

Danish Cancer Society Research 2020

ANNUAL RESEARCH IMPACT REPORT





 **Danish Cancer Society**

Editorial staff: Mef Nilbert (Editor-in-Chief)

Mette Vinter Weber and Marianne Vestergaard,
scientific editors for the DCRC

Analyses: Hanne Bødtcher and Linda Aagaard Thomsen

Design and layout: Nanna Berentzen Østergaard

Circulation: 400 copies of DK version, 100 copies of GB version

Printed by: Reklametryk

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Danish Cancer Society research

Through research, the Danish Cancer Society has spent almost 80 years focusing on cancer, supporting those affected by the disease, and promoting the development of new knowledge. Almost two thirds of our budget are spent on research because research is the road to a future without cancer.

The Danish Cancer society is involved in research, from the first discoveries are made in the lab, until new treatments are offered to patients. The efforts include basic research, translational research and clinical research, which combine to help us develop better understanding, diagnostics and treatment of cancer, and offer patients improved lives with and following cancer.

Ever more people develop cancer, and in 2018, 43,000 individuals were diagnosed with cancer in Denmark. Although a growing number of patients survive, we must improve our efforts to combat the disease. That is what motivates the Danish Cancer Society to develop a deeper understanding of this diverse group of diseases that require multidisciplinary commitment to guarantee patients the best possible treatment and quality of life following cancer. Our research approach describes the three pillar strategy that the Danish Cancer Society follows to fulfil the objective of combating cancer. It includes support for the Danish Cancer Society Research Center and research supported via strategic and open calls for applications.

Consequently, we are working with prevention, for new diagnostics opportunities, to discover new therapeutic goals, and to improve patient support and rehabilitation. Our efforts are focused, although they involve a wide range of areas that are necessary to meet the challenges which cancer causes to society and to individual people.

Investing in research makes a difference, and over the years, the Danish Cancer Society has supported generations of Danish cancer researchers. Now, two thirds of the patients who develop cancer in Denmark are alive five years after they were diagnosed. Cancer research has made a considerable and visible difference in the shape of earlier and more accurate diagnostics, improved treatments, etc., meaning that more patients survive, and side effects and late effects are reduced.

The Danish Cancer Society's research support go to both our own research centre, DCRC, and to scientists in hospitals, universities and private research institutions throughout Denmark. Moreover, we support Danish cancer researchers who carry out research abroad and aim to bring their results back to Denmark. Research grants from the Danish Cancer Society reach most of the nation's universities and hospitals. To boost fields of research that are currently underexposed, we set up focused research funds in fields such as rare cancer, cancer in elderly people and health inequality studies.

With overwhelming support from our 47,000+ volunteers and 400,000 members, we reach patients and relatives, and help raise the awareness of cancer and how to prevent it. We share new knowledge and invest in research. We are grateful for the commitment we experience and for all the donations. Together, we can contribute to a better life following cancer and pave the way for a life without cancer.

Happy reading!

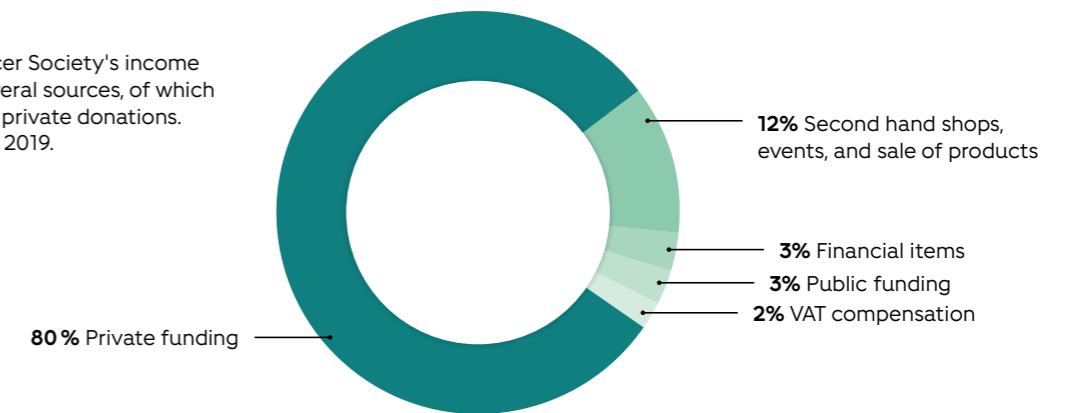
Mef Nilbert
Scientific Director

Jesper Fisker
CEO

Throughout this report, we introduce a series of specifications of the support that the Danish Cancer Society has granted to research and of the support which the Danish Cancer Society Research Center has received. Short travel grants are not included.

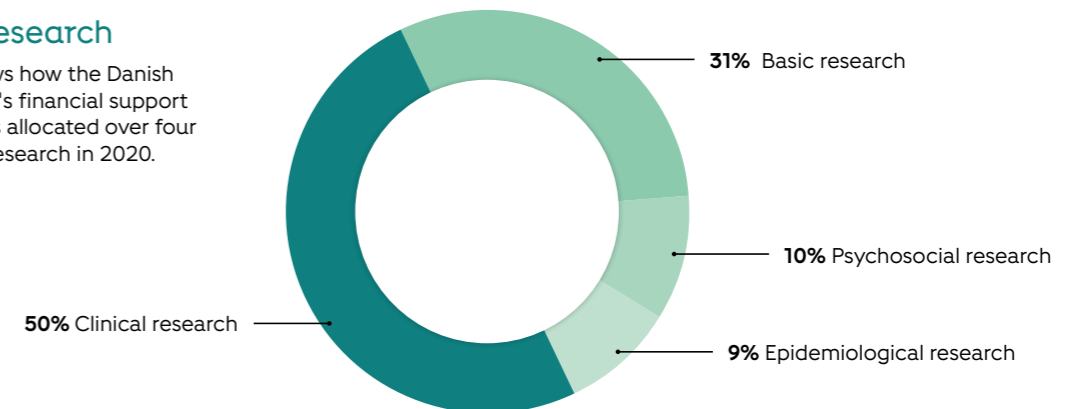
Income

The Danish Cancer Society's income derives from several sources, of which the major one is private donations. The data is from 2019.



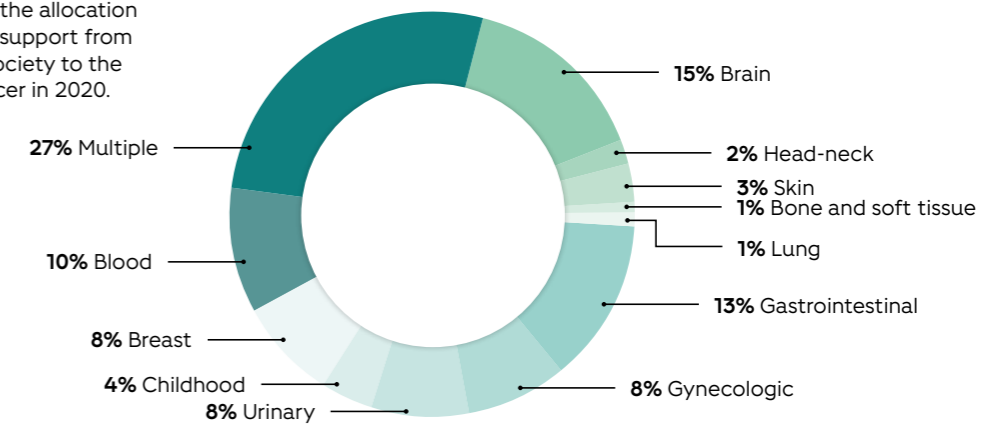
Areas of research

The figure shows how the Danish Cancer Society's financial support to research was allocated over four main areas of research in 2020.



Cancer types

The figure illustrates the allocation of financial research support from the Danish Cancer Society to the various types of cancer in 2020.



THEME

COVID-19

Research during the COVID-19 pandemic

2020 was the year in which COVID-19 changed the everyday lives of people throughout world. In Denmark, everything changed on 11 March when Prime Minister Mette Frederiksen locked down the nation. Cancer patients and researchers were also affected, leading to both challenges and opportunities.

If anything, the COVID-19 pandemic has shown us the importance of science. In 2020, we benefited from new COVID-19 testing methods and from new treatments and vaccines against the disease. In 2021, we hope that research can contribute to ending the pandemic.

Research is based on networking and exchange of ideas through national and international cooperation, but in 2020, everybody's everyday lives changed. Scientists' highly important seminars, workshops

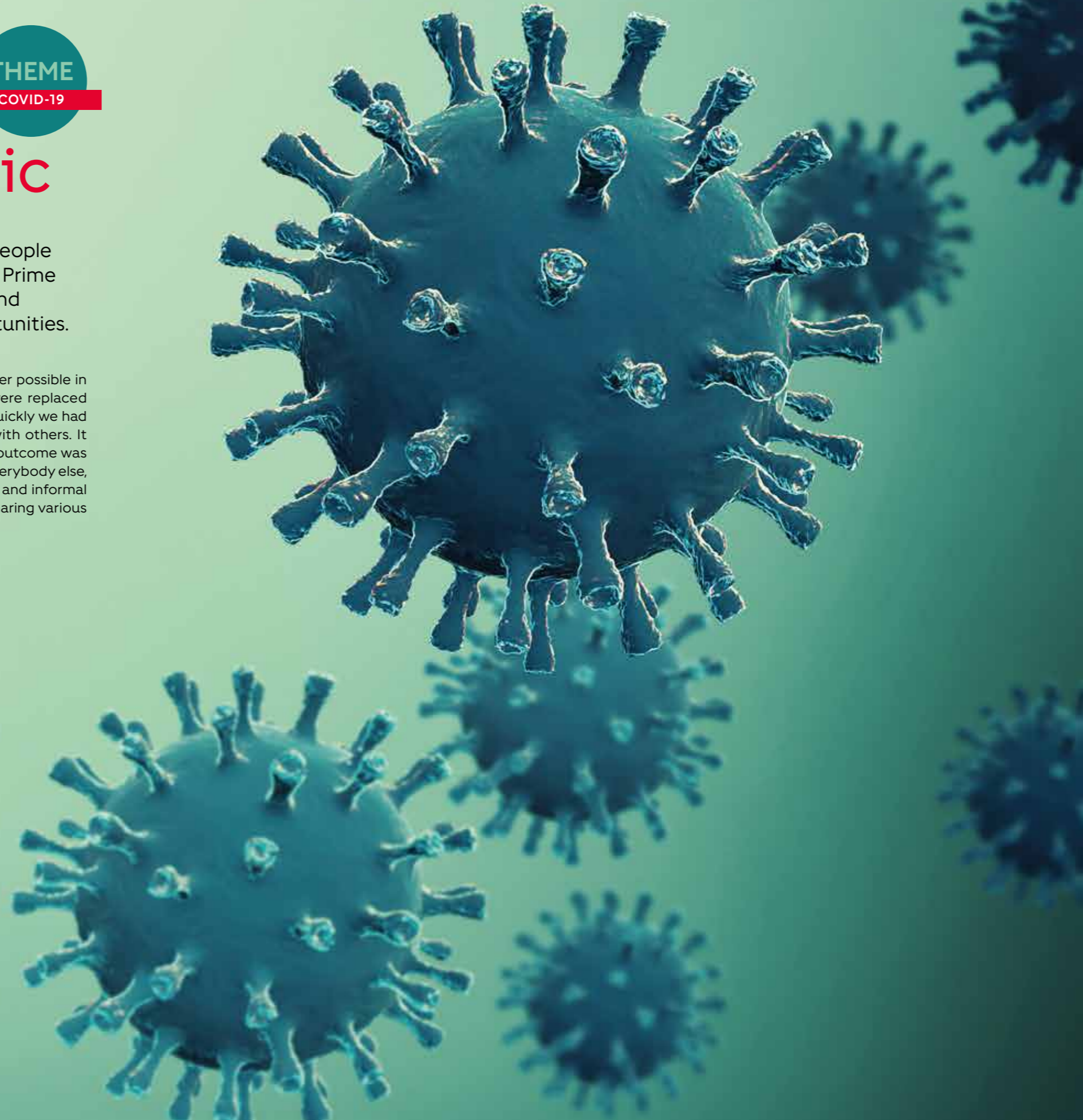
and conferences were suddenly no longer possible in the familiar formats. Overnight, they were replaced by online video conferences, and very quickly we had to find new ways of being in contact with others. It was an impressive adjustment, and the outcome was efficient and functional. However, like everybody else, scientists missed the personal meetings and informal talks about ideas, interpretations, and sharing various results.

Worrying drop in new cancer diagnoses during the COVID-19 crisis

Danish Cancer Society scientists have shown that in March-May 2020, approximately 33 % fewer cancer diagnoses were made as compared to the average of the same period over the previous five years; a reduction corresponding to about 2,800 fewer new diagnoses.

– There is no reason to believe that fewer people developed cancer, rather it is probably the result of the disease being discovered in fewer people, and that is worrying, says postdoc Charlotte Wessel Skovlund from the Cancer Surveillance and Pharmacoepidemiology research group, who headed the study.

The results are published here: Skovlund CW. et al.: Hidden morbidities; Drop in cancer diagnoses during the COVID-19 pandemic in Denmark. Acta Oncologica. Published online 2020, Dec 07



A good balance

The Danish Cancer Society Research Center's research continued during the COVID-19 crisis in the spring, and good solutions to the challenges of working from home and in labs were found.

Like in hundreds of other workplaces, the scientists of the Danish Cancer Society Research Center also had to work from home as well as they could to contribute to slowing down the spread of infection.

Major challenges were suffered by scientists working in labs where cancer cells constantly required attention. The most critical experiments were continued to avoid months of work being wasted. Scientists worked shifts, kept a distance, and used hand disinfectants and plastic gloves to prevent the spread of coronavirus infection.

One of the lab scientists, Giuseppe Filomeni, is the head of the Redox Signaling and Oxidative Stress research group.

– We have cell models, the cultivation of which takes a long time, and some of them are unique. We had to attend to them or they would die, and some of them would be impossible to recreate, says Giuseppe Filomeni.

A lot of research could be done from home, and much effort was put into finding solutions that would make the workday a good one. The Danish Cancer Society Research Center scientists come from 26 different coun-



The scientists of the Computational Biology group met every day via Zoom. Photos from the group's Instagram profile

tries, including Italy and Spain, that were badly affected by the COVID-19 pandemic in the spring, making it difficult to be far away and worry about one's family without being able to go home.


One of them was Elena Papaleo, the head of the Computational Biology group. She is from Northern Italy and was in contact with her parents every day to learn how they were doing. The Computational Biology researchers carry out most of their work by using computers to



Giuseppe Filomeni in the lab during the lockdown in the spring. Photo: Danish Cancer Society

analyse major quantities of data. In the spring, they met online every day, sharing a cup of coffee in front of their individual computer screens and trying to create daily routines together so nobody felt isolated, though they were all working from home.

– One of our employees normally makes lab experiments, but we ended this and chose that we all worked on the same project from home. That contributed to creating a sense of community, says Elena Papaleo.



Scan the QR code with your smartphone's camera to watch and hear Giuseppe Filomeni talk about research during the COVID-19 pandemic.

NEW PROJECT IN 2020 + RESULT FROM 2020

Patients with haematological disorders are particularly vulnerable to COVID-19

A Danish study demonstrates for the first time what the outcome is for patients with haematological malignancies, who get sick with COVID-19. The research results emphasise the importance of patients paying attention to even mild symptoms.

When the coronavirus struck Denmark, its effect on cancer patients was unknown. Haematology researchers quickly coordinated a study of the risk suffered by such patients. Based on 66 Danish patients with haematological disorders who were diagnosed with COVID-19 in the spring of 2020, the scientists recorded the number of patients admitted to intensive care and the number who remained alive after one month. The study shows that 21.2 % of the patients were admitted to intensive

care, and 24.2 % of the 66 patients died during their hospitalisation. Those numbers are much higher than the average risk suffered by other COVID-19 patients, and they provide important insights concerning the importance of protecting patients.

The scientists also observed that about 20 % of the patients of the study who had been infected with coronavirus, did not run a fever.

– This demonstrates that it is important that patients with haematological disorders pay attention to even weak symptoms of COVID-19 and get in touch with their doctor, even though they do not run a fever, etc. The combination with another disease could lead to the symptoms of COVID-19 being different for these patients than for others, says Henrik Frederiksen.

He is a professor and Consultant at Odense University Hospital and headed the study, which was carried out in cooperation with all haematological departments in Denmark.

The scientists will continue to collect data about patients with haematological disorders who are infected with COVID-19. The results of the complete study are expected in 2021.

The results are published here: Glenthøj A. et al.: SARS-CoV-2 infection among patients with haematological disorders: Severity and one-month outcome in 66 Danish patients in a nationwide cohort study. Eur J Haematol. 2020, Sep 29



The Danish Cancer Society supports the research

The project 'Novel Coronavirus infection in patients with haematological disorders' received DKK 150,000 from the Danish Cancer Society in 2020.



We would like to know how patients and their relatives have perceived the introduction of phone consultations. The patients have accepted it because they understand the background, but what are the drawbacks? And how can we do better?

Susanne Dalton, Professor, Danish Cancer Society Research Center, head of the Danish Research Center for Equity in Cancer (COMPAS).

NEW PROJECT IN 2020

The COVID-19 crisis could stimulate online doctor consultations – new research looks into pros and cons

Zealand University Hospital chose to carry out a large proportion of cancer patients' doctor consultations over the phone to reduce the risk of infection. Scientists are investigating if something can be learned from the practice.

Zealand University Hospital's Department of Oncology quickly decided to replace a large proportion of doctor consultations with phone consultations to reduce the risk of infection with coronavirus. Instead of going to the hospital, the patients received a call from their doctor. The new approach did not include consultations with newly diagnosed cancer patients who were to be informed of their treatment, if they were to receive treatment, or if the doctor needed to feel a cancer tumour, etc. But other consultations such as follow-ups or results of blood tests or scans were moved to phone consultations. Is this good enough, and can we learn something to the benefit of future cancer patients? Scientists are investigating this under the direction of Professor Susanne Dalton from the Danish Cancer Society Research Center, and who is the head of the Danish Research Center for Equity in Cancer (COMPAS).

– We would like to know how patients and their relatives have felt about the introduction of phone consultations. The patients have accepted it because they

understand the background, but what are the costs? And how can we do better?, she asks.

Head Consultant Mads Nordahl Svendsen from Zealand University Hospital's Department of Oncology adds:

– It is important to follow up on the development during the COVID-19 crisis, preferably enabling us to offer patients a new and more flexible procedure. Perhaps it could even be easier to go to work during cancer treatment because patients do not need to spend a lot of time on transportation and waiting, he says.



Collaborating researchers

The research is carried out in cooperation between Zealand University Hospital's Department of Oncology and Palliative Units, the Danish Cancer Society, the Danish Research Center for Equity in Cancer (COMPAS), and Changing Cancer Care that aims to improve cancer treatment via patient involvement.

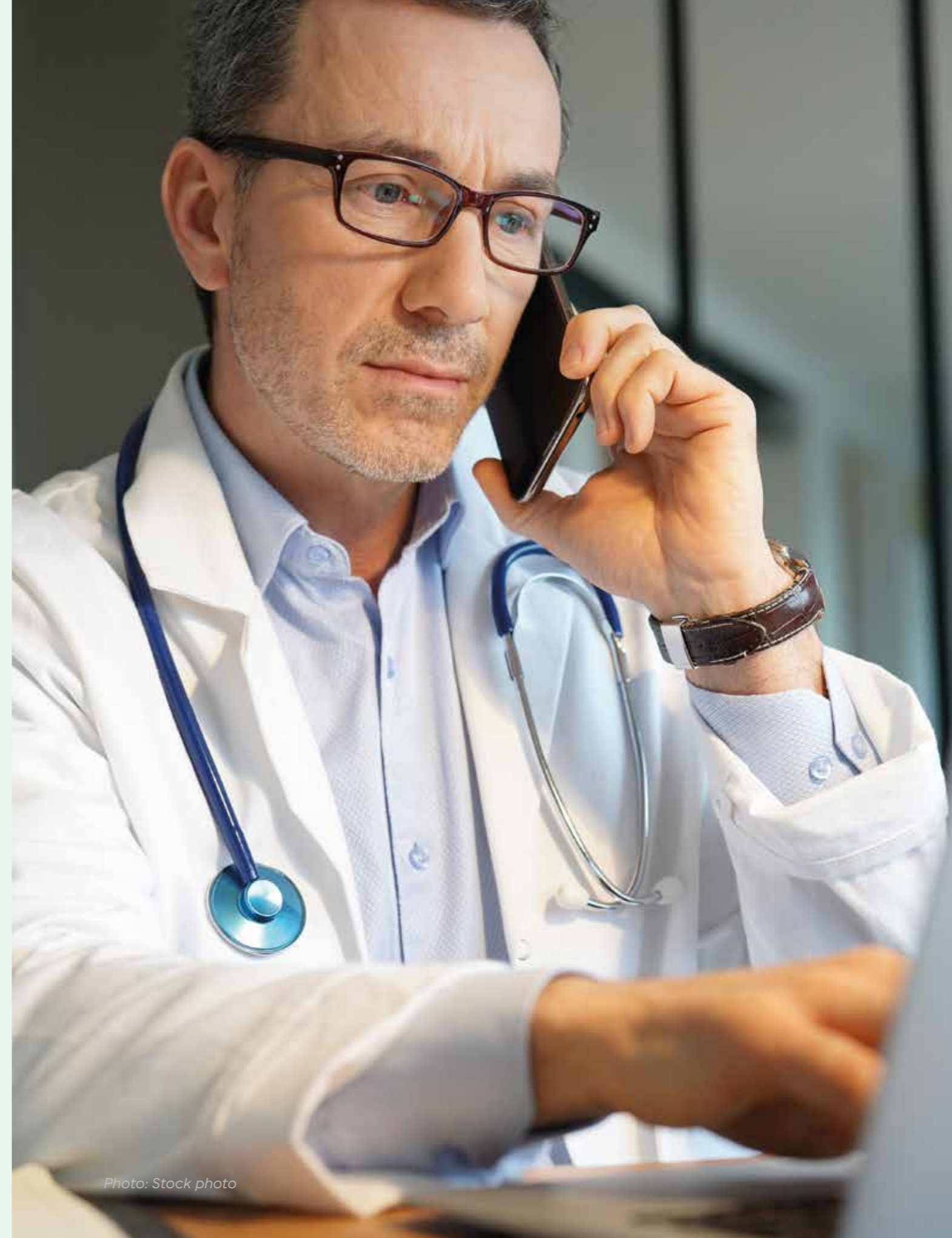


Photo: Stock photo



Danish Cancer Society Research Center

The Danish Cancer Society Research Center is the Danish Cancer Society's intramural research centre. It is a powerful research environment with proud traditions going back to the 1940s when the Danish Cancer Registry was founded, and the Fibiger Institute initiated tumour biology research.

In addition to biological research, the research carried out by the Danish Cancer Society Research Center now includes fields such as prevention, personalised medicine and survivorship perspectives. The research efforts are based on ground-breaking research programmes and access to unique technologies, records, and population studies in order to use the funds from our donors in the best possible way.

A multidisciplinary and multicultural research environment

The Danish Cancer Society Research Center employs about 250 scientists and students from 26 nations, who publish some 300 scientific articles annually. The research includes the discovery of molecules and mechanisms involved in DNA repair and cell signalling, identification of cancer risk factors, biomarkers for early diagnostics, new treatments using existing drugs, and inequality in cancer treatment and survival.

Cooperation across fields and research groups is in focus because it allows innovative thinking and learning from each other to find new ways of meeting challenges. Several research group leaders also work for Danish universities to improve cooperation, supervision of young researchers, and knowledge sharing within the academic environments.

Important research is one of the centre's cornerstones, so the efforts are focused on key areas and on identifying new areas in which development is required. An international scientific advisory board consisting of six leading researchers advises the centre management and contributes to regular evaluation to ensure high research quality, and offers advice about strategic developments

in line with the centre's strategy. The members of the scientific advisory board come from France, the Netherlands, the UK and Sweden, and the next time they visit the Danish Cancer Society Research Center is in February 2021.

The Danish Cancer Society Research Center is also responsible for training future cancer researchers in an attractive educational environment, and every year, new students and researchers with various educations and fields of research are welcomed. The postdoctoral and PhD student communities contribute to creating an environment that encourages knowledge sharing and the development of social relations, and they contribute to the planning of research days, seminars and new formats of research presentation.

As a research centre of Denmark's biggest NGO, the Danish Cancer Society Research Center has, moreover, a special responsibility to cooperate with patients and society.

One of the Danish Cancer Society Research Center's important aims is that the results of the research reaches the patients. This is achieved by hosting workshops together with clinicians, establishing translational cooperation, and improving academic clinical networks. As a research centre of Denmark's biggest NGO, the Danish Cancer Society Research Center has, moreover, a special responsibility to cooperate with patients and society. In the course of the year, this has led to the foundation of a patient and relatives panel, which is

described on page 29.

The Danish Cancer Society Research Center has a special responsibility to communicate research and a clear expectation that scientists contribute to sharing new knowledge both in the research community and in society as such.

Learn more about the Danish Cancer Society Research Center at www.cancer.dk/research.

Danish Cancer Society Research Center areas of research



Risk factors, prevention, early diagnosis

Cancer Surveillance and Pharmacoepidemiology
Lina Steinrud Mørch

Diet, Genes and Environment
Anne Tjønneland

Nutrition and Biomarkers
Anja Olsen

Molecular Diagnostics
Per Guldberg

Work, Environment and Cancer
Ole Raaschou-Nielsen

Virus, Lifestyle and Genes
Susanne Krüger Kjær

Lifestyle, Reproduction and Cancer
Allan Jensen

Lifestyle, Genes and Breast Cancer
Lene Møllekjær



Molecular mechanisms, biomarkers, new treatments

Cell Stress and Survival
Francesco Cecconi

Redox Signaling and Oxidative Stress
Giuseppe Filomeni

RNA and Autophagy
Lisa Frankel

Genome Integrity
Jiri Bartek

DNA Replication and Cancer
Apolinar Maya-Mendoza

Nucleolar Stress and Disease
Dorthe Helena Payne-Larsen

Cell Death and Metabolism
Marja Jäätelä

Membrane Integrity
Jesper Nylandsted

Invasion and Signaling
Tuula Kallunki

Cell Division and Cytoskeleton
Marin Barisic

Computational Biology
Elena Papaleo



Precision medicine, social inequality, survivorship

Childhood Cancer
Jeanette Falck Winther

Translational Cancer Genomics
Zoltan Szallasi

Psychological Aspects of Cancer
Pernille Envold Bidstrup

Survivorship and Inequality in Cancer
Susanne Oksbjerg Dalton

Cancer surveillance and drug research

Lina Steinrud Mørch is the head of the Cancer Surveillance and Pharmacoepidemiology group of the Danish Cancer Society Research Center. The researchers in this unit base their work on two registries in particular.

The Danish Cancer Registry is an inexhaustible source of knowledge about cancer in Denmark. How many people develop cancer, which types of cancer do they develop, how many survive cancer?, etc. The registry is therefore an important tool for the Cancer Surveillance and Pharmacoepidemiology scientists, who cooperate with the Danish Health Data Authority about cancer surveillance based on the registry.

– The Danish Cancer Registry is very central to the Danish Cancer Society's research in cancer epidemiology. It includes Danish cancer data in black and white, indicating the development in the field of cancer. That is not least true for cancer survival data, which is an excellent indicator of the state of cancer treatment in a nation, says Lina Steinrud Mørch, who heads the Cancer Surveillance and Pharmacoepidemiology research group.

Lina Steinrud Mørch and her colleagues also cooperate with international organisations about cancer data comparisons, not least via the cancer statistics database of NORDCAN, which includes data from all Nordic cancer registries.

– Comparisons of cancer survival have been crucial to the fact that society has chosen to allocate major resources to the cancer field. 20 years ago, cancer survival in Denmark was lower than that of the other Nordic countries, but now we almost match them, says Lina Steinrud Mørch.

According to a study from 2020, in which Lina Steinrud Mørch and Senior Statistician Gerda Engholm participated, cancer survival has improved in all Nordic countries, but Denmark boasts the by far greatest improvement.

Drugs and cancer

Another registry that is also central to the work of the Cancer Surveillance and Pharmacoepidemiology group is the Medicines Registry that includes information about all patients' purchases of drugs in Danish pharmacies. When data from the Medicines Registry is combined with the Danish Cancer Registry, it could provide new knowledge about the relationship between the use of drugs and cancer incidence and prognosis. Sci-

Lina Steinrud Mørch



entists from the group have demonstrated that existing drugs such as antabuse and aspirin seem to be able to prevent some cancer types. Unfortunately, there are also drugs that could increase the risk of cancer, such as hormones. Lina Steinrud Mørch has contributed to demonstrating this.

One of the research group's important tasks is to research both beneficial and harmful effects of the drugs consumed by Danes. Senior Researcher Søren Friis cooperates with scientists from all over Denmark to develop a tool that can screen all drugs for potential beneficial effects on cancer survival.

The results are published here:

Lundberg FE et al.: Trends in cancer survival in the Nordic countries 1990-2016: the NORDCAN survival studies. Acta Oncologica 2020, Oct 19

Støer NC et al.: Drug use and cancer risk: a drug-wide association study (DWAS) in Norway. Cancer Epidemiol Biomarkers Prev. 2020, Nov 3

Skriver C et al.: Associations of low-dose aspirin or other NSAID use with prostate cancer risk in the Danish Diet, Cancer and Health Study. Cancer Causes Control. 2019, Dec 10



Two registries are particularly central to the Cancer Surveillance and Pharmacoepidemiology group: the Danish Cancer Registry and the Medicines Registry. Photo: Das Büro

Experts on cells' transport systems

Marin Barisic



Marin Barisic is the head of the Cell Division and Cytoskeleton group of the Danish Cancer Society Research Center. The scientists study transport routes in cell interiors that play an important role to ensure normal cell division.

When a cell divides, it must copy the genetic material in its nucleus and distribute it very accurately to each of the two new cells. The cell uses a microtubule network that functions as a kind of "rail tracks". The genetic material follows the tracks during division so it is placed correctly in the cell.

Microtubule errors could play a role in cancer, and the Cell Division and Cytoskeleton group researches why the "rail tracks" of some cancer cells have a series of changes. This has been observed in aggressive breast cancer and neuroblastomas.

In 2020, scientists once again taught us a little more about how microtubules work. Microtubules move in a flux towards opposite sides of the cell, when they divide, but how or why it happens has so far been unknown.

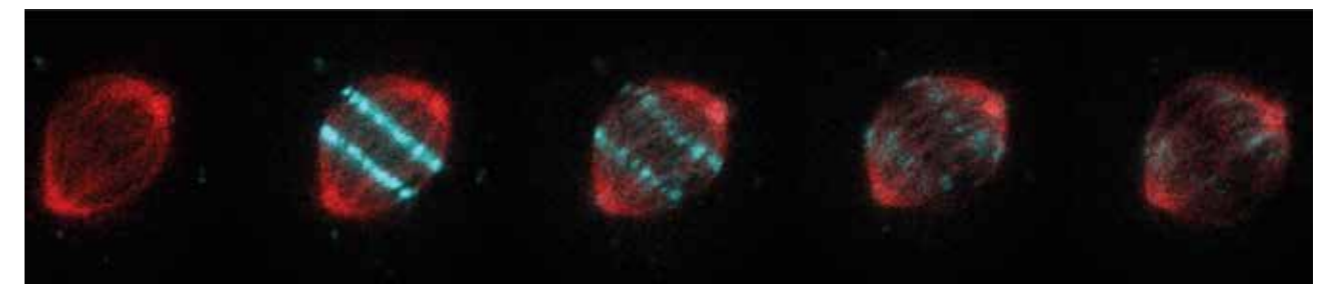
– The motion happens to regulate the length of the rows of microtubules that make up the rail tracks in a cell for the transport of the genetic material. And the motion takes place thanks to carefully coordinated interaction between four motor proteins known as kinesines. The motor proteins move along microtubules, organising them to ensure that the cell division takes place without errors, says Marin Barisic.

In the future, knowledge about how microtubules and the associated motor proteins work could lead to improved treatments. Several types of chemotherapy work by affecting the microtubules. Unfortunately, micro-

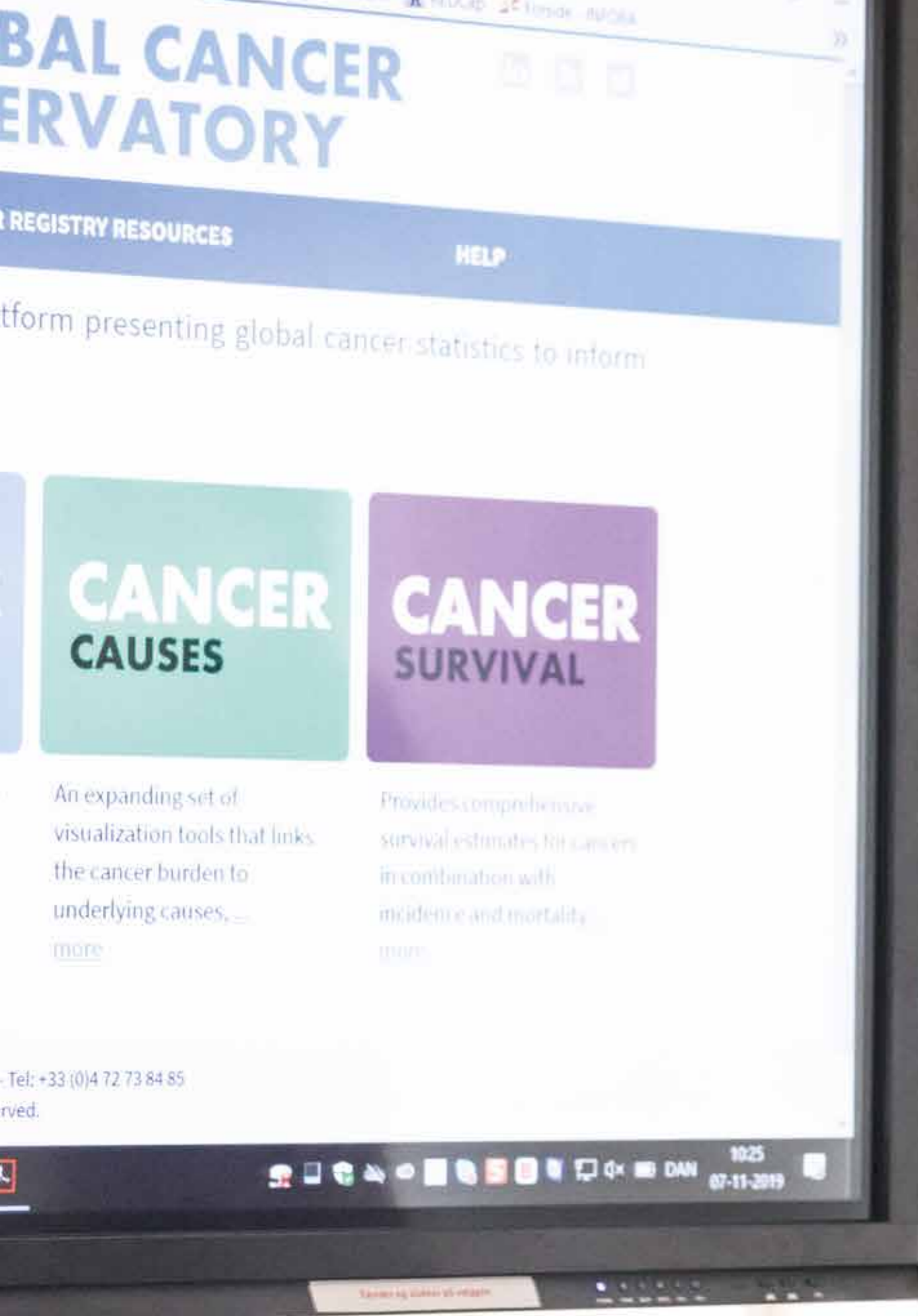
tubules are also important transport molecules of nerves, and so, some types of chemotherapy cause nerve damage, such as a tingling and pricking sensation in fingers and toes, intestinal problems, pain or numbness.

– We hope that it might be possible to develop treatments that cause fewer side effects because they do not affect the entire microtubule network, rather perhaps only specific parts of it, or the system around it, says Marin Barisic.

The results are published here: Steblyanko Y et al.: Microtubule poleward flux in human cells is driven by the coordinated action of four kinesins. EMBO J. 2020, Oct 19



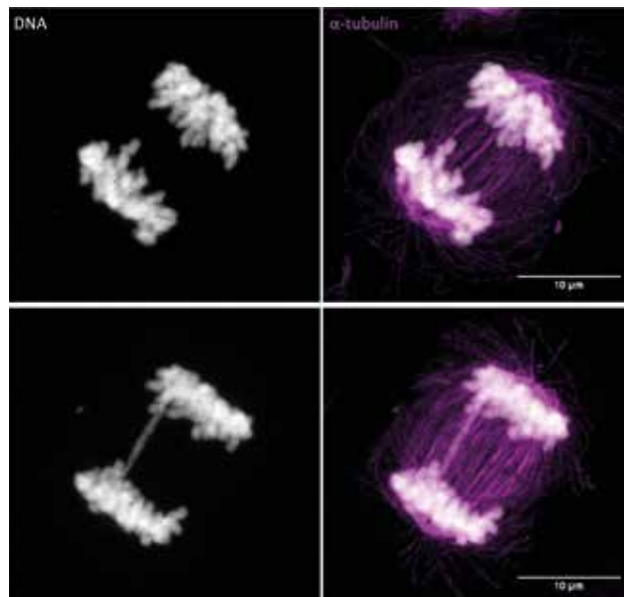
The image shows a cell that divides as observed through a microscope. The blue colour indicates how microtubules move towards the sides of the cell. Photo: Yulia Steblyanko



Results from 2020

In 2020, scientists from the Danish Cancer Society Research Center published 322 scientific articles. The results span from basic research and epidemiology to clinical trials.





Images of a cell that is dividing as observed through a microscope. In the top images, the new and the old copies of the DNA are correctly separated. In the bottom ones, the effect of the lysosomes is obstructed, and the two copies remain linked. Photo: Jonathan Stahl



We have developed a brand new understanding of what happens when cells divide

Marja Jäättelä,
Professor and Research Unit Head,
Danish Cancer Society Research Center.

RESULT FROM 2020

A puff of acid is vital for healthy cells

Several chapters of biology textbooks need to be revised after scientists from the Danish Cancer Society Research Center discovered an unknown mechanism of cell division that could become important to the research of a number of diseases.

Research is typically about finding the answers to unresolved questions, but the new research from the Danish Cancer Society adds new knowledge within a field that was believed to be broadly under control: cell division.

Thanks to a brand new method developed by the scientists themselves, they demonstrate the existence of an unknown stage of cell division, which involves lysosomes – tiny organelles packed with acid and enzymes, that have a kind of janitor function, making sure that cell waste is broken down.

The research demonstrates that during cell division, the lysosomes place themselves close to the cell nucleus, and for a few seconds, they deliver a puff of the

enzymes they contain. This probably happens to make sure that the enzymes can cut up parts of the new and old copies of the DNA which remain linked. Without the accurate puff, the separation might take place before the cell is ready for it, and that could cause DNA rupture, which might cause diseases such as cancer.

– We have developed a brand new understanding of what happens when cells divide. It might have an impact on the research of a series of diseases, from cancer that could be due to DNA division errors to neurological diseases caused by cell lysosome errors, explains Professor and Research Unit Head Marja Jäättelä from the Danish Cancer Society Research Center, who is responsible for the new research together with her colleagues Jonathan Lucien Stahl and Saara Hämälistö.

The results are published here: Hämälistö S. et al.: Spatially and temporally defined lysosomal leakage facilitates mitotic chromosome segregation. Nature Communications 2020, Jan 13

Cancer and ageing causes

Research from the Danish Cancer Society's Genome Integrity research unit provides new and unexpected knowledge about how cells repair damage to genes that could develop into cancer. The knowledge can also help us understand what happens when we get older.

Lamins have been the focus of scientists' attention in the new study. Lamins are parts of structures that form a skeleton in cell nuclei and which hence shape the cell nuclei. Lamins also play a role in the transport of proteins in cells and influence the genes expressed by cells. These functions are important when a cell divides and when our genes are to be repaired and maintained.

For the first time, the new research shows that two types of lamins, known as lamin A and lamin C, also play an important role in the type of genetic material repair known as base excision repair. If lamin A or lamin C are missing, the repair functions poorly, and that could affect our health.

– If base excision repair functions poorly, it increases the risk of cancer caused by DNA oxidative damage. This type of DNA damage could originate due to UV radiation, such as from sunlight, and it could originate as byproducts in cells when they generate energy, says postdoc Scott Maynard from the Genome Integrity research unit, who headed the new research.

– We are still a long way from an actual treatment, but we hope that improved understanding of lamins and how to change their activities in the future could lead to new treatments and diagnosis strategies that might benefit patients, says Scott Maynard.

The results are published here: Maynard S. et al.: Lamin A/C promotes DNA base excision repair. Nucleic Acids Research 2019, Dec 16

Lamins and unnaturally accelerated ageing

A special change of the structure of the lamin A protein caused by a change of the gene that produces lamin A causes a disease known as Hutchinson-Gilford progeria syndrome, by which patients age unnaturally quickly. The disease is due to the fact that the changed lamin A (known as progerin) is toxic to the cells of these patients. For base excision repair, it is, moreover, also known that many patients with Alzheimer's disease have an error in this repair pathway.

Prestigious award for research unit head

It is one of the major Nordic awards in medicine that Professor Jiri Bartek was awarded along with his cooperation partner of many years, Professor Jiri Lukas from the University of Copenhagen. The Anders Jahre Award for Medical Research is awarded by the University of Oslo, and it is accompanied by NOK 1 million. Jiri Bartek heads the Danish Cancer Society Research Center's Genome Integrity research unit, and he was presented the award for his groundbreaking cell division research. Jiri Bartek has researched how cells divide and their ability to repair DNA damage that could cause cancer.



Research Unit Head Jiri Bartek. Photo: Tomas Bertelsen

RESULT FROM 2020

Fewer divorces among parents of children with cancer

When a child develops cancer, it affects the entire family, but Danish parents who have a child with cancer are slightly more likely to stay together than parents of healthy children – and their likelihood of having more children is the same.

Learning that one's child has a potentially fatal disease is probably one of the most painful messages that a parent can receive. Moreover, it is also the beginning of a trajectory that often stretches over several years. But what does it mean to a family to live with a potentially fatal disease for such a long period of time?

You might think that parents of a child with cancer suffer an increased risk of divorcing, or that they subsequently have fewer children. But luckily, that is not so, according to PhD Luzius Mader from the Danish Cancer Society Research Center, who headed the new study:

– Parents of a child with cancer suffer an approximately 4 % lower risk of divorcing than other parents. Moreover, their likelihood of separating is the same, and their risk of divorcing is 8 % lower than that of other parents. In addition, the parents' likelihood of having more children is the same, says Luzius Mader.

The results are published here: Mader L. et al.: The impact of childhood cancer on parental separation, divorce and family planning in Denmark. CANCER 2020, May 25



The research into parents of children with cancer was carried out by PhD Luzius Mader with financial support from the Swiss National Science Foundation. Photo: Büro Jantzen



Scan the QR code with your smartphone's camera to read more about the research and meet Winnie and Martin, whose son got cancer (article in Danish).

New professor



In 2020, Per Guldberg, who heads the Molecular Diagnostics research group was appointed Professor of Translational Cancer Research by the University of Southern Denmark. The professorship is funded by the Danish Cancer Society.

Photo: Tomas Bertelsen

RESULT FROM 2020

New PhD focuses on patients and relatives

In 2020, Beverley Lim Høeg completed her PhD at the Danish Cancer Society Research Center. She has researched how patients and relatives can be more involved in the cancer trajectory – also known as patient-centeredness.

The number of cancer patients who survive their disease is increasing. This means that we need knowledge about how patients get a good trajectory, also after the treatment has ended. Beverley Lim Høeg has collected knowledge about whether following and examining the patients after the treatment has ended can affect survival, relapses, quality of life, depression and anxiety.

The study, which was carried out in cooperation with the Cochrane Network, is the first systematic review across cancer types. The results show that there is more focus on patient-related strategies, such as improved patient training, and on patient-reported outcomes, i.e. the patients' responses to their own symptoms. Nevertheless, knowledge about how cancer follow-up is organised optimally remains in short supply.

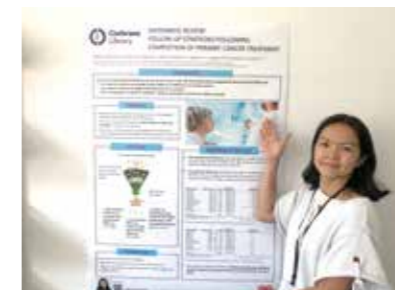
Another part of the PhD focused on relatives has provided new knowledge about relatives' 'health literacy'. The concept includes the ability to acquire and understand knowledge about health, and Beverley Lim Høeg demonstrates for the first time that relatives' abilities in this respect influence the quality of life of cancer patients.

– Patients whose relatives have good health literacy experience less depression and have a better quality of life, she says.

Today, good health literacy very much have to do with the ability to overcome digital challenges, allowing access to a lot of information about the cancer trajectory. This development continues, meaning that it will be increasingly important to involve relatives and focus information and communication to benefit the patient, according to Beverley Lim Høeg.

The research was carried out in collaboration between the Danish Cancer Society, Rigshospitalet, and Region Zealand.

During her PhD studies, Beverley Lim Høeg communicated her research at e.g. the Danish Cancer Research Days 2019 where she won a poster prize. Photo: Danish Cancer Society



PhD graduates from the Danish Cancer Society Research Center in 2020

- **Lena Saltbæk:** Follow-up after treatment for breast cancer
- **Annet Bens:** Chemopreventive therapies and contralateral breast cancer
- **Malene Bredahl Hansen:** Searching for new treatment options for ErbB2-positive, invasive breast cancer
- **Beverley Lim Høeg:** Towards Patient-Centeredness in Cancer Follow-Up
- **Cecilie Dyg Sperling:** Potential anti-neoplastic drugs and endometrial cancer mortality
- **Ida Rask Moustsen-Helms:** Cardiovascular events after prostate and colorectal cancer - three studies using a prospective population-based cohort to investigate long-term risk
- **Helle Kiellberg Larsen:** Risk of anogenital warts and anal intraepithelial neoplasia in Danish renal transplant recipients
- **Julie Volk:** Parental occupational exposures in relation to childhood cancer
- **Sonia Guleria:** Fertility Drugs and Cancer Risk in Women
- **Yulia Steblyanko:** Molecular mechanism behind the microtubule poleward flux and its role in suppression of aneuploidy
- **Elise Harder:** Cervical Cancer Screening in Denmark - Factors associated with non-participation in screening and acceptance of HPV self-sampling
- **Elisabeth Obara:** The role of glioblastoma stem-like cells in resistance to radiotherapy

Achievements in 2020

Over the year, the Danish Cancer Society Research Center has boosted a number of areas.

In some ways, the results and developments of 2020 did not turn out as planned. Nevertheless, we have achieved a lot, although the format often had to be reconsidered. Aside from all the scientific studies and results, the scientists have:



Research that makes a difference

- **Upgraded the service functions** of the four core facilities: Statistics and Data Analysis, Animal Facility and Technical Service, Bioimaging, and Lipidomics (read more about the core facilities on page 33)
- **Continued knowledge sharing initiatives** through monthly centre meetings, regular seminars and workshops, lab meetings and research group meetings - all of this now mainly takes place online
- **Introduced a bioinformatics 'task force'** that has supported projects and held workshops about software and technical developments
- **Established a core histology facility** in a recently refitted lab
- **Held workshops and developed information material** about responsible research practice, responsible data handling and GDPR for all relevant employees/managers
- **Produced a high number of political consultation responses**
- **Prepared four theme-based reports** concerning the quality of Danish cancer treatment



Partnerships with patients and society

- **Participated in the Danish Cancer Society's strategic efforts**, particularly concerning 'Reduce cancer inequality' and 'One step ahead of cancer', focusing on research initiatives in lung cancer, colon cancer and urological cancer
- **Held a national lung cancer workshop** to share knowledge about progress and define future focus areas of research that can contribute to improving survival
- **Updated the structure of our website** at cancer.dk/ research and contributed to the Danish Cancer Society's work with a new web universe
- **Held the annual Science Slam** with six participants, who all gave excellent presentations. Senior Scientist Salvatore Rizza from the Redox Signaling and Oxidative Stress research group won the annual contest with his presentation about autophagy staged as an Italian restaurant
- **Improved research communication** by hiring a digital research editor, who has prepared digital scientist portraits, video narratives and explainers



Scan the QR code with your smartphone's camera to watch the video about CRISPR-Cas9



A powerful environment for the education and training of scientists

- **Organised tuition and workshops** concerning the European Molecular Biology Organization, the Danish Bioinnovation Institute, the Danish National Genome Center, Computerome, etc.
- **Conducted a management review** to define key areas of future development and a work environment review of the physical and mental work environment of all employees
- **Updated the job structure** of academic positions with new researcher categories
- **Represented the Danish Cancer Society Research Center** at presentations for PhD students of Danish universities



Translational research and efforts

- **Held an online department seminar** focusing on national and international research where external speakers drew inspiration from the Danish Comprehensive Cancer Center and the EU Cancer Mission
- **Developed action plans** for high-priority efforts of separate research groups based on the research centre's strategy from 2020
- **Obtained funding** for a series of applications to foundations and cooperated with a series of partners to carry out clinical trials concerning new uses of existing cancer drugs and patient support

RESULT FROM 2020

Artificial intelligence to pave the way for the best treatment

Based on major quantities of data, a new information tool can identify cancer driver genes. Named Moonlight, the new tool will eventually be used to find the best treatment for individual cancer patients.

BCL2 is a gene that plays a role in the development of cancer. The special thing about BCL2 is that it seems to play two very different roles, depending on the cancer type. While BCL2 drives the development of cancer in the thyroid gland, it counteracts the development of prostate cancer. This knowledge was achieved by means of Moonlight; a new information tool which uses lots of data and computer power to identify genes that drive the development of different cancer types. In particular, Moonlight can identify dual role cancer genes, i.e. cancer genes that boost cancer development in one cancer type and counteract cancer development in another.

– Dual role cancer genes remain new territory for cancer researchers, but the prospects are great. A drug that works against a specific gene with a dual role, should only be given to patients in which the gene drives the development of cancer. In other patients, you might aggravate the disease, says Elena Papaleo, group leader at the Danish Cancer Society Research Center and bioinformatics expert, who developed the idea for Moonlight together with her colleague Antonio Colaprico from the University of Miami.

The results are published here: Colaprico A. et al.: Interpreting pathways to discover cancer driver genes with Moonlight. Nature Communications 2020, Jan 3

Key figures

Key performance indicators are part of the monitoring of research achievements. They are combined with internal monitoring and external scientific evaluation and advice provided by the Scientific Advisory Board.

In 2020, the Danish Cancer Society Research Center published 322 peer-reviewed articles within a wide range of fields. An analysis carried out in December 2020 based on Scopus and Scival for the years 2015-2020 follows below.

Key figures for scientific articles published by the Danish Cancer Society Research Center

Citations

Total	4,288
Mean	21
Mean for national collaborative publications	9.5
Mean for international collaborative publications	27.6
Field-weighted citation index	2.3
Publications in the top 10 % of cited journals	53 %

Views

Total downloads	79,400
Mean downloads	39.6
Top 10 % most viewed publications	26 %

Collaborations

Percentage of co-authored publications with international institutions	66 %
Academic-corporate collaborations	8 %

Funding

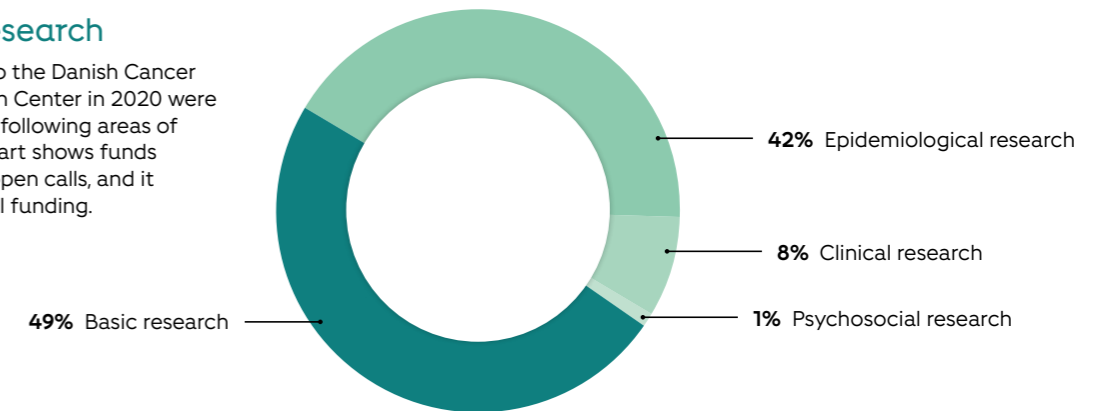
In 2020, the budget of the Danish Cancer Society Research Center consisted of a basic budget from the Danish Cancer Society of DKK 101.9 million. Of these, DKK 36.7 million were allocated to rent and IT, DKK 4.8 million were allocated to research evaluation and communication expenses, and DKK 60.4 million were distributed among the 24 research groups. Of the total budget, basic funds from the Danish Cancer Society make up 52 %.

In the course of 2020, scientists from the Danish Cancer Society Research Center received research grants worth DKK 71.5 million from a large number of foundations. The money will be spent on research projects in the years to come.

Read more about the Danish Cancer Society's financial position and see annual results at the society's website www.cancer.dk

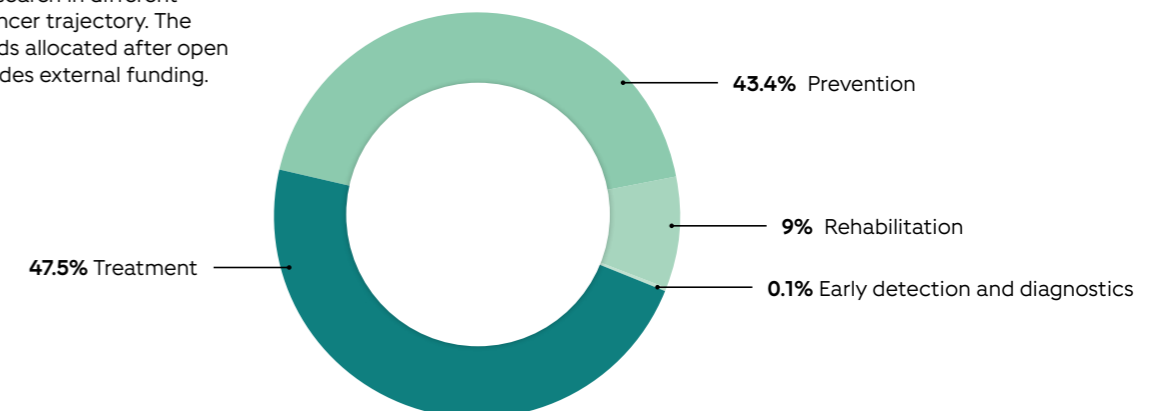
Areas of research

Funds granted to the Danish Cancer Society Research Center in 2020 were allocated to the following areas of research. The chart shows funds allocated after open calls, and it includes external funding.



Cancer trajectory focus

The funding granted to the Danish Cancer Society Research Center in 2020 went to research in different stages of the cancer trajectory. The chart shows funds allocated after open calls, and it includes external funding.



Plans and challenges for 2021

- **A two-day visit from the Scientific Advisory Board.** The visit follows up on the recommendations from the most recent visit in 2019, advises on current challenges, and evaluates half of the research groups
- **Seminar series on biology and bioinformatics** will be expanded by a similar seminar series on epidemiology based on a training programme developed by the centre's statistical experts
- **The development and consolidation of core facilities continue**, such as through strategies that are to allow access to external cooperation
- **Multidisciplinary cooperation and research training must be improved** for students and young scientists, such as through efforts to improve our reputation as a research training centre
- **Continuous work on the action plans** that all research groups have established based on the Danish Cancer Society Research Center's strategy from 2020
- **Improvement of managerial skills**, such as concerning communication and feedback structures. The effort will be based on teamwork between managers and experts
- **The Danish Cancer Society introduces a new website** that will allow the Danish Cancer Society Research Center new and improved opportunities for popular science communication

RESULT FROM 2020

Scientists ask patients for advice

In 2020, the Danish Cancer Society Research Center obtained its own panel of patients and relatives, bringing patients and relatives closer to research, and including their perspective, experience and input in concrete research projects.

The panel currently consists of nine patients and relatives who are invited twice a year to a meeting with scientists, who introduce them to specific research projects and ask them a series of questions.

– The Danish Cancer Society would like to involve patients and relatives in research. Partly to ensure that we carry out research that the patients consider relevant, and partly because we expect it to improve the quality of research, says Pernille Bidstrup, group leader at the Danish Cancer Society Research Center.

In 2020, the Patient and Public Involvement in Research Panel handled 15 approaches from scientists, and even though the second meeting of the year had to be held online due to the COVID-19 pandemic, both panel and researchers have voiced that they get a lot out of the meetings.

– The panel members have been highly committed, embracing the task, and scientists have been very interested in involving the panel in their research. Both meetings in 2020 have been well attended, and one of the experiences made is that the opportunity to ask questions and have discussions with patients is important, says Pernille Bidstrup.

Scientists ask questions about many different things. Some would like to know what problems the patients and their relatives consider the most important to be solved in a research project. Others have very specific questions to the panel's insights as patients and relatives. Most are curious to know the best way of communicating their research to patients.

– We have experienced that some of the researchers who work with basic biological research find it inspiring to meet the patients of the panel because they often do not meet patients in their everyday work in the lab. With the panel, we hope to inspire and provide scientists with tools to involve patients more in their research, says Pernille Bidstrup.

Deep concentration during the Patient and Public Involvement in Research Panel's first meeting with scientists from the Danish Cancer Society Research Center in January 2020. Photo: Danish Cancer Society



Brain tissue collection is the strong basis for new discoveries

PhD student Kirstine Juul Elbæk is looking for 'the golden proteins' of blood plasma from patients with glioblastoma.

In a freezer at the Danish Cancer Society, there is a unique collection of blood and tissue samples from patients with brain tumours of the glioblastoma type. The patients had surgery at Rigshospitalet over the past six years, and the collection was established by Petra Hamerlik, the head of the Brain Tumour Biology research group in cooperation with Consultant Jane Skjøth-Rasmussen and other surgeons from Rigshospitalet.

The collection both includes samples of the patients' first brain tumours and from relapses, if any, allowing an important opportunity to obtain new knowledge about glioblastoma, says PhD student Kirstine Juul Elbæk, who has just initiated a project in which she is searching for proteins in blood plasma from patients with glioblastoma.

– I hope to find new markers that are indicative of the disease's mechanism of action, says Kirstine Juul Elbæk.

Mass spectrometry

Kirstine Juul Elbæk carries out 'discovery research' by which the researcher, instead of searching for specific proteins, starts off with a broad search to discover which proteins the samples include and which seem to be of

interest. The key word of the effort is mass spectrometry (MS), which is a rapidly developing method that can be used to find proteins.

Before she gets to that point, Kirstine Juul Elbæk is accumulating a library of peptides: tiny chains of protein amino acids, which can subsequently be researched using MS. Kirstine Juul Elbæk considers proteins to be an interesting field of research.

– We hear a lot about genes, but genes code for proteins so the proteins are the result of the genes. As personalised medicine gains ground, protein research will become ever more important, and there is a great potential involved in identifying and understanding 'the golden proteins' in cancer, she says.

Plasma samples on ice. Ready to form part of experiments. ►

Photo: Danish Cancer Society



PhD student Kirstine Juul Elbæk in the lab where she is preparing glioblastoma samples for mass spectrometry research.

Photo: Danish Cancer Society



New research in ribosomal genes' safety system

Our genetic material defines the proteins that make up the building blocks of the body. And when the genetic code is translated into proteins, it happens by the ribosomes. New research is to teach us more about the system which ensures that the ribosomes function in the way they are supposed to.

Proteins have many functions in the body, from signaling between the cells of our brain, building blocks in our muscles, and the breakdown of the food that we eat. Therefore, it is important that they are made correctly. Proteins produce ribosomes in cells, and that is also where you find safety systems which ensure that the ribosomes work in the way they are supposed to.

The members of the Nucleolar Stress and Disease research group which is headed by Dorthe Payne-Larsen, are experts on one of these safety systems. And in 2020, the group focused on how the DNA that codes for the ribosomes is protected.

– Ribosomal DNA is basically what allows all other proteins in a cell to be translated correctly. Therefore, we are interested in the cascade of signals in a cell that is initiated in the case of changes in the ribosomal DNA, says Dorthe Payne-Larsen.

The cascade is initiated by the ATM and ATR proteins and it ends by the DNA being repaired. This happens in order that DNA damage does not become permanent changes copied into new cells, possibly causing cancer.

Scientists have mapped out 166 proteins which are included in the cascade. The next step will be to identify the ones that are most important to the maintenance of the ribosomal DNA. A major part of the work takes place in cooperation with the High Throughput Cell Based Screening facility of the University of Copenhagen and colleagues from the Danish Cancer Society Research Center, who are experts on bioinformatics. Approximately 10 proteins are selected and studied more closely in cell experiments in the lab.

– The aim of our work is to identify proteins that could be used in new drugs. We are still a few years of work from that, but we are very excited to get the results, says Dorthe Payne-Larsen.

The research is funded by the Independent Research Fund Denmark.



Scan the QR code with your smartphone's camera to watch a video of Dorthe Payne-Larsen.



Dorthe Payne-Larsen. Photo: Danish Cancer Society

Experts across scientific fields

The Danish Cancer Society Research Center has four research support groups – core facilities, from which all research groups can get professional help within selected areas.

The core facilities consist of a Statistics and Data Analysis facility, an Animal Facility and Technical Service, a Lipidomics facility and a Bioimaging facility. The heads of the facilities support the Danish Cancer Society Research Center's own research groups work to ensure knowledge sharing, and cooperate with scientists outside the Danish Cancer Society.



Mesut Bilgin is the head of Lipidomics. Lipids are fatty molecules that build the membranes of all our cells. The Lipidomics facility makes sophisticated analyses of different types of lipids, producing basic knowledge about cancer cell membranes.

Photo: Tomas Bertelsen



Christian Dehlendorff is the head of Statistics and Data Analysis. Choosing the correct research data analysis method is very central to get a true and accurate answer to research questions. The facility includes statistical analysis expertise and ensures professional development and knowledge sharing in the field. Photo: Tomas Bertelsen

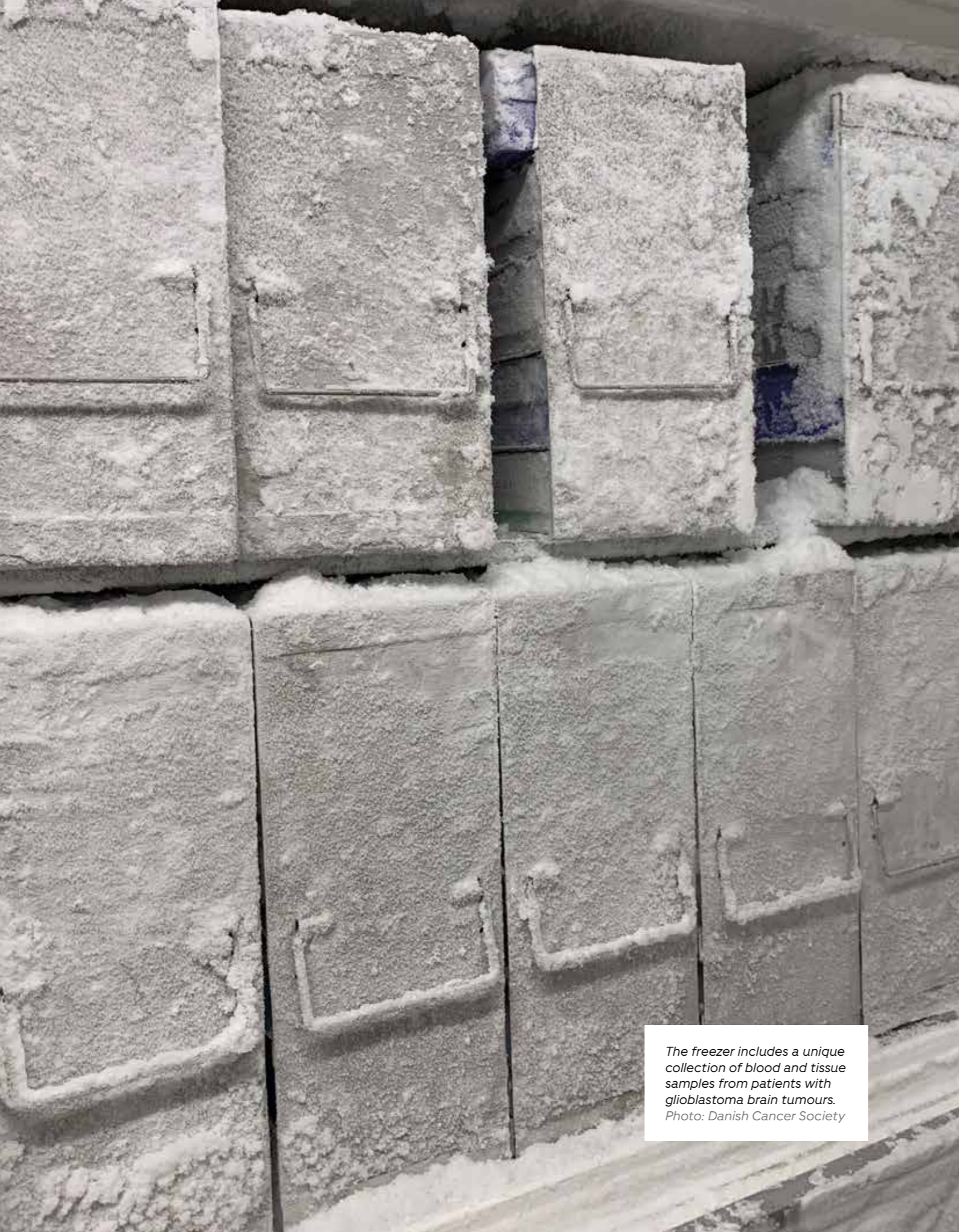


Christoffel Dinant is the head of Bioimaging. Modern microscopy, or bioimaging, is about so much more than tissue images. With its sophisticated equipment, the facility offers new methods for depicting living cells.

Photo: Danish Cancer Society



Helle Vestergaard Petersen is the head of the Animal Facility and Technical Service in which animal keepers cooperate with some of the research group focusing on animal well-being. The facility also offers breeding of different mouse lines. Photo: Danish Cancer Society



The freezer includes a unique collection of blood and tissue samples from patients with glioblastoma brain tumours. Photo: Danish Cancer Society

Women researchers of the Danish Cancer Society

The Danish Cancer Society Research Center focuses on ensuring an equitable research environment, that attracts the most talented cancer researchers – men as well as women.

The Danish Cancer Society Research Center has some 250 employees – of which three quarters are women. Scientific Director and Professor Mef Nilbert is proud of the fact that the Danish Cancer Society Research Center employs many women:

– In most EU member states, women make up 40-60 % of PhD graduates, but all the 12 people who completed their PhDs with us in 2020 were women.


For different reasons, women researchers are often underrepresented at the management level, but we have struck a nice balance with 13 women out of our 23 group leaders, says Mef Nilbert, who believes that it is an advantage to both the world of research and the rest of society that women are represented in research on an equal footing with men.

– Research produces changes and new ideas, ensuring improvement for patients and shaping developments in other parts of society. Consequently, it is important that women have a clear voice in research so we get their input on how to do things differently, says Mef Nilbert.



Scientific award

In 2020, Professor Susanne Krüger Kjær was awarded the clinical KFJ award from Kirsten og Freddy Johansens Fond. She received the prize for her unique and innovative HPV virus and cervical cancer research. Susanne Krüger Kjær's research has had a great impact on the prevention of gynaecological cancer and has contributed to the fact that we now have a HPV vaccine. Photo: Anton Willemann



Scan the QR code with your smartphone's camera to watch and hear Susanne Krüger Kjær talk about her research.



The Danish Cancer Society supports research throughout Denmark

In 2019, the Danish Cancer Society supported research with a total of DKK 416 million.

The Danish Cancer Society supported a total of 169 projects in 2020. This was possible thanks to the money donated by the Danish public.

The Danish Cancer Society has two standing committees: the Danish Cancer Society's Scientific Committee, which changed its name on 1 January 2021 to the Danish Cancer Society's Scientific Committee – Biology & Clinic, and the Danish Cancer Society's Psychosocial Research Committee, which changed its name on 1 January 2021 to the Danish Cancer Society's Scientific Committee –

People & Society. Both committees grant money to cancer research projects throughout Denmark in free competition. Moreover, Danish cancer researchers who carry out their research abroad and aim to bring their results back to Denmark are supported. The grants take place in the shape of free and strategic research funds. The free funds are not earmarked for specific fields of research and can be broadly applied for. The strategic funds, such as money from Knæk Cancer, are granted to research within selected fields, as decided by the Central Board of The Danish

Cancer Society. The money is granted by committees which include voluntary experts from the fields to which money is granted as well as cancer patients and relatives.

The committee members are personal members, i.e. they do not represent the interests of neither organisations nor associations.

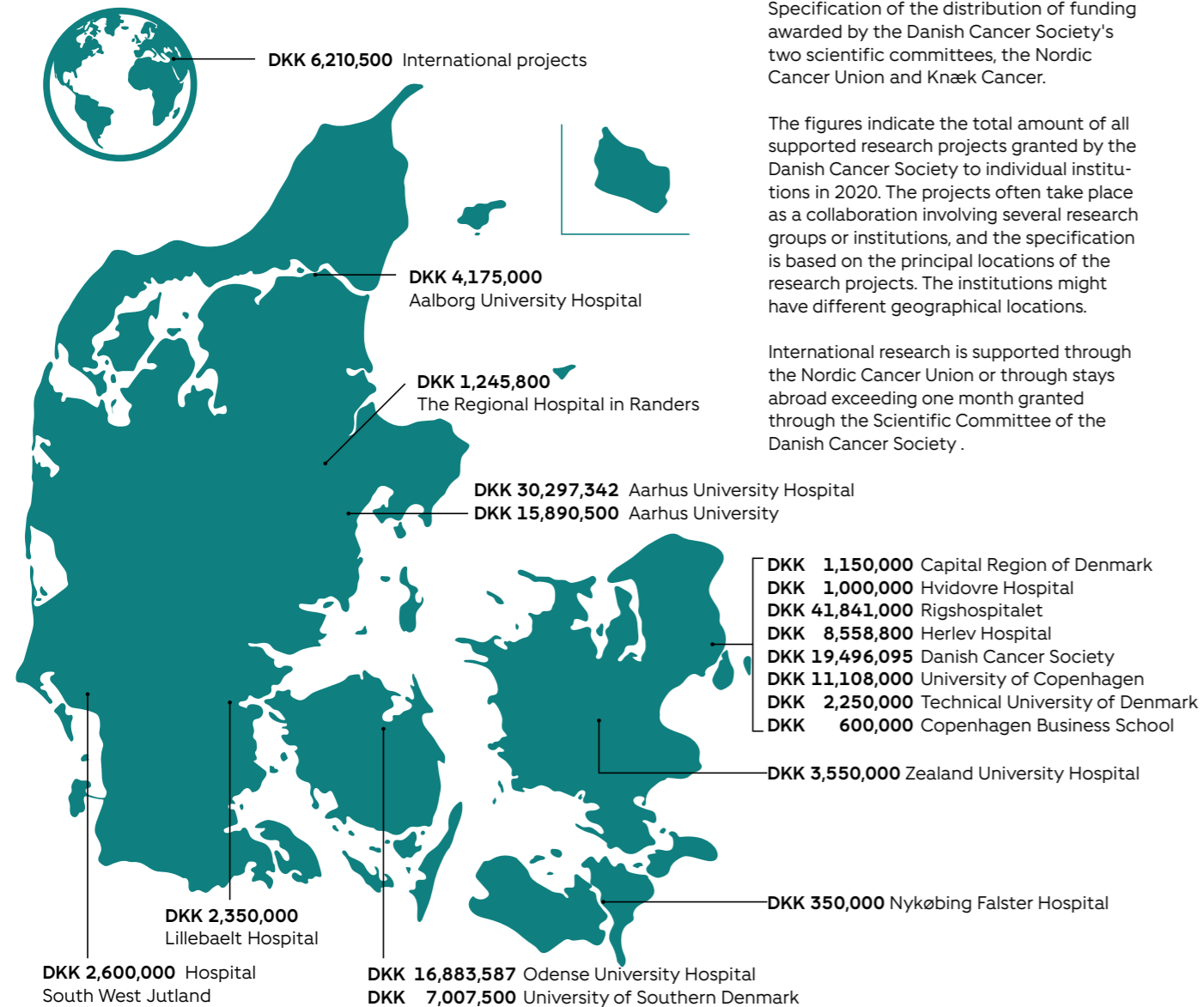
In 2020, the Scientific Committee awarded DKK 71 million to 37 different research projects. A major part of the funds went to proton therapy research, which is a special type of radiotherapy. A total of five research pro-

jects focusing on proton therapy received a total of DKK 10+ million. Read more about proton therapy on page 50.

In 2020, the Psychosocial Research Committee awarded DKK 4.4 million to eight research projects. Some of the funds went to the research project concerning socially vulnerable citizens' participation in cancer screening, which you can read about on page 44.

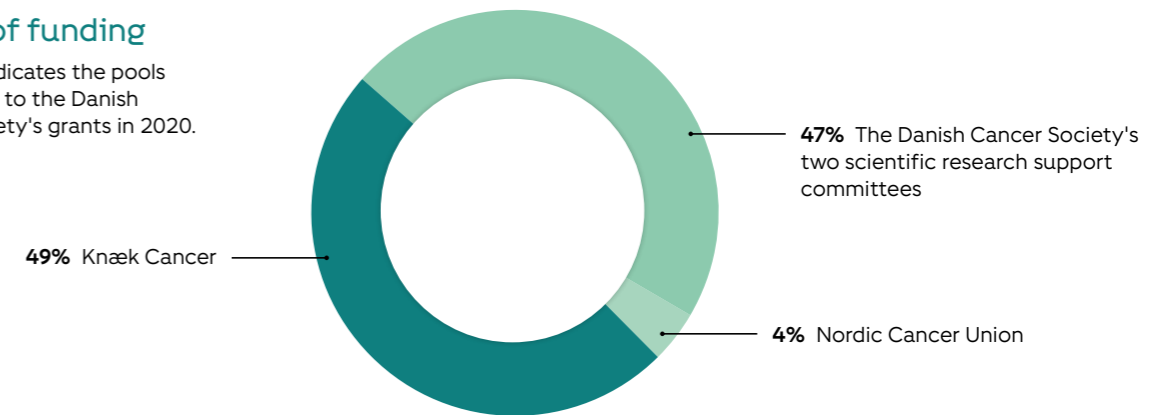
The supported research spans a broad range of fields, from basic, epidemiological and clinical research to psychological and social aspects of cancer.

Geographical distribution of the Danish Cancer Society's research grants in 2020



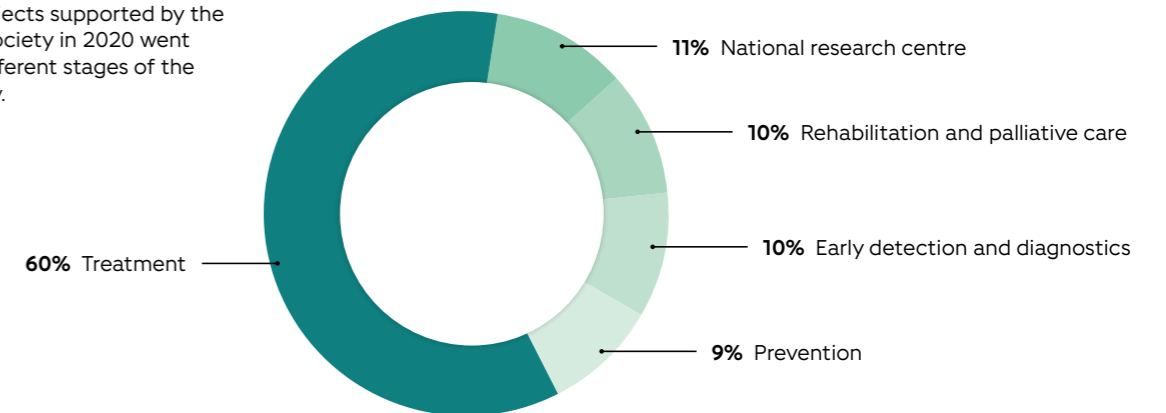
Source of funding

The chart indicates the pools contributing to the Danish Cancer Society's grants in 2020.



Cancer trajectory focus

The research projects supported by the Danish Cancer Society in 2020 went to research in different stages of the cancer trajectory.



POWERFUL PARTNERSHIP

International partnership for cancer patients throughout the world

The Danish Cancer Society is a member of the International Cancer Benchmarking Partnership (ICBP), which aims to ensure improved conditions for cancer patients. In 2020, ICBP research showed that Danish women with ovarian cancer have a better survival rate than many other women in the world with the disease.

Representatives from eight nations on three continents collect, analyse, and share knowledge in the International Cancer Benchmarking Partnership (ICBP).

The ICBP partners research cancer incidence and survival in the member nations and why there are differences, allowing the partners to learn from each other.

All the ICBP members are affluent nations with national and government funded health systems and excellent cancer registries so their data are comparable. Consequently, the ICBP contributes to identifying the best international practice and provides new knowledge that can influence political cancer agendas and improve clinical practice for the benefit of cancer patients in many countries. The ICBP's work is divided into two stages. The first stage compared the survival and mortality rates of four major cancer types: breast cancer, lung cancer, colorectal cancer and ovarian cancer in patients diagnosed in 1995-2004.

Additionally, the next stage focuses on selected cancer types which are difficult to treat: esophageal cancer, stomach cancer, liver cancer and pancreatic cancer in 1995-2015.

The most recent comparative study was published in 2019. Based on data from 3.9 million cancer patients, it demonstrates that survival has generally improved over time. The development in Denmark has been particularly positive. In the 1990s, the Danish survival rate was markedly poorer than that of most other nations, but now we almost match the 'best'.

In 2020, ICBP research demonstrated how the survival rate following ovarian cancer developed in 2010-2014. All nations in the study have improved their survival rates, but in Denmark, the improvement has been particularly significant.

The results of the ovarian cancer study are published here: Cabasaga J et al.: Exploring variations in ovarian cancer survival by age and stage (ICBP SurvMark-2): A population-based study. Gynecologic Oncology 2020, Jan 28

ICBP member nations:
Australia, Canada,
Denmark, Ireland,
New Zealand, Norway,
Sweden and the UK



Find more information here: The ICBP website includes infographics of the cancer development in all nations, a series of research tools, a knowledge bank with scientific articles from ICBP, and informative material for decision-makers in the field of cancer.



Scan the QR code with your smartphone's camera to visit the ICBP website.

POWERFUL PARTNERSHIP

New clinical trials database to benefit patients and research

In 2020, the Danish Comprehensive Cancer Center achieved a major goal when the work on establishing a national clinical trials database was really put into motion.

The Danish Comprehensive Cancer Center (DCCC) is a national partnership concerning cancer research and treatment, which aims to ensure optimum conditions for Danish cancer research and treatment.

Clinical trials give cancer patients access to the most recent diagnostics and treatments, and they are important for developing and improving cancer care. Therefore, the DCCC aims to make it easier for patients, relatives and doctors to access ongoing clinical trials. The solution is a national database, allowing all doctors who are responsible for treatment and patients, disregarding geography, the same access to information and opportunities. The new database will also improve the Danish research infrastructure considerably.

– A national database will be highly valuable for both patients and the doctors who are responsible for their treatment. Patients and relatives get the opportunity to find understandable descriptions of relevant clinical trials. Moreover, it becomes easier for doctors to form a general view and find the best clinical trial for the patient, says DCCC Chair Anne Bukh.

In 2020, the DCCC and Trial Nation – a partnership that promotes clinical trials in Denmark – took the last crucial steps to establishing such a database. The onward procedure rests with the Danish Ministry of Health. The contents will be based on the statutory reports that scientists who conduct clinical trials must continuously produce.

Three successful years

Having only existed for three years, the DCCC has contributed to a series of major initiatives, such as the national research centres that have been established in a partnership between the Danish Cancer Society, individual regions and the DCCC. In 2020, the 11th national research centre was established, i.e. the Danish Center for Targeted treatment of Primary Brain Tumors, about which you can read more on page 66. On page 67, you can see a list of all the research centres.

To build an infrastructure that can boost clinical research and knowledge sharing and improve national

cooperation, the DCCC has, over the years, systematically supported national and multidisciplinary activities and networks in the field of cancer in Denmark. The centre has supported 69 initiatives and projects with a total amount of DKK 10.8 million, including 30 new multidisciplinary networks that bring together all relevant players in their respective fields to improve knowledge and ensure high quality, and uniform treatment of all Danish cancer patients. The networks cover anything from heart-related, long-term side effects following cancer treatment, over early palliative efforts to focus on elderly and vulnerable cancer patients.

The DCCC also facilitates exchange of knowledge between specialists and patients, such as through popular science lectures about relevant research and new treatment methods. In 2020, the DCCC focused on late effects of cancer, and scientists from the national research centres talked about and answered questions concerning the physical and psychosocial late effects that might occur following cancer and treatment, and about how the late effects can be relieved. Visit www.dccc.dk to access the popular science lectures.



The Danish Comprehensive Cancer Center (DCCC) was established in 2017 as a result of Cancer Plan IV with an annual Finance Act grant of DKK 5 million. The Danish Cancer Society is one of the DCCC initiators, supporting its start-up phase with a grant of DKK 10 million over five years.



Scan the QR code with your smartphone's camera to access the popular science lectures at the DCCC website (in Danish).

RESULT FROM 2020

Young cancer patients help develop an app

The Kræftværket app is a rare example of young cancer patients being actively heard and involved in the development of a cancer app.

You can check out the state of your health, hear audio books, read emails or get the weather forecast. The small app icons, that many people have on their smartphones, allow access to a wealth of different functions. Apps aimed at cancer patients also exist, but if you are young and have cancer, the range of choices is limited.

– Young cancer patients are rarely involved in the development and testing of cancer apps. Therefore, the knowledge of their preferred contents, functionalities and design is very limited, says postdoc Signe Hanghøj from Rigshospitalet. She has contributed to a user

test of the Kræftværket app which allows young cancer patients to record symptoms, chat or find information.

The idea for the app originated in 2016 among young cancer patients in Kræftværket, Rigshospitalet's meeting place for young people with cancer. And young cancer patients have been actively involved in the development and evaluation of the app, such as by testing the prototype.

This caused the addition of notifications which alert you of replies to postings, etc. Without the notifications, the young people simply forgot to use the app. And having the app tested and optimised by the young people is very important, Signe Hanghøj explains.

– The app is aimed at them and so, co-creation has been important all along. Moreover, the app is more valuable with committed users. So everybody who posts something gets a reply. And the users remember to record all symptoms so they get a usable specification that they can show to their doctor. The more the app is used, the more valuable it is, she says.

The results are published here: Hanghøj S. et al.: Usability of a Mobile Phone App Aimed at Adolescents and Young Adults During and After Cancer Treatment: Qualitative Study. JMIR Cancer 2020, Jan 2



The app allows you to keep a diary and make notes for your doctor. In 2020, the app has become available to young cancer patients from all over Denmark. Photo: Daman



The Danish Cancer Society supports the research

The project 'The app teleKræftværket - use and importance for young cancer patients' everyday life' received DKK 700,000 from the Danish Cancer Society's Psychosocial Research Committee in 2018.



- We hope that immunotherapy can also be an option for patients with pancreatic cancer in the future, says Consultant and Professor Morten Ladekarl, who heads the new experiment. Photo: North Denmark Region

NEW PROJECT IN 2020

Immunotherapy and electric impulses to combat pancreatic cancer

Scientists from Aalborg aim to activate patients' immune systems to combat cancer by combining immunotherapy and irreversible electroporation with NanoKnife.

Doctors from Aalborg University Hospital have already used the NanoKnife for other types of cancer treatment. The new experiment is aimed at patients with metastatic pancreatic cancer, and doctors will use the device on a liver metastasis which is subjected to a high-frequency current.

The aim is to destroy the cancer cells so DNA and proteins from the cancer flow into the surroundings where they are recognised by the patient's immune system as something alien.

– International mouse studies have demonstrated that this can boost the immune system. We will be among the first in the world to test the method on humans, says Professor and Consultant from Aalborg University Hospital's Department of Oncology Morten Ladekarl, who heads the study.

Subsequently, the patient is treated with immunotherapy, i.e. a drug that is to activate immune cells to eliminate the cancer. The cancer has an ability to slow down the immune system, but the brake can be removed

again with immunotherapy.

As the cells of the immune system travel through the entire body, the idea is that they can kill the cancer throughout the body, not only in the places in which doctors have used NanoKnife treatment.

– So the aim is not only to remove individual metastases, rather to activate the immune system to attack the cancer throughout the body, says Morten Ladekarl.

The experiment will begin in 2021. 16 patients with metastatic pancreatic cancer are offered the treatment.



The Danish Cancer Society supports the research

The project 'Electroporation Potentiated Immunotherapy in Metastatic Pancreatic Cancer (EPIC-1)' received DKK 1,850,000 from the Danish Cancer Society's Scientific Committee in 2020.

NEW PROJECT IN 2020

New project to reduce inequality in screening

Particularly vulnerable people rarely participate in the national cancer screening programmes. A new project involving field work among vulnerable groups is to find out why and how to make more people participate.

Initially, it will be homeless people and addicts in the municipalities of Aarhus and Randers who will be asked why they participate in cancer screening more rarely than others, whether they would actually like to participate, and, if so, what it would take to make them do it.

The researcher behind the new project, PhD student Camilla Rahr Tatari, approaches them in shelters in the two municipalities, and even though the COVID-19 pandemic has made this more difficult, she has initiated her project.

– They do not see their invitation letters in their electronic mailboxes in the same way as most other people do, and they may have a lot of other things on their minds. However, I turn up and hope that they will speak to me so I can find out if they are interested in screening. And if they are, what is the best way to invite them so they will participate, says Camilla Rahr Tatari, who works in the Central Denmark Region's Department of Population Studies.

Social inequality in cancer

The cancer field in Denmark is characterised by major social inequality, and that is also true for the participation in three national screening programmes for cervical cancer, breast cancer and colorectal cancer. People with short-cycle education, low income, minority background or who live alone participate more rarely than other groups in society.

– The screening programmes aim to find cancer and initial stages of cancer at an early point. If we can get more people from the most vulnerable groups to participate in screening, there will be a great potential to prevent severe cancer and death, says Camilla Rahr Tatari.

Customised help

Apart from homeless people and addicts, the project also focuses on vulnerable Greenlanders and involuntarily lonely people. She will meet everybody where they are, and hopefully include them in the preparation of one or more customised offers for people from the most

vulnerable groups who would like to participate in the screening programmes.

– It will probably require that some people get more help than others to participate in screening, but how is it going to happen? The aim is that, in the end, we can prepare significant recommendations for customised solutions, partly based on the voices of the citizens themselves, says Camilla Rahr Tatari.



– If we can make more people from the most vulnerable groups participate in screening, there will be a great potential to prevent severe cancer and death, says the scientist behind the new study, Camilla Rahr Tatari. Photo: The Central Denmark Region's Department of Population Studies



The Danish Cancer Society supports the research

The project 'A qualitative study of cancer screening participation among vulnerable citizens: potential for tailored interventions' received DKK 575,000 from the Danish Cancer Society's Psychosocial Committee in 2020.

Young scientists received junior researcher award

Every year, the Danish Cancer Society awards up to two junior researcher prizes to support particularly talented young scientists who have made a special contribution to Danish cancer research. The one award is in the field of basic, biological and epidemiological cancer research,

the other one in clinical cancer research. In 2020, the awards of DKK 100,000 each went to Christian Grønhøj from Rigshospitalet and Andres Lopez-Contreras from the University of Copenhagen.



Andres Lopez-Contreras, aged 38, is a research group leader employed by the University of Copenhagen. Personal photo



Christian Grønhøj, aged 37, is a Rigshospitalet MD. Photo: Rigshospitalet

Andres Lopez-Contreras researches DNA damage response which influences cells avoiding DNA damage, and in the discovery and repair of damage when it has originated. Andres Lopez-Contreras' work takes place in the lab, where he researches, how DNA damage response works.

– DNA damage response is both important when cancer originates, but also for the treatment of cancer. By understanding how the system works, it is our aim to contribute knowledge that can lead to new ways of preventing or treating the disease, says Andres Lopez-Contreras.

Christian Grønhøj's research has shown that it may be possible to use stem cells to help head and neck cancer patients who suffer severe mouth dryness following radiotherapy.

– When treating head and neck cancer patients with stem cells, we have observed promising results when it comes to improving the saliva production. In the first pilot experiment, we observed that patients who had stem cells injected into their salivary glands obtained a 50 % increase in their saliva production, says Christian Grønhøj.



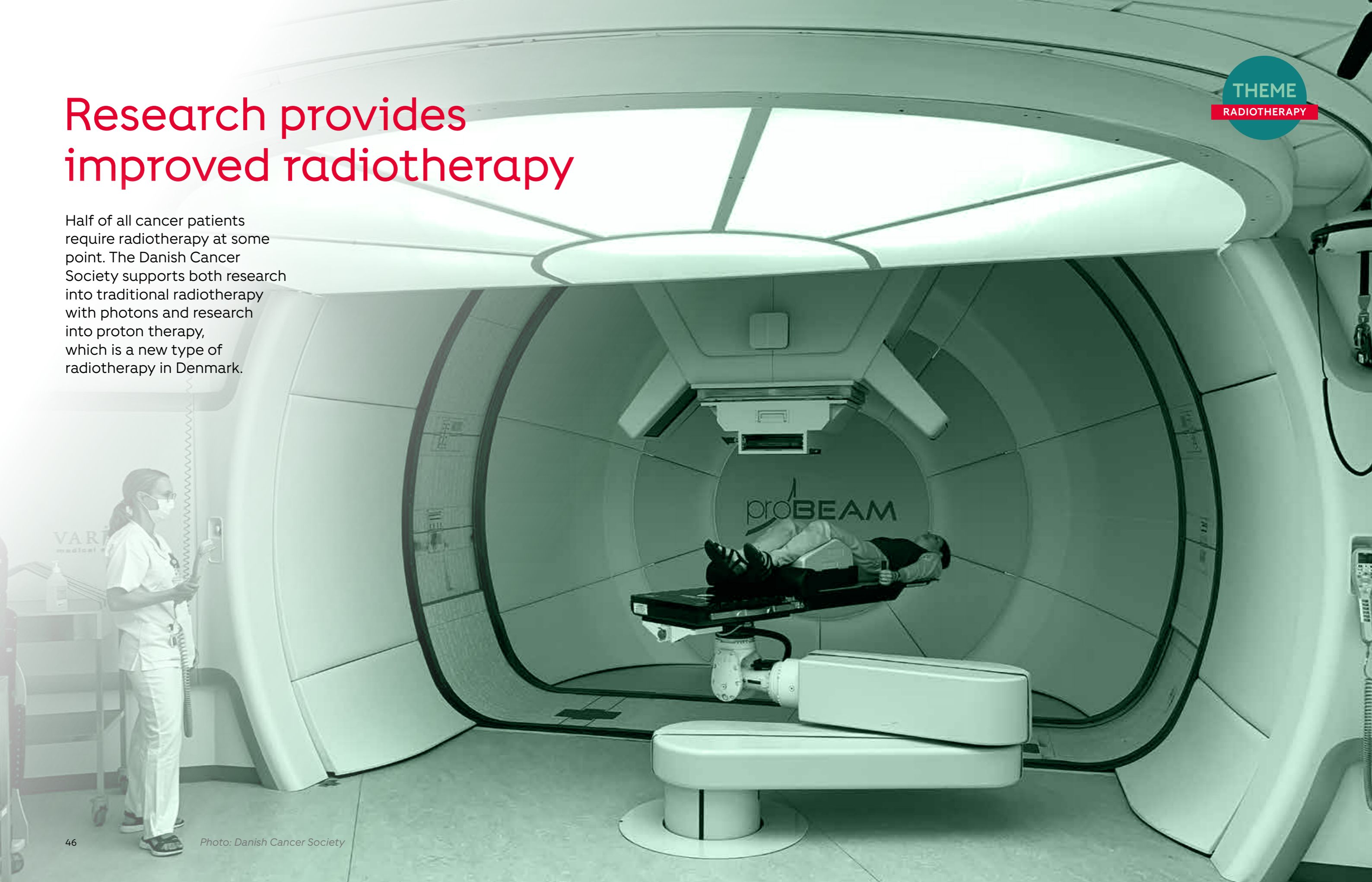
Scan the QR code with your smartphone's camera to watch and hear Andres Lopez-Contreras talk about his research and what the award means to him.



Scan the QR code with your smartphone's camera to watch and hear Christian Grønhøj talk about his research and what the award means to him.

Research provides improved radiotherapy

Half of all cancer patients require radiotherapy at some point. The Danish Cancer Society supports both research into traditional radiotherapy with photons and research into proton therapy, which is a new type of radiotherapy in Denmark.



Research allows more cancer patients access to proton therapy

The Danish Centre for Particle Therapy was established in January 2019 to treat cancer patients with proton therapy, which is a sophisticated and very accurate type of radiotherapy. Research is given high priority, allowing access for new patient groups.

Since January 2019, radiotherapy with protons has been offered to cancer patients by Aarhus University Hospital's Danish Centre for Particle Therapy. It is a sophisticated type of radiotherapy which is more gentle to some cancer patients.

This is true for children who are very vulnerable to radiation, and adults with cancer tumours close to a radiation-sensitive organ, such as the heart or in the brain.

– The protons can strike the cancer tumour very accurately so they only cause minor damage to the tissue in front of the cancer tumour and hardly any behind the tumour. In ordinary radiotherapy, the surrounding tissue gets a larger radiation dose, and that could cause damage, explains Morten Høyer, medical director at the Danish Centre for Particle Therapy.

Before Denmark got its own particle centre, Danish patients could have proton therapy abroad. They can now be treated at the Danish Centre for Particle Therapy.

Lack of knowledge

Danish and international studies indicate that 10-15 % of the patients who are to receive radiotherapy benefit from proton therapy. But there is a lack of knowledge, and therefore research is given high priority by the Danish Centre for Particle Therapy, concerning both improving the method and testing proton therapy on new patient groups.

Proton therapy experiments are currently being carried out on patients with head and neck cancer, esophageal cancer and breast cancer where there is a risk of the radiation harming heart and lungs. The next experiments in the pipeline concern prostate cancer.

Patients of the Danish Centre for Particle Therapy receive about 30 proton therapy treatments in the course of approximately seven weeks, and those who live far away often choose to stay in Aarhus, for example in one of the hotels with which the particle centre cooperates.

– We are highly aware of the fact that we are a national centre so it must be easy to come here for anyone, says Morten Høyer.



The Danish Centre for Particle Therapy aims that 80 % of the patients are included in experiments, says medical director Morten Høyer. Photo: Danish Cancer Society

It cost approximately DKK 800 million to build the Danish Centre for Particle Therapy. The A.P. Møller Foundation donated the cyclotron and therapy equipment, and the Danish government funded the building.

Scan the QR code with your smartphone's camera to watch and hear Morten Høyer talk about proton therapy.

Research and treatment go hand in hand

Professor Brita Singers Sørensen is one of the scientists from the Danish Centre for Particle Therapy. Her work has provided exciting new knowledge, indicating that combining proton therapy with other treatments could be beneficial.

Brita Singers Sørensen is a biologist, and together with her team, consisting of a postdoc and a PhD student, she aims to understand what happens when cells are radiated with protons.

– We have shown that radiation with protons results in less activation of genes, which have an impact on the immune system, than ordinary radiotherapy with photons does. Moreover, other factors with an impact on the immune system are activated by proton therapy than in the case of ordinary radiotherapy. Together, this indicates that combining proton therapy and immunotherapy could be beneficial, says Brita Singers Sørensen.

Many of the centre's patients participate in research protocols in which blood, skin and tissue samples are taken which can tell the scientists something about how their bodies react to the treatment. This might explain why patients react differently to the proton treatment and why the damage done to patients' ordinary tissue is different, and hence also the late effects they experience.

Scientists investigate whether the differences between patients could be due to genetic differences. And they hope to be able to find out if there are markers – biological characteristics of individual patients – which can be used to predict whether the tumour is particularly vulnerable to proton radiation as compared to photon radiation. This knowledge might lead to even more customised treatment.



The Danish Cancer Society supports the research
Brita Singers Sørensen has been supported by the Danish Cancer Society twice. In 2014, she received a grant from the Knæk Cancer pool earmarked for 'Young talented cancer researchers' and in 2017, she received funding from the Danish Cancer Society's Scientific Committee.



Professor Brita Singers Sørensen carries out her research by means of cells cultured in bottles and radiated with protons. The red liquid in the bottle includes nutrition for the cells. Photo: Danish Cancer Society ▶

FACTS

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Ordinary radiotherapy and proton therapy

Ordinary radiotherapy uses ionising radiation, usually in the shape of powerful X-rays (photons) or electron radiation. X-rays leave the most energy in the tissue they penetrate first and will weaken as they travel deeper into the body. The energy left before and after the cancer tumour could cause damage.

Protons are hydrogen atom nuclei. When protons are directed into the body, they release energy and their speed is reduced. When they reach a specific speed,

they will release all energy at a specific distance under the skin.

When you know the location of a cancer tumour, you can calculate the ideal proton firing speed for them to reach the cancer tumour at a speed that allows them the maximum effect and causes the most damage.

The result is that only slight damage is done to the tissue in front of and hardly any behind the tumour. The major damage is done in the area with cancer cells.

How proton therapy works

You take a small bottle of protons and make an injection at one end. The result is one of the most modern and spectacular cancer treatments offered in Denmark.

The cyclotron - or the accelerator, in which the protons are isolated and accelerated to a high speed.

The beam is supplied via a gantry and controlled at all angles by large magnets.



The protons are accelerated to 2/3 of the speed of light before they are directed into the beam line behind the treatment rooms.

Photo: Danish Centre for Particle Therapy

Treatment room, where patients are treated.

From the cyclotron, the proton beam travels into the treatment rooms via a beam line.



The beam line directs the protons from the accelerator to the treatment rooms. Magnets bend and focus the beam. Photo: Danish Centre for Particle Therapy

4.5-m-thick concrete walls protect the surroundings from radiation.

Research room with horizontal proton beam where scientists can work.

Illustration: Varian Medical Systems, Inc. All rights reserved.



The Danish Cancer Society supports the research

The Danish Cancer Society has supported proton therapy research by **DKK 52 million** since 2013. Five projects received grants from the Danish Cancer Society's Scientific Committee in 2020:

- 'Real-time tumor dose reconstruction during dynamic proton therapy treatments of moving tumors': **DKK 2,332,334**
- 'Identification, prediction and reduction of radiation-induced brain tissue changes following photon vs proton radiotherapy in children with CNS cancer': **DKK 1,937,500**
- 'Enabling safe delivery of proton FLASH therapy with an ultra-fast in vivo dosimetry system': **DKK 1,800,000**
- 'Reduction in irradiation of healthy tissue through differentiation of target dose-volumes': **DKK 1,800,000**
- 'Proton therapy combined with brachytherapy to reduce toxicity in locally advanced cervical cancer treatment: towards proEM-BRACE': **DKK 2,309,000**

RESULT FROM 2020

New research paves the way for improved breast cancer radiotherapy

Almost 2,000 women participated in a Danish-led study, that has resulted in gentler breast cancer radiotherapy. The Danish Cancer Society has supported the study, which is one of the world's biggest concerning breast cancer and radiotherapy.

The study began in 2009, and in 2014, it led to a change in the Danish radiotherapy guidelines for breast cancer patients who do not have spreading to the arm pit lymph nodes and who only require radiation on the breast. This is true for two in three of the women who are recommended radiotherapy following breast cancer. A total of 2,000+ patients annually in Denmark.

Previously, the women received radiotherapy against the breast for five weeks, but as a result of the study, three weeks of radiotherapy became the standard. I.e. fewer radiation treatments, but with a larger dosis per session. In the study, the women received either three or five weeks of radiotherapy.

Half of the women have now been observed for seven years or more. The conclusion is that slightly fewer side effects are observed among women who receive radiotherapy for three weeks. The risk of breast cancer relapses is the same as in the case of five weeks of radiotherapy – i.e. 3 % after nine years.

– With these results we now have strong documentation that the vast majority of women need only receive radiotherapy for three weeks, but with a larger dosis of radiation per treatment, which is just as efficient and safe as five weeks of treatment, says Aarhus University Hospital Professor and Consultant Birgitte Vrou Offersen. She headed the study that stems from the Danish Breast Cancer Group's Radiation Therapy Committee.

Skagen Trial

Birgitte Vrou Offersen also heads the 'Skagen Trial' that is supported by the Danish Cancer Society's Scientific Committee and Knæk Cancer, and which she hopes will lead to three weeks of radiotherapy for yet another group of women: those who receive radiation on the breast or chest wall and on adjacent lymph nodes, and who still receive five weeks of radiation as the standard.

– In 2014, when we observed the early positive results of the first study, we also wanted to be able to give three weeks of radiotherapy to this group of patients. Women

from Denmark and five other nations participate in the study, and we expect to have early results in 2022, says Birgitte Vrou Offersen.

Some 3,500 women in Denmark receive radiotherapy annually following breast cancer.

The results are published here: Offersen BV et al.: Hypofractionated Versus Standard Fractionated Radiotherapy in Patients with Early Breast Cancer or Ductal Carcinoma in situ in a Randomized Phase III Trial: The DBCG HYPO Trial. Journal of Clinical Oncology 2020, Sep 10

Professor and Consultant Birgitte Vrou Offersen thanks all the women who participate in the breast cancer and radiotherapy studies: - We can only develop the treatment through research, she says. Photo: Aarhus University Hospital ►



The Danish Cancer Society supports the research

The project 'Hypofractionated adjuvant radiotherapy to women operated with breast conserving strategy for node-negative early breast cancer' received DKK 633,900 from the Danish Cancer Society's Scientific Committee in 2009.

The project 'Moderately hypofractionated loco-regional adjuvant radiation therapy of breast cancer combined with a simultaneous integrated boost: The Skagen Trial' received DKK 840,000 from Knæk Cancer in 2015.



Scan the QR code with your smartphone