Operating Room of the Future
Annual report 2023

St. Olavs hospital FOR – NorMIT Infrastructure

Operating Room of the Future

ST. OLAVS HOSPITAL
TRONDHEIM UNIVERSITY HOSPITAL

NTNU

ST. OLAVS HOSPITAL
UNIVERSITETSSYKEHUSET I TRONDHEIM

NTNU | Norwegian University of Science and Technology

Frontpage photo: Lars Bugge Aarset, NTNU
From the Opening ceremony of the OR-lab at Gløshaugen

Preface

2023 has been an exciting year, a lot has happened on the activity front. New tasks have been assigned to us. It has also resulted in us changing the overall name of the business, where we previously used the name "Fremtidens Operating Room", we have now changed the name to; "Center for Medical Equipment, Technology and Innovation", a name that reflects the breadth of our field of activity.

NorTrial's center for medical devices, which was established the year before, has had many inquiries from industry, the health industry and start-up companies, nationally and internationally. There have been a total of 43 different activities during the year. Clinical studies are central to the development of medical equipment. It gives patients access to new forms of treatment, it gives doctors and researchers new knowledge, and it gives the industry the opportunity to test the effect of medical equipment.

During the year, the National Research Center for Minimally Invasive and image-assisted diagnostics and treatment (MIDT) established, as a result of an evaluation of the national competence services, the Ministry of Health and Care Services (HOD) proposed to continue the activity in the national competence services for 3D ultrasound (USIGT), functional MRI (fMRI) and advanced laparoscopic surgery (NSALK) as a national research center that is added to St. Olav's hospital HF.

The research center is being established to further develop and utilize the synergy effects of the accumulated knowledge, infrastructure and expertise of the three former national expertise services. The research center will carry out research, innovation and education in the fields of minimally invasive surgery/treatment, medical imaging, image analysis, and image-guided diagnostics and treatment/intervention. The new center will strengthen and further develop the environment's position nationally and internationally.

During the year, we have also followed up and arranged for PhD scholars, master's students and bachelor's students who all carried out their tasks using the FOR infrastructure. We are very pleased with the increase in scope and activity.

We wish you a good reading of our annual report for 2023!

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

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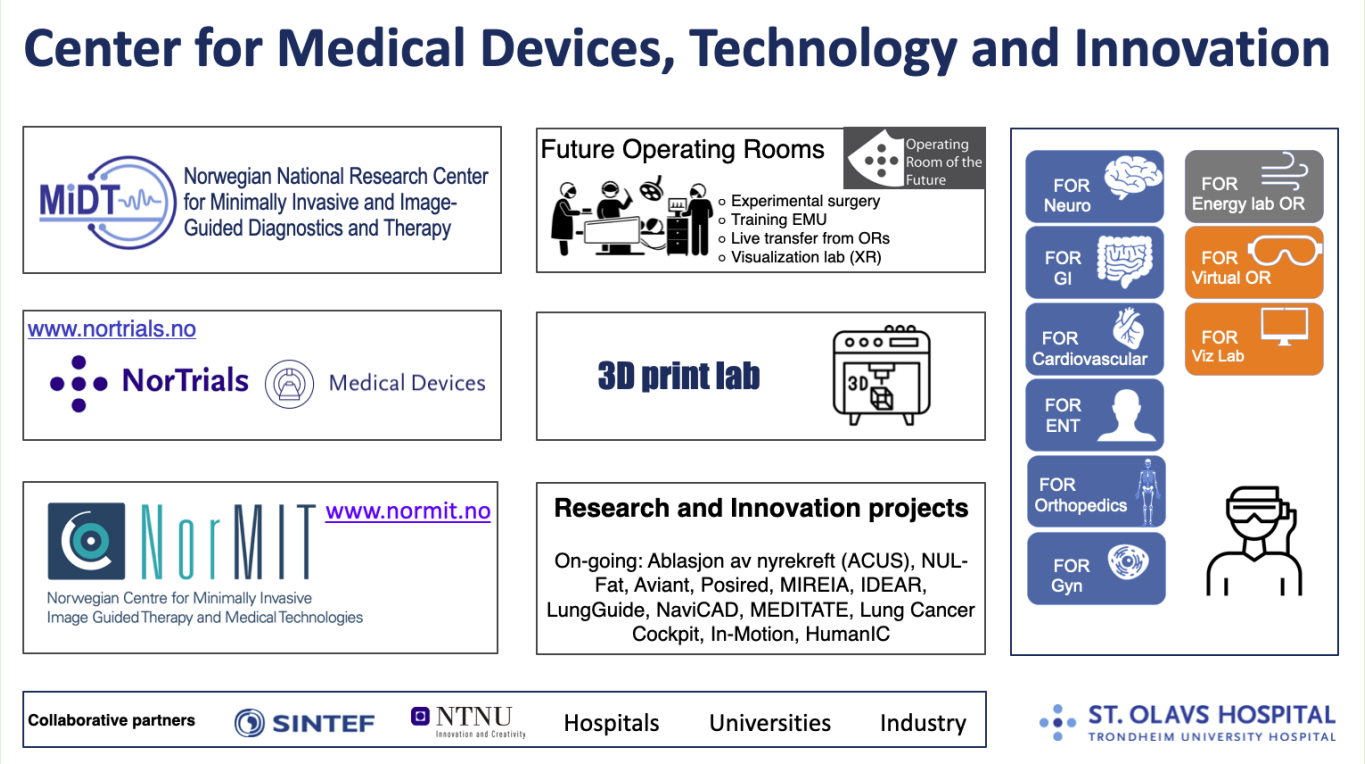
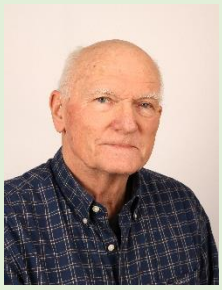


Staff



Hans Olav Myhre
Emeritus professor of surgery

Jan Gunnar Skogås
Managing Director

Thomas Langø
Chief Scientist

Sara Edvardsen
Scientist, R&D coordinator

Jan Magne Gjerde
Engineer, 3D-print

Hanna Helga Sulimahn
ICT coordinator,
3D- print

Liv- Inger Stenstad
R&D coordinator

Gunnar Gjeldnes
R&D coordinator

Gabriel Kiss
Scientist, R&D coordinator

Ivar Rossvoll
Associate Professor

Frode Manstad- Hulaas
Associate Professor

Vigdis Schnell Husby
R&D coordinator

Guangyu Cao
Professor NTNU

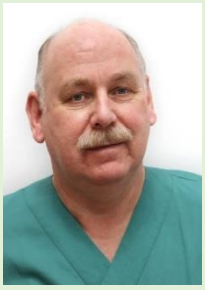
Lars Adde
Scientist

Photo: St. Olavs Hospital

Per Even Storli
Laparoscopic surgery

Kirsten Rønning
Laparoscopic surgery

Hilde Merete Klungerbo
Laparoscopic surgery



Ronald Mårvik
Laparoscopic surgery

Gjermund Johnsen
Laparoscopic surgery

Håkon Olav Leira
Pulmonary medicine
and bronchoscopy

Aasta kristine Håberg
fMRI

Arne Seternes
Vascular surgery

Ole Solheim
Neurosurgery

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:

Associate Professor Ivar Rossvoll (leader)

Emeritus professor Hans Olav Myhre

Professor Per Farup

Professor Olav Haraldseth

Professor Ståle Nordgård

Associate Professor Frode Manstad-Hulaas

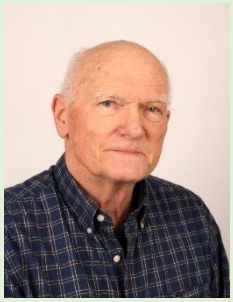
Associate Professor Knut Haakon Stensæth

Research director Thomas Langø

Associate Professor Wenche Moe Thorstensen

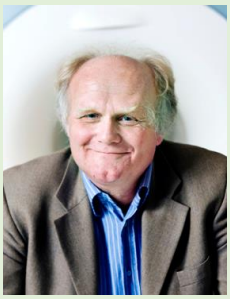
Specialist in clinical pharmacology Trond Oskar Aamo

Ivar Rossvoll
Scientific adviser
Associate professor



Hans Olav Myhre
Emeritus professor
in surgery

Per G. Farup
Professor



Olav Haraldseth
Professor

Wenche Moe
Thorstensen
Associate Professor

Ståle Nordgård
Professor

Frode Manstad-Hulaas
Associate Professor

Knut Haakon Stensæth
Assistant professor

Thomas Langø
Chief Scientist

Trond Oskar Aamo
Specialist in clinical
pharmacology

Photos: St. Olavs Hospital, NTNU, SINTEF and private

Higlights in 2023

National research center MiDT
One of the major highlights in 2023 was the awarding and establishment of the National Research Center for Minimally Invasive and Image-Assisted Diagnostics and Treatment, MiDT.

The centre's purpose is to respond to challenges in the healthcare system by carrying out research, innovation, competence development and dissemination as well as education in minimally invasive treatment/surgery, medical imaging, image analysis (including artificial intelligence), image-guided diagnostics and treatment/intervention (including robotics) and simulator-based learning.

MiDT, is a merger of three former competence services National competence service for advanced laparoscopic surgery (NSALK), National competence service for functional MRI (fMRI), National competence service for ultrasound and image-guided treatment (USIGT).

There is already an impressive amount of activity delivered by our researchers, clinicians and subject managers during 2023. Dissemination, scientific articles, awarded doctorates, research projects, teaching and training of personnel

As of today, the centre's subject areas are the following subjects:

-Pulmonary and bronchoscopy
- Neurosurgery
-Laparoscopic surgery
- Vascular surgery and endovascular treatment
-Functional MRI, brain health

FOR Annual seminar at Røros 2023
FOR Annual seminar was held in Bergstaden Røros on 26-27. January 2023. Many thanks to all of you who participated! It was great to finally be able to get together again after a long absence since January 2020. We hope the participants had an educational and enjoyable seminar in Røros. This year's program was rich and varied with interesting and relevant topics.

It was important for us to show all the innovation and creativity that is going on. Such a gathering is of great importance the professional communities, since we meet in a different arena than what we do on a daily basis. New ideas are created, the research infrastructure and environments are strengthened. A lot has happened since we last met, many innovations, researchprojects and development of medical equipment, technologies and new surgical methods, which we now were able to share with you.


Jan Gunnar Skogås
Photo. FOR

Opening ceremony

The Minister of Health was leading the opening ceremony at the new unit of the operating room of the future Hospital infections are common complications in the health service, and Norconsult, NTNU and Fremtidens Operasjonsrom (FOR) at St. Olav's hospital collaborate to reduce this the incidence of such complications.

The laboratory used in the project is designed as an operating room, with technology and equipment that makes it possible to visualize ventilation currents and particles in the air, as well as stereo cameras that record the movement patterns of the healthcare personnel. An XR tool (augmented reality) is being built that captures the interaction between the movements of the healthcare personnel, virtual air currents and the distribution of particles in the room. The project is financed by the Norwegian Research Council and Norconsult.

The laboratory was opened with Minister of Health Ingvil Kjerkhol «cutting the cord» together with rector Anne Borg at NTNU. Project manager Thorgeir Harsem from Norconsult in the background.
Photo: Lars Bugge Aarset, NTNU

During the opening, the minister and the other participants were given a thorough review of the project, as well as a demonstration of the laboratory where a surgical team from St. Olav's Hospital carried out a sham operation.

