisor: Prof. Guangyu Cao

Photo: NTNU

Medical Student`s Research Program Faculty of Medicine and Health Sciences, NTNU

At the Faculty of Medicine and Health Sciences, NTNU, a separate research programme has been established around the ordinary curriculum of medicine. The research programme involves two additional semesters devoted only to research, and that research is organized in parallel with the medical curriculum.
The research programme is an offer for medical students interested in research and a possible future research career, possibly inparallel with clinical activities.
Admission to the research programme takes place after two or three years of medicine studies at NTNU. From the autumn of 2002, the research programme was established at all four medical faculties in Norway, based on a wish to recruit more medical students to research, improving the organization of research education, and promoting scientific attitude for the practise of medicine.

Henrik A. Runde

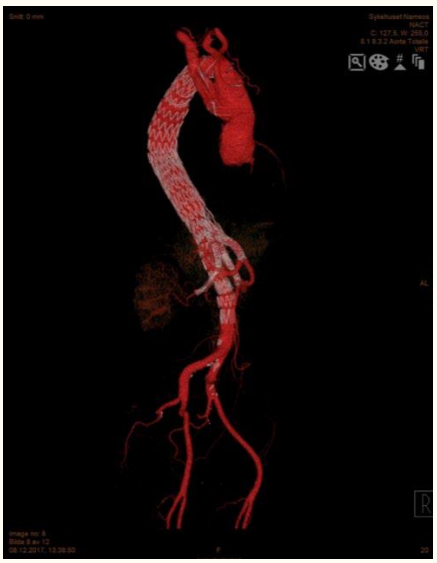
The study *«Mortality, Physical Function and Quality of Life in Patients Treated within the Standardized Patient Care Fast-track Hip Fractures»* is a prospective cohort study including 118 patients treated at the Department of Orthopaedic Surgery, St. Olav's hospital. The aim of the study is to investigate how altered biomechanics in the hip affects physical function and independence in patients treated for hip fractures. While the patient was hospitalized, pre-fracture function and quality of life were measured with EuroQol EQ-5D-5L and two days post-operatively Short Physical Performance Battery (SPPB) was carried out with physiotherapist. Other information, such as medical history, x-ray findings and information related to the treatment, were recorded in the registry for hip fracture patients. 58 patients met to the 1-year control during spring 2018, where pelvic x-rays w. calibration ball were gathered along with the clinical outcome measures EQ-5D-5L, SPPB, Harris Hip Score, Trendelenburg and VAS for pain in the affected hip. Measurements of biomechanical variables such as femoral offset, LLD *(leg length discrepancy)*, CCD *(caput-collum-diaphyseal angle)* and collum shortening has been performed and will be further analysed in conjunction with the clinical outcome measures during spring 2020.

