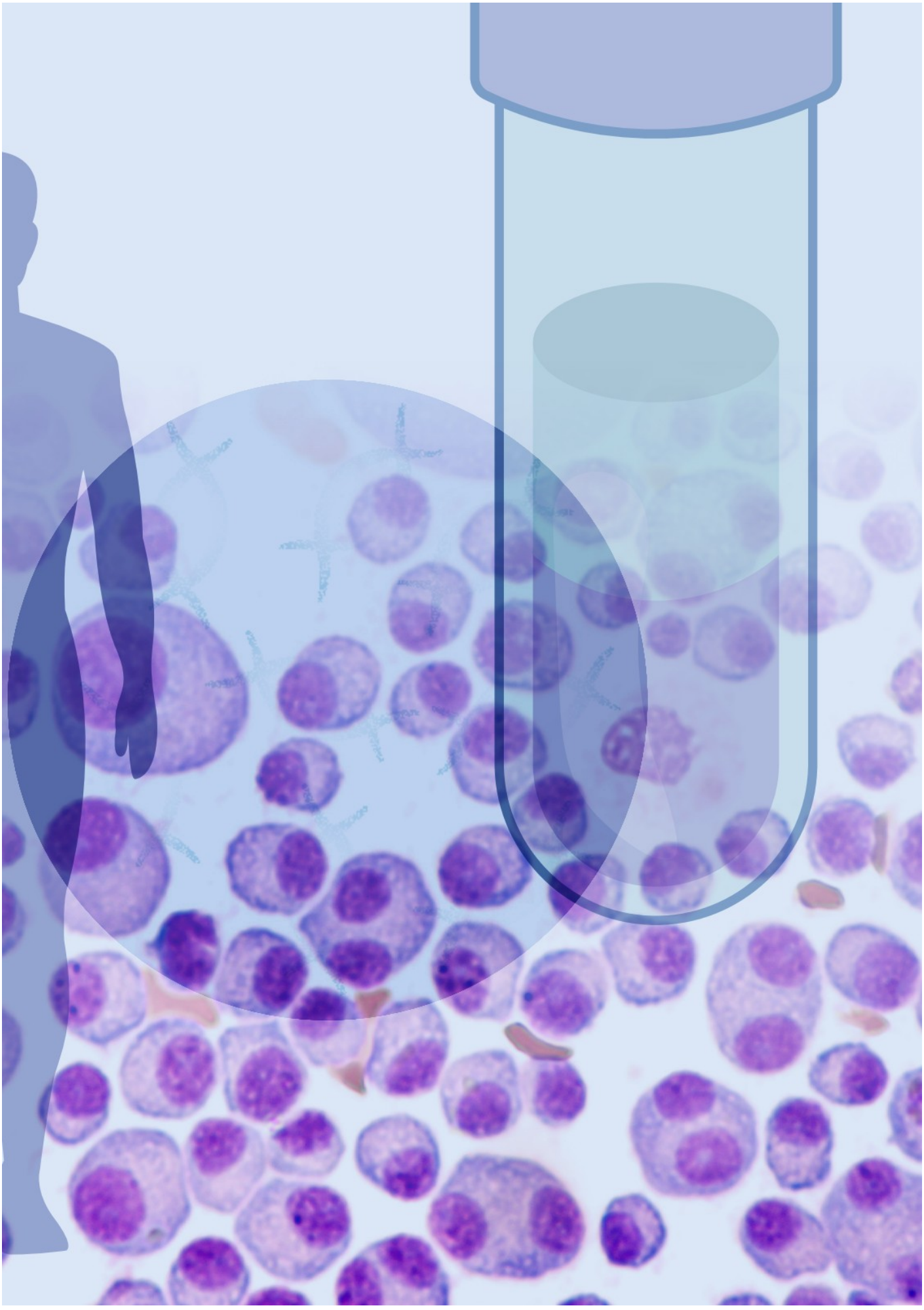
Oslo University Hospital

Comprehensive Cancer Centre

OECI COMPREHENSIVE Cancer Centre

UiO : University of Oslo



Oslo University Hospital Comprehensive Cancer Centre

Oslo University Hospital (OUS) was designated as a European Comprehensive Cancer Centre (CCC) in 2017. This concept, on how to organise a cancer centre within a university hospital, is vital for the consistent delivery of high level quality of care and research within the cancer field. This annual report summarizes some of our recent accomplishments.

The backbone of the Cancer Centre is the cancer programs covering one or a group of cancer diagnoses. These are coordinated by a program management team. A main task for the cancer program management teams are the patient pathways. Other key areas are to deliver updated institutional in-detail treatment guidelines and running clinical trials. I am very happy to report that we last year were able to increase the number of patients recruited to clinical trial to more than 1000 patients, but we aim even higher and to reach 15 % recruitment of our patients to trials.

The single most important outcome measurement in oncology is survival. OUS CCC annually reports relative survival by the cancer programs based on data from the Cancer Registry of Norway. We are pleased to have achieved improved survival rates for most programs compared to previous periods and for some diagnoses world-class results.

As a tertiary referral hospital, OUS has regional and national responsibilities. In 2019 we have extended the concept with regional video-meetings including more programs to strengthen coordination between hospitals and improve patient pathways at a regional level. OUS has struggled with the pathways times and we do not reach the national standards. In 2019, a task force was established and together with other efforts as the regional video-meetings, the pathways times improved during the fall and hopefully this trend will continue in 2020.

Cancer research is a cornerstone for OUS CCC. One third of the publications and more than 50 % of the clinical trials at OUS are in oncology. For the institute part more than 2/3 of the research is external funded and we are dependent on continuous delivery of high-class research for future funding. With this perspective, an important and wanted development is that we are able to compete and get recognised at the top European level and in in 2019 these included both EU Innovation Award ERC and Consolidator Grant to researcher at OUS.

OUS CCC has an ambition to be a leading cancer centre in Europe. A focus for 2020 is to update the institutional cancer strategy from 2016 and to include the planning of the cancer activity in the New OUS. First is building the NEW Radium Hospital (NRH), which will be opened in 2023/24. A NRH will be extremely important for the OUS-CCC and also cancer care in all Norway and will establish The Radium Hospital as the hub for cancer in Norway for the next generation.

Prof. Sigbjørn Smeland MD
Head, Division of Cancer Medicine
Chair, OUS CCC Board

Content

OUS CCC

Patient Treatment

Research

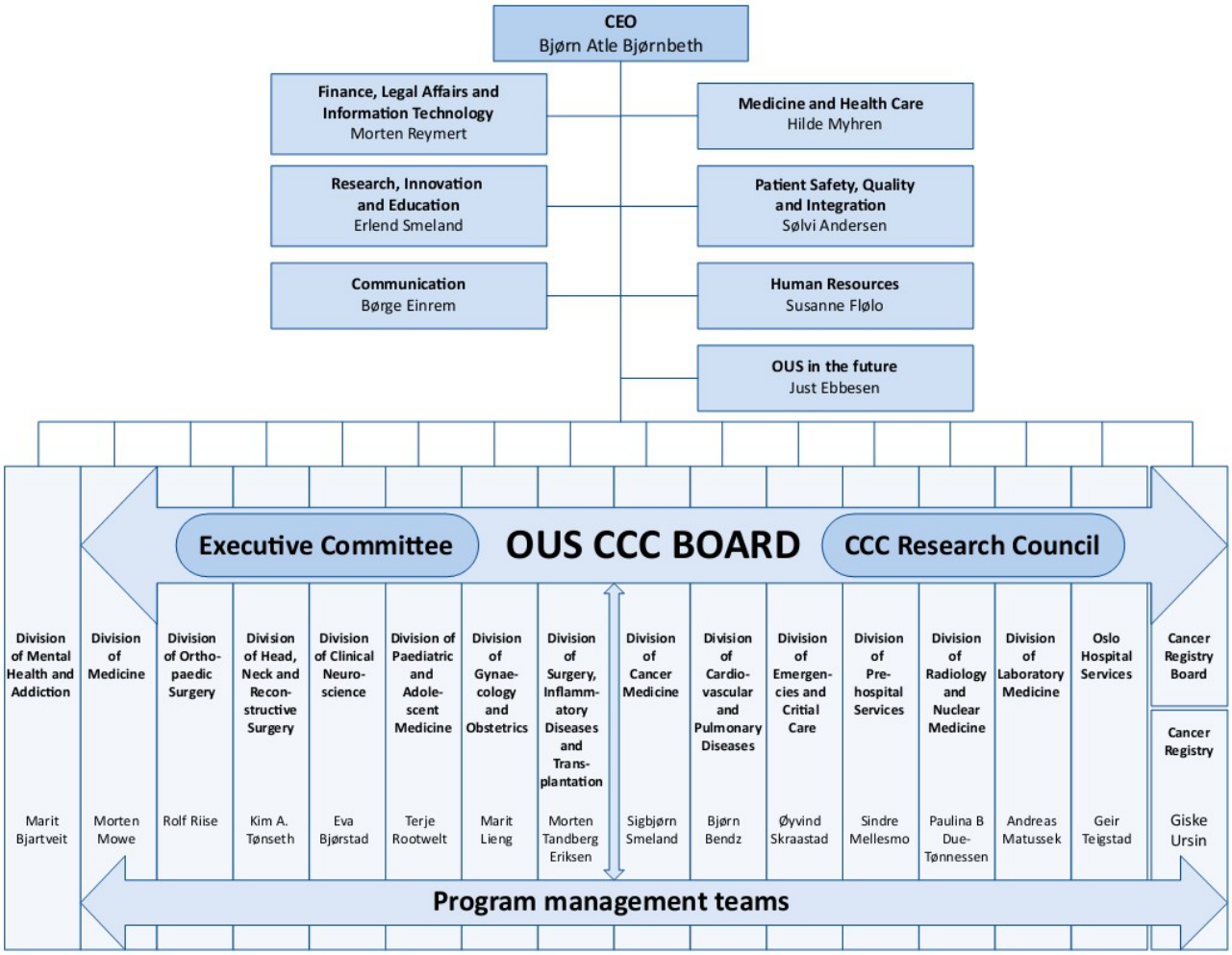
Cancer Strategy

Vision: OUS will be a leading cancer centre in Europe
Mission: We are a complete cancer centre and the hub of Norwegian cancer care.
We are developing the hospital of the future in cooperation with our patients

The OUS Cancer Centre's most important strategic measures from 2017-2022

1. Strengthen the information, education and involvement for patients at all stages in illness
2. Develop standardised pathways for all patient groups
3. Gather the same type of patient treatment in one location in OUS and improve the infrastructure, including new buildings and a proton centre
4. Increase the use of personalised diagnostics as the basis for correct treatment, and to avoid over- and under-treatment
5. Further-develop work-sharing with other hospitals
6. Develop existing and establish new prioritized areas of research with particular international impact fraction or potential
7. Increase the number of clinical studies and patient accrual to trials
8. Establish national and enterprise-based quality registers for all cancer groups
9. Establish IT solutions which facilitate quality improvement and improve patient security, support patient pathways, and support research
10. Increased commitment to primary and secondary prevention of cancer in cooperation with the Cancer Registry
11. Establish institutional governance for the CCC
12. Set the agenda for public discussion of cancer in Norway

OUS Management Structure



Comprehensive Cancer Centre (CCC) Board

The CCC board contributes to strengthening the line managements' power of action across organisational divides and where activities are located. This is strived for by strengthening the overall ability to coordinate work with operational challenges and the development and implementation of the cancer strategy. The work includes diagnostics, treatment, research, care, and rehabilitation.

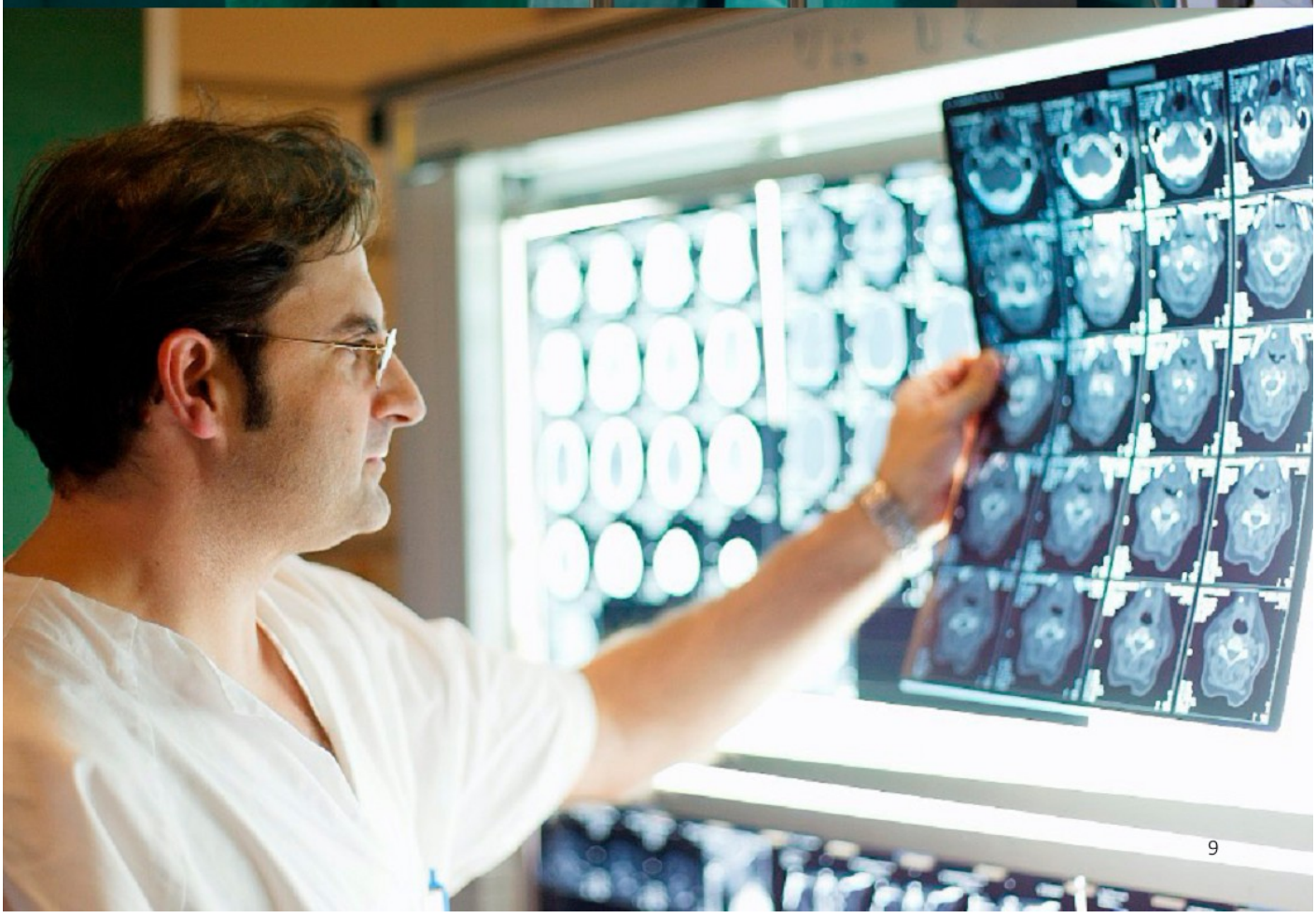
Main focus areas in 2019:

- Cancer patient pathways (CPPs)
- Biobank
- Clinical quality registries
- Dialogues with pathway teams
- Developing the role of cancer coordinators
- Collaboration with other hospitals
- Precision medicine
- Myeloid gene panels
- New Radium Hospital
- Tools for shared decision making
- Cancer competence plans
- Cancer patients pathways home-to-home
- Governance systems focused on cancer

1. Prof. Sigbjørn Smeland MD, Head, Division of Cancer Medicine (Chair)
2. Assoc. Prof. Morten Tandberg Eriksen MD, Head, Division of Surgery, Inflammatory diseases and Transplantation
3. Prof. Andreas Matussek, Head, Division of Laboratory Medicine
4. Paulina Due-Tønnessen MD, Head, Division of Radiology and Nuclear Medicine
5. Hilde Myhren MD, Director of Medicine
6. Elin Henriksen, Head, Department of Gastro- and Paediatric Surgery
7. Prof. Åslaug Helland MD, Head of Research, Division of Cancer
8. Per Magnus Mæhle, Secretary, Division of Cancer Medicine

Executive committee

9. Torill Krøvel, Senior advisor, Staff Division of Surgery, Inflammatory diseases and Transplantation
10. Prof. Giske Ursin, Director, The Cancer Registry of Norway
11. Prof. Geir Tjønnfjord MD, Head, Department of Haematology
12. Prof. Gunnar Sæter MD, Head of Researh, Division of Cancer Medicine
13. Tove Nakken, Head, The OUS Patient Council
14. Erik Rokkones MD, Head, Department of Gynaecological Cancer
15. Prof. Stein Kaasa MD, Head, Department of Oncology
16. Ying Chen MD, Head, Department of pathology
17. Prof. Kjetil Taskén MD, Head, Institute for Cancer Research, Division of Cancer Medicine
18. Prof. Ellen Ruud MD, Head, Department of Paediatric Oncology and Haematology
19. Ole-Jacob Norum, Head, Department of Cancer Orthopaedics
20. Bjørn Wølstad-Knudsen, Union representative, Norwegian Union of Municipal and General Employees
21. Aasmund Bredeli, Union representative, The Norwegian Medical Association
22. Svein Erik Urstrømmen, Union representative, Norwegian Nurses Organisation



CCC Research Council

The CCC Research Council at OUS aims at contributing to comprehensive, optimal use and further development of the OUS potential within the field of cancer research. The scope of the Research Council includes clinical research, translation-research, foundation research and research-based innovation. The Research Council at OUS will work based on specific tasks from the CCC Board at OUS, but have several projects areas with an independent initiative.

Main focus areas in 2019:

- Recruiting patients to clinical studies
- Time for clinicians to do clinical studies
- Translational studies
- Biobank

1. Prof. Gunnar Sæter MD, Head of Research, Division of Cancer Medicine (Chair, till October)
2. Prof. Åslaug Helland MD, Head of Research, Division of Cancer Medicine (Chair, from November)
3. Prof. Tom Hemming Karlsen MD, Head of Research, Division of Surgery, Inflammatory diseases and Transplantation
4. Prof. Kristin Bjordal MD, Head, Department of Research Support, Oslo Hospital Services
5. Prof. Kjetil Taskén MD, Head, Institute for Cancer Research, Division of Cancer Medicine
6. Tove Nakken, Head, The OUS Patient Council
7. Prof. Ellen Ruud MD, Head, Department of Paediatric Oncology and Haematology
8. Prof. Ben Davidson MD, Department of Pathology, Division of Laboratory Medicine
9. Prof. Stein Kaasa MD, Head, Department of Oncology
10. Kristina Kjærheim, Research Department, The Cancer Registry
11. Per Magnus Mæhle, Secretary, Division of Cancer Medicine

Scientific Advisory Board

Prof. Carl-Henrik Heldin, University of Uppsala and Chairman of the Board, The Nobel Institute (Chair)

Prof. Mef Nilbert, Director of Research, Danish Cancer Society, Copenhagen

Prof. Kjeld Schmiegelow, Professor of Paediatrics and Paediatric Oncology, University Hospital Rigshospitalet, Copenhagen

Prof. Jenny Chang-Claude, Division of Cancer Epidemiology, DKFZ Heidelberg

Prof. Fabien Calvo, Chief Scientific Officer, Cancer Core Europe and Institut Gustave Roussy

Prof. Inger Sandlie, Institute of Biosciences, University of Oslo

Prof. Josep Tabernero, Vall d'Hebron Institute of Oncology, Barcelona

Collaborating Partners

University of Oslo (UiO)
OUS has close organizational links with a number of faculties at the University of Oslo, in particular the Faculty of Medicine and The Faculty of Natural Sciences. Around 100 of the division's employees are also employed by The University of Oslo's Faculty of Medicine, teaching medical students in six of the twelve semesters. Guest students are also received from other universities in Norway and from abroad. OUS is the major institution for specialized training in oncology for physicians and nurses in Norway. The close collaboration between the hospital and University of Oslo is an important platform for this.

Oslo Cancer Cluster (OCC)
OCC is an oncology research and industry cluster dedicated to improving the lives of cancer patients by accelerating the development of new cancer diagnostics and treatment. OCC is a national non-profit member organization with about 90 members, including OUS CCC along with other Norwegian and international companies, research and financial institutions, university hospitals and organizations – all working in the cancer field. OCC represent the entire oncology value chain, doing everything from exploratory research to selling therapeutics and diagnostics to global markets.

Cancer Registry of Norway
The Cancer Registry of Norway is part of South-Eastern Norway Regional Health Authority and is organized as an independent institution under Oslo University Hospital Trust, with its own board. The Cancer Registry of Norway, consisting of about 40 researchers, collects data and produces statistics of the cancer prevalence in Norway, and has an extensive research activity. They also got the administrative responsibility for the public screening programmes in Norway.

Inven2
Inven2 is Norway's largest player in the commercialization of research and is owned by the University of Oslo and Oslo University Hospital. Inven2 is the next generation of innovation company, established to safeguard and further develop Norwegian innovation, building bridges between outstanding research and the industry of the future.

New buildings at the Radium hospital, including a Proton Centre in 2023

Oslo University Hospital is in the start of a hospital development plan including four main sites; Gaustad, Aker, Ila and at Montebello.

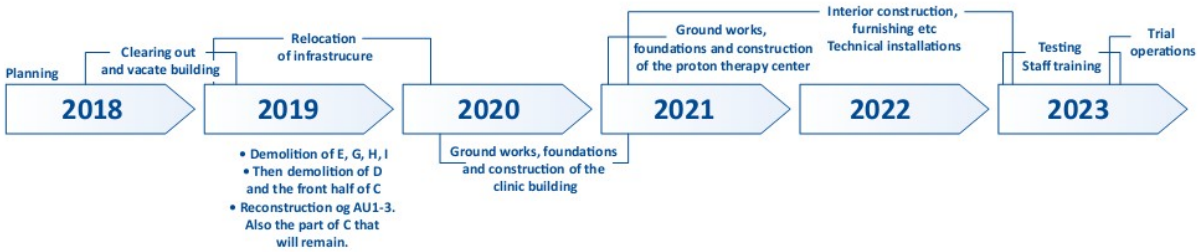
Radium Hospital is located at Montebello and is an elective cancer treatment hospital. The hospital consists of several buildings at the site. Currently we are at the end of the demolition period- tearing down 22000m2 of old buildings and renewing 44000m2 in new buildings that are expected to be ready for use at the end of 2023. The two new buildings are integrated in each other and are connected to the other buildings at the site, with corridors and walking bridges.

The capacities that are being built are:

Function	Clinical Building	Proton Building
Beds	155	
Day treatment	50	
Day treatment research	6	
Outpatient rooms	39	6
Outpatient research facility rooms	11	
Special laboratory	20	1
Operating Theatres	10	
Treatment Gantrys Proton		2+1
Scanning modalities (MR, CT+)	13	2

The project was accepted for realization in November 2019 by the board of Helse Sør- Øst who also is responsible for the realization of the project. The budget is 4,8 mrd NOK. A more detailed plan is in the next figure.

Schedule of building works 2019–2023



Major Events

Q1

- Visit from Karolinska hospital
- Action plan for increased clinical research
- Resource group for improving cancer patient pathways (CPPs)

Q2

- Forum for patient pathways coordinators
- Research group leader gathering
- CCC symposium
- Proton supplier determined
- Section of Experimental Diagnostics opened
- OUS initiated national meeting: Precision medicine and molecular pathology
- Visit from the leadership group for Cancer Networks at MD Anderson Cancer Center, University of Texas

Q3

- Visit from Sahlgrenska hospital
- OUS 10 years

Q4

- Lumiblast won the prestigous EU innovation award
- Opening of the Oslo Myeloma Centre
- Jim Allison
- ERC grant to Johanna Olweus
- Biobank decision
- OUS leader of National network for precision medicine selected
- Prosigna test approved as predictive gene panel in breast cancer
- Section of Experimental Diagnostics established in Department of Pathology

Core Activity Data

Patient Treatment

Number of cancer patients:

30 750

Number of cancer patient admissions:

25 392

Number of outpatient consultations:

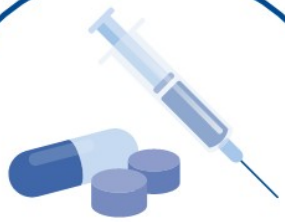
117 650

Number of beds:

300

Number of over-night stays:

14 781



Chemotherapy treatments:

64 229

Radiotherapy: treatment series:

6 601

Radiotherapy: number of fractions:

98 925

Radiotherapy: number of patients:

5 874

MRI scans:

9 003

CT scans:

17 830

Radiology examinations:

62 839

Cytology:

16 823

Estimated pathology evaluations:

64 876

Molecular pathology:

17 635

Key Indicators in Research

Total number of peer-reviewed publications (with OUS-CCC first or last author):

736 (350)

Number of publications with impact factor >10 (with OUS-CCC first or last author):

109 (24)

Number of publications with impact factor >20 (with OUS-CCC first or last author):

35 (4)

Budget: estimate of research budget (by parameters):

750 mill. kr

Completed Ph.D. degrees:

7

Disclosures of Invention (DOFIs):

26

Active projects funded by EU (H2020):

11

Approx. Total number of FTEs in cancer research:

550

Number of active clinical trials:

235

% increase in number of patients included in clinical trials:

19.6 %

Number of patient included in clinical trials:

1006

Relative Survival

Relative survival (%) estimated for Norway and regional catchment areas defined by patients' area of residence, with associated 95 % confidence intervals. The estimates are predicated for 2014-2018.

Gender	ICD-10	Location	Years from diagnosis	Norway	South-East Region	OUS
Both	All	All	3	77,0 (76,7–77,3)	77,0 (76,6–77,3)	78,6 (77,7–79,6)
			5	72,9 (72,6–73,2)	73,1 (72,7–73,5)	74,8 (73,6–75,9)
	C00	Oral cavity and pharynx	3	75,7 (73,8–77,5)	74,4 (71,8–76,7)	70,8 (63,8–76,7)
			5	70,3 (68,1–72,4)	69,2 (66,2–71,9)	63,8 (56,0–70,6)
	C15	Esophagus	3	27,3 (24,9–29,8)	25,4 (22,3–28,7)	28,1 (19,4–37,4)
			5	23,1 (20,7–25,7)	22,2 (19,1–25,5)	24,6 (15,8–34,4)
	C16	Stomach	3	32,4 (30,4–34,4)	29,9 (27,1–32,7)	30,0 (22,6–37,7)
			5	27,2 (25,1–29,2)	24,8 (22,1–27,7)	23,6 (16,4–31,7)
	C18	Colon	3	71,4 (70,5–72,3)	70,8 (69,6–72,0)	69,8 (66,2–73,1)
			5	67,2 (66,1–68,2)	66,9 (65,4–68,4)	66,0 (61,8–69,8)
	C19–20	Rectum	3	76,1 (74,8–77,2)	75,0 (73,3–76,6)	74,0 (69,2–78,3)
			5	69,7 (68,2–71,0)	69,4 (67,4–71,3)	67,0 (61,4–72,0)
	C33–34	Trachea and lung	3	28,4 (27,6–29,2)	27,7 (26,7–28,7)	32,9 (29,7–36,1)
			5	22,5 (21,8–23,3)	22,1 (21,1–23,1)	25,3 (22,0–28,6)
	C43	Melanoma	3	91,7 (90,9–92,4)	90,9 (89,8–91,9)	91,1 (87,9–93,5)
			5	88,5 (87,4–89,5)	87,8 (86,4–89,1)	87,5 (83,3–90,6)
	C64	Kidney	3	80,8 (79,3–82,2)	80,4 (78,4–82,2)	82,5 (76,4–87,2)
			5	76,8 (75,1–78,4)	76,2 (73,9–78,4)	78,5 (71,2–84,1)
	C65–68	Urinary	3	80,1 (79,0–81,2)	79,6 (78,0–81,1)	83,3 (78,6–87,0)
			5	76,6 (75,2–78,0)	76,4 (74,4–78,3)	81,9 (76,0–86,4)
	C70–72	CNS	3	70,5 (69,2–71,8)	71,1 (69,3–72,8)	70,7 (65,6–75,1)
			5	68,2 (66,8–69,6)	68,7 (66,8–70,6)	65,6 (60,1–70,5)
	C81	Hodgkin lymphoma	3	89,6 (87,0–91,7)	88,7 (84,9–91,6)	92,5 (81,6–97,0)
			5	86,8 (83,9–89,3)	86,5 (82,3–89,7)	87,2 (71,3–94,6)
	C82–86, C96	Non-Hodgkin lymphoma	3	79,4 (78,0–80,7)	78,3 (76,5–80,1)	81,4 (76,2–85,5)
			5	75,7 (74,1–77,2)	74,1 (72,0–76,1)	76,1 (70,1–81,1)
	C90	Myeloma	3	65,9 (63,6–68,1)	64,5 (61,3–67,4)	61,6 (54,0–68,4)
			5	50,6 (48,1–53,1)	50,0 (46,7–53,3)	54,9 (46,3–62,6)
	C91–95	Leukemia	3	73,3 (71,9–74,6)	73,3 (71,5–75,0)	78,1 (73,4–82,1)
			5	67,6 (66,1–69,1)	67,6 (65,6–69,6)	73,5 (68,0–78,1)

The development over the last 15 years shows that there has been an improvement in survival both three and five years after diagnosis. This applies to almost all cancers for both men and women. The trend is positive in all diagnostic groups, also for diagnoses where the survival was already relatively high 15 years ago.

Relative survival (%) estimated for two five-year periods for patients treated at OUS (operation or radiotherapy), with the associated 95% confidence intervals.

Relative survival (%) estimated for two (.....)"