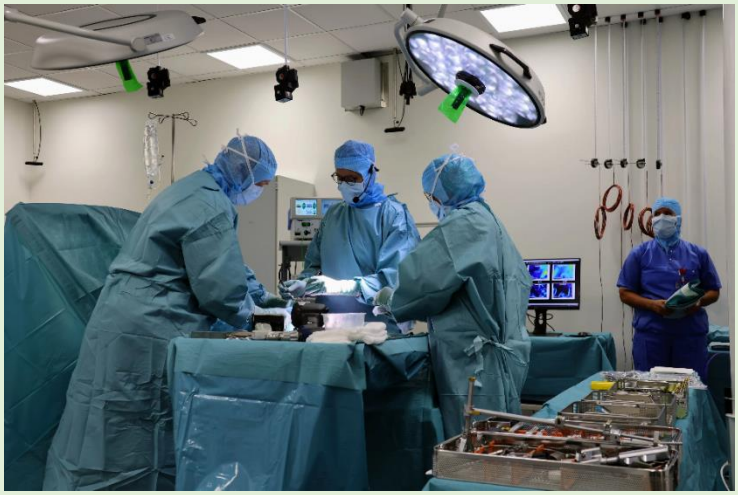
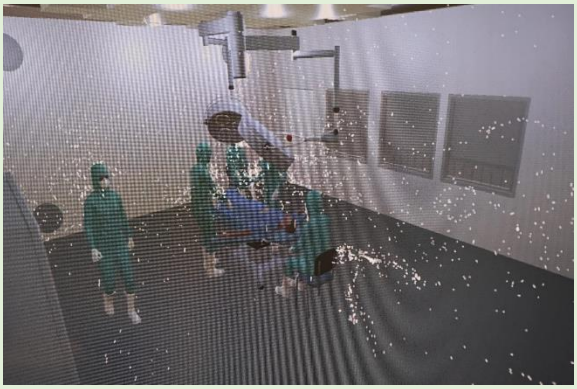


Photo: Lars Bugge Aarset, NTNU

Real-timedigitization of people and equipment in the operating room showing particle flows.

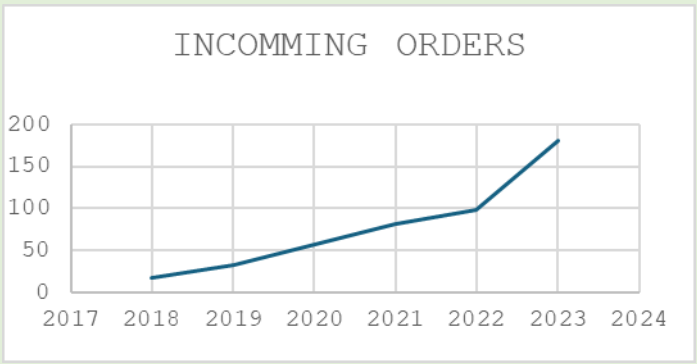


Se innslaget på NRK Midtnytt
Les artikkelen på Norconsults nettsted
Les artikkelen på NTNU's nettsted

Activity in 2023

FOR – NorMIT 3D-printlab

Since FOR 3D Lab was established in 2018 the number of incoming orders has increased steadily. The 82% increase from 2022 to 2023 is however much higher than previous years. The main reason is increase in Orthognatic cases, and a logistical change that improves the workflow at the CMF-department.
In order to cope with the increasing workload, Hanna Sulimahn has started working at the lab. With her background as a veterinarian and ICT Coordinator at St Olavs Hospital, Hanna has the perfect combination of anatomical and digital knowledge. This combined with her passion for patient treatment and problems solving is a perfect match for the 3D-Lab. Hannas position at the 3D-Lab will be 40% initially, but hopefully it will become a 100%-position soon.
Increased manpower enables the lab to expand its services to new departments at the hospital, and to improve workflow and documentation which in turn will lift the quality of our services.
In addition to clinical cases the lab receives a lot of requests from new customers who would like to explore if 3d printed anatomical models could be used for surgical training within different disciplines. Printing models of soft internal organs with realistic material properties could bring similar benefits as the orthopaedic- and CMF-surgeons are exploiting to new departments.



Photos. Jan Magne Gjerde

Collaboration with DRIV NTNU

FOR is continuing to inspire students to work with innovation in healthcare. In 2023 we once again hosted the Health Tech Challenge, together with the health innovation arena and the student organization DRIV NTNU. In this competition we encourage students in the field of medicine to work together with students from other fields, to boost innovation in healthcare and solve today's problems in patient care. The participants usually consist of students from medicine, nursing, science and technology. However, we do encourage students from other fields to join the competition as well.

We notice that students are becoming more interested in medical technology and innovation, as the number of participants this year significantly increased compared to previous years. With 43 students joining the challenge, we sat a new record! See figure below for information on number of participants per year.

The competition started 7.March, where students got to be inspired by winners of previous competitions, and were introduced to this years challenge. The cases this year were brought forward by teams from the ear-nose-throat, cardiology and angiography departments at the hospital. We want to thank Ståle Nordgård, Jan Pål Loennechen and Frode Manstad-Hulaas for proposing the cases and putting great effort into supervising the students.

To inspire the students to bring a medical device from idea to market, NTNU Technology Transfer and Spark* NTNU came 14.March to enlighten the participants and help them during the challenge. On 16.March all eight groups presented their final solution to the cases in front of a jury. A picture from the final day of the competition can be seen below.

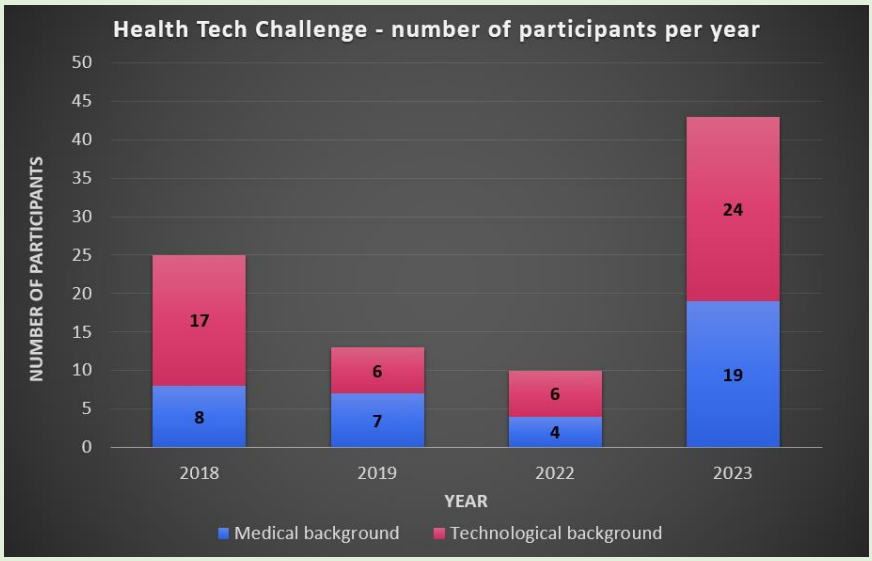


Figure: Number of participants in Health Tech Challenge per year, and ration between students with medical background and technological backround.

Students at the final day of the Health Tech challenge, when each group presented their project in front of the jury.
Photo: Sara Edvardsen

NorTrials Medical Devices

Medical devices is central to most diagnostics and treatment of patients in hospitals. Clinical studies in research, development and testing of medical devices (technology) is something that most hospitals engage in to a greater or lesser extent, either in their own research, collaborative projects with universities and research institutes, or in collaboration with industry. The NorTrials center for medical devices has been added to St. Olav's hospital HF.
St. Olav's hospital has extensive experience in research, development, innovation and testing (in collaboration with industry) of medical devices and technology.

NorTrials center for medical devices is organized in the research department and placed under the research infrastructure "The Operating Room of the Future", where we have projects, infrastructure, national roles, etc. in collaboration with the other health regions, for example NorMIT infrastructure in collaboration with Oslo University Hospital. NorTrials medical devices will lift this collaboration further and contribute to coordination and increased participation from several hospitals, small and large around the country, in studies involving medical devices in collaboration with national and international industry.

Photo: FOR

Center manager: Jan Gunnar Skogås
Academic supervisor: Thomas Langø
Regulatory advisor: Sara Edvardsen

Artikkel om samarbeid med Decon-X på nettsiden til Norwegian Smart Care Cluster
Artikkel om senteret på LMIs nettsider 14.12.2022
Artikkel om senteret i Dagens Medisin 1.9.2022

Senterpresentasjon fra NorTrials oppstartsmøte

Regulatory Guidance for Medical Devices

In order for a medical device to be used in standard patient care, the device has to bear a CE mark. Such a certificate implies that the device and its manufacturing process complies with Regulation (EU) 2017/745 – the European Medical Device Regulation (MDR). By fulfilling all requirements put on a medical device in this regulation, the device is considered safe for use on patients, and is thereby granted market access in Europe. Once the market access is granted, European hospitals are able to buy the device and use it to improve patient care. In order to successfully get from an idea of a new medical device to market access, it is important to consider regulatory requirements early on.

The regulatory pathway starts already when the intended purpose of the device is decided. The intended purpose decides whether the device is a medical device, and what clinical evidence is needed to evaluate safety and performance. Therefore, a lot of considerations regarding strategy must be taken into account when deciding upon an intended purpose.

As we have regulatory expertise internally in our team, we are able to offer both industry and researchers guidance in regulatory pathways for medical devices. This includes help in understanding how to plan and perform a clinical investigation of a medical device, and which authorities you are required to be in dialogue with for approval. All questions researchers and developers new to MDR may be struggling finding answers to.

Our team is always continuing to improve our regulatory knowledge, by participating internationally at courses and summits with the medtech industry and authorities. We are also trying to increase the knowledge of MDR nationally by giving presentations about MDR and medical devices in several parts of the country.

If you, or your team, needs help understanding the regulatory requirements for medical devices and clinical investigations of medical devices, please reach out to our research scientist and regulatory advisor Sara Edvardsen - sara.edvardsen@stolav.no .

MiDT- National Research Center for Minimally Invasive and Image-Guided Diagnostics and Therapy

After evaluation of the national expertise services, the Ministry of Health and Care Services (HOD) proposed to continue the activity in the national expertise services for 3D ultrasound (USIGT), functional MRI (fMRI) and advanced laparoscopic surgery (NSALK) as a national center to be added to St. Olav's hospital HF. In 2023, the new organisation and structure was effectuated and in place with scientific / clinical leaders and other research positions established.

Research areas of MiDT:

- Pulmonary medicine and bronchoscopy
- Neurosurgery
- Laparoscopic surgery (former NSALK)
- Vascular surgery and endovascular treatment
- Functional MRI

The center will cover a wide range of activities to achieve the purpose set forth by HOD:

- Research on medical technology, ultrasound used in diagnostics and treatment/surgery, image-guided treatment, medical and nuclear medical imaging (fMRI/MRI/PET, ultrasound, CT, X-ray), new/improved clinical methods, treatment methods and techniques
- Service and product development, innovation, together with the health service and the private sector (industry)
- Training in minimally invasive treatment (including use of simulator technology in LIS education)
- Education, teaching and training of health personnel and health technologists (LIS, masters, research lines, PhD, postdoc, research nurses, technologists, physicists, etc.)
- Dissemination to professionals and the general population

The activities in the center must be dynamic and adapted to needs and changes in technology and disease patterns, as well as the needs of the healthcare system and society, and adapted to the economy.