Main supervisor: Lars Gunnar Johnsen
Assistant supervisor: Trude Basso

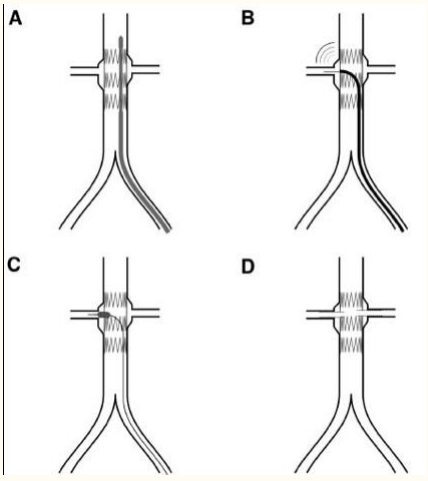
Henrik A. Runde
Photo: Private

Håvard Ulsaker

In the first part of the project, we will perform a national multicenter study to assess patients that are treated with endovascular aortic repair (EVAR) for thoracoabdominal aortic aneurysms (TAAA). Open surgery for TAAAs are comprehensive operations, and mortality rates have been reported as high as 20% in small volume centers. Many patients are deemed too high risk to undergo open surgery. Recent years' advancement in endovascular techniques have made it possible to treat TAAAs with an endovascular approach. In such interventions, a combination of the four main visceral arteries are incorporated into the stent graft. I the study we assess the short and medium term outcomes in patients treated with branched EVAR (t-Branch, Cook Medical) at the Norwegian centers. Patients from all four university hospitals in Norway are included. Mortality, complications and comorbid data will be compared with that of patients having undergone open surgery for their thoracoabdominal aortic aneurysms. In the second part of the student research thesis, we will 3D print human aortic aneurysms and assess whether or not in situ fenestration is a feasible technique to revascularize the four main visceral arteries. In situ fenestration is a technique where a standard, non-fenestrated stent graft is implanted in the abdominal aorta in such a way that it covers the ostia of the visceral arteries. Thereafter, the stentgraft is perforated at the artery ostia to revascularize the visceral organs. We will use an electromagnetic navigation system, which is not based on traditional fluoroscopy technology, to visualize the surgical instruments. An important research question is whether the electromagnetic navigational system is sufficiently accurate to localize the ostia of the visceral arteries. Two other major questions are how fast the superior mesenteric artery can be revascularized, and whether or not we can restore blood flow to at least one kidney within 30 minutes.
Main supervisor: Frode Manstad-Hulaas
Assistant supervisors: Reidar Brekken and Arne Seternes



T-Branched stent graft implanted in thoracoabdominal aorta

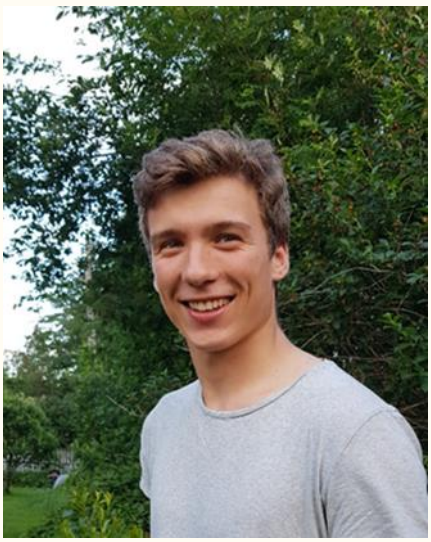


In situ-fenestrating, renal artery.

Håvard Ulsaker
Photo: Private

Audun Bakke Jensen

Audun Bakke Jensen started as a research line medical student in the autumn 2019. His topic is “Advanced visualization in lung cancer diagnostic”, with Associate Professor Håkon Olav Leira as main supervisor and chief scientist Thomas Langø from SINTEF and researcher Gabriel Hanssen Kiss from FOR as co-supervisors. He will work with machine learning and advanced visualization techniques in the context of virtual bronchoscopy and develop new ways of combining pre- and intra-procedure image data in order to improve the diagnostic procedure.
Main supervisor: Håkon Olav Leira
Assistant supervisors: Gabriel Kiss and Thomas Langø



Audun Bakke Jensen
Photo: Private

Driv - Student Project, DMF, NTNU

DRIV and FOR Workshop

DRIV NTNU wanted to repeat the success of 2018 and again invited FOR-NorMIT infrastructure in a workshop where the intention was to bring medicine and technology into joint projects. The workshop was organized over three Mondays, 03, 05 and 18 March 2019. At the first workshop, Jan Gunnar Skogås gave a presentation on the research infrastructure FOR and that relevant scientific projects at FOR were presented. The groups consisted of students at the medical education and from the technological units at Gløshaugen. Representatives from the student community and the organization were looked after by Milena Egiazaria and Dag Håkon Haneberg.

Moon Labs, by Julian Veisdal, gave an inspirational talk on the road from a challenge to a finished product. He emphasized the importance of working in a multidisciplinary team as one of the successes in having managed to develop intuitive sensors and software that can be used to monitor patients.