Gender	ICD-10	Location	Years from diagnosis	2004–2008	2014–2018
Female	C15	Oesphagus	3	12,5 (6,9–19,8)	42,1 (33,9–50,1)
			5	9,8 (4,8–16,8)	41,9 (33,0–50,6)
	C33–34	Trachea and Lung	3	30,1 (27,4–32,8)	45,5 (43,1–47,8)
			5	23,3 (20,8–25,9)	36,2 (33,8–38,7)
	C56, C57.0–4, C48.2	Ovary	3	60,9 (57,4–64,3)	75,8 (72,1–79,1)
			5	45,6 (42,0–49,2)	60,4 (56,2–64,3)
Male	C15	Oesphagus	3	17,2 (12,2–23,0)	34,0 (28,7–39,4)
			5	14,5 (9,7–20,4)	26,4 (21,5–31,5)
	C33–34	Trachea and Lung	3	20,8 (18,6–23,0)	36,1 (33,8–38,4)
			5	14,9 (13,0–16,9)	28,5 (26,1–30,9)

Relative survival – a selection of cancer diagnoses related to gender. The data for relative survival is from the Cancer Registry. (See Cancer in Norway for definition of relative survival).

Chair of the CCC Board, Sigbjørn Smeland, points out that Norway is in the tier strata of cancer survival internationally. This is evidenced by a comparison of relative survival among seven high-income countries for seven selected cancer diagnoses, published in The Lancet Oncology fall 2019.

Increased survival for patients with esophageal cancer

Esophageal, ovarian and lung cancers are among the cancers that have had the greatest improvement in relative survival at OUS. Patient pathway head of esophageal cancer, consultant Hans-Olaf Johannessen, says the increased survival among patients with esophageal cancer has several explanations.

– First, we are now using surgical techniques that enable us to make more precise and radical interventions. Second, there has been a development in the way of combining radiation therapy and chemotherapy. Third, with the help of PET-CT, we have become better at identifying patients who may benefit from surgery. Thus, we avoid interventions in patients you would probably have only been injured, says Johannessen.

Best in treating ovarian cancer

Although ovarian cancer is still being detected at a late stage, the comparison in The Lancet Oncology shows that Norway has the highest survival rate for ovarian cancer among the countries included in the study.

– The improvement in survival for ovarian cancer patients is largely due to the introduction of multi-disciplinary and more radical surgery over the last 10-15 years. In addition, we have started treatment with a new preparation for patients with poor prognosis, says Erik Rokkones, head of department of gynecological cancer and patient pathway head of gynecological cancer.

Hans Olaf Johannessen

Improvement for lung cancer patients

For lung cancer patients treated at OUS, there is a clear improvement in survival. Consultant Frøydis Stornes, patient pathway head of lung cancer and section manager of the pulmonary medicine department, points to several explanations.

– The use of endoscopic bronchial ultrasound examination (EBUS) has allowed us to describe the cancer far more precisely. At the same time, the use of PET-CT has made it easier for us to determine which patients who should not receive surgery, says Stornes.

Erik Rokkones

Both Stornes and lung medicine consultant Lars Fjellbirkeland point out that new examination methods entail that lung cancer is now detected earlier than before and can be cured.

– Over the past 15 years, we have received new, curative treatments for lung cancer. We provide stereotactic radiation therapy, that is, very high radiation doses more accurately and purposefully. We also combine drug treatment and radiation therapy. In addition, for lung cancer patients, the use of immunotherapy and new drugs will result in better survival in the future, says Stornes and Fjellbirkeland.

Lars Fjellbirkeland

https://www.sciencedirect.com/science/article/pii/S1470204519304565

Patient Satisfaction

In 2019, approximately 1/3 of the cancer patients replied to OUSs web-based survey. Results show overall high satisfaction scores (>90%). In addition to the questionnaire, the patients have the opportunity to leave comments. These opinions are valuable for the improvement of patients' experience at OUS.

The comments are generally positive:
"I have experienced an incredibly pleasant treatment here; helpful, professional and nice nurses and doctors. Well prepared treatments. I have felt cared for and have believed in the treatment from day one"

Melanoma patient

"The doctors and personnel do not only see the cancer, but the whole person. It feels good coming to the hospital"

Thyroid cancer patient

However, some also comments for improvement:
"My treatment has been going on for many years and I wish the same doctors / nurses would follow the whole process, if possible."

Breast cancer patient

"Patient information about the planned pathway could be improved"

Patient with tumor in lymphoid or hematopoietic tissue

Patient Involvement

Too many people die every year from cancer. The cancer area is therefore a particularly important part of Oslo University Hospital's treatment offer- seen from a patient and next of kin perspective. Many of us have spent a long time in the system and have both expertise and experience in which we can supplement the professional environment. This is a particularly important time for many of the disciplines that together will provide a modern offer to cancer patients. Not solely in Oslo, but be the spearhead for the entire country. Soon new buildings will emerge, buildings that will be adapted to a future that will certainly be different from today's reality. The buildings will be adapted to tomorrow's patients with expectations of effective and seamless treatment in aesthetic and health-giving environments.

In this area we, the service users, are used in many contexts. After introducing the cancer patient pathways for cancer, I, for example, joined the working group that defined the content of the important position of the cancer coordinator. The cancer coordinator is our first meeting with the clinic, and my expectations for this role were sky-high and completely unrealistic. Competent professionals got me down to the ground while taking some of my views along. This is a good example of how we can contribute in interaction for the benefit of patients.

In the past year, many of the old buildings at the Radium Hospital have been leveled with the ground. This transpired without excessive disadvantages for the patients. Amazing. Parallel to this, the plan for the new hospital has been developing. The service users have participated through the whole process. Of course, we are dependent on enough space for operating rooms, outpatient clinics, etc., but functional common areas and pleasant surroundings are also important. The new hospital will be an exciting and good workplace, and a place that creates hope for patients and their next of kin. We will be constructive partners when new methods and technical solutions are to be adapted in the new building.

Hope has been created on many fronts in the past year. Research creates hope for the patients of the future. We, the service users, are increasingly drawn into the research projects. What is important to «us» is becoming increasingly in demand. User panels have been formed where we get together with researchers and discuss everything from hypotheses to methods and expected results. This is an exciting training arena for us «amateurs», which provides knowledge that we pass on to associations and others who request recruitment and practical training of users in a field that is considered scary and overly advanced for «ordinary» people.

Tove Nakken, *chair of the OUS Service User Committee*

OUS Service User Committee 2017-2019. Chair, Tove Nakken, to the far right.

Forum for Cancer Coordinators

One of the top priorities of the CCC board is to strengthen the cancer coordinator role in Oslo University Hospital (OUS). This commitment reflects the importance of obtaining predictability for our patients whose pathways often encompass numerous departments or even hospitals.

- The role of the cancer coordinator requires clinical insight and knowledge of the patient groups, good communication skills and knowledge of registering and handling data. In addition, they should be a link to the referring body, cancer pathway leaders and doctors. That is why it is also very important for the coordinators to participate in the multidisciplinary team meetings, says Sigbjørn Smeland, chair of the CCC board.

Two successful forums for cancer coordinators took place in 2019. Sharing experiences, network-building and increasing competence was on the agenda. Next to arranging the two annual forums in OUS, the executive committee began mapping the cancer coordinators' need of competence development. This work will result in a competence plan, matching the diverse responsibilities, in 2020.

Haematology Advanced Nurse Practitioner

Reports to: Haematology Consultants

Accountable to: Head of Nursing Haematology

The post holder must be a Registered Nurse (RN) and in addition the post holder must have carried through a master program of Advanced Clinical Nursing.

SUMMARY

- In conjunction with the medical team in the Haematology Department provide expert care for a complex caseload of patients, accepting professionally and legal responsibility and accountability for all aspects of own work
- With clinical support and appropriate education, to develop skills in and carry out extended roles including:
  - Advanced Clinical Assessment of Haemato-oncology patients, including patients receiving Cellular Therapies (i.e CAR-T)
  - Making referrals to other healthcare professionals
  - Bone Marrow Aspiration
  - Insertion of PICC lines
  - Removal of Hickman lines
  - Independent Prescribing including blood products
- To be an active leader in Haematology and contribute to strategic planning within the department
- To contribute to the education of the multi disciplinary team and departmental research and audit programmes as appropriate

Department of Pathology

Department of pathology in the Clinic of laboratory medicine performs extensive cancer diagnostic service including histology, cytology and molecular diagnostics. The department has reorganized and divided molecular cancer pathology in two sections with the responsibility of routine genetic analysis in malignant tumors including next generation sequencing HTS as one section and a new section supporting clinical cancer studies with experimental diagnostics.

Section of molecular pathology started deep sequencing (HTS) service in 2019 for various myeloid malignancies using TruSight™ Myeloid Sequencing Panel. In 2020 the HTS service was expanded with implementation of Oncomine Childhood Cancer Research Assay, covering 203 genetic markers for a wide variety of somatic cancer types. This will increase the quality in diagnostics and predictive and prognostic markers as well.

Section for Experimental Diagnostics

During the period 2016-2019, Dept. of pathology has been fostering a laboratory environment focusing on molecular diagnostic testing for clinical cancer trials. In 2019, Dept. of pathology at Oslo University Hospital formalized the activity by establishing a new “Section for experimental diagnostics and trial support” (lead by MD, PhD Hege G. Russnes; comprising Unit for trial related diagnostics and Unit for research support). The section coordinates the transdisciplinary “infrastructure for precision diagnostics for cancer” (InPreD) which received strategic funding from South-Eastern Norwegian Health Authority for 2019-2021. The aim was to establish a stable environment providing state-of-the-art diagnostics for clinical cancer trials and also facilitating interdisciplinary interaction between environments performing clinical-, diagnostic- and translational research. The Infrastructure interacts directly with the Clinical Cancer Trial Unit at the Dept. of Oncology at Oslo University Hospital and the environments at Regional Core Facility for Cancer Genomics and Bioinformatics at the Institute for Cancer Research, OUS (Leonardo A. Meza-Zepeda and Eivind Hovig). A wider network is now planned; a national Infrastructure for Precision Diagnostics (InPreD – Norway) to secure a robust, interactive structure facilitating clinical cancer trials on a national level by providing equal access to advanced diagnostics, state-of-the-art competence and technology.

Cancer patient pathways

In 2015, Norway implemented cancer patient pathways (CPPs) for 28 cancer diagnoses. The reform implies standardizing patient pathways, by streamlining the logistics to ensure a predictable time horizon for cancer patients. Diagnosis-specific time objectives were set with the patients' best interest in mind, not taking capacity or prognosis into account (which are ensured by other measures). If a cancer patient is referred to our hospital with the label "cancer patient pathway", they are prioritized.

National cancer patient pathway (CPP) goals
70% : Share of cancer patients included in CPPs (OA1)
70% : Share of cancer patients in CPPs within the normative time frame…
… from referral is received to medical evaluation starts (OF1)
… from medical evaluation starts to diagnosis is set (OF2)
… from diagnosis is set to treatment starts (OF3)
… from referral is received to treatment starts (OF4)

2019 OUS cancer patient pathways results

OA1	*% included*	*Number of patients with cancer diagnosis*
Q1	73%	1244
Q2	72%	1134
Q3	71%	1171
Q4	70%	1162
2019	**71%**	**4711**

OF4	*% within time*	*Number of patients in CPPs*
Q1	61%	991
Q2	59%	927
Q3	56%	812
Q4	65%	813
2019	**60%**	**3543**

In 2019 there were prominent variations in goal achievement between diagnoses. The diagnoses with the least satisfactory results required analyses and measures of both transverse and diagnosis-specific challenges.

Resource group 2019

In January 2019 a resource group was given mandate by the OUS CEO and the CCC Board. The 8 members included staff from CEO Executive staff, Oslo Hospital Service, Division of Cancer Medicine and Division of Medicine.

After an initial analysis comprising challenges of all cancer groups, several areas of improvement were shed light on. Key roles in CPPs (clinicians, pathway coordinators, diagnosticians) had, to a varying degree, gaps in knowledge of the reform and its time-objectives. Consequently, the resource group created a 'competence development team' who developed an educational presentation directed towards the key roles in CPPs. In 2020, this will be further developed into an interactive platform. Another area of improvement was communication, where the work resulted in clarifying and updating internet and intranet pages.

Further, the resource group facilitated extensive analyses of six cancer groups; kidney, prostate, thyroid, pancreas, ovary and uterus. In the beginning of 2019, these showed the least satisfactory results. After prioritizing, testing and implementing efforts during the year, many of the pathway management teams experienced considerable improvements in their respective pathways, measured by the CPP time-objectives.

Gynecological Patient Pathway

In the spring of 2019, a team was set up to improve patient pathway lead times for patients with gynecologic cancer. The work sought to ensure measureable and durable improvements in line with national guidelines.

Initial analyses revealed challenges and logistical bottlenecks. The Department of Gynecologic Cancer, together with key functions involved in the patient pathways, including radiologists and pathologists, created and prioritized an action plan. Improving the patient pathways entailed competence development among staff.

Two measures have been particularly central. First, newly referred patients should have an outpatient consultation within six days. This provides us with the opportunity to plan further treatment at an early stage in the process, as well as shortening the time to initial treatment. Importantly, patients will also experience being better taken care of by being faster admitted. Second, operational capacity has been increased with extra resources per week. We have also gained an additional staff resource from 2020.

Compared to 2018, we see improvements in ovarian, uterus and cervical cancer patient pathways. In the last months of 2019 over 70% of our patients has been treated within the standardized days, thus achieving the national goal.

Looking forward

To further ensure a good patient flow, we are keeping the pathway management group active. As the number of referrals is variable, and resources in holiday seasons is weakened, it is especially important to plan coordinated diagnostic and treatment capacity.

The first period of the patient pathways are crucial. Thus, the referrals to our department must have a high quality. Unfortunately, a high proportion of incomplete referrals cause patients avoidable loops back to the local hospital to complete diagnostic examinations. This greatly delays the patient flow. Therefore, we now have an even closer dialogue with the local department in the region through regular video meetings where the quality of the referrals is the main theme.

Erik Rokkones
Head, Department of Gynaecological Cancer

Ecco lab

Cancer treatment can be tough for the heart. Both drug treatment and radiation therapy can cause heart damage; this is especially seen in patients with lymphomas and breast cancer. Therefore, it is necessary to monitor whether the cancer treatment is too tough for the patients' hearts and adjust the cancer treatment accordingly. In order to prevent heart damage due to cancer treatment, closer cooperation has been established between the cardiovascular and oncological departments of OUS.

In 2018, funds from the Radium Hospital Foundation have been allocated to an echocardiography scanner for cardiac examinations of cancer patients. A state-of-the-art echocardiographic scanner was purchased in the beginning of 2019 and work was completed on the examination room for cardio-oncology patients at the Radium Hospital in Mars 2019.

A cardiologist in a 20% position dedicated to cardio-oncology was employed in 2018 and scanning of cancer patients treated with potentially cardiotoxic medication started at the Radium Hospital in May 2019.

Until recently, heart function in the majority cardio-oncology patients was assessed and followed-up by MUGA (Multi Gated Acquisition Scan). MUGA is a nuclear imaging test, showing how well the heart is pumping. Unfortunately, it uses radioactive tracers and gives information exclusively about pumping function. On the other hand, echocardiography uses no radioactive tracers and gives a complete assessment of the entire heart including all aspects of heart structure and function. Our plan is to completely replace MUGA with echocardiography in order to give cardio-oncology patients a safer and better examination of their hearts.

In the beginning of 2020, the cardio-oncology service at Radium Hospital was extended with an echocardiography technician also performing heart scanning on additional two weekdays and the plan is to further extend the service to every weekday. This way now the cancer patients will not have to go from Radium Hospital to Rikshospitalet to have their heart examined.

Sebastian Imre Sarvari, *MD, PhD*
Senior consultant cardiologist
Cardio-oncologist

Cardio-Oncology

The field of Cardio-Oncology is a comparably new kid on the block. The efficacy of modern cancer therapy has increased the number of long-term cancer survivors, but on the other side of the coin is the unwanted cardiovascular side effects. Cardiologists and oncologists have different perspectives of cancer therapy and cardiac side effects. A collaboration between the two fields is essential to offer the patients the best possible cancer treatment with minimal injury to the heart. Internationally this has been recognized and the first Global Cardio-Oncology Summit was held in 2015. At Oslo University Hospital, Ullevaal we established a Cardio-Oncology Unit at the Department of Cardiology in November 2018. The purpose was to focus on development of cardiac side effects and intervene early with cardio protective treatment in those undergoing known cardiotoxic cancer treatment. In the beginning this was mainly Human Epidermal Growth Factor Receptor (HER)2 positive breast cancer patients. The purpose of the cardio-oncology unit is not to limit the oncology treatment, but rather encourage treatment under aggressive cardiac care where previously cardiac problems may have been a limitation for the oncology treatment. As the field of cardio-oncology is evolving rapidly a dedicated cardiologist who has some insight into cancer treatment is essential. The collaboration between the oncologist and cardiologist has been a success at Ullevaal and the cardio-oncology clinic is now expanding to include other cancer groups. Additionally Radiumhospitalet has opened a cardiology service once a week.

Geeta Gulati, *M.D, PhD*
Consultant in Cardiology
President Nordic Cardio-Oncology Society

Cancers of Unknown Primary Site (CUP)

In cases where the primary tumor has an unknown location, the diagnostics is often prolonged and time-consuming for the patient. However, diagnostic tools are developing to become increasingly precise. As a result, cases where the primary tumor is not eventually found is fortunately infrequent.

In 2019, a project of standardizing and documenting the patient pathway of CUP patients commenced. The project group, led by oncologist Maria Thomsen, has consisted of an oncologist, a gynecologist, a surgeon, a radiologist and a pathologist. A facilitator has had a key role in this work by coordinating the writing and flow charts into a document.

For developing a standardized patient pathway, the coordination and logistics between the different departments is vital for better and faster diagnostics. One ambition in investigating the pathway logistics was to stimulate doing things across departments simultaneously. The pathway coordinator has a key role in ensuring this process.

While The Department of Oncology has the main responsibility of the CUP patients, a tight network of clinicians across the departments enhances the ability to make fast decisions.

The document will be distributed to clinical practitioners, other hospitals within the region, and within the departments in Oslo University Hospital. This way the involved actors will gain a shared understanding of tasks and responsibilities. Further, the project group is organizing meetings twice a year to investigate cases, pursuing improvement potential and learning opportunities.

Maria Thomsen
Oncologist and program manager

Brilliant masks for superheroes

In a Google search with the keyword «radiation therapy» and images as the chosen presentation of the topic, we see high technology: machines and instruments. Some of the images represent people and patients, but the focus is on the machines.

Patients in need of radiation treatment to the head and neck area, have to wear a treatment masks. The masks are necessary to provide this treatment, they ensure precision and reproducibility. But, the masks used are the same for children and adults and some find them quite intimidating.

Therefore, in collaboration with the Innovation Department at OUS, "Brilliant Masks For Superheroes" were started in June 2018. The project is led by the radiotherapy section, and consists of an interdisciplinary project group with five different health professions.

The goal is to increase well-being and reduce stress for 1) Patients, 2) Next of kin, friends and family, and 3) Staff in the treatment line, as well as prevent the feeling of loneliness and reducing the need for anesthesia during CT scan and radiotherapy treatment.

Tools in children's arena: Balancing the power for patients <18 years undergoing radiotherapy treatment

Creativity is playful and appealing, the form of conversation takes place on children's premises, and it becomes a resource they master to a greater extent than adults. Siblings, family and friends can be included in our project. Drawing, making handprints or writing something together with-, or instead of the patient on the treatment mask. The painting can give an opportunity to care and support through visual expression, and reduce stress during treatment because the motive gives motivation and strength.

Our pilot for the project has been going on for 1.5 years, and all patients <18 years have been offered, and said yes to painted treatment mask during this period. Each mask that has been designed has been tailored to the individual patient and family needs.

The project has aroused interest, and several of our patients and/or their families have heard about us before starting treatment in 2019. Two of the images associated with the project now also appear as the first search using the Norwegian keywords "Strålebehandling Barn" (Radiotherapy Children) on Google.

The most important thing about the project is being able to make the treatment masks better suited for our young patients and becoming a more child-friendly department.

Mathilde Haraldsen Normann, *Professional Development radiation therapist*, Oslo University Hospital

Home Hospital

The Department of Haematology, Oslo university hospital, is a national treatment centre for allogeneic stem cell transplantation and performs autologous stem cell transplants for the South-East Health Region. Stem cell transplant recipients have long treatment courses and usually very long hospital admissions. Home-based specialist health service for this group of patients has been implemented on a regular basis at the Department since March 2019.

Patients treated in their own home, are more active than patients treated in the hospital. At home patients eat and drink more, suffer fewer infections, have lower needs for supportive treatment, and feel better in general. Home care services are safe, and are likely to provide better treatment outcomes according to the literature. (Swahn et al. Huddinge, Stockholm)

To participate in home-based health care, patients must have a caregiver 24/7, patient and caregiver want to join this home care service, and they must be able to understand and act according to instructions. The maximum distance from the patient's home to the hospital is one hour by car. Since the Department is a national treatment centre, we plan to offer apartments to patients who live far from the hospital by April 2020.

We are going to evaluate our home care service in a prospective manner to address safety, feasibility, patient outcome, and economy.

Geir Tjønnfjord
Head, Department of Haematology

Cancer rehabilitation and coordination

– a collaborative project between two districts in the municipality of Oslo (Bjerke and Frogner) and the Cancer Clinic in Oslo University Hospital

Medical specialists, general practitioners and the municipal health care system all play an important role in the identification and follow-up of cancer patients in need of rehabilitation after treatment. Oslo University Hospital (OUS) is involved in a collaborative project across health care levels in Oslo in order to identify and implement better coordination of rehabilitation services after cancer treatment.

The project aims to develop routines for identification of needs for rehabilitation after cancer treatment, and to improve the coordination between OUS, local hospitals, the municipal health care system and general practitioners.

The project was granted funds in 2019 from the City of Oslo and the South-Eastern Norway Regional Health Authority and is led by an interdisciplinary group with members from OUS and the two districts of Oslo municipality. The project administration group is chaired by Sigbjørn Smeland.

Rehabilitation and structured patient education programs for cancer patients

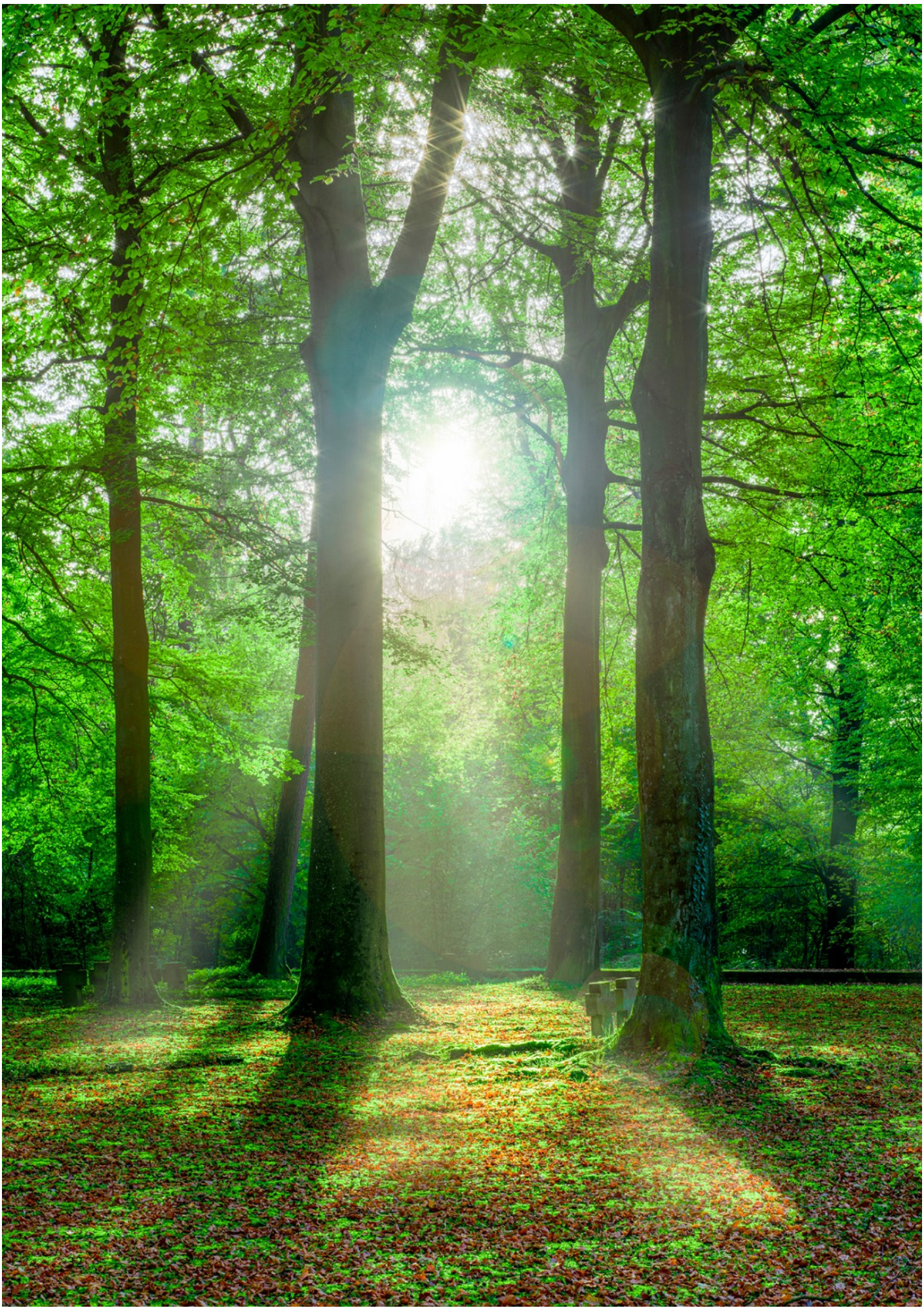
OUS has several rehabilitation services for cancer patients both during and after treatment. During treatment there are in-house services of psychosocial and psychiatric follow-up, nutritional support, occupational therapy, physiotherapy and physical training. In the Cancer Rehabilitation Centre patients within working age are offered post-treatment outpatient multidisciplinary rehabilitation.

The hospital has structured patient education programs for the majority of cancer diagnoses. These programs run for one or two days, and both patients and a close family member are welcome to join the program. The schedule include educational elements (learn about the cancer diagnosis, treatment, adverse effects, physical exercise, nutrition and life style during cancer) and coping elements (coping with stress, mindfulness, relaxation techniques).

During the program days patients and relatives are invited to share some of their experiences in small groups, and to seek advice from the professionals in charge of the program. Specific patient education programs are given for patients with late-effects after cancer, such as chronic fatigue.

To complement the diagnosis-specific programs that are part of the standardized patient care pathway there are general coping courses open for all cancer diagnoses. These courses address general challenges living with and after a cancer diagnosis.

Tone Skaali, MD PhD,
Head of Unit for Psychosocial Oncology,
Coping and Rehabilitation



Head of CCC Research Council

OUS CCC Research Activity 2019

Research is a central and integrated part of the activities in Oslo University Hospital Comprehensive Cancer Center. The research activities comprise a broad range of different fields, from biochemistry and cell studies to studies of quality of life in cancer patients. There is extensive collaboration between different groups, departments including the Norwegian Cancer Registry and the University of Oslo, taking advantage of synergies and complementary competence. In 2019, there has been more EU-funded research and several large projects have received external funding.

Research within the OUS CCC is diverse and covers all major fields of cancer research. With a total of 734 publications, there has been an increase from 2018. There has also been an increase in number of publications in high impact journals, with 111 publications in journals with impact factor (IF) more than 10, and 36 in journals with IF more than 20.

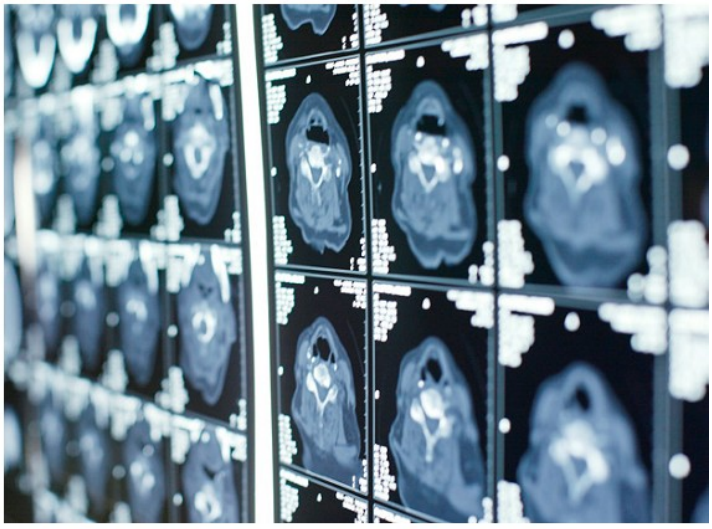
The CCC research council meets every second or third months to discuss strategic research issues, and have representation from all major departments involved in research. This year, we have initiated a focused effort in the field of precision cancer medicine. A department of experimental diagnostics is being established, focusing covering the gap between standard molecular pathology and research in precision medicine.

This year one of our senior researchers have received a consolatory grant from the EU, in addition to several EU projects having being funded. A network in radiation oncology has been funded through the regional health authorities,- an important effort as OUS is the major radiotherapy hospital in Norway, and the building of the proton centre has been initiated.

Prof. Åslaug Helland MD
Head of Research
Division of Cancer Medicine

Research and Innovation Highlights

- Lumiblast won the prestigous EU innovation award
- ERC-consolidator grant to Johanna Olweus
- EU-H2020 and EU-ITN projects
- Molecular Blocking Commercialization Project funded with NOK 8 million from The Research Council of Norway and NOK 1.5 million from South-Eastern Norway Regional Health Authority
- YTG (NOK 7 million), FRIPRO (NOK 10 million) og Behandlingsforskningsprosjekter (NOK 12 million) funded from The Research Council of Norway
- Various project funding from Health South East Region and the Norwegian Cancer Society
- KlinBeForsk funded NOK 14 million to the clinical lung cancer study DART
- Cell-based immunotherapy and Tumor development in advanced models funded with 2 x NOK 4.5 million
- Development of a Pancreas cancer quality register in the Cancer Registry funded with NOK 8 million
- Two expert groups in lung cancer and pancreas cancer funded with 2 x NOK 15 million
- The Norwegian Cancer Society funded OUS with approximately NOK 100 million:
  - 7 projects in Open Call (NOK 50 million)
  - National centre of competence in lung cancer (NOK 15 million)
  - National centre of competence in palliation (NOK 20 million)
  - Pink Ribbon (NOK 5 million)
  - DAM Foundation (NOK 0.75 million)
  - The Norwegian Cancer Registry (NOK 12 million)
- OUS award for Excellent articles winner:
  - Proton-dynamic therapy following photosensitiser activation by accelerated protons demonstrated through fluorescence and singlet oxygen production (fall 2019)
    - Published in Nature Communications
    - Authors: M. Grigalavicius, M. Mastrangelopoulou, K. Berg, D. Arous, M. Ménard, T. Raabe-Henriksen, E. Brondz, S. Siem, A. Görgen, N.F.J. Edin, E. Malinen & T.A. Theodossiou
  - Induction of neoantigen-reactive T cells from healthy donors
    - Published in Nature protocols
    - Authors: Ali Muhammad & Foldvari Zsofia/ Olweus Johanna
  - WDFY2 restrains matrix metalloproteinase secretion and cell invasion by controlling VAMP3-dependent recycling
    - Published in Nature Communications
    - Authors: Sneeggen Marte/ Schink Kay Oliver & Stenmark Harald



Biobank

The Cancer Biobank at Oslo University Hospital (OUS) is a large scale prospective research biobank. The main aim is to routinely collect and store patient samples for future use in cancer research. Biobank material is also of crucial importance for the development and implementation of precision cancer medicine.

The goal is to collect blood samples from all new cancer patients at OUS, approx. 8500 yearly, and to acquire tissue samples from all patients that undergo surgical procedures.

The material is collected, processed and stored on the basis of common and standardized procedures, and the work is performed by dedicated staff at the laboratory. This effort enables a large scale collection offering high quality material for cancer research.

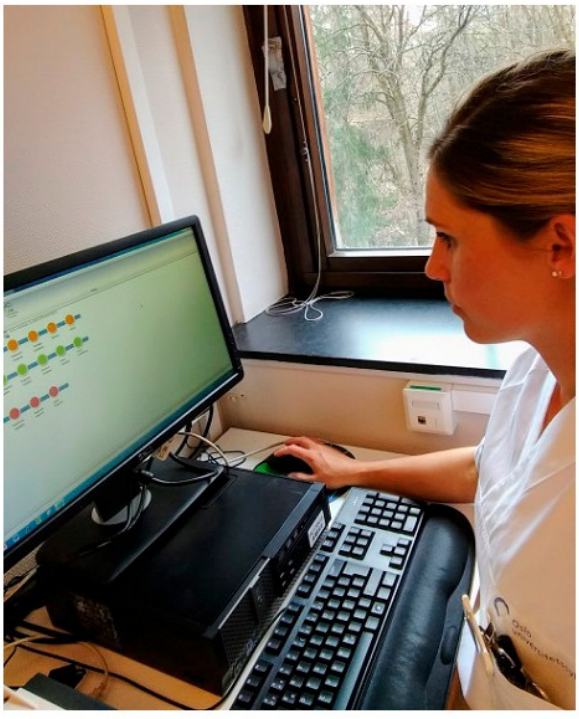
The project is the first biobank project that takes into use an electronic consent solution, developed within OUS. This electronic solution allows the patients to sign the informed consent on a tablet, and the signature is automatically generated to a consent registry, ensuring that we keep track of all signatures while ensuring privacy protection. The consent rate using this system is in excess of 90%.

The Cancer Biobank uses the digital biobank tracking system eBiobank, and all samples are traced down to their individual position, making them easily accessible.

In 2019 the biobank collection consisted of biobank material from four cancer types, and the aim for 2020/2021 is to expand and include material from all cancer types. When this goal is achieved The Cancer Biobank will be a valuable resource, facilitating research on all cancer diagnose groups, and across cancer types.

In addition to the general cancer biobank effort there are more specialized biobank collections, e.g. in connection with ongoing prospective clinical trials.

The use of biobank material is governed by tumor specific steering groups, and the overarching Cancer Biobank Board is chaired by the Head of Research in OUS CCC. The project is financed jointly by Oslo University Hospital, The South-Eastern Norway Regional Health Authority and the University of Oslo.



Samples for The Cancer Biobank are being registered in the eBiobank tracking system.

Improving access to cancer drug therapy data – The INSPIRE project

The INSPIRE project aims to improve data access on drug therapy in individual cancer patients in Norway. Today, there is limited access to data on drug therapy and sources available are either inaccessible (like patient charts) or not detailed enough (statistics on health trust's overall drug use). CRN aims to publish annual statistics on cancer drug therapy. Currently we publish statistics on surgical, and to some extent radiation therapy for all clinical registries. Drug therapy data will be available for research on the same terms as other treatment data.

In this project, hospitals will extract data on drug therapy directly from hospital systems and report it to the cancer registry. The data capture will go back as far as possible (several years back) and will be updated regularly with new data. We will start by analysing data on lung and breast cancer, and hope to be able to publish the first results in 2020.

INSPIRE is a unique collaboration between no less than ten pharmaceutical companies, the Cancer Society and the Cancer Registry of Norway (CRN). CRN supports 1/3 of the funding and the collaborators contributes the remaining 2/3. The project is conducted by the CRN. The legal basis for the data collection is the Norwegian health registry legislation and specifically the Cancer Registry regulations.

Lena Holmström, Espen Enerly and Giske Ursin

The NeoAva study:

Sorting out the important molecular biology from patients undergoing antiangiogenetic and breast cancer therapy

Chemotherapeutic agents such as anthracyclines and taxanes are commonly used for treatment of patients with large breast tumors before surgery, in order to achieve an optimal result. Despite the improved results obtained by such therapy, breast cancer patients with large tumors still have a less favourable outcome. The NeoAva study integrated conventional chemotherapy with antiangiogenic treatment using bevacizumab to neutralize an important factor stimulating angiogenesis. Translational molecular research was performed on DNA, RNA and protein from biopsies and serum sampled from all the patients in the study (1-6). Pathological complete response (pCR) was observed in 15 patients (23%) receiving bevacizumab and chemotherapy and 8 patients (12%) receiving only chemotherapy. In the estrogen receptor positive patients, 11 out of 54 (20%) treated with bevacizumab and chemotherapy achieved pCR, while only 3 out of 57 (5%) treated with chemotherapy reached pCR. Studies on RNA expression demonstrated that patients with estrogen receptor positive tumors treated with combination therapy had elevated immune activity associated with good response (1). Changes in expression were subtype specific, and the effect of adding bevacizumab was most evident for Luminal B tumors (i.e. hormone receptor positive tumors with high proliferative activity). Genomic aberrations were also found to be linked to response in this study (2). Data quantifying protein expression in the patient tumors have been used to select a predictive protein signature for the response of bevacizumab therapy in such a clinical setting (7). We have also demonstrated that a significant number of patients experienced fatigue as a consequence of the therapy, but this was not linked to the antiangiogenic therapy (8). In conclusion, the information gathered from the tumor material and serum of the patients undergoing therapy with and without angiogenesis inhibition contains information with implications for clinical decision making and monitoring of treatment efficacy (1-13)

PI Olav Engebråten

References:

1. Silwal-Pandit L, Nord S, von der Lippe Gythfeldt H, Moller EK, Fleischer T, Rodland E, *et al.* The Longitudinal Transcriptional Response to Neoadjuvant Chemotherapy with and without Bevacizumab in Breast Cancer. Clin Cancer Res **2017**;23(16):4662-70 doi 10.1158/1078-0432.ccr-17-0160.
2. Hoglander EK, Nord S, Wedge DC, Lingjaerde OC, Silwal-Pandit L, Gythfeldt HV, *et al.* Time series analysis of neoadjuvant chemotherapy and bevacizumab-treated breast carcinomas reveals a systemic shift in genomic aberrations. Genome medicine **2018**;10(1):92 doi 10.1186/s13073-018-0601-y.
3. Jabeen S, Zucknick M, Nome M, Dannenfelser R, Fleischer T, Kumar S, *et al.* Serum cytokine levels in breast cancer patients during neoadjuvant treatment with bevacizumab. Oncoimmunology **2018**;7(11):e1457598 doi 10.1080/2162402x.2018.1457598.
4. Lindholm EM, Ragle Aure M, Haugen MH, Kleivi Sahlberg K, Kristensen VN, Nebdal D, *et al.* miRNA expression changes during the course of neoadjuvant bevacizumab and chemotherapy treatment in breast cancer. Molecular oncology **2019**;13(10):2278-96 doi 10.1002/1878-0261.12561.
5. Nome ME, Euceda LR, Jabeen S, Debik J, Bathen TF, Giskeodegard GF, *et al.* Serum levels of inflammation-related markers and metabolites predict response to neoadjuvant chemotherapy with and without bevacizumab in breast cancers. Int J Cancer **2019** doi 10.1002/ijc.32638.
6. Saldova R, Haakensen VD, Rodland E, Walsh I, Stockmann H, Engebraaten O, *et al.* Serum N-glycome alterations in breast cancer during multimodal treatment and follow-up. Molecular oncology **2017**;11(10):1361-79 doi 10.1002/1878-0261.12105.
7. M.H. Haugen OCL, Ø. Garred, I. Hedenfalk, N. Loman, G. Mills, A. Borresen-Dale, B. Naume, G.M. Mælandsmo, O. Engebraaten. Design of a protein signature predicting response to neo-adjuvant treatment with chemotherapy combined with bevacizumab in breast cancer patients. Annals of Oncology, Volume 30, Issue Supplement_3, 1 May 2019, mdz095022 **2019**.
8. Reinertsen KV, Engebraaten O, Loge JH, Cvancarova M, Naume B, Wist E, *et al.* Fatigue During and After Breast Cancer Therapy-A Prospective Study. Journal of pain and symptom management **2017**;53(3):551-60 doi 10.1016/j.jpainsymman.2016.09.011.
9. Lai X, Geier OM, Fleischer T, Garred O, Borgen E, Funke SW, *et al.* Toward Personalized Computer Simulation of Breast Cancer Treatment: A Multiscale Pharmacokinetic and Pharmacodynamic Model Informed by Multitype Patient Data. Cancer research **2019**;79(16):4293-304 doi 10.1158/0008-5472.Can-18-1804.
10. Nilsen LB, Fangberget A, Geier OM, Engebraaten O, Borgen E, Olsen DR, *et al.* Associations between tumor vascularization assessed by in vivo DCE-MRI and the presence of disseminated tumor cells in bone marrow in breast cancer patients at the time of diagnosis. Journal of magnetic resonance imaging : JMRI **2014**;40(6):1382-91 doi 10.1002/jmri.24502.
11. Bidard FC, Michiels S, Riethdorf S, Mueller V, Esserman LJ, Lucci A, *et al.* Circulating Tumor Cells in Breast Cancer Patients Treated by Neoadjuvant Chemotherapy: A Meta-analysis. Journal of the National Cancer Institute **2018**;110(6):560-7 doi 10.1093/jnci/djy018.
12. Debik J, Euceda LR, Lundgren S, Gythfeldt HVL, Garred O, Borgen E, *et al.* Assessing Treatment Response and Prognosis by Serum and Tissue Metabolomics in Breast Cancer Patients. Journal of proteome research **2019**;18(10):3649-60 doi 10.1021/acs.jproteome.9b00316.
13. Euceda LR, Haukaas TH, Giskeødegård GF, Vettukattil R, Engel J, Silwal-Pandit L, *et al.* Evaluation of metabolomic changes during neoadjuvant chemotherapy combined with bevacizumab in breast cancer using MR spectroscopy. Metabolomics **2017**;13:*https://doi.org/10.1007/s11306-017-1168-0*

Circulating cell-free DNA in plasma

– a potential biomarker for improving individualized care pathways of patients with metastatic colorectal cancer

Survival of patients with metastatic colorectal cancer (mCRC) has improved during the last 30 years, mainly due to improved and individualized surgical and oncological treatment strategies. Still patient care pathways are heterogeneous in terms of treatment response, quality of life and survival. Our overall research question is; can circulating cell-free DNA in plasma (cfDNA) benefit patients and support physicians in deciding what treatment to offer and aid in evaluating if a given treatment has effect?

This project investigates mores specifically if cfDNA has prognostic value in this patient group prior to starting life-prolonging oncological treatment. We and others have identified a poor prognosis group based on elevated levels of total cfDNA. This patient group could benefit from more intensive treatment upfront. Patients with normal levels of total cfDNA represent a good prognosis group, and we hypothesize that cfDNA measured at baseline reflects fundamental aspects of the tumor and host, rather than predicting the effect of first-line chemotherapy alone [1].

Our further work aims at identifying which clinicopathological factors that affect recovery of tumor-specific cfDNA in plasma, and characterizing the clinical implications of total and tumor-specific cfDNA dynamics during the initial phase of first-line chemotherapy. Although the results have not yet reached clinical utility, liquid biopsies have the potential to guide individualized treatment at various time points in a patient care pathway with the overall aim of improving survival and/or quality of life.

[1] Hamfjord, J., et al. (2019). "Total circulating cell-free DNA as a prognostic biomarker in metastatic colorectal cancer before first-line oxaliplatin-based chemotherapy." ***Ann Oncol*** 30(7): 1088-1095.

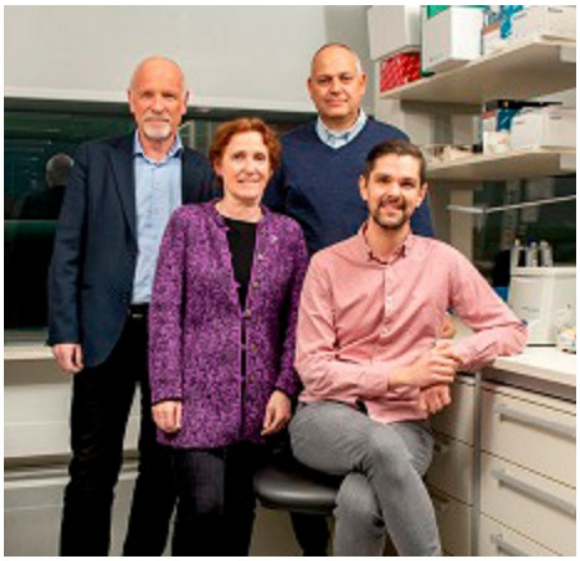


Photo legend: Prof. Kjell M. Tveit, MD, Ph.D., PI; Prof. Elin H. Kure, Ph.D., MPH, project leader; Tormod K. Guren, MD, Ph.D.; Julian Hamfjord, MD, B.Sc., Ph.D. candidate. Photo by Per Marius Didriksen.

Facts:

- This is a PhD project evolving from the NORDIC-VII study, an investigator-initiated randomized multicenter trial of patients receiving first-line oxaliplatin-based chemotherapy.
- Several members of the Nordic Colorectal Cancer Biomodulation Group participate in this project, and there is ongoing collaboration with researchers at Aarhus University Hospital and Zealand University Hospital.
- This project is part of the strategic research area of liquid biopsies for gastrointestinal, lung and breast cancer at the Department of Cancer Genetics, Institute for Cancer Research, Oslo University Hospital.

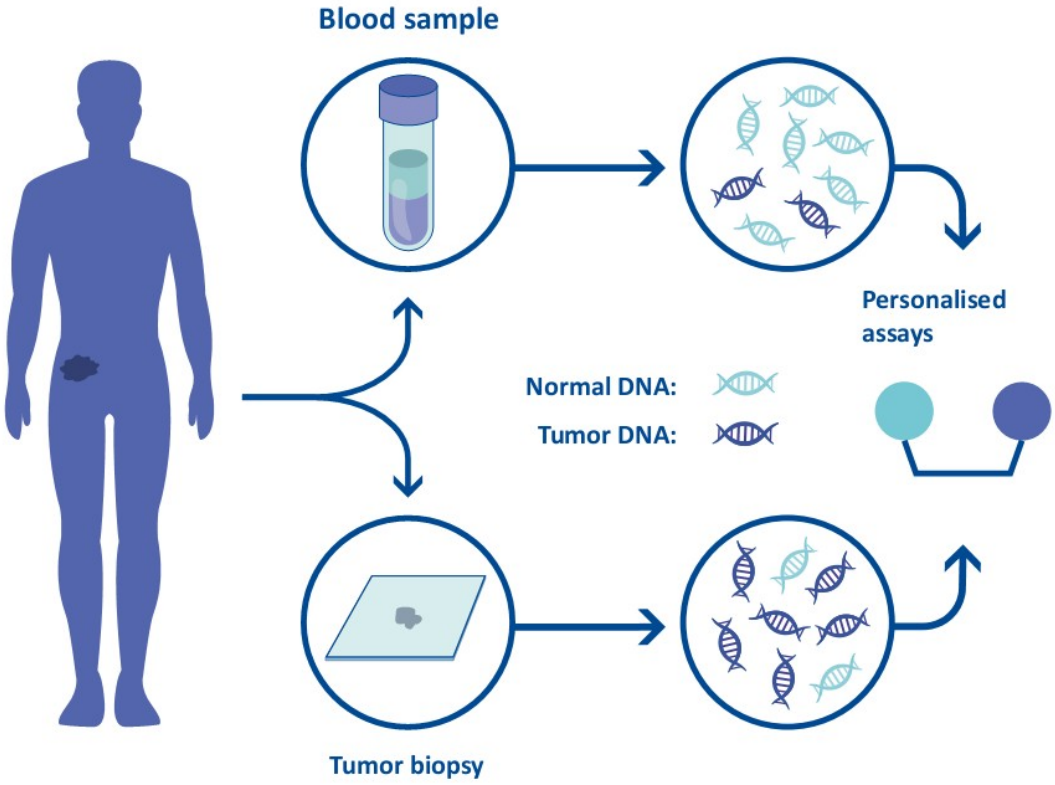
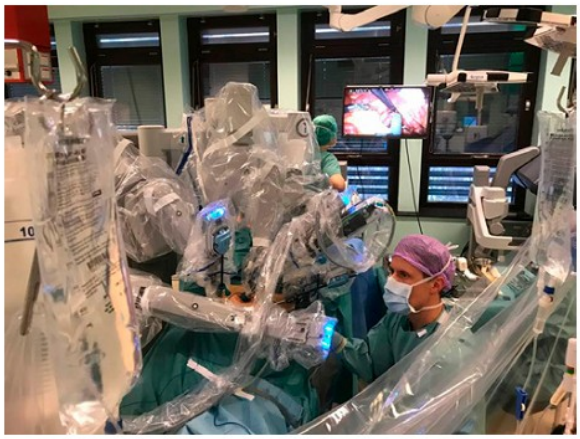


Figure legend: DNA is normally located within the cell nucleus, but small fragments of DNA may be temporarily shed into the blood stream as non-malignant and malignant cells are cleared by the body. These fragments are called circulating cell-free DNA (cfDNA) and can be detected, quantified and characterized from a simple blood sample. Total and tumor-specific cfDNA may provide real-time information on disease burden as well as tumor and host characteristics relevant for treatment decisions. Ilustration by Kragsfeldt and Spindler 2016.

Development of robot-assisted surgical oncology in OUS



Laparoscopic robot-assisted surgery is developing into a major tool in all surgical specialties. Characteristics like high magnification, stable 3D-vision, ability to dissect in confined spaces in the pelvis and in the thorax, and reduced learning curves are making the robotic surgical platform the preferred choice in surgical oncology. Rigorous training including hours in console simulator, much like in aviation, is preparing the surgeon before using the systems on patients. Furthermore, the ability to use two surgical consoles makes training of new robotic surgeons safe and efficient as the senior surgeon can instantly assist the operation from the second console.

A new robotic system located at the Radium Hospital got in place in March 2019 with a designated purpose of scientific clinical research, thanks to a donation from The Radium Hospital Foundation. A program for colorectal surgical oncology has proven feasible with great oncological results and enhanced recovery with shorter hospital stay. In the near future, a program for plastic reconstructive robotic surgery is in the making. Simultaneously studies spanning from enhancing quality of life for cancer survivors (e.g. nerve sparing in prostate surgery to preserve erectile function), to imaging techniques to improve surgical accuracy (e.g. sentinel lymph node localization in cervical cancer), to study the impact on the immune system after rectal surgery and to develop highly advanced surgery for the most advanced pelvic cancers (e.g. pelvic excenterations) are implemented.

At Aker Hospital, a program for robotic colorectal and gastric surgical oncology was initiated in 2018 with promising early results. Plans for further development of this program to include surgery for esophageal malignancy are being prepared. Further development of the robotic platform with integrated imaging and guiding technology may in the close future offer further improvements.


da Vinci S
SURGICAL SYSTEM

SMART – colorectal cancer

S.MA.R.T is a multidisciplinary research project designed to reflect the colorectal cancer (CRC) patient-flow in the Hospital: "Screening, MAnagement, Research and Translation". A SMART-patient is included in a large translational research program aiming to offer improved risk stratification and treatment options for patients with primary or metastatic CRC. The program unites translational and clinical researchers across multiple clinics in the OUS-CCC. Here we report from an ongoing project involving genomic analyses and ex vivo drug sensitivity testing of the patients' own cancer cells, taking intra-patient metastatic heterogeneity into account.

Nearly half of all patients with CRC develop metastatic disease, for which systemic treatment is primarily based on combination chemotherapies. The majority of patients have no targeted therapy options, and available therapies are associated with a low response rate and secondary resistance even in biomarker-selected populations (Sveen et al., Nat Rev Clin Oncol 2020).

We have built a large pharmacogenomics resource of CRC cell lines (n>100) and "individualized cancer models", the latter consisting of >100 patient derived organoids (PDOs) grown from resected liver metastases (n = 50 patients) and screened for sensitivity to 40 anticancer agents (fig). All cell lines and PDOs are submitted to genomic and transcriptomic analyses (Sveen et al., Clin Cancer Res 2018; Bruun et al., Mol Oncol 2019; Kryeziu et al., BBA-Rev Cancer 2019; Smeby et al., submitted). The majority of the PDOs were sensitive to clinically tested drugs, and together with only a modest level of intra-patient inter-metastatic pharmacological heterogeneity, this reinforces the potential for increased use of targeted agents in selected patients (Bruun et al., in revision). Furthermore, the pharmacogenomic resource will be used for development of molecular response prediction models, drug synergy predictions and testing of promising combination therapies.

Clinical translation of the ex vivo drug testing platform is in progress for patients with metastatic CRC at OUS, and a protocol for a next generation clinical trial based on PDO drug screens is in writing.

Ragnhild A. Lothe, Bjørn Atle Bjørnbeth,
Marianne G. Guren, Tormod K. Guren, Arild Nesbakken.

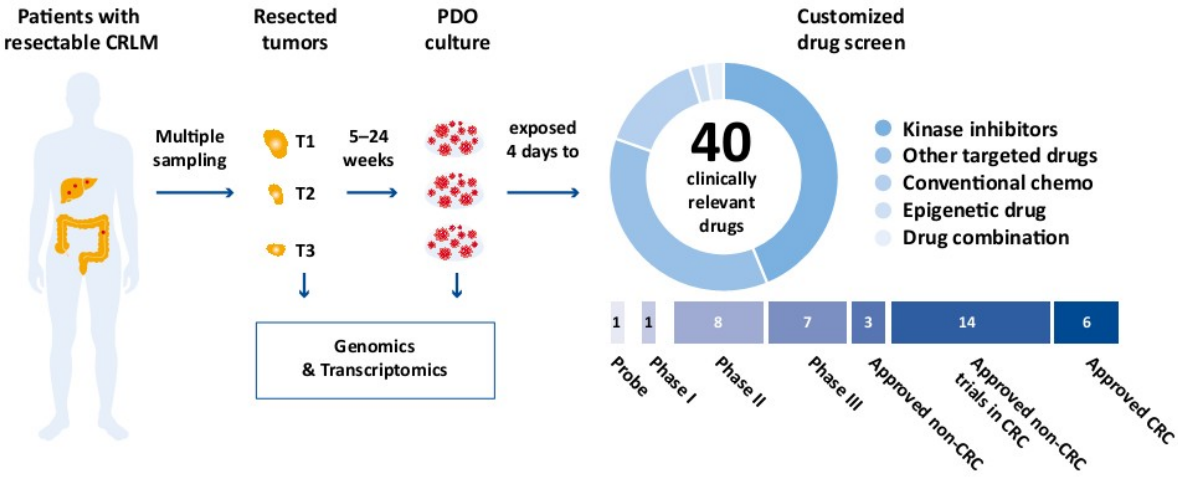


Figure. Pharmacogenomics of a living biobank of colorectal cancer liver metastases (CRLM).

Advanced Course in Ovarian Cancer Surgery

December 4-5th 2019 the Department of Gynecologic Oncology, Division of Cancer Medicine, invited gynecologic and surgical oncologists from Europe to participate in the inaugural Advanced course in cytoreductive surgery for ovarian cancer (OC) at Oslo University Hospital. In addition to OC surgeons Drs. Skeie-Jensen, Dørum, Eyjolfsdottir, Wang and Eriksson from our department, local course faculty Dr. Bjorn Atle Bjørnbeth (Dept. of Hepatobiliary malignancies) and Dr. Stein Larsen (Dept. of Colorectal malignancies) were joined by guest faculty from the Ovarian Cancer Surgery section, Gynecology service at Memorial Sloan Kettering Cancer (MSKCC) in New York. The Gynecology service at MSKCC was ranked first in gynecology by U.S. News and World report in 2019, and represents an experienced group of high-volume surgeons dedicated to the treatment of women with advanced OC.

The thoroughness of cytoreductive surgery is the largest contributor to survival for patients with advanced ovarian and primary peritoneal carcinoma. This course is designed to provide information through formal lectures, panel discussions and cadaver dissection regarding clinical applications of advanced cytoreductive surgery for OC. The course consisted of one day of lectures and one day of cadaver lab, held in collaboration with Akershus Univeristy Hospital.

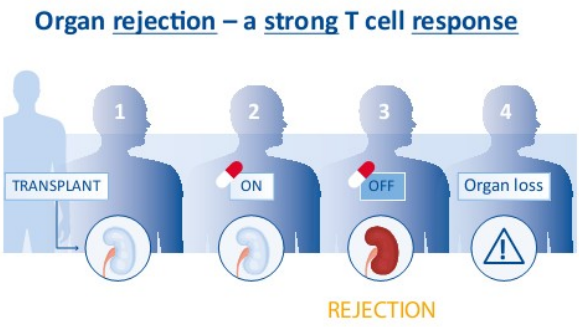
Ane Gerda Zahl Eriksson, MD, PhD
Course Director

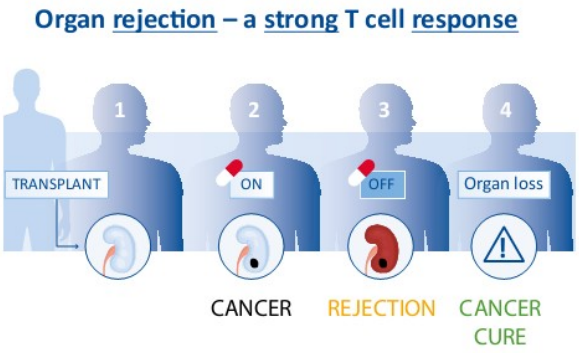
ERC Consolidated Grant to Johanna Olweus

Immunotherapy has been a revolution in cancer therapy, but we still lack a curative treatment for the majority of patients with metastatic (widespread) cancer. Johanna Olweus was in November 2019 awarded an ERC Consolidator Grant, as the only Norwegian in the Life Science category. The grant (2 million Euro over 5 years) will be used to carry out the project "Outsourcing cancer immunity to healthy donors". It was during her residency as a medical doctor at Oslo University Hospital, that Olweus first conceived the idea behind her innovative research. Learning transplantation immunology made her realize that organ rejection triggers powerful immune responses that can be used in cancer treatments.

"We have shown that we can utilize this mechanism to reject cancer cells in the laboratory" says Olweus. Her research group selects T cells with anti-tumor reactivity from the T cell repertoires of healthy donors. T-cell receptors (TCRs) from such T cells can be used in gene-therapy of cancer in a similar way as CAR T cell therapy. The advantage of TCRs from healthy donors is that they are independent of co-evolution with the patient cancer cells, making patient T cells insufficient.

Researchers are faced with two main challenges when improving T cell therapy. The first is to identify new targets that are abundant in the cancer cells and can be safely targeted. The second is to identify immune receptors that recognize the targets with high efficacy and precision. Olweus` research aims to answer both of these challenges.





Precision Cancer Medicine at OUS Comprehensive Cancer Centre

Kjetil Taskén, Chair, CCC PCM Working Group The Cancer Precision Medicine Working Group (Jan-Sept 2019) has consisted of Tormod Guren (Onc), Ragnhild Lothe (ICR), Per Magnus Mæhle (CCC), Hege Russnes (ICR/Pat), Gunnar Sæter (CCC), and Kjetil Taskén (ICR, chair) and with Live Fagereng (ICR) as secretary. From Oct 2019 the CCC PCM Working Group consists in addition to the above members of: Monica Cheng Munthe-Kaas (Ped), Nils Tore Vethe (ClinPharm), Ben Davidson (Pat), Espen Enerly (CRN), Åslaug Helland (Onc/CCC), Yngvar Fløysand (Hem), Kristina Lindemann (GynOnc), Turid Vetrhus (Rad), Torunn Berge (HSE, observer)

The implementation of genomic medicine and individualised treatment has been lagging behind in Norway and other countries in Northern Europe with publicly funded health care systems. However, patients expect access to both molecular cancer diagnostics and availability of state-of-the-art individualised treatment as part of the standard-of-care or as experimental treatment. Furthermore, the Ministry of Health has instructed the Norwegian health care system to act on demand and start working with implementation strategies for precision cancer medicine (PCM). Against this backdrop, the Head of the Division for Cancer Medicine and Chair of the OUS Comprehensive Cancer Centre appointed a PCM working group[1] that started its activities in January of 2019. The working group decided to make a concrete plan for PCM implementation and delivered the results of its work to the Division and the CCC Board in June 2019. The plan set out a vision and objectives and identified main action points necessary for implementation of PCM.

Vision and objectives for implementation of precision cancer medicine

- Patients who are referred to OUS with cancer and where advanced molecular cancer diagnostics will be instrumental for selection of treatment should be offered such diagnostics at the right time during the course of the disease.
- Cancer patients should have opportunity to receive individualised treatment where this is shown to impact on clinical outcome or where it is probable that it would give patient benefit.
- OUS will learn and build competence in advanced molecular cancer diagnostics and individualised treatment and contribute to development and production and dissemination of knew knowledge in this area.

1 The Cancer Precision Medicine Working Group (Jan-Sept 2019) has consisted of Tormod Guren (Onc), Ragnhild Lothe (ICR), Per Magnus Mæhle (CCC), Hege Russnes (ICR/Pat), Gunnar Sæter (CCC), and Kjetil Taskén (ICR, chair) and with Live Fagereng (ICR) as secretary.

Action points necessary for implementation of PCM, three main areas:

I. Establishment of a platform that can provide advanced (experimental) molecular cancer diagnostics. Develop such service also in the standard process to examine and diagnose patients.
II. Increase the volume of clinical trials and number of patients in trials in the precision medicine area (industry studies, researcher-initiated trials). Phase IV studies
III. Offer individualised cancer treatment in the ordinary standard of care in OUS according to national and international guidelines.

In the spring of 2019, the Division for Laboratory Medicine responded to the needs of the cancer area with respect to action points I and II (above) and decided to establish a Section for Experimental Diagnostics and Research Support in the Department of Pathology to provide a genomic medicine platform to ensure delivery of necessary molecular cancer diagnostics (Head Hege Russnes). The CCC PCM working group also on behalf of the CCC in June organized a national meeting on implementation of advanced molecular cancer diagnostics,

In the fall of 2019, the PCM working group was reinforced and expanded[2] and now reports directly to the CCC Governing Board. The work has next focussed on attracting PCM clinical trials (action point II). Specifically, the CCC PCM working group has looked at the possibility of establishing a national PCM trial modelled on the DRUP study in the Netherlands (National Coordinator and PI, Åslaug Helland). The work has involved raising national support, discussion with key stakeholders, planning of a public-private partnership with industry participation and national consensus as well as organising a second national meeting in January 2020.

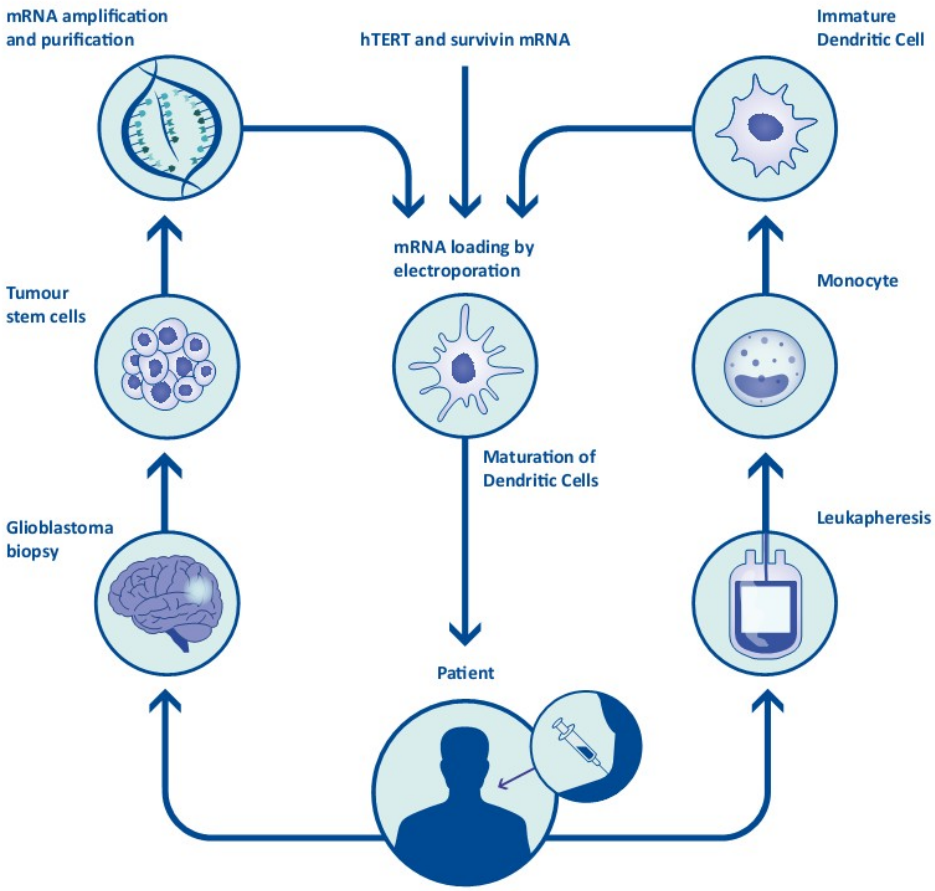
2 From Oct 2019 the CCC PCM Working Group consists in addition to the above members of: Monica Cheng Munthe-Kaas (Ped), Nils Tore Vethe (ClinPharm), Ben Davidson (Pat), Espen Enerly (CRN), Åslaug Helland (Onc/CCC), Yngvar Fløysand (Hem), Kristina Lindemann (GynOnc), Turid Vederhus (Rad), Torunn Berge (HSE, observer)

A personalized vaccine therapy of patient with malignant brain cancer (DEN-STEM)

Glioblastoma is the most common and malignant form of brain cancer. The standard treatment for this cancer is maximal safe resection, followed by radio- and chemotherapy. Despite this, prognosis is poor.

We are currently performing an early phase randomized trial exploring the therapeutic potential of a vaccine therapy. The study is use well characterized patient-specific cancer stem cell cultures derived from brain tumor biopsies. These cultures have been adapted to the strictly regulated clinical grade culturing conditions to allow for clinical use. These tumor cells contain a pool of tumor-promoting antigens that is not presented properly to the patient's immune system. By harvesting white blood cells from the patient and educating these cells outside the body, theses immune cells can become aware of these signals and start an immune response. These educated immune (dendritic) cells are given back to the patient as a vaccine. This study includes 60 patients randomized 1:1 to receive standard treatment or the vaccine therapy (Clinicaltrials.gov ID: NCT03548571).

The study is collaboration between the Vilhelm Magnus laboratory, Department of Neurosurgery, and the Section of Cell Therapy, Clinical Cancer Research and Neuro-oncology, Department of Clinical Oncology.



Durvalumab After chemoRadioTherapy (DART)

for stage III NSCLC patients – a phase II translational and biomarker study – the DART-trial

Lung cancer is one of the most common malignant diseases and the most common cause of cancer-related deaths. In Norway, 3214 new cases were diagnosed and 2234 patients died from lung cancer in 2017 (Cancer registry in Norway). Approximately one third of patients with non–small-cell lung cancer (NSCLC) have stage III, locally advanced disease at diagnosis (Auperin et al 2010). The standard of care for patients with a good performance status is platinum-based doublet chemotherapy concurrent with radiotherapy (chemoradiation) (nlcg.no). This treatment cure some patients, however, the median progression-free survival is poor (approximately 8 months), and only 15% of patients are alive at 5 years (Antonia et al 2017).

A recent study (PACIFIC) revealed superior outcome for patients treated with durvalumab as consolidation treatment after chemoradiation (Antonia et al 2017). The median progression-free survival from randomization was 16.8 months with durvalumab versus 5.6 months with placebo. The benefit was found in the intention to treat-population, and PD-L1 expression was not a good predictive biomarker.

As of today, we have no robust predictive biomarkers for response or resistance. In the DART-study, we will investigate biological material from patients treated with durvalumab after chemoradiation. Several analyses will be performed to identify predictive biomarkers, and to increase the understanding of the biology underlying response and resistance. This clinical study will include 100 patients, and is supported by KlinBeForsk. Tumour microenvironment, plasma biomarkers, tumour mutational burden and immune responses in blood samples are among the planned analyses in addition to microbiome changes and PET-CT analyses.

PI Åslaug Helland
Sponsor OUS, NCT04392505

ImPRESS - Imaging Perfusion Restrictions from Extracellular Solid Stress

An open-label, single institutional phase II trial of losartan with an individual stepped-wedge, randomized, assessor-blinded, dose-finding design on three indications

ClinicalTrials.gov Identifier: NCT03951142
Study period:
2019-10-01 to 2023-12-31

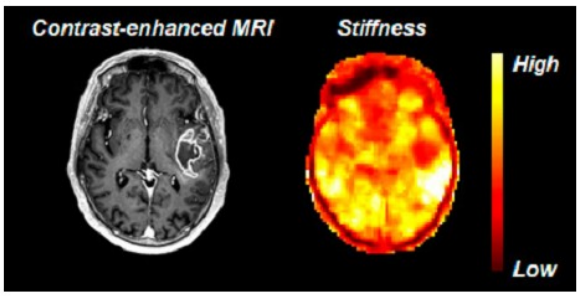
Sponsor:
Division of Radiology and Nuclear Medicine, Oslo University Hospital:

Principal Investigators at Oslo University Hospital:
Kyrre Eeg Emblem, PhD, (Sponsor and Coordinating PI)
Department of Diagnostic Physics, Division of Radiology and Nuclear Medicine

Petter Brandal, MD, PhD, (Clinical PI)
Department of Oncology, Division of Cancer Medicine

ÅslaugHelland, MD, PhD, (Clinical Co-PI)
Department of Oncology, Division of Cancer Medicine

Summary:
Brain cancers include some of the deadliest forms of cancer and the primary goal of treatment is simply to decelerate tumor growth. Still, after decades of research, standard-of-care for most brain tumors only includes surgery, radiotherapy and chemotherapy. A significant challenge of therapy is reduced penetration of anti-cancer drugs from a dysfunctional and impaired tumor vasculature. Oslo University Hospital is currently spearheading an international effort to identify and alleviate impaired perfusion directly in brain cancer patients by targeting the abnormal physical forces of the tumor microenvironment (so-called solid stress). Using a safe and affordable anti-hypertensive medicine, an angiotensin II receptor blocker (ARB), we will remove the physical barriers of the extracellular matrix that prevent anti-cancer drugs from reaching their target. The recently initiated clinical trial, ImPRESS, will explore the potential of the ARB drug losartan to modulate solid stress in patients with brain cancers. The ImPRESS study is a high-profile project funded by national entities, as well as the European Research Council (ERC), and utilizes advanced functional MRI methods including perfusion, diffusion and elastography in patients with glioblastoma and brain metastases from non-small cell lung cancer.



Computational Radiology and Artificial Intelligence in Oncology (prof.Atle Bjørnerud, KRN)

The recently established unit Computational Radiology and Artificial Intelligence (CRAI) aims at bringing AI-based diagnostic tools from research to clinical use, with special focus on the branch of AI referred to as deep learning (DL). We are currently working on using DL for improved tumor segmentation and early detection of tumor recurrence in primary brain tumor patients. Figure 1 shows example of use of DL-based fully automated segmentation of tumor progression at different post-operative weeks. The top and middle rows show native structural MR images visualizing regions of edema (top

row) and contrast enhanced tumor (middle row). The bottom row shows the result of the DL-based segmentation of edema and enhancing tumor, respectively.

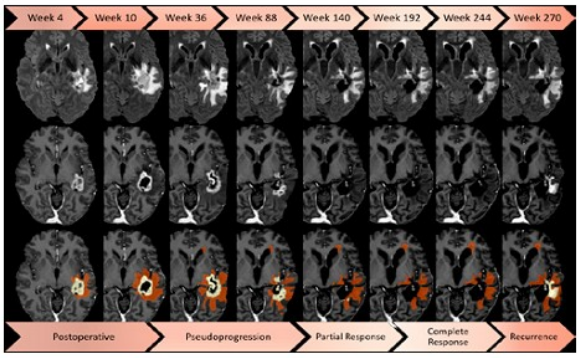


Figure 1. From Vardal et al. ECR 2020

The DL-based segmentation tool is now used in combination with advanced computational radiology techniques with the aim to earlier detect tumor recurrence. Here, we combine DL-based longitudinal tissue segmentation with analysis of 'tissue displacement' as early indicator of disease progression. In figure 2, the bottom row shows the result of tissue displacement analysis, indicating local changes in the area where recurrence is confirmed weeks later by conventional MRI. This research is done in close collaboration with the MRI Research & Technology research group, led by Kyrre Emblem.

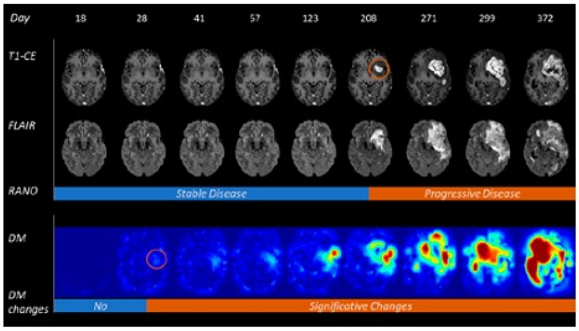


Figure 2. From Fuster et al. Submitted, MICCAI 2020.

Use of Diffusion Weighted imaging in MRI, the important role of imaging tumor hypoxia, quantification of hypoxia grade and use in clinical practice (Ass.prof.Knut Haakon Hole, Radiology Depart. Radiumhospitalet, KRN; OUS)

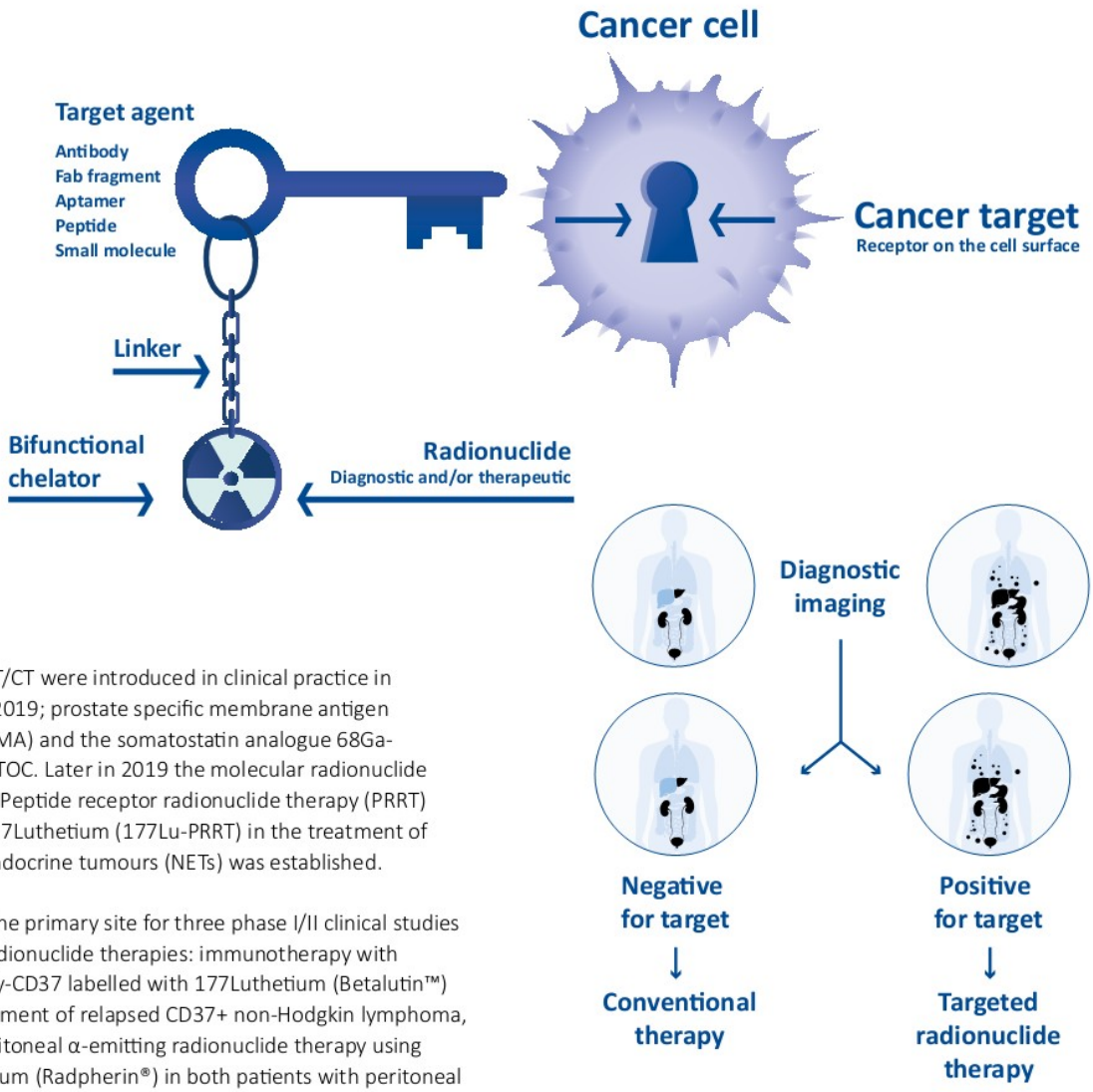
**Combined MR Imaging of Oxygen Consumption and Supply Reveals Tumor Hypoxia and Aggressiveness in Prostate Cancer Patients.*

Hompland T, Hole KH, Ragnum HB, Aarnes EK, Vlatkovic L, Lie AK, Patzke S, Brennhovd B, Seierstad T, Lyng H.

Cancer Res. 2018 Aug 15;78(16):4774-4785. doi: 10.1158/0008-5472.CAN-17-3806.

KRN – Dept of Nuclear Medicine and Research group for Functional and molecular Imaging (Ass.prof. Mona-Elisabeth Revheim)

In recent years, there has been increased interest in the use of molecular radionuclides both in the diagnosis and treatment in different cancers. Two new molecular radionuclide imaging techniques

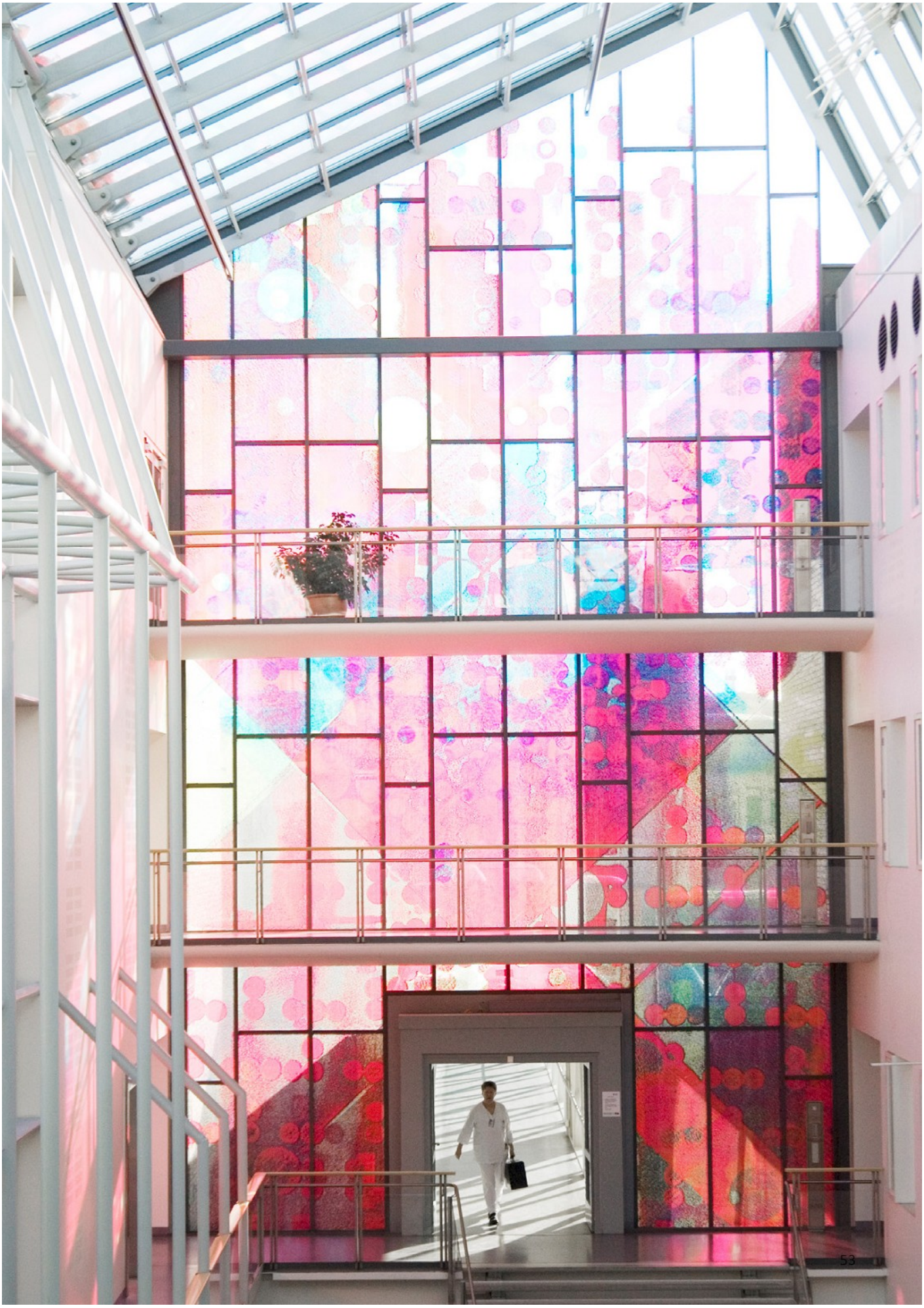


with PET/CT were introduced in clinical practice in OUS in 2019; prostate specific membrane antigen (18F-PSMA) and the somatostatin analogue 68Ga-(DOTA)-TOC. Later in 2019 the molecular radionuclide therapy Peptide receptor radionuclide therapy (PRRT) using 177Luthetium (177Lu-PRRT) in the treatment of neuroendocrine tumours (NETs) was established.

OUS is the primary site for three phase I/II clinical studies using radionuclide therapies: immunotherapy with antibody-CD37 labelled with 177Luthetium (Betalutin™) for treatment of relapsed CD37+ non-Hodgkin lymphoma, intraperitoneal α-emitting radionuclide therapy using 224Radium (Radpherin®) in both patients with peritoneal carcinomatosis from colorectal carcinoma and patients with recurrent epithelial ovarian, fallopian tube or primary peritoneal carcinoma with peritoneal carcinomatosis.

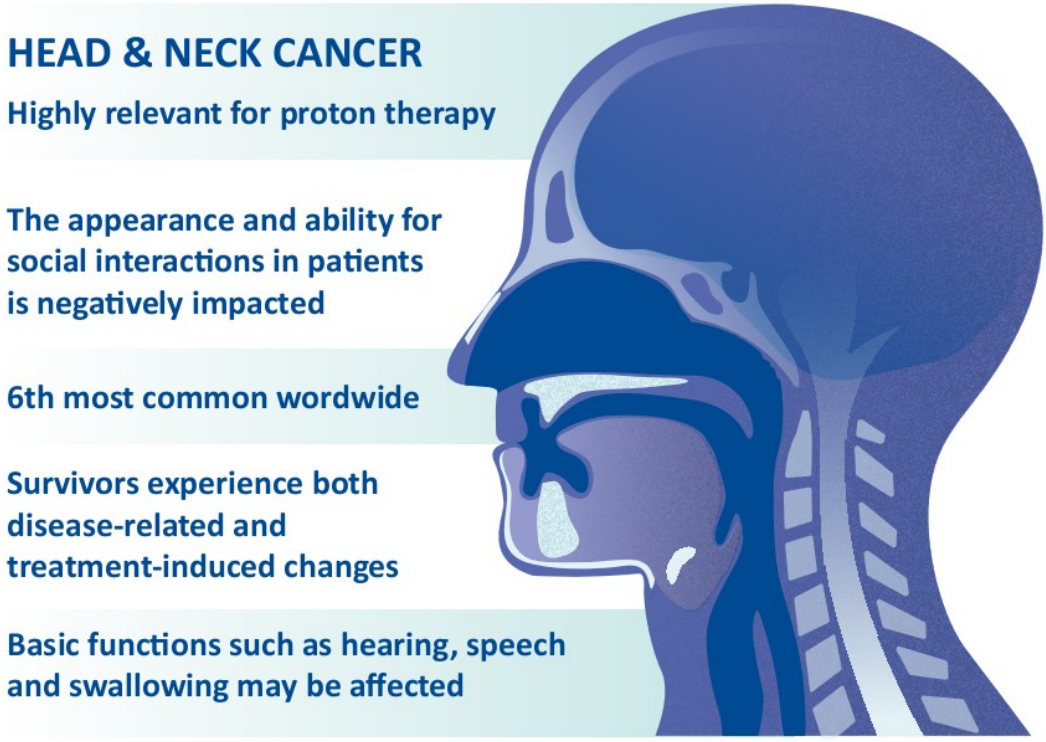
OUS and Division of Radiology and Nuclear Medicine are also responsible for the project: *Theranostic radiopharmaceuticals for metastatic cancer* with further development of novel molecular radionuclide therapies. The overall aim is to improve selection and treatment outcomes for patients with specific molecular phenotypes using molecular imaging with PET/CT to guide molecular radionuclide therapy. Here novel radiopharmaceuticals developed in Norway are studied in collaboration with our industry partners; OncoInvent, Sciencons AS, Nordic Nanovector, Institute for Energy Technology, and The Norwegian Cyclotron Center. Sharing a research vision and thematic interest, our industry partners also support a PhD position and a postdoc position through the Scientia fellowship program Transnational Postdoctoral Mobility Programme for Experienced Researchers in Health Life Sciences (EU Horizon 2020) employed by the University of Oslo, Faculty of Medicine and hosted by Dep of Nuclear Medicine/Division of Radiology and Nuclear Medicine).

Over the last two years, Oslo University Hospital has invested ten million Euro in the latest generation PET and SPECT scanners and related infrastructure. PET imaging is introduced in a rapidly increasing number of clinical settings, and more than four thousand oncological examinations are performed each year. Division of Radiology and Nuclear Medicine has several ongoing clinical studies using PET imaging's unique ability to non-invasively depict molecular activity on a whole-body level allowing early identification of active disease and response to treatment. Furthermore, PET also provides quantitative information of the disease burden and characterizes its biology (metabolism and heterogeneity) within different lesions. By integrating emerging imaging opportunities with image-derived biomarkers (radiomics) and artificial. intelligence, our goal is to contribute to the progress in the field of cancer management and establish a novel PET-based prediction platform.



Protons contra cancer - PROCCA

Radiation therapy is a well-established treatment for many cancer types. Norway will get its first proton therapy center in Oslo in 2023. Proton therapy is more precise in delivering the dose to the patient and is therefore expected to significantly reduce side effects compared to state-of-the-art X-ray therapy. Also, protons deposit their dose in tissue differently from X-rays, and some studies indicate that protons may induce less toxicity per dose. However, the potential benefits of accelerated protons are not fully exploited in current proton therapy. The interdisciplinary life science environment PROCCA[1], supported by UiO:Life Science for 2019-2023, consists of physicists, biologists, oncologists, and psychologists from the University of Oslo and Oslo University Hospital. We will investigate how protons and X-rays induce biological responses resulting in damage to healthy tissue. Moreover, we will study how this in turn affects quality of life for cancer survivors, both on terms of physical and psychological health. Our focus is mainly on head and neck cancer (see figure). The long-term aim is to use protons in a better way to cure more patients, and at the same time ensure high quality of life after treatment.



1 https://www.uio.no/english/research/strategic-research-areas/life-science/research/convergence-environments/procca/

A New Infrastructure for Cell and Gene Therapy

Immunotherapy has become a cornerstone in cancer therapy that includes a broad array of strategies aiming to unleash, direct and boost the patients' own immune system through adoptive transfer of expanded naturally circulating or genetically engineered cytotoxic lymphocytes. Despite the recent clinical breakthroughs, the field is still in its infancy and the potential for identifying new and more effective strategies is huge. The first FDA-approved gene-edited T cell products for lymphoma and leukemia came out on the market only in 2017 and the needs for new therapies targeting resistant cases and other diseases, in particular solid tumors, remains high. On this basis, the OUS recently announced the formation of a strategic research program in cell and gene therapy (Strat-Cell), bringing together a multi-disciplinary team of basic immunologists and physician scientists across several research units and clinical departments at the OUS. In parallel, a new core facility for experimental cell therapy has been formed at the Section for Cell Therapy, Department of Oncology. This new infrastructure will address key logistic and scientific bottlenecks for the clinical implementation of first-in-class armed biological cell therapy drugs. Another major objective is to foster the training of the next generation physician-scientist to lead the clinical trial program within the Strategic Research Area of cell therapy.

Oslo Myeloma Centre

Oslo Myeloma Center (OMC) is a center for clinical research in multiple myeloma and light chain (AL-) amyloidosis. The group consists of 5 secretaries, 2 research coordinators, 8 doctors, 1 lab chief, and 11 study nurses. 3 of the doctors are part-time PhD students, doing registry research and clinical studies. The largest endeavor in 2020 was to move the entire group from Rikshospitalet to new facilities at building 20 in Ullevål hospital. Yet, we managed to enroll what was a group and national record of 119 patients for a cancer disease in a year, in studies within all phases of disease, from phase 1 to phase 4. The biggest accomplishment was to set up the first CAR-T-cell trial for myeloma in the Nordics, which continues to enroll in 2020. We were also able to fully finance the first completely, in many senses of the word, national study in myeloma, REMNANT; established through the newly founded Norwegian Myeloma Association, and discussed in the newly started Norwegian Myeloma Workshops, both entities initiatives from OMC. Through the year, we were part of 7 high-impact papers, and numerous posters and presentations around the Western world. In 2021, we are expecting an even larger activity.

Fredrik Schjesvold

Oslo University Hospital
Comprehensive Cancer Centre
02770

www.oslo-universitetssykehus.no/oslo-university-hospital
E-mail: oushfkreftstyret@ous-hf.no