OVERVIEW OF COURSES/SEMINARS ORGANISED/CO-ORGANISED BY MiDT-NSALK IN 2023:

RECOMMENDED COURSES FOR LIS DOCTORS:
Basic course in laparoscopic surgery - course 1
Basic course in laparoscopic surgery - course 2
Basic course in laparoscopic surgery - course 3
Basic course in laparoscopic surgery – course 4
Basic Surgical Skills - last part
Advanced laparoscopy (with pig (3 pigs))
Advanced laparoscopy (with pig (6 pigs))
Endoscopy course with simulator training
Course in hernia surgery
Course in elective general surgery – urology

OTHER ORGANIZED TRAINING FOR LIS DOCTORS:
Training on a simulator (flexible endoscopy) - 7 smaller seminars
Professional day for gynecologists
Seminars for LIS1 – 3 seminars tailored to learning objectives

FOR STUDENTS:
Master's study obesity and health II: surgical treatment.

CONGRESSES:
Nordic congress of gynecology - workshop
MedSim Norway network conference:
→One poster, two presentations + 2 workshops

WORKSHOPS IN COOPERATION WITH COMPANY:
Workshop Medtronic (2 workshops) (one workshop with pig: 3 pigs)

FOR-NorMIT infrastructure

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

Department of Circulation and Imaging (ISB)
Thomas Grønli, senior engineer, ISB

The ultrasound laboratory at NTNU, Department of Circulation and Medical Imaging hosts two Verasonics Vantage systems which are used in various projects related to cardiovascular imaging, contrast agent development and imaging, and for the development and use of dual-frequency ultrasound transducers, used for instance to enhance image quality and cancer treatment. The laboratory also hosts the Onda Acoustic Intensity Measurement System (AIMS III) which is used for determining acoustic safety in clinical trials using both NorMIT Verasonics systems and research scanners owned by the laboratory.

At ISB we use these systems to develop high frame rate imaging applications, such as vector-Doppler imaging which may shed light on the development of plaques in the carotid artery, as well as new high frame rate cardiac imaging setups to improve quantification of cardiac function. These efforts use extensive imaging setup enabled by the powerful Verasonics systems in NorMIT and has resulted in international collaboration.

Another project connected to Center for Innovative Ultrasound Solutions (CIUS) focuses on optimizing the performance of Doppler ultrasound using single element transducers for flow estimation through cracks/fissures in industrial construction and resulted in one journal paper in 2023[1].

Several other groups are using the systems, including the Dept. of Physics and Prof. Catharina Davies, SINTEF Digital, and SURF imaging, a spin-off company from ISB led by Prof. Bjørn Angelsen, with a journal paper on estimating fat content of soft tissues using a custom dual frequency transducer published in 2023[3]
NorMIT has been very important in conducting both experimental, preclinical, and clinical investigations of new ultrasound methods for better detection of cancer in the early stages, and also ultrasound efficacy of chemotheraphy

NorMIT has been very important in conducting both experimental, preclinical, and clinical investigations of new ultrasound methods for better detection of cancer in the early stages, and also ultrasound efficacy of chemotheraphy.

1. Indimath, S., Fiorentini, S., Bøklepp, B.R. et al. Effect of bubble size on ultrasound backscatter from bubble clouds in the context of gas kick detection in boreholes. Sci Rep 13, 11825 (2023). https://doi.org/10.1038/s41598-023-38937-6
2. Stian Solberg, Naseh Amini, Yamen Zaza, Bjørn A. J. Angelsen, Rune Hansen; Estimation of fat content in soft tissues using dual frequency ultrasound—A phantom study. J. Acoust. Soc. Am. 1 March 2023; 153 (3): 1766–1775. https://doi.org/10.1121/10.0017601

SINTEF Digital, Department of Health Research, uses the NorMIT infrastructure in several ongoing research projects. The Verasonics Vantage systems are instrumental in our effort to develop novel ultrasound imaging algorithms, and the Onda Acoustic Intensity Measurement System (AIMS III) is of critical importance when doing acoustic safety tests before preclinical and clinical trials, and the setup for MR-guided focused ultrasound treatment allows investigation of novel strategies for drug delivery. Also, The BK5000 ultrasound scanner has a variety of probes particularly suited for intraoperative use, and a research interface that allows for real-time communication and image streaming from the scanner to external systems, and the endobronchial ultrasound (EBUS) bronchoscope from Olympus enable clinical studies in lung cancer patients.

Sigrid Berg, Research Manager (PhD),Medical Technology Group Dept. of Health ResearchSINTEF Digital

Projects

Fatty liver disease characterization by Sonography

In the project "Fatty liver disease characterization by Sonography (2022-2024)" financed by The Liaison Committee for Education, Research and Innovation in Central Norway, researchers at SINTEF collaborate with the Regional Centre of Obesity Research and Innovation (ObeCE) at St. Olavs hospital and engineers from SURF Technology AS to implement and test a novel ultrasound method for quantitative measurements of fat content in tissue. The technique is based on non-linear acoustics and estimation of an elastic tissue parameter called nonlinear compressibility. The research ultrasound platform Verasonics Vantage system, provided by NorMIT, has been used together with a custom-made ultrasound transducer that is capable of transmitting two distinct frequencies simultaneously. The goal of the project is to test and validate an ultrasound method for diagnosis of fatty liver disease. The disease is characterized by the accumulation of fat in the liver, and in patients with untreated fatty liver disease, the condition can eventually lead to inflammation, the formation of scar tissue and a significantly increased risk of chronic liver disease or liver cancer.
The method has been tested in tissue mimicking materials (in vitro) with various amounts of added fat, and in a preclinical study (in vivo) where rats were fed a high-fat diet to develop fatty liver disease. The results from experiments are very promising, and the next step is to test the method in patients with suspected fatty liver disease. A publication describing the in vitro experiments was published in 2023, and a publication on the in vivo experiment is in preparation. In 2023 a new transducer which is optimized for patients with suspected fatty liver disease has been designed, and the first-in-human recordings are expected in 2024.
Participants: Rune Hansen and Sigrid Berg (SINTEF Digital), Rønnaug Astri Ødegård (St. Olavs hospital), Naseh Amini and Stian Solberg (SURF Technology)

Lymph node characterization with quantitative ultrasound methods.

In a project funded by The Liaison Committee for Education, Research and Innovation in Central Norway, SINTEF is working in collaboration with the Dept. of Circulation and Medical Imaging (ISB), NTNU and pulmonologists at St. Olavs hospital and Levanger Hospital to improve characterization of mediastinal lymph nodes in lung cancer patients. The Verasonics Vantage system is used to quantify the stiffness of the tissue by using an implementation of shear wave imaging. Both clinical linear transducers and a custom-made dual frequency transducer have been used. The latter transducer is also used for assessing the nonlinear compressibility, similar to what is done in the characterization of liver fat. The hypothesis is that both tissue stiffness and nonlinear compressibility can be of diagnostic value when differentiating between benign and malignant lymph nodes. A manuscript is submitted for publication and is expected to be published in 2024.
Participants: Rune Hansen, Jørgen Avdal and Sigrid Berg (SINTEF Digital), Øyvind Ervik and Hanne Sorger (Levanger Hospital and ISB, NTNU), Håkon Olav Leira (St. Olavs hospital and ISB, NTNU), Bjørn Skallerud (Dept. of structural engineering, NTNU)

Improved ultrasound-guided resection of brain tumors

In a qualification project financed by the Research Council of Norway, researchers at SINTEF have developed a method for improved ultrasound imaging of brain tumors. The method is implemented on the Verasonics Vantage platform and the clinical transducer L8-18i from GE Healthcare is used. The method has been tested on tissue-mimicking materials in the lab, and together with neurosurgeons at St. Olavs hospital the method has also been tested on patients scheduled for surgical removal of brain tumors.

Few cancers have proven to be as difficult to treat as malignant brain tumors, and the prognosis remains dismal for the most common types. Maximal surgical resection of the tumor has been shown to be very important in increasing survival. However, it is often difficult for the surgeon to distinguish between tumor and healthy tissue. This is especially true towards the end of the surgery when the neurosurgeon is approaching the outer border of the tumor. Both before and during the surgery it is advantageous to use ultrasound to image the tumor and the surrounding area. As tumor tissue is removed it often becomes increasingly difficult to interpret the images and find the boundary between the tumor and healthy brain tissue. By improving the image quality of the ultrasound images, especially towards the last phase of the operation, the surgeon can get a tool that makes it easier to remove the last important millimeters of the tumor.
Participants: Rune Hansen, Jørgen Avdal and Sigrid Berg (SINTEF Digital), Ole Solheim (St. Olavs hospital)

Drug delivery with MR-guided focused ultrasound treatment
Delivery of drugs to the brain and central nervous system is inherently difficult due to the blood brain barrier (BBB). The barrier is the brain's primary defense against harmful substances, but also hinders the delivery of drugs with the potential of treating diseases in the brain. Using ultrasound in combination with microbubbles to breach the BBB and increase delivery of drugs or other compounds to the brain has shown great promise, and in collaboration with researchers at Oslo University Hospital, researchers at SINTEF have used the FUS instrument RK100 system provided by NorMIT, to optimize ultrasound parameters for delivery of a new and promising drugs for the treatment of glioblastoma.
Participants: Rune Hansen and Sigrid Berg (SINTEF Digital), Deo Prakash Panday (Oslo University Hospital)

RAMPUS 2: Real-Time Accurate Measurement of Placental Volume by Ultrasound
Research has shown that there is an association between the volume of the placenta and the risk of complications during pregnancy. However, to measure this volume, one must have good three-dimensional (3D) images. Ultrasound probes for 3D imaging are becoming more common, but these cover a limited area, and it is often not possible to fit the entire placenta within one image. In the verification project, financed by The Research Council of Norway, RAMPUS 2, SINTEF and Akershus University Hospital are developing a method for measuring the placental volume automatically by stitching together two-dimensional (2D) images from a normal ultrasound probe. This is done by equipping the probe with a position sensor, and then image a large number of placentas while measuring the position of each individual ultrasound image. To achieve this, the BK5000 ultrasound scanner provided by NorMIT was used, which has a research interface that allows the ultrasound images to be recorded and combined with information from a tracking camera in real time. Using modern machine learning methods, the computer program can be taught how 2D images can be combined into a 3D image based solely on what is seen in the images. These 3D images can then be used to calculate the volume of the placenta.
Participants: Lars Eirik Bø and Torgrim Lie (SINTEF Digital), Anne Eskild, Karianne Sagberg og Helene Peterson (Akershus University Hospital)

Navigated ultrasound bronchoscopy with integrated positron emission tomography - A human feasibility study
Patients suspected to have lung cancer undergo endobronchial ultrasound bronchoscopy (EBUS) for the purpose of diagnosis and staging. For presumptive curable patients, the EBUS bronchoscopy is planned based on images and data from computed tomography (CT) images and positron emission tomography (PET). This patient study aimed to evaluate the feasibility of a multimodal electromagnetic (EM) navigation platform for EBUS bronchoscopy, integrating ultrasound and CT (volume and segmented structures), and PET scan imaging data. Patients with suspected lung cancer identified on both CT and PET scans were included in the study. Images obtained from these two modalities were segmented to delineate target lymph nodes and then incorporated into the CustusX navigation platform. The EBUS bronchoscope, Olympus BF-UC180F, was provided by NorMIT, and it was equipped with a 3D printed click-on device with an integrated EM sensor at the tip. The study was funded by The Ministry of Health and Care Services of Norway through the Norwegian National Research Center for Minimally Invasive and Image-Guided Diagnostics and Therapy (MiDT) at St. Olavs hospital, Trondheim, Norway.
Participants: Erlend Fagertun Hofstad, Ole Vegard Solberg and Thomas Langø (SINTEF), Arne Kildahl-Andersen, Tore Amundsen and Håkon Olav Leira (St. Olavs hospital), Hanne Sorger (Levanger hospital)

Department of Physics at NTNU uses the FOR-NorMIT infrastrucure for characterization of transducers
Preclinical research

Catharina de Lange Davies, professor

Water tank-hydrophone system (Onda AIMS III Scanning Tank)
The water tank-hydrophone system is used regularly to characterize the acoustic field from various ultrasound (US) transducers. In 2023, we have particularly used the system to characterize a new dual frequency transducer from FUS Instrument to be used to open the blood-brain barrier.

Magnetic Resonance imaging (MRI) guided ultrasound (FUS Instruments RK-100)
The MRI-guided ultrasound system from FUS Instruments, has been used to optimize the opening of the blood-brain barrier comparing three different microbubbles in combination with ultrasound. The efficiency of blood-brain barrier opening was quantified by measuring the intensity of the MRI contrast agent gadolinium. The delivery of a fluorescent macromolecule was imaged in a small animal optical imager, and the distribution of nanoparticles imaged by confocal laser scanning microscopy. Safety was assessed by histology.

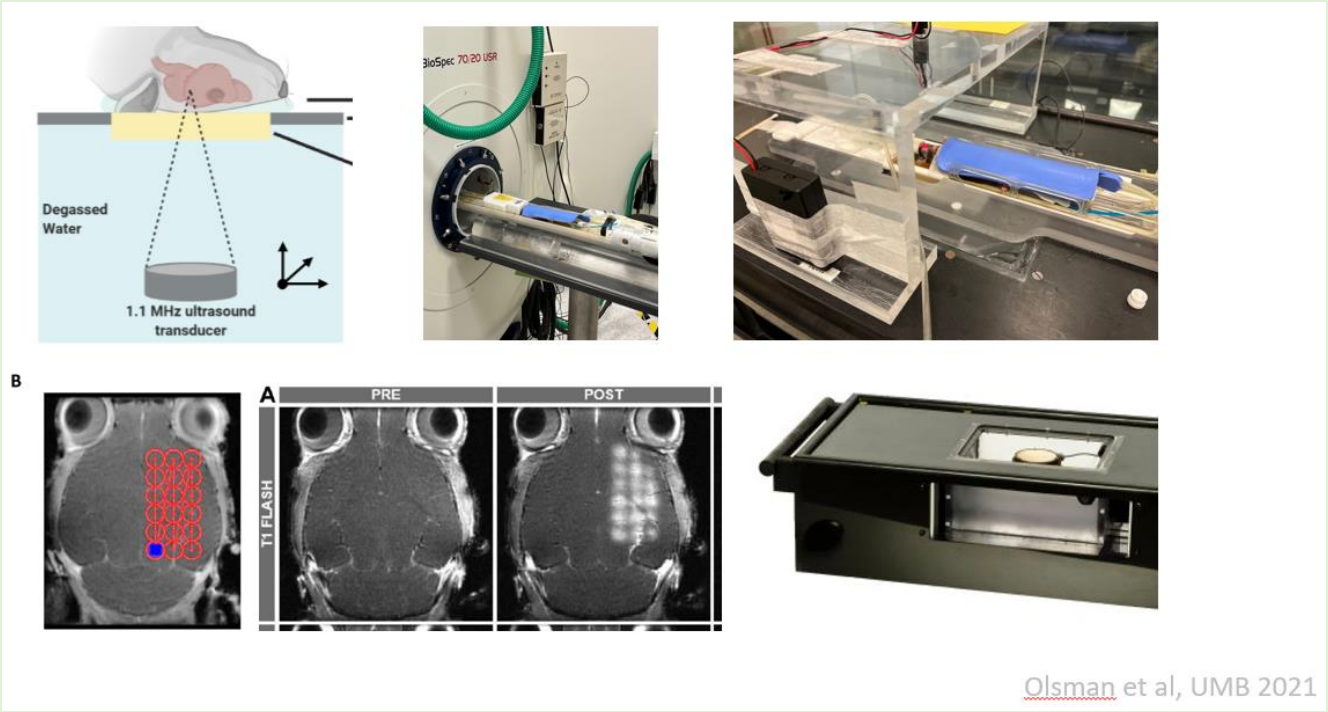


Image guided ultrasound setup

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.

We had 12 experimental surgeries in 2023

Research Collaborations - National and international partners

In 2023, we have run several projects in collaboration with partners in our own health region; Helse Midt-Norge RHF, the health register HUNT and Møre og Romsdal at Kristiansund Hospital, with a focus on prosthetic surgery and day surgery.

In collaboration with the Intervention Center (IVS) at Oslo University Hospital, we have since 2014 run the national research infrastructure, NorMIT; Norwegian center for minimally invasive image-guided therapy and medical technology, an infrastructure in both Oslo and Trondheim, with several ongoing projects. Over the years, the NorMIT infrastructure has been available both nationally and internationally, and has a significant portfolio of available research equipment and expertise available in Oslo and Trondheim.

SINTEF is an important collaboration partner. The collaboration is, among other things, built around the former "National Competence Center for Ultrasound and Image-Guided Therapy", now MIDT etc. We are mutually dependent on each other's knowledge, expertise and infrastructure. We also have a very good collaboration with NTNU through the MH faculty, at the Department of Circulation and Medical Imaging, other faculties and departments such as the Department of Energy and Process Engineering, the Department of Design, the Department of Mathematics, the Department of Electronic Systems and the Department of technical cybernetics and AI laboratory, as well as 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.

The students at the Faculty of Health Sciences at NTNU use the infrastructure for projects related to the bachelor's and master's degrees in collaboration with FOR.

An important infrastructure on the way forward will be the six National NorTrials centres, especially NorTrials Medical Devices, where we, together with all hospitals in Norway, will become an important infrastructure in collaboration with national and international industry. This will be a great arena for increased clinical research with a focus on medical equipment.

FOR has good cooperation with a number of industrial partners, internationally and nationally.
Good practice and guidelines for cooperation with industrial partners have been developed over many years together with experts in this area and deal exclusively with research and development, testing of prototypes and approved products that change the area of application.
FOR is not an arena for marketing and sales.

We currently have several joint research projects with international partners, where we examine the effect of new treatment methods on technological solutions and decisions made in the operating room.
For example, collaborating on the effective use of ICT in the operating theaters to optimize workflow and patient flow.

FOR also collaborates with organizations such as the European Association for Endoscopic Surgery (EAES), Society for Minimally Invasive Therapy (SMIT), MedTec Summit Brussels, Norway Health Tech, Nordic Proof, Norwegian Smart Care Cluster, NTNU Technology Transfer AS (TTO) and Trondheim Tech Gate.

Research and development in collaboration with SINTEF

The Operating Room of the Future (FOR) is the arena and infrastructure provider for several ongoing research projects, including many projects in collaboration with SINTEF and NTNU. At SINTEF, FOR, and especially MiDT, collaborates closely with Research Group for Medical Technology and Research Group for Medical Image Analysis, at the SINTEF Digital, Department for Health Research. The Medical Technology group at SINTEF constitutes approximately 15 research scientist, most of them are working on or in relation to projects at FOR and MiDT (The reesently established National Research Center for Minimally Invasive and Image-Guided Diagnostics and Therapy, at St. Olavs hospital, FOR). The 15 researchers at SINTEF all have PhDs in related fields to medical imaging (ultrasound), medical image analysis and/or image-guided interventions (diagnostics and therapy). Some of them have collaborated with St. Olavs Hospital since 1995, at the time of establishing the previous National Advisory Unit for Ultrasound and Image-Guided Therapy (www.USIGT.org).

SINTEF is a key research partner in the new MiDT center and in FOR. Thomas Langø at SINTEF/St. Olavs hospital was leading the former USIGT-part of MiDT and was also previously the coordinator for USIGT. The new MiDT is a merging of three previous national advisory units. In addition to USIGT, fMRI (National Advisory Unit for Functional MR Imaging) and NSALK (the National Advisory Unit for Advanced Laparoscopic Surgery) are part of the new center, from 2023 organized under Center for Medical Devices, Technology and Innovation (previously FOR) at St. Olavs hospital.

SINTEF carries out many projects in collaboration with FOR, i.e., using it as an arena for a number of clinical and technological research projects, development and innovation projects, ranging from technology development, prototyping and clinical trials / studies of new solutions to improve patient care. In 2023 there were more than ten PhD projects in progress at different clinics and at SINTEF/NTNU within the field of medical image analysis and minimally invasive diagnostics and therapy. 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, investigating the problem from both a clinical and a technological perspective. There were published about 20 scientific papers with peer review were published at USIGT (now MIDT) in 2023, and some from projects were conducted at FOR, St. Olavs hospital.

Through several user-driven projects supported by the Research Council and EU, the collaborative group at SINTEF / St. Olavs hospital / NTNU unit has been an important competence environment for innovation and industrial cooperation in the field of medical technology. 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 center. Through participation in several EU projects like the previous (finished) VECTOR, IIIOS, FUSIMO, MISTELA, RASIMAS, TRANS-FUSIMO, HiPerNav, and currently (2023) on-going projects like IDEAR, MIREIA, and MEDITATE, 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.

The new MIDT research center focuses on competence fields built up in the previous national advisory units. In the description from the Ministry of Health and Care Services in Norway, the fields of focus for the new MiDT center are:

- minimally invasive therapy and allied technologies
- medical imaging, focus on ultrasound and MRI
- image analysis, including artifical intelligence
- image-guided diagnostics, therapy, intervention, including robotics
- technology enhanced learning (simulator based training)

The clinical areas of focus are vascular surgery, endovascular treatment, neurosurgery, laparoscopic and flexible endoscopic surgery, pulmonary medicine and radiology/urology. In addition to the use of ultrasound, navigation, visualization, image analysis using deep learning techniques (artificial intelligence) and decision support are also important fields of research in the center and carried out in collaboration with SINTEF / NTNU.

Software research platforms like CustusX and FAST, developed and maintained by SINTEF/NTNU, are available as open-source software packages (at: www.CustusX.org and fast.eriksmistad.no) to the research community. Through collaboration in NorMIT with the Interventional Centre at the National hospital in Oslo, these platforms are expanded with the planning

and intraoperative guidance software platform of NorMIT (www.normit.no). The purpose is to make the diagnosis better and the treatment safer and more targeted. These platforms are disseminated nationally through the NorMIT infrastructure and internationally as open-source software 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 the planning phase) 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 research center MiDT is a good example of how St. Olavs hospital and SINTEF in close collaboration can support research, development and testing of new medical technology and methods, while strengthening national and international cooperation, including industry. In addition, MiDT 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
Chief Scientist, Medical Technology
Dept. Health Research, SINTEF
and Center for Medical Devices, Technology and Innovation, St. Olavs hospital
Photo: SINTEF

Bachelor degrees completed in 2023

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

Alganesh L Tesfagergis, Heide Thorsen	**To what extent do healthcare personnel comply the surgical handwashing procedure?**
Marit Lufall, Ane Lundestad	**To what extent do nurses at a gynecological department experience to have sufficient knowledge and care in dealing with women who undergo induced abortion?**
Hedda T Pedersen, Ronja A I Sivertsen	**Abortion Care—Women need a new and better one follow-up from the specialist healt service**
Elise H Høvik, Guro Myrset	**How do nurses prevent hypothermia preoperatively in patients who are being prepared for elective intervensions?**
Astrid K Skaarberg Holen, Emma K Heimgård	**How do nurses experience the encounter with patients with endometriosis?**

Fra venstre: Alganesh L Tesfagergis, Heide Thorsen, Marit Lufall, Ane Lundestad, Hedda T Pedersen

Fra venstre: Ronja A I Sivertsen, Elise H Høvik, Guro Myrset, Astrid K Holen, Emma K Heimgård

Hege Grytten, Paulius Liachovas and Tora Aasheim Nymark
Project title: Improvement of Continuous Larynx Examination test equipment.

Mechanical engineering students, Hege Grytten, Paulius Liachovas and Tora Aasheim Nymark, at NTNU Trondheim collaborated with FOR and St. Olavs Hospital during fall 2023, while writing a bachelor thesis focusing on improving and developing a standard test equipment for Continouous Larynx Examination (CLE) test for the ENT department. CLE tests are used to confirm if a patient shows signs of Exercise Induced Laryngeal Obstruction (EILO). EILO is a condition that affects many young adults, both professional athletes and young adults that want to live an active life. With EILO one experiences difficulty breathing and impaired performance during high intensity exercise.

Hege Grytten, Paulius Liachovas and Tora Aasheim Nymark
Photo: Sara Edvardsen

The current testing procedure used to diagnose EILO involves using a medical camera inserted into the nasal cavity during exercise, most commonly on a treadmill. Both the physicians at St.Olavs Hospital and patients expressed the need for improvement of the test set-up, and explained that the current equipment is too heavy, unreliable for diagnosis, and uncomfortable for the patient. The goal of the thesis was to develop a new test set-up with equipment that is optimized for this test and eliminates these cons. During the thesis, a prototype for a new set-up was developed, it performed well in tests and received good feedback from the physicians. The collaboration has continued past the course of the thesis, and the group is now working on making the equipment accessible for all ENT clinics.

PhD degrees - Ongoing

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

Innomet is a research group based at St. Olavs 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 has been usedin 10 patients with headache pains using transnasal access under the anesthesia.Endoscopic block of the sphenpalatine ganglion is investigated 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 in patients with 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, PhD candidate SINTEF/NTNU

Javier Pérez de Frutos
Photo: SINTEF

Javier defended his PhD successfully in December 2023. He worked on a PhD project with the title: “Intraoperative registration techniques for improved ultrasound-based navigation in laparoscopic soft tissue surgery.” It was a technological PhD linked to the HiPerNav EU project (an ITN project under the MSCA program). Oslo University Hospital coordinated the project and among the partners were SINTEF and NTNU. In Trondheim the project overlapped and was linked to the Laparoscopy project at MiDT research center, St. Olavs hospital, where Javier together with a fellow PhD at the Intervention Center in Oslo used one of the Future ORs at St. Olavs hospital for on of their studies.

Erik Nypan
Three-Dimensional Visualization and Navigation in Endovascular Procedures

Photo: Private

Abdominal aortic aneurysm (AAA) can be treated minimally invasively by inserting a stent graft endovascularly. However, this endovascular treatment may not be possible for all aneurysms, depending on the patient's anatomy. In more complex cases, advanced stent grafts that allow for fenestrations or branches to be deployed through the graft are now available. In recent years, image fusion has been introduced, which allows high-definition pre-operative imaging to be used during the procedure. The goal of this PhD project is to improve endovascular navigation in aortic procedures, potentially enabling more patients to be treated using endovascular methods. This could also lead to a reduction in x-ray radiation and the use of contrast media, which can be harmful to the kidneys. The project includes several sub-studies conducted on phantoms, animal models, and in patients. Three papers have been published as part of the project, and it is expected to be completed with the submission of a doctoral thesis in 2024.

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

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Arne Kildahl-Andersen
PET and advanced ultrasound in navigated bronchoscopy

Photo: Private

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. Olavs 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

Øyvind Ervik
Improved ultrasound solutions and AI analytics in endobronchial ultrasound (EBUS)

Foto: Thomas Langø

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. Olavs hospital. The group has long track record with electromagnetic navigation integrated in the bronchoscope. Together with the project group, Øyvind will continue to work on ultrasound bronchoscopy and AI analysis to develop both better ultrasound and AI real time analysis of EBUS images.

Main supervisor: Hanne Sorger, Levanger hospital and NTNU
Øyvind Ervik.

Masab Khalid Annaqeeb
Simulation of Energy/related Occupant Behavior in Buildings

Masab Khalid Annaqeeb
Photo: NTNU

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. The collected data is being used to develop databases, and agent-based models to simulate OB in buildings.
Supervisor: Prof. Guangyu Cao

Yang Bi
"Energy efficient airflow distribution methods for surgical microenvironment control in operating rooms".

Yang Bi
Photo: Private

The design of indoor air distribution system of operating rooms (OR) is a complex task due to the strict requirements of indoor environment parameters on which there is no global consensus.The purpose of this PhD project is to explore energy efficient indoor environment control and airflow distribution methods enabling safe surgical microenvironment in ORs.

To achieve this goal, many tasks should be accomplished. Firstly, an evaluation system should be established to help designers directly evaluate the comprehensive effect of air distribution systems in ORs. Secondly, a well-performed air distribution system in ORs should be developed, optimized, and validated. Finally, a new model/tool of virtual reality should be developed to visualize the indoor environment together with St. Olavs Hospital.

The main method of the research is the combination of simulation and experiments. The experiments will be carried out in the laboratory of NTNU and a real OR of St Olavs Hospital. CFD simulations will be performed for validation and optimization of the air distribution system.
The results of this study will provide a solid scientific basis for ventilation design in ORs. Visualization tools will help designers better analyze CFD results.
Supervisor: Prof. Guangyu Cao

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 scientific career, possibly in parallel 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, a research programme was established at all four medical faculties in Norway, based on the intention to recruit more medical students to research, improving the organization of research education, and promoting scientific attitude for the practise of medicine.

Håvard Ulsaker
As of 2023, the student research project was defended and completed. From 2024 the project will continue towards a PhD. In the project we performed a national multicenter study to assess patients that were 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 has made it possible to treat TAAAs with an endovascular approach. In the study we assessed 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 are compared with that of open repair patients.

We also conducted a study in which we compared outcomes in patients treated with the t-Branch and custom-made devices (CMDs) at St. Olavs Hospital. The t-Branch is a standard off-the-shelf stent graft system suitable in 60-70% of TAAAs, while CMDs are patient specific to suit individual patient's aortic and visceral vessel anatomy. The study showed low 30-day mortality, acceptable technical success rates, high medium-term survival, and no significant differences in clinically relevant outcomes between t-Branch and CMD patients.

Main supervisor: Frode Manstad-Hulaas
Assistant supervisors: Reidar Brekken and Arne Seternes


Håvard Ulsaker
Photo: Norsk medisinstudentforening

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.

ELSYS Hackathon

This year, FOR was contacted by students from the programme Electronic Systems Design and Innovation (ELSYS) and the Innovation Manager from NTNU's Department of Electronic Systems. As engineering students are showing a great interest for medical technology and innovation, we together hosted an event dedicated to this subject. The event was named "ELSYS Hackathon – High Tech to Granny", with focus on how technology could pose solutions to problems regarding healthcare and the continuously growing older population. In just two days (4.-5.February) the participating students had to find issues relevant to the ageing population, and develop technological solutions. The solution had to build on the tools available to them: smart, wireless electronics and sensors. A total number of 42 students participated in the hackathon, with backgrounds in electronics, cybernetics, cyber security and data communication, physics and mathematics, industrial design and medicine.

To get insight into challenging problems the hospital faces due to the aging population, we brought on senior physician in orthopedics – Lars Gunnar Johnsen. By the end of the weekend, the students developed technology for proactive healthcare. Involving technology that can help elders avoid hip fractures by training their balance, technology to improve the blood circulation in legs, technology to avoid pressure ulcers, and technology that allows for easier ways to call for help if an accident occurs. To sum it up, all groups focused on how technology could help elders master a lifestyle that allow them to live a healthy life at home for a longer period. Such solutions could help reduce the issue of overloaded hospitals and nursing homes.

42 enthusiastic engineering students after a weekend with ELSYS Hackathon – High Tech to Granny.
Photo: Erik Wessel-Berg, NTNU.

The effects of tourniquet on muscle strength and function in patients operated on 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 to minimize hemorrhage, may have impact on pain and physical function. Whether TKA surgery should be performed with or without the use of tourniquet, is a controversial 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. no tourniquet on pain, muscle strength and function. The results from the project might 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 survival after TKA using the Persona total knee system. All patients have been included in the study.
The study is initiated by Zimmer Biomet.

Posired

The laboratory used in the project is designed as an operating room, with technology and equipment that make it possible to visualize ventilation currents and particles in the air, as well as stereo cameras that record the movement patterns of the healthcare personnel. An XR tool (augmented reality) is being built that captures the interaction between the movements of the healthcare personnel, virtual air currents and the distribution of particles in the room.

An important part of the solution is to eliminate airborne contamination from outside the operating room. Norconsult has solved this by designing and building a special airlock, which the operating team must pass to enter the operating theatre. They then have to pass a high-speed air stream, which prevents particles from following the staff into the airlock and further into the operating room. There are mainly four sources of infection that can cause post-operative infections in an operating room, namely the patient himself, operating staff, instruments and airborne infection that accompanies the staff. With this ventilation lock, the risk of infection from outside the room might be reduced.

Drone project

The Operating Room of the Future ("Fremtidens Operasjonrom", FOR) has collaborated with the NTNU-based drone logistics company Aviant since September 2020. The collaboration led to the first flight from Røros to Trondheim in February 2021, marking the longest autonomous drone flight conducted in Scandinavia (120 KM). The success of the first flight proved the technology feasible and regulations mature and laid the foundation for future work on drone-based logistics in Trøndelag.

The collaboration has resulted in transporting 80 biological samples and over 40 trips by drone from Røros to Trondheim, as well as transporting surgical equipment and consumables. This is the first medical payload flown over such long distances in Norway with a drone. LuftVei has received a lot of media attention, including on NRK Kveldsnytt1. The project has also given Helse-Midt a leading position in using drones in Health-Norway.

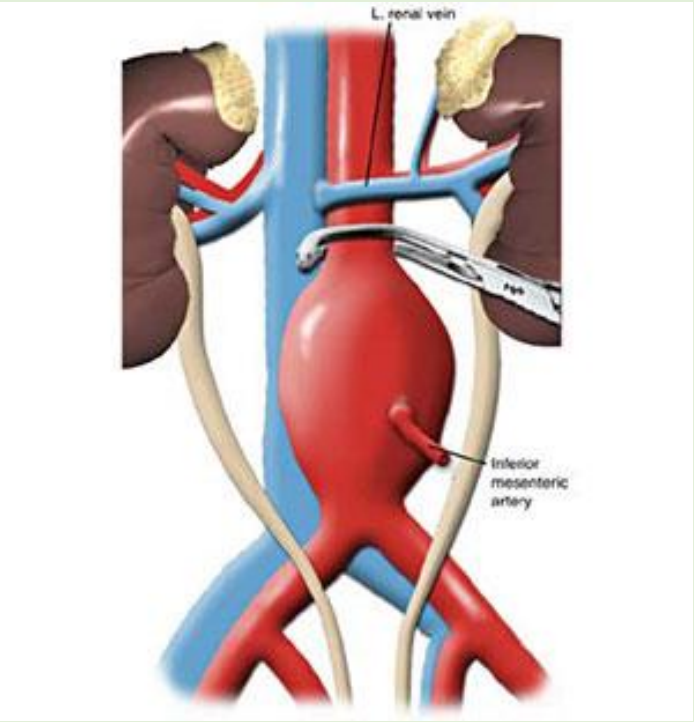
This year's project has demonstrated that drone transport in the health service can improve response times to biological samples because the drones are readily available and are faster than traditional transport alternatives. Thus, the regular test transport by car, which only runs once a day, will no longer represent a bottleneck for the Hospital in Røros. The result of this is a shorter interval from diagnosis to treatment for patients. Shipping of surgical equipment and consumables by drone also helps to increase the availability of resources in hospitals. Drones are a need-based solution that can deliver up to four times faster than alternative transport solutions, in addition to cutting transport costs by 90% and reducing emissions of greenhouse gases by 95%.

The Aviant team
Photo: Aviant

FOR's experience with drones has thus positioned the Central Norway Regional Health Authority as the leading professional environment within drone logistics in the Norwegian healthcare sector. The projects have proven that the technology is mature, and regulations open up for more advanced use cases with drones. The project has also documented the negative and positive impacts of using this new transport medium.

Building on the results and insights from previous years, the drone project tested two new use cases within the healthcare sector: (1) support the home care service in Nordre-Land with logistics to help them tackle the large demand, and (2) transport of blood samples from islands to labs outside of Gothenburg in Sweden. Both projects proved the drone's unique ability to offload current manual transport processes and ensure a more efficient healthcare sector. This is especially true for the homecare service, which is facing several challenges in Scandinavia with the elderly wave and lack of capacity to take care of them. In September and October 2024, Røros municipality will build upon these results and test autonomous drone transportation to support the local home care service.

Challenge ischemia during aortic surgery



During open aortic surgery an inevitable step is to clamp the aorta. The consequences are a reduced perfusion distally until the artificial aortic graft is in place and the peripheral circulation is reestablished. The are many physiological consequences of the ischemia- reperfusion injury. Examples thereof are: Free radical formation, platelet aggregation, cell mediated damage, neutrophil infiltration and accumulation. Clinically it is seen as reduced Cardio-pulmonary capacity with extended hospital stays and rehabilitation.

FOR has done several experiments in a porcine model to try to overcome the above drawbacks. The project has been led by Dr Linn Nyrønning, the leader of the Department of Vascular Surgery at St Olavs University Hospital Dr Frode Aasgaard and Professor Erney Mattsson. The project also has a tight collaboration with “Mittuniversitetet” in Östersund, Sweden.

The project has been followed with observations in humans of the ischemia- reperfusion situation during aortic surgery. A new version of this big operation will hopefully be in place during 2025. The project includes devices to be patented. Additional information will be given through FOR and its different channels

Photo: Erney Mattsson

Day surgery and robot-assisted surgery at Kristiansund Hospital

Advances in surgical technique, implants and pain control mean that many patients can have prosthetic surgery performed just as safely and with just as good quality without having to spend the night in hospital(1).

Day surgery and robot-assisted systems/artificial intelligence can contribute to less invasive and more precise surgery, thereby providing shorter hospital stays and faster convalescence with positive patient-related and socio-economic consequences.

The introduction of robotic surgery, and artificial intelligence throughout the entire course of treatment, will generate research projects (master's degree, PhD) that will contribute to increased knowledge and more personalized treatment and follow-up. FOR has held the role as coordinating link and primary contact for collaboration partners in industry and expertise environments in order to be able to establish robot-assisted prosthetic surgery as a sub-project with the simultaneous introduction of day surgery at the orthopedic department at Kristiansund Hospital.
In 2023, it was decided to enter into an agreement with Zimmer Biomet, which will make the robotic system ROSA available for the implementation of a clinical study that will compare functional and mechanical adjustment in knee replacement surgery. The system was installed at the hospital in autumn 2023, and it is planned to start the study in spring 2024. The study will be conducted in a PhD race. The person responsible for the study is Frank-David Øhrn (MD, PhD), consultant and spesialist in orthopedic surgery at Kristiansund hospital.

Wignadasan W, Haddad FS. Day-case hip and knee arthroplasty: stages of care and the development of an institutional pathway. Br J Hosp Med (Lond). 2023;84(12):1-11.

Gait Analysis, Stair Performance and Micromotion on Radiostereometric Analysis in Robotic Assisted Total Knee Arthroplasty Surgery comparing Bicruciate-retaining versus Cruciate-retaining implants. A single centre patient-blinded randomized controlled trial.

We are preparing for a randomized controlled clinical trial intended to compare walking function and movement of the prosthesis after robot-assisted knee replacement surgery with two knee replacement designs;

One prosthesis is preserving the anterior cruciate ligament (Smith+Nephew Journey II XR) and the other is sacrifizing the anterior cruciate ligament (Smith+Nephew Jourrney II CR). It is common for the anterior cruciate ligament to be removed during knee replacement surgery. There is speculation whether this could weakens the balance in the operated knee and whether this can explain some of the problems that up to 20% experience after knee replacement surgery, and preservation of the anterior cruciate ligament during knee arthroplasty, should in theory provide a more natural movement and better balance in the operated knee, and this in turn could provide increased patient satisfaction.

Previous studies have shown that knee replacement surgery where the anterior cruciate ligament is preserved has an increased incidence of per- and postoperative complications and reduced implant survival. Robot assisted navigation in knee arthroplasty surgery has shown the possibility of increased precision and accuracy when implanting the knee prostheses. This might provide increased satisfaction when performing elective knee prosthetic surgery with robotic assistance and at the same time preserving the anterior cruciate ligament without an increased risk of complications.

In this study, postoperative function will be assessed by exploring whether the walking pattern has normalized. The study will also compare the movement of the prosthetic components over time in relation to the skeleton using a CT based micromotion analysis method(CT-RSA)

From left: Rune Unander, Product specialist from Smith+Nephew, Stine Thonstad, Surgical nurse, Åsgerd Liberg, Section manager nursing, Tarje Egeberg, Ortopedic surgeon, Anders Sjøstrøm, Ortopedic surgeon.
Photo: St. Olav

Scientific articles 2023

Scientific peer reviewed journal papers from MiDT research center, 2023:

1. Altreuther M, Seternes A, Saltnes T; Myrbø N; Kristin Krangsås Vikan, M Sc; Linn Hege Nilsen, PhD; Tingting Feng. Antithrombotic and Lipid Lowering Therapy is Associated With Improved Survival After Vascular Surgery: A Population Based Study From Norway. Eur J Vasc Endovasc Surg. 2023 Oct 20: S1078- 5884(23)00864-X. doi: 10.1016/j.ejvs.2023.10.019. Online ahead of print. PMID: 37866794
2. Belgau Ingrid. Johnsen Gjermund. Græslie Hallvard. Mårvik Ronald. Nymo Siren. Bjerkan Kirsti. Hyldmo Åsne. Klöckner Christian. Kulseng Bård. Hoff Dag. Sandvik Jorunn. Frequency of cholelithiasis in need of surgical or endoscopic treatment a decade or more after Roux-en-Y gastric bypass. Surgical endoscopy. 2023
3. Bjerkan Kirsti K. Sandvik Jorunn. Nymo Siren. Græslie Halvor. Johnsen Gjermund. Mårvik Ronald. Hyldmo Åsne A. Kulseng Bård Eirik. Sommerseth Sandra. Høydal Kjetil Laurits. Hoff Dag Arne L. Vitamin and Mineral Deficiency 12 Years After Roux-en-Y Gastric Bypass a Cross-Sectional Multicenter Study. Obesity surgery. 2023
4. Boen R, Kaufmann T, van der Meer D, Frei O, Agartz I, Ames D, Andersson M, Armstrong NJ, Artiges E, Atkins JR, Bauer J, Benedetti F, Boomsma DI, Brodaty H, Brosch K, Buckner RL, Cairns MJ, Calhoun V, Caspers S, Cichon S, Corvin AP, Crespo-Facorro B, Dannlowski U, David FS, de Geus EJC, de Zubicaray GI, Desrivières S, Doherty JL, Donohoe G, Ehrlich S, Eising E, Espeseth T, Fisher SE, Forstner AJ, Fortaner-Uyà L, Frouin V, Fukunaga M, Ge T, Glahn DC, Goltermann J, Grabe HJ, Green MJ, Groenewold NA, Grotegerd D, Grøntvedt GR, Hahn T, Hashimoto R, Hehir-Kwa JY, Henskens FA, Holmes AJ, Håberg AK, Haavik J, Jacquemont S, Jansen A, Jockwitz C, Jönsson EG, Kikuchi M, Kircher T, Kumar K, Le Hellard S, Leu C, Linden DE, Liu J, Loughnan R, Mather KA, McMahon KL, McRae AF, Medland SE, Meinert S, Moreau CA, Morris DW, Mowry BJ, Mühleisen TW, Nenadić I, Nöthen MM, Nyberg L, Ophoff RA, Owen MJ, Pantelis C, Paolini M, Paus T, Pausova Z, Persson K, Quidé Y, Marques TR, Sachdev PS, Sando SB, Schall U, Scott RJ, Selbæk G, Shumskaya E, Silva AI, Sisodiya SM, Stein F, Stein DJ, Straube B, Streit F, Strike LT, Teumer A, Teutenberg L, Thalamuthu A, Tooney PA, Tordesillas-Gutierrez D, Trollor JN. Biol Psychiatry. 2024 Jan 15;95(2):147-160. doi: 10.1016/j.biopsych.2023.08.018. Epub 2023 Sep 3.PMID: 37661008 Beyond the Global Brain Differences: Intraindividual Variability Differences in 1q21.1 Distal and 15q11.2 BP1-BP2 Deletion Carriers.
5. Bouget David. Alsinan Demah. Gaitan Valeria. Helland Ragnhild Holden. Pedersen André. Solheim Ole. Reinertsen Ingerid. Raidionics: an open software for pre- and postoperative central nervous system tumor segmentation and standardized reporting. Scientific reports. 2023
6. Carstam L, Latini F, Solheim O, Bartek J Jr, Pedersen LK, Zetterling M, Beniaminov S, Sjåvik K, Ryttlefors M, Jensdottir M, Rydenhag B, Smits A, Jakola AS. J Long-term follow up of patients with WHO grade 2 oligodendroglioma. Neurooncol 2023. PMID: 37603235
7. Cepeda S, Luppino LT, Pérez-Núñez A, Solheim O, García-García S, Velasco-Casares M, Karlberg A, Eikenes L, Sarabia R, Arrese I, Zamora T, Gonzalez P, Jiménez-Roldán L, Kuttner S.Cancers (Basel). 2023 Mar 22;15(6):1894. doi: 10.3390/cancers15061894.PMID: 36980783 Predicting Regions of Local Recurrence in Glioblastomas Using Voxel-Based Radiomic Features of Multiparametric Postoperative MRI.
8. Eikenes L, Visser E, Vangberg T, Håberg AK.Hum Brain Mapp. 2023 Feb 1;44(2):691-709. doi: 10.1002/hbm.26093. Epub 2022 Oct 3.PMID: 36189786 Both brain size and biological sex contribute to variation in white matter microstructure in middle-aged healthy adults.
9. Emendi Monica. Støverud Karen H. Tangen Geir A. Ulsaker Håvard. Manstad-H Frode. Di Giovanni Pierluigi. Dahl Sigrid K. Langø Thomas. Prot Victorien. Prediction of guidewire-induced aortic deformations during EVAR: a finite element and in vitro study. Frontiers in physiology. 2023
10. Groot JM, Miletic S, Isherwood SJS, Tse DHY, Habli S, Håberg AK, Forstmann BU, Bazin PL, Mittner M.J Neurosci. 2023 Sep 27;43(39):6609-6618. doi: 10.1523/JNEUROSCI.1020-23.2023. Epub 2023 Aug 10. PMID: 37562962 Echoes from Intrinsic Connectivity Networks in the Subcortex.
11. Hara Sozaburo. Andresen Hege. Solheim Ole. Carlsen Sven M. Jakola Asgeir S. Salvesen Øyvind O. Gulati Sasha. Six-Month Follow-up of a Trial of Spinal Cord Burst Stimulation vs Placebo Stimulation and Disability in Patients With Chronic Radicular Pain After Lumbar Spine Surgery. JAMA, Jun 13;329(22):1985-1986, 2023. PMID: 37314281.
12. Haram S, Andresen H, Solheim O, Carlsen SM, Jakola AS, Salvesen ØO, Gulati S. Six-Month Follow-up of a Trial of Spinal Cord Burst Stimulation vs Placebo Stimulation and Disability in Patients With Chronic Radicular Pain After Lumbar Spine Surgery. JAMA. 2023. PMID: 37314281
13. Haram Margrete. Hansen Rune. Bouget David. Myhre Ola Finneng. Davies Catharina de Lange. Hofsli Eva. Treatment of Liver Metastases With Focused Ultrasound and Microbubbles in Patients With Colorectal Cancer Receiving Chemotherapy. Ultrasound in medicine & biology. 2023
14. Helland Ragnhild Holden. Ferles Alexandros. Pedersen André. Kommers Ivar. Ardon Hilko. Barkhof Frederik. Bello Lorenzo. Berger Mitchel S. Dunås Tora. Nibali Marco Conti. Furtner Julia. Hervey-Jumper Shawn. Idema Albert J S. Kiesel Barbara. Tewari Rishi Nandoe. Mandonnet Emmanuel. Müller Domenique M J. Robe Pierre A. Rossi Marco. Sagberg Lisa M. Sciortino Tommaso. Aalders Tom. Wagemakers Michiel. Widhalm Georg. Witte Marnix G.

Zwinderman Aeilko H. Majewska Paulina L. Jakola Asgeir S. Solheim Ole. Hamer Philip C De Witt. Reinertsen Ingerid. Eijgelaar Roelant S. Bouget David. Segmentation of glioblastomas in early post-operative multi-modal MRI with deep neural networks. Scientific reports. 2023

15. Hering Alessa. Hansen Lasse. Mok Tony C W. Chung Albert C S. Siebert Hanna. Hager Stephanie. Lange Annkristin. Kuckertz Sven. Heldmann Stefan. Shao Wei. Vesal Sulaiman. Rusu Mirabela. Sonn Geoffrey. Estienne Theo. Vakalopoulou Maria. Han Luyi. Huang Yunzhi. Yap Pew-Thian. Brudfors Mikael. Balbastre Yael. Joutard Samuel. Modat Marc. Lifshitz Gal. Raviv Dan. Lv Jinxin. Li Qiang. Jaouen Vincent. Visvikis Dimitris. Fourcade Constance. Rubeaux Mathieu. Pan Wentao. Xu Zhe. Jian Bailiang. De Benetti Francesca. Wodzinski Marek. Gunnarsson Niklas. Sjolund Jens. Grzech Daniel. Qiu Huaqi. Li Zeju. Thorley Alexander. Duan Jinming. Grosbrohmer Christoph. Hoopes Andrew. Reinertsen Ingerid. Xiao Yiming. Landman Bennett. Huo Yuankai. Murphy Keelin. Lessmann Nikolas. van Ginneken Bram. Dalca Adrian V. Heinrich Mattias P. Learn2Reg: Comprehensive Multi-Task Medical Image Registration Challenge, Dataset and Evaluation in the Era of Deep Learning. IEEE transactions on medical imaging. 2023
16. Hervey-Jumper SL, Zhang Y, Phillips JJ, Morshed RA, Young JS, McCoy L, Lafontaine M, Luks T, Ammanuel S, Kakaizada S, Egladyous A, Gogos A, Villanueva-Meyer J, Shai A, Warrier G, Rice T, Crane J, Wrensch M, Wiencke JK, Daras M, Oberheim Bush NA, Taylor JW, Butowski N, Clarke J, Chang S, Chang E, Aghi M, Theodosopoulos P, McDermott M, Jakola AS, Kavouridis VK, Nawabi N, Solheim O, Smith T, Berger MS, Molinaro AM Interactive Effects of Molecular, Therapeutic, and Patient Factors on Outcome of Diffuse Low-Grade Glioma. . J Clin Oncol. 2023. PMID: 36599113
17. Hindenes LB, Ingebrigtsen T, Isaksen JG, Håberg AK, Johnsen LH, Herder M, Mathiesen EB, Vangberg TR.J Neurol Sci. 2023 Sep 15;452:120740. doi: 10.1016/j.jns.2023.120740. Epub 2023 Jul 25.PMID: 37517271 Anatomical variations in the circle of Willis are associated with increased odds of intracranial aneurysms: The Tromsø study. PMID: 37517271
18. Ingvaldsen SH, Hansen TI, Håberg AK, Moholdt V, Evensen KAI, Dammann O, Austeng D, Morken TS.Acta Paediatr. 2023 Apr;112(4):753-761. doi: 10.1111/apa.16667. Epub 2023 Jan 19.PMID: 36627478 Visual function correlates with neurodevelopment in a population cohort of school-aged children born extremely preterm. PMID: 36627478
19. Isherwood SJS, Bazin PL, Miletić S, Stevenson NR, Trutti AC, Tse DHY, Heathcote A, Matzke D, Innes RJ, Habli S, Sokołowski DR, Alkemade A, Håberg AK, Forstmann BU.Neuroimage. 2023 May 1;271:119988. doi: 10.1016/j.neuroimage.2023.119988. Epub 2023 Mar 1.PMID: 36868392 Investigating Intra-Individual Networks of Response Inhibition and Interference Resolution using 7T MRI.
20. Kildahl-Andersen, A., Hofstad, E. F., Sorger, H., Amundsen, T., Langø, T., Leira, H. O., & Kiss, G. H. (2023). Bronchoscopy using a head-mounted mixed reality device—a phantom study and a first in-patient user experience. https://doi.org/10.3389/frvir.2023.940536.
21. Kljajevic V, Evensmoen HR, Sokołowski D, Pani J, Hansen TI, Håberg AK.Memory. 2023 Jul;31(6):831-849. doi: 10.1080/09658211.2023.2203431. Epub 2023 Apr 28.PMID: 37114402 Female advantage in verbal learning revisited: a HUNT study.
22. Lauvsnes ADF, Hansen TI, Ankill SØ, Bae SW, Gråwe RW, Braund TA, Larsen M, Langaas M.JMIR Form Res. 2023 Jun 23;7:e45254. doi: 10.2196/45254.PMID: 37351934 Mobile Assessments of Mood, Cognition, Smartphone-Based Sensor Activity, and Variability in Craving and Substance Use in Patients With Substance Use Disorders in Norway: Prospective Observational Feasibility Study.
23. Majewska P, Sandvei MS, Gulati S, Müller TB, Hara KW, Romundstad PR, Solheim O Return to Work after Surgical Clipping versus Endovascular Treatment of Unruptured Intracranial Aneurysms: A Nationwide Registry-Based Study. . J Vasc Interv Radiol. 2023. PMID: 36739083
24. Mansoor N, Gulati S, Fredriksli OA, Salvesen Ø, Solheim O Epidemiology and practice variations of shunt surgery for hydrocephalus: a nationwide registry-based study. . J Neurosurg. 2023. PMID: 36738458
25. Masoumi Nima. Rivaz Hassan. Hacihaliloglu Ilker. Ahmad M Omair. Reinertsen Ingerid. Xiao Yiming. The Big Bang of Deep Learning in Ultrasound-Guided Surgery: A Review. IEEE transactions on ultrasonics, ferroelectrics, and frequency control. 2023
26. Näslund Olivia. Strand Per Sveino. Solheim Ole. Al Masri Mohammad. Rapi Okizeva. Thurin Erik. Jakola Asgeir S. Incidence, management, and outcome of incidental meningioma: what has happened in 10 years? Journal of neuro-oncology. 2023
27. Näslund O, Strand PS, Skoglund T, Solheim O, Jakola AS Overview and recent advances in incidental meningioma. Expert Rev Anticancer Ther. 2023. PMID: 36951191
28. Nilsson K. Klevebro F. Sunde B. Rouvelas I. Lindblad M. Szabo E. Halldestam I. Smedh U. Wallner B. Johansson J. Johnsen G. Aahlin E K. Johannessen H-O. Alexandersson von Döbeln G. Hjortland G O. Wang N. Shang Y. Borg D. Quaas A. Bartella I. Bruns C. Schröder W. Nilsson M. Oncological outcomes of standard versus prolonged time to surgery after neoadjuvant chemoradiotherapy for oesophageal cancer in the multicentre, randomised, controlled NeoRes II trial. Annals of oncology : official journal of the European Society for Medical Oncology. 2023

29. Nymo Siren, Lundanes Julianne, Eriksen Kevin, Aukan Marthe, Rehfeld Jens Fredrik, Holst Jens Juul, Johnsen Gjermund, Græslie Hallvard, Kulseng Bård, Sandvik Jorunn, Martins Catia. Suboptimal weight loss thirteen years after Roux-en-Y gastric bypass is associated with blunted appetite response. Obesity Surgery, online. 2023
30. Pérez de Frutos Javier. Pedersen André. Pelanis Egidijus. Bouget David. Survarachakan Shanmugapriya. Langø Thomas. Elle Ole-Jakob. Lindseth Frank. Learning deep abdominal CT registration through adaptive loss weighting and synthetic data generation. PloS one. 2023
31. Reitlo LS, Mihailovic JM, Stensvold D, Wisløff U, Hyder F, Håberg AK.Geroscience. 2023 Jun;45(3):1667-1685. doi: 10.1007/s11357-022-00719-9. Epub 2023 Jan 10.PMID: 36626020 Hippocampal neurochemicals are associated with exercise group and intensity, psychological health, and general cognition in older adults.
32. Rimol LM, Rise HH, Evensen KAI, Yendiki A, Løhaugen GC, Indredavik MS, Brubakk AM, Bjuland KJ, Eikenes L, Weider S, Håberg A, Skranes J.Neuroimage. 2023 Feb 1;266:119816. doi: 10.1016/j.neuroimage.2022.119816. Epub 2022 Dec 14.PMID: 36528311 Atypical brain structure mediates reduced IQ in young adults born preterm with very low birth weight.
33. Rivaz H, I. Reinertsen and I. Hacihaliloglu, "Guest Editorial A Glimpse Into the Cutting Edge of Interventional Ultrasound," in *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control*, vol. 70, no. 9, pp. 905-908, Sept. 2023, doi: 10.1109/TUFFC.2023.3302608
34. Schei Stine. Sagberg Lisa Millgård. Bø Lars Eirik. Reinertsen Ingerid. Solheim Ole. Association between patient-reported cognitive function and location of glioblastoma. Neurosurgical review. 2023
35. Schipmann-Miletic S, Sivakanesan S, Rath DS, Brandal P, Vik-Mo E, Bjørås M, Solheim O, Ingebrigtsen T, Sund F, Bjerkvig R, Miletic H, Johannessen TA, Sundstrøm T. Glioblastoma in adults. Tidsskr Nor Laegeforen. 2023. PMID: 36718891
36. Siqueira Pinto M, Winzeck S, Kornaropoulos EN, Richter S, Paolella R, Correia MM, Glocker B, Williams G, Vik A, Posti JP, Haberg A, Stenberg J, Guns PJ, den Dekker AJ, Menon DK, Sijbers J, Van Dyck P, Newcombe VFJ.J Neurotrauma. 2023 Jul;40(13-14):1317-1338. doi: 10.1089/neu.2022.0365. Epub 2023 May 18. PMID: 36974359 Use of Support Vector Machines Approach via ComBat Harmonized Diffusion Tensor Imaging for the Diagnosis and Prognosis of Mild Traumatic Brain Injury: A CENTER-TBI Study.
37. Skirbekk V, Bowen CE, Håberg A, Jugessur A, Engdahl B, Bratsberg B, Zotcheva E, Selbæk G, Kohler HP, Weiss J, Harris JR, Tom SE, Krokstad S, Stern Y, Strand BH.J Aging Health. 2023 Aug;35(7-8):543-555. doi: 10.1177/08982643221131926. Epub 2022 Nov 2. PMID: 36321864 Marital Histories and Associations With Later-Life Dementia and Mild Cognitive Impairment Risk in the HUNT4 70+ Study in Norway.
38. Skoie Inger Marie. Skogås Jan Gunnar. Langø Thomas. Myhr Kjell-Morten. Myhre Peder Langeland. Goll Rasmus. Fretland Signe Øien. Helland Åslaug. New centres to carry out more clinical trials in Norway. Tidsskrift for den Norske laegeforening : tidsskrift for praktisk medicin, ny raekke. 2023
39. Smevik H, Habli S, Saksvik SB, Kliem E, Evensmoen HR, Conde V, Petroni A, Asarnow RF, Dennis EL, Eikenes L, Kallestad H, Sand T, Thompson PM, Saksvik-Lehouillier I, Håberg AK, Olsen A. Cereb Cortex. 2023 May 24;33(11):7100-7119. doi: 10.1093/cercor/bhad024. PMID: 36790738 Poorer sleep health is associated with altered brain activation during cognitive control processing in healthy adults.
40. Stenberg J, Skandsen T, Moen KG, Vik A, Eikenes L, Håberg AK.J Neurotrauma. 2023 Mar;40(5-6):457-471. doi: 10.1089/neu.2022.0206. Epub 2022 Dec 9. PMID: 36305387 Diffusion Tensor and Kurtosis Imaging Findings the First Year following Mild Traumatic Brain Injury.
41. Storli Per Even. Dille-Amdam Rachel Genne. Skjærseth Gaute Havik. Gran Mads Vikhammer. Myklebust Tor Åge. Grønbech Jon Erik. Bringeland Erling A. Cumulative incidence of first recurrence after curative treatment of stage I-III colorectal cancer. Competing risk analyses of temporal and anatomic patterns. Acta oncologica (Stockholm, Sweden). Acta Oncol. 2023 Dec;62(12):1822-1830. doi: 10.1080/0284186X.2023.2269644. Epub 2023 Nov 25. PMID: 37862319
42. Strand PS, Wågø KJ, Pedersen A, Reinertsen I, Nälsund O, Jakola AS, Bouget D, Hosainey SA, Sagberg LM, Vanel J, Solheim O. Growth dynamics of untreated meningiomas. Neuro-Oncology Advances. 2023 Dec 20:vdad157. PMID: 38187869
43. Søfteland Eirik Østensen, Aasebøstøl Anne Kristin, Johnsen gjermund, Bringeland Erling Audun. Endoluminal treatment for Zenker's diverticulum - a population-based observational study. Scandinavian Journal of Gastroenterology. 2023
44. Tollefsen SE, Solheim O, Mjønes P, Torp SH. Meningiomas and Somatostatin Analogs: A Systematic Scoping Review on Current Insights and Future Perspectives. Int J Mol Sci. 2023 Mar 1;24(5):4793. doi: 10.3390/ijms24054793. PMID: 36902224
45. Ulsaker Håvard. Lam Mina. Herje Martin Leangen. Seternes Arne. Manstad-Hulaas Frode. A Retrospective Evaluation of Intra-Prosthetic Thrombus Formation After Endovascular Aortic Repair in Cook Zenith Alpha and Medtronic Endurant II Patients. European journal of vascular and endovascular surgery : the official journal of the European Society for Vascular Surgery. 2023
46. Ulsaker H, Martin Herje, Mina Lam, Reidar Brekken, Arne Seternes, Frode Manstad- Hulaas. Intra-prosthetic thrombus formation after endovascular aortic repair in Cook Zenith Alpha and Medtronic Endurant II stent graft

limbs. Eur J Vasc Endovasc Surg. 2023 Nov;66(5):644-651. doi: 10.1016/j.ejvs.2023.05.043. Epub 2023 Jun 5. PMID: 37286099
47. Vikan KK, Arne Seternes, Linn Hege Nilsen, Erik Mulder Pettersen, Martin Altreuther. Peri-Operative Mortality and Survival After Repair of Abdominal Aortic Aneurysm in Advanced Age Patients: A National Study from the Norwegian Registry for Vascular Surgery Focused on Nonagenarians. Eur J Vasc Endovasc Surg. 2023 Sep 29: S1078-5884(23)00801-8. doi: 10.1016/j.ejvs.2023.09.038. Online ahead of print. PMID: 37778499
48. Winther RR, Skovlund E, Andreassen JS, Arvidsson L, Halvardson J, Solheim O, Bartek J, Kaasa S, Hjermstad MJ, Vik-Mo EO. Preoperative Prognostic Index for Patients with Brain Metastases-A Population-Based Multi-Centre Study. Cancers (Basel). 2023 Jun 13;15(12):3174. doi: 10.3390/cancers15123174. PMID: 37370784
49. Werlenius K, Kinhult S, Solheim TS, Magelssen H, Löfgren D, Mudaisi M, Hylin S, Bartek J Jr, Strandéus M, Lindskog M, Rashid HB, Carstam L, Gulati S, Solheim O, Bartek J, Salvesen Ø, Jakola AS. Effect of Disulfiram and Copper Plus Chemotherapy vs Chemotherapy Alone on Survival in Patients With Recurrent Glioblastoma: A Randomized Clinical Trial. JAMA Netw Open. 2023 Mar 1;6(3):e234149. doi: 10.1001/jamanetworkopen.2023.4149. PMID: 37000452
50. Woodrow RE, Winzeck S, Luppi AI, Kelleher-Unger IR, Spindler LRB, Wilson JTL, Newcombe VFJ, Coles JP; CENTER-TBI MRI Substudy Participants and Investigators; Menon DK, Stamatakis EA. Acute thalamic connectivity precedes chronic post-concussive symptoms in mild traumatic brain injury. Brain. 2023 Aug 1;146(8):3484-3499. doi: 10.1093/brain/awad056. PMID: 36811945
51. Zotcheva E, Bratsberg B, Strand BH, Jugessur A, Engdahl BL, Bowen C, Selbæk G, Kohler HP, Harris JR, Weiss J, Tom SE, Krokstad S, Mekonnen T, Edwin TH, Stern Y, Håberg AK, Skirbekk V.Lancet Reg Health Eur. 2023 Aug 29;34:100721. doi: 10.1016/j.lanepe.2023.100721. eCollection 2023 Nov.PMID: 37927437 Trajectories of occupational physical activity and risk of later-life mild cognitive impairment and dementia: the HUNT4 70+ study.
52. Zotcheva E, Strand BH, Bowen CE, Bratsberg B, Jugessur A, Engdahl BL, Selbaek G, Kohler HP, Harris JR, Weiss J, Grøtting MW, Tom SE, Krokstad S, Stern Y, Håberg AK, Skirbekk V.Int J Geriatr Psychiatry. 2023 Jul;38(7):e5967. doi: 10.1002/gps.5967.PMID: 37475192 Retirement age and disability status as pathways to later-life cognitive impairment: Evidence from the Norwegian HUNT Study linked with Norwegian population registers.

Other publications:

Interaction of thermal plumes from a patient wound with mixing and laminar airflow at different room temperatures in two operating rooms at St. Olav's hospital
Fečer, Tomáš; Morgenstierne, Marina Asuero Von Munthe Af; Bi, Yang; Mathisen, Hans Martin; Harsem, Thorgeir; Stenstad, Liv- Inger; Cao, Guangyu. 2023, REHVA European HVACJournal. STOLAV, NTNU
REHVA Journal Interaction of thermal plumes from a patient wound with mixing and laminar airflow at different room temperatures in two operating rooms at St. Olav's hospital

Poster:
The influence of instrument table position on CFU level in the operating room with laminar airflow
Bi, Yang; Lundøy, Runar; Fečer,Tomáš; Stenstad, Liv- Inger; Edvardsen, Sara; Harsem, Thorgeir; Mathisen, Hans Martin; Skogås, Jan Gunnar; Liu, Yiliu; Cao, Guangyu.2023, Healthy Building 2023 Jul. 16-19, 2023. STOLAV, NTNU

1. Indimath, S., Fiorentini, S., Bøklepp, B.R. et al. Effect of bubble size on ultrasound backscatter from bubble clouds in the context of gas kick detection in boreholes. Sci Rep 13, 11825 (2023). https://doi.org/10.1038/s41598-023-38937-6

2. Stian Solberg, Naseh Amini, Yamen Zaza, Bjørn A. J. Angelsen, Rune Hansen; Estimation of fat content in soft tissues using dual frequency ultrasound—A phantom study. J. Acoust. Soc. Am. 1 March 2023; 153 (3): 1766–1775. https://doi.org/10.1121/10.0017601

Wignadasan W, Haddad FS. Day-case hip and knee arthroplasty: stages of care and the development of an institutional pathway. Br J Hosp Med (Lond). 2023;84(12):1-11.

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. Olavs 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. Costeffective transmissions 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 2023 FOR provided the broadcasting support for 3 workshops arranged by the Gynecology Department at St.Olavs Hospital in collaboration with different suppliers of medical equipment. Gynecology departments from different Norwegian hospitals visited the workshops to learn how St. Olavs Hospital has enabled to perform certain procedures at the out-patient clinic rather than surgically. The combination of live participation and live broadcast has proven to be a good solution for such workshops.
Additionally, FOR supported the Gastrology department in making instruction videos for robotic surgery.

FOR in media

Se innslaget på NRK Midtnytt
Les artikkelen på Norconsults nettsted
Les artikkelen på NTNU's nettsted

Artikkel om samarbeid med Decon-X på nettsiden til Norwegian Smart Care Cluster
Artikkel om senteret på LMIs nettsider 14.12.2022
Artikkel om senteret i Dagens Medisin 1.9.2022

Senterpresentasjon fra NorTrials oppstartsmøte

NorTrials: Stadig flere ønsker å utføre kliniske studier på medisinsk utstyr – må øke kapasiteten

Storsatsingen er i gang: Vil skape en rekke muligheter for industrien

NorTrials Medisinsk utstyr og HealthCatalyst jobber sammen for å forenkle testing av helseteknologi

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