Once again it was a successful workshop in collaboration with DRIV NTNU, and we couldn't be more satisfied! 4 teams of medical and technology students worked for two weeks on issues from St. Olav, and delivered great presentations and solutions. The winners of the Health-Tech-Challenge ran away with NK 25,000 to spend on developing their idea through summer jobs at FOR. We would like to thank the staff of DRIV NTNU, NTNU medicine and health, Innovation Lab DRIV, and not least all the participants - for a great and inspiring engagement!

Photo: FOR

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.

Prophylactic treatment with negative pressure at closed surgical incisions – Development project

In recent years there have been technological innovations and product innovations in wound healing treatment with negative pressure. This makes it interesting to evaluate the latest version of the treatment principle in a clinical context. A qualitative project with the purpose a systematically evaluating of patient satisfaction and user-friendliness/ease of use where NPWT is used. Such a systematic evaluation of the treatment principle will therefore be able to provide important knowledge in the design of the service offer and in systematic improvement work. The project will take place in a safe and controlled environment at The Operating Room of the Future, St. Olav`s hospital, University hospital in Trondheim, Norway.
Project Manager: Marianne Haugvold, The Operating Room of the Future, St. Olavs Hospital.

The effects of tourniquet on muscle strength and function in patients operated with total knee arthroplasty and a multicenter prospective cohort study on Persona total knee system

About 5000 total knee arthroplasties (TKA) are performed annually in Norway. Pain and reduced physical function are present in patients operated with TKA up to a year after surgery and about one of five patients are not satisfied with the outcome from TKA surgery. The use of tourniquet during surgery may also have impact on pain and physical function. Whether TKA surgery should be performed with or without the use of tourniquet, is a much-debated issue in orthopedic surgery today, and there is still no consensus in this field. The overall aim of this project is to improve knowledge about the effects of tourniquet vs. not tourniquet on pain, muscle strength and function and thereby improve patient satisfaction. The results from the project will have implications for rehabilitation and the outcome after TKA surgery. This project will investigate early muscle strength and power recovery, neuromuscular recordings, neuronal changes and patient reported outcome measures. 80 patients will be included in this randomized controlled study. The patients are also invited to participate in a multicenter study which evaluates patient reported outcome measures and survivorship after TKA using the Persona total knee system. The study is initiated by Zimmer Biomet.

Live streaming and high-resolution recording in the operating room

NorMIT has built expertise and technology related to recording, broadcasting and live transmissions from the operating room. This means that today we are able to perform high quality live streaming from all operating rooms at St. Olav's hospital in a cost-effective way without the need for a permanent installation. The production systems we use are mobile solutions that are easily rigged in the operating room and in the conference auditorium. With access to high-speed internet, live surgery and other medical procedures can be shared rapidly with colleagues internally as well as globally. Cost effective transfers and recordings of all forms of medical procedures are now possible, regardless of surgical specialty. We transfer both images and support two-way sound from the operating room to the lecture hall. We also perform recording of the live transfer so that it can be reviewed afterwards.

In 2019, altogether 5 eye surgeries, one laparoscopic surgery and 3 gynecological surgical procedures have been recorded for various purposes by using FOR-NorMIT technology. Additionally, for all the gynecological procedures video editing and post-processing was performed in collaboration with the surgeon in order to prepare them as teaching material to be released in connection with a textbook. In 2020 two conferences, one related to urology and one regarding laparoscopic surgery have defined the need for a live streaming from one of the operating rooms at FOR. Additionally, two local courses will benefit from having this in-house technology as they will use the FOR NorMIT platform for teaching purposes.

Visits at FOR

Visit from The Office of the Auditor General (OAG)

Photo: FOR

On Tuesday, September 24, the OAG visited FOR. Kristin Henriksen, Ingrid Engstad Risa and Nils-Erik Bjørge from the OAG received an introduction on FOR-NorMIT and a tour of the FOR-operating room at AHL and the FOR-operating room ØNH. Here together with the head of department, FOR Jan Gunnar Skogås.

The background is that the OAG is considering, if possible, conducting an administrative audit on clinical research in the health trusts. The study is initially limited to a preliminary analysis. Once the pre-analysis has been completed, it will be decided whether the audit will be carried out in a main analysis. The meeting was primarily a conversation and discussion, the purpose of which was to gain greater insight into the topic.

Scientific articles

Evaluation of airborne contaminant exposure in a single-bed isolation ward equipped with a protected occupied zone ventilation system. Amar Aganovic, Guangyu Cao First Published January 3, 2019, Indoor and Built Environment https://journals.sagepub.com/doi/abs/10.1177/1420326X18823048

Retningslinje for kirurgisk antibiotikaprofylakse blir ofte ikke fulgt. Ane Andersdotter Kielland, Nina Christine Oldervik Sande, Trine Tømmerdal, Jan Gunnar Skogås and Beate Andre
Sykepleien 2019 107(76613)(e-76013)
DOI: https://doi.org/10.4220/Sykepleiens.2019.76613

Can we meet the requirement for ultra-clean operation room (10CFU/m3) with dilution ventilation? Christoffer Pedersen, Guangyu Cao, Finn Drangsholt, Liv-Inger Stenstad and Jan Gunnar Skogås
E3S Web of Conference 111, 010416 (2019)
https://www.e3s-conferences.org/articles/e3sconf/abs/2019/37/e3sconf_clima2019_01041/e3sconf_clima2019_01041.html

An experimental study on the effects of positioning medical equipment on contaminant exposure of a patient in an operating room with unidirectional downflow. Amar Aganovic, Guangyu Cao, Liv-Inger Stenstad, Jan Gunnar Skogås
Building and Environment, Volume 165, nov 2019, 106096
https://www.sciencedirect.com/science/article/pii/S0360132319302768?dgcid=coauthor

Laminar airflow and mixing ventilation: Which is better for operating room airflow distribution near an orthopedic surgical patient? Cao, Guangyu; Nilssen, Anders Mostrøm; Cheng, Zhu; Stenstad, Liv-Inger; Radtke, Andreas; Skogås, Jan Gunnar.*American Journal of Infection Control* 2019 ;Volum 47.(7) s. 737-743
NTNU
STOhttps://www.semanticscholar.org/paper/Laminar-airflow-and-mixing-ventilation%3A-Which-is-an-Cao-Nilssen/f46fcb37f4059c7fb8813c9e714eb5077b4ffd1f

Laminar airflow ventilation and mixing ventilation, which is better for operating rooms in Norwegian hospitals?Nilssen, Anders Mostrøm; Aganovic, Amar; Cao, Guangyu; Stenstad, Liv-Inger; Skogås, Jan Gunnar.
ICPIC International conference on prevention and infection control 2019; 2019-09-10 - 2019-09-13

Early experience with 3D and 4K imaging for minimally invasive neurosurgery.
Kiss, Gabriel; Ichino, Takuya; Myhre, Hans Olav; Skogås, Jan Gunnar.
The 23rd World Multi-Conference on Systemics, Cybernetics and Informatics; 2019-07-06 - 2019-07-09
STO NTNU

Basal Strain Estimation in Transesophageal Echocardiography (TEE) using Deep Learning based Unsupervised Deformable Image Registration
Torjus Haukom, Erik Andreas Rye Berg, Svend Aakhus, Gabriel Hanssen Kiss
Proceedings of IEEE Ultrasonics Symposium, 2019, Glasgow, UK

Semantic segmentation and detection of mediastinal lymph nodes and anatomical structures in CT data for lung cancer staging.
Bouget, David Nicolas Jean-Marie; Jørgensen, Arve; Kiss, Gabriel; Leira, Håkon Olav; Langø, Thomas. 2019, International Journal of Computer Assisted Radiology and Surgery. STOLAV, SINTEF, NTNU,
https://www.ncbi.nlm.nih.gov/pubmed/30891655
Int J Comput Assist Radiol Surg. 2019 Jun;14(6):977-986. doi: 10.1007/s11548-019-01948-8. Epub 2019 Mar 19.

Operating Room of the Future: An Arena for Minimally Invasive Intervention in Trondheim, Norway.
Kiss, Gabriel; Manstad-Hulaas, Frode; Langø, Thomas; Myhre, Hans Olav; Skogås, Jan Gunnar.
MWV Medizinisch Wissenschaftliche Verlagsgesellschaft 2019 (ISBN 978-3-95466-436-8) 7 s.
STO SINTEF NTNU

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Kiss G, Ichino T, Myhre HO, Skogås JG. Early experience with 3D and 4K imaging for minimally invasive neurosurgery. The 23rd World Multi-Conference on Systemics, Cybernetics and Informatics; 2019-07-06.

Individual lectures/ presentations at conferences

09.01.19 - Presentasjon «det Virtuelle Undersøkelsesrom» VER. Programstyret og OHS. Jan Gunnar Skogås

16. 01.19 – Basalkurs laparoskopisk kirurgi NSALK: Laparoskopi og elektrokirurgi. Jan Gunnar Skogås

Jan Magne Gjerde. For Fagseminar: «3D-printing innen medisin – status etablering av 3D-print LAB» 01.02.2019

11.02.19 – Presentasjon «det Virtuelle Undersøkelsesrom» med fokus på avstandsbehandling, oppfølgingVER. IBM i Oslo. Jan Gunnar Skogås, Geir Andre Pedersen

04.03.19 – FOR som infrastruktur for forskning og utvikling. DRIV, studentoppgaver og problemstillinger. Jan Gunnar Skogås

19.03.19 – Presentasjon av FOR-infrastruktur ved UNN, kliniske miljøer ved styremøte NorMIT, Tromsø. Jan Gunnar Skogås Alexander Moen. Presentation on National Innovation Network for University Hospitals. Theme: Outstanding treatment: FOR-NorMIT research infrastructure 2019.

24.04.19 - Alexander Moen Presentasjon på Nasjonalt innovasjonsnettverk for universitetssykehus. Tema: Fremdragende behandling: FOR-NorMIT forskningsinfrastruktur 2019.

25.04.2019 - Jan Magne Gjerde. Inspirasjonsdag i Trondheim for Nasjonalt innovasjonsnettverk for universitetssykehus. «3D-print og innovasjon – Erfaringer fra FOR-NorMIT 3D-printlab»

15.05.19 – EMU-kurs ØNH, Kjeve og Øye. Elektrokirurgi og endoskopi. Jan Gunnar Skogås

27.09.19 - Basalkurs laparoskopisk kirurgi NSALK: Laparoskopi og elektrokirurgi. Jan Gunnar Skogås

01.10.19 – Videreutdanningen, NTNU. Elektrokirurgi og endoskopi. Jan Gunnar Skogås

24.05.19 - Erfaringer fra samarbeid med næringslivspartnere ved Fremtidens operasjonsrom. Felles ledermøte for ledelsen ved St. Olav og MH-fakultetet. Jan Gunnar Skogås

05.06.19 Alexander Moen. Presentation on Cluster for Co Creative Service Design and Innovation (CCSDI): Theme Collaborative health innovation with the use of service design.

05.06.19 – OR-LAB NTNU. -Innledning av FOR – Fremtidens operasjonsrom, bakgrunn og behovet for en test-lab på NTNU. Jan Gunnar Skogås

17.06.19 – FOR som innovasjons-lab innen nye behandlingsmetoder og medisinsk teknologi, Siemens Erlangen, Tyskland. Jan Gunnar Skogås

08.07.19 - Early experience with 3D and 4K imaging for minimally invasive neurosurgery, BMIC, Orlando USA. Jan Gunnar Skogås og Gabriel Kiss

14.08.19 - Presentasjon av FOR for hudavdelingen, Liv- Inger Stenstad

02.09.19 - Presentasjon av FOR og forslag på bacheloroppgaver for Radiografutdanningen, NTNU, Liv- Inger Stenstad

23.09.19 - Jan Magne Gjerde. DRIV/NTNU 3D-print-kurs: «3D-print og helse – noen eksempler»

24.09.19 – Presentasjon av «Fremtidens Operasjonsrom» med fokus på kirurgisk forskning og medisinsk teknologi. Møte med Riksrevisjon. Jan Gunnar Skogås

25.09.19 - Internundervisning ved hudavdelingen: «FOR-NorMIT 3D-Printlab – 3D-printing og Hud» Jan Magne Gjerde

10.10.19 - Operating Room of the Future A testbed for minimally invasive surgery, Presentation at XPOMET, Berlin, Germany, Gabriel Hanssen Kiss

21.10.19 - NTNU, Fakultet for informasjonsteknologi og elektroteknikk Institutt for elektroniske systemer. FOR og NorMIT som forskningsinfrastruktur, en mulighet for din Masteroppgave. Tverrfaglighet i utviklingen og prosjektene. ELSYS-studenter, gjesteforelesning.
Jan Gunnar Skogås

31.10.19 - Augmented reality: Medical applications, Presentation at FOR seminar, Røros, Gabriel Hanssen Kiss

31.10.19 – Advanced visualization, Presentation at LUNA group meeting, Trondheim, Gabriel Hanssen Kiss

31.10.19 - Mixed Reality Projects in Trondheim, Presentation at IVS/OUS, Gabriel Hanssen Kiss

05.11.19 - Operating Room of the Future, medical technology at St.Olavs hospital Sony Corporation R&D. Jan Gunnar Skogås and Gabriel Kiss

19.11.19 - DRIV/NTNU 3D-print-kurs: «3D-print og helse – noen eksempler». Jan Magne Gjerde

22.10.19-Institutt for elektroniske systemer. FOR og NorMIT som forskningsinfrastruktur, en mulighet for din Masteroppgave. Tverrfaglighet i utviklingen og prosjektene. ELSYS-studenter, gjesteforelesning.
Jan Gunnar Skogås

28.11.19 - Internundervisning Ortopediske avdelinger i Helse-MR: «FOR-NorMIT 3D-printlab – Ortopedi.
Jan Magne Gjerde

28.11.19 - Presentation "Prophylactic treatment with negative pressure in surgical incisions", Surgical clinic. Marianne Haugvold

07.12.19 - Medical 3D-printing and innovative technologies conference (M3D+IT): «Establishment of Point of Care-3DD-Print Lab at St. Olav's hospital, Norway – Our experience so far». Jan Magne Gjerde

07.12.19 - Medical 3D-printing and innovative technologies conference (M3D+IT): «Better prepared orthopaedic surgeons with Point of Care 3D-printing». Jan Magne Gjerde

17.12.19 - Helsehagen lunsj - Helse Nord-Trøndelag: «Medisinsk 3D-printing». Jan Magne Gjerde

FOR-related lectures

Lectures and posters at conferences with summaries (peer review), other lectures for health professionals, popular scientific publications, visits to the service where there are lectures, and invited lectures

National

Langø T. Hvordan kunstig intelligens former fremtidens pasientbehandling. Invitert foredrag på eHIN 2019, Oslo, 9. mai 2019. Kåret til beste innlegg på konferansen, evaluert av deltagerne.

Langø T. eHealth 2019 seminar by the Norwegian medical association. An update on image guided interventions and machine learning – How is this technology changing future health care. Oslo, May 9, 2019.

Langø T. 3 separate presentations on the global perspective of the Mariana projects (and other projects at USIGT/SINTEF) to industry: ImFusion (Munich March 29, 2019), BK Medical (March 8, 2019), SIEMENS Healthineers, spring 2019.

Langø T. Presentation of Mariana to Norwegian lung doctors in Mo in relation to the planning part in a clinical study. March 22, 2019.

Langø T. Presentation of Mariana (and other projects at SINTEF) to Center of e-Health in Tromsø, Norway, January 15, 2019.

Langø T. How is artificial intelligence changing health care? Presentation at annual meeting in the Future OR, Røros, Norway, February 1, 2019.

Langø T. National meeting in the Norwegian National Advisory Unit for Ultrasound and Image-Guided Therapy. Lecture during the meeting of the Reference Group; 1-2 members from each of the health regions of Norway. January 28, 2019.

Langø T. Invited lecture at Workshop on AI, Norwegian Health Directorate, Oslo, January 17, 2019. Presentation on Medical technology development at SINTEF in collaboration with industry, incl. Mariana.

Langø T, Bø LE. Presentasjoner for Ob/Gyn på Ahus ifm felles prosjektsøknader innen AI-basert volummåling av placenta/morkake hos gravide. Oslo, 22. November 2019.

Bø LE. Presentasjon av USIGT og aktiviteter med potensiale for globale anvendelser. SINTEF, Oslo, workshop, ca 25 deltagere, 21. November 2019.

Langø T. Presentasjon av USIGT og noen utvalgte aktiviteter på seminar i Helsedirektoratet; Workshop 3 om kunstig intelligens i helsetjenesten. Online deltakelse, 6. November 2019.

Leira HO, Langø T. Workshop innen lungediagnostikk, arrangert av USIGT Lunge, St. Olavs hospital, 35 deltakere, 8 presentasjoner fra gruppa. 31. Oktober 2019.

Leira HO. Multisenterstudien Fraxinus: evaluering og første erfaringer, deltagere fra Mo, Ålesund, Trondheim. 30. Oktober 2019.

Langø T. Invitert foredrag på AI Inspirational day, NTNU, St. Olavs hospital, 24. Oktober 2019. Tittel: How is AI influencing the OR of the future.

Langø T. Invitert foredrag på Medical Imaging Day, Bergen, 18. Oktober 2019. Tittel: AI – State of the art – Are we ready?

Smistad E, Østvik A. Invitert foredrag på Medical Imaging Day, Bergen, 18. Oktober 2019. Tittel: Optimizing echocardiographic recordings by AI.

Dahl SK. Invitert foredrag på Medical Imaging Day, Bergen, 18. Oktober 2019. Tittel: What can fluid dynamics provide in diagnostics and treatment planning?

Smistad, Erik. Kunstig intelligens i medisinsk bildediagnostikk - muligheter og utfordringer. HEMIT konferansen 2019; 2019-08-19.

Smistad, Erik. Machine learning and artificial intelligence in medical imaging. Forelesning for NTNU IKOM; 2019-03-04.

Smistad, Erik. Machine learning in medical imaging. SINTEF Digital Kick off; 2019-01-30

Smistad, Erik. Maskinlæring og kunstig intelligens i medisinsk bildeanalyse. Årsmøte i den norske patologforening; 2019-03-07

Dahl SK. Cardiosim – fra rørstrømning til blodstrømning. Presentasjon ifm. besøk hos Nasjonalt senter for e-helseforskning , Tromsø 15.01.19.

Dahl SK- Kan teknologien hjelpe klinikken? Foredrag på Diakonhjemmet, Oslo 15.10.19.

Solheim O.: Scandinavian Training Course Neurosurgery, Beitostølen, March 2019 (Case discussions and short lecture

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International

Østvik A, Bø LE, Smistad E. EchoBot: An open-source robotic ultrasound system. IPCAI 2019; 2019-06-18 - 2019-06-19, Rennes, France.

Langø T. Presentasjon på Kirurgisk Høstmøte, Oslo, 25. Oktober 2019. Tittel: kunstig intelligens algoritme for automatisk analyse av ct bilder i beslutningsstøtte for lungekreftutredning.

Dahl SK. Presentasjon på Kirurgisk Høstmøte, Oslo, 25. Oktober 2019. Tittel: beslutningsstøttefor behandlingsplanlegging av hjertesykdom basert på pasient-spesifikke strømningssimulering i hjertet.

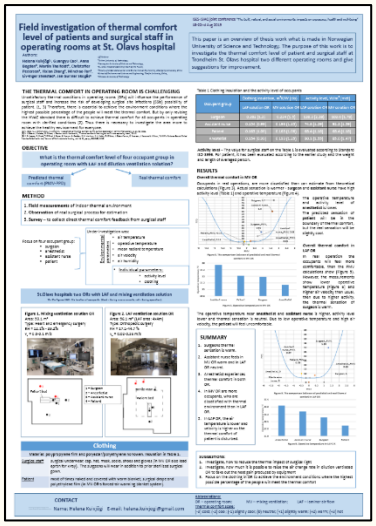
Langø T. Image guided therapies and technologies for airway disease. Oral presentation at SMIT 2019, Heilbronn, Germany, October 11, 2019.

MICCAI Challenge 2019 for Correction of Brainshift with Intra-Operative Ultrasound (CuRIOUS2019), Shenzen, Kina, oktober 2019.

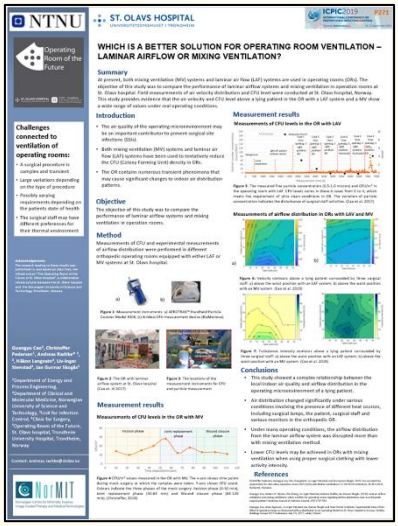
Solheim O. German Society of Neurosurgery, 70th annual meeting May 2019 (Würzburg), Management of low grade glioma

Reinertsen I. Image-guided surgery inside and outside the operating room, Surgetica, Rennes, Juni 2019

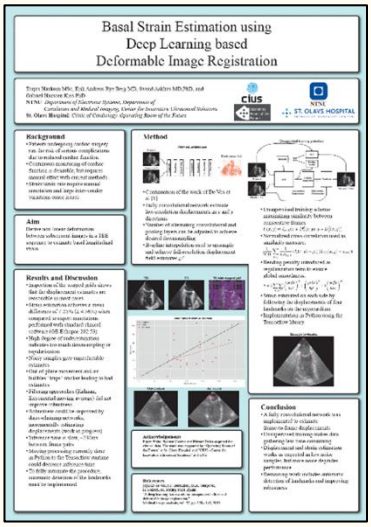
Posters



ISES-ISAQ joint conference «The build, natural and social environments: impacts and exposure, health and well-being" 18-22-aug 2019, in Kaunas, Lithuania. Presented by Helena Kuivjõgi



ICPIC2019, International conference on prevention & infection control. 10-13 September 2019, Geneva, Switzerland. Presented by Andreas Radtke



IEEE Ultrasonics Symposium, Glasgow, UK, 6-9 October 2019 Presenters: Torjus Haukom and Gabriel Hanssen Kiss

You can read the posters here: https://stolav.no/fag-og-forskning/kompetansetjenester-og-sentre/for#poster

FOR in the media

UpNorth Film and Yoko Sen visited in May the Operation Room of the Future, St. Olavs Hospital. UpNorth Film is one of the leading documentary film production companies in Norway. This was related to a production of a documentary about sound and how sound can affect us in different ways. In this context, recording was made with American-Japanese Yoko Sen at the Operation Room of the Future at ENT surgery department. In this documentary, Yoko tells about the motivation for her work in the field of sound from machines, monitors and intensive care units. Her commitment to this work came after she had a long hospital stay a few years ago where she describes all the sounds of machines/monitors as very disturbing.
Read more about Yoko - www.sensound.space

This documentary was supported by the Norwegian Film Institute (NFI) for the documentary film project «Oh, it Hertz!». Gunnar Hall Jensen is one of three screenwriters for this audio documentary, as well as being the film's director. The film will be about sound, more specifically about how sound can be used both as medicine and as torture.
UpNorth Film has won Amanda awards, the Golden Route and many international awards such as The Golden Nymph, The Amnesty International Human Rights Award and The Most Valuable Documentary of the Year Award at the Cinema for Peace in Berlin.

Recording at the Operation Room of the Future, ENT surgery department.

Photo: FOR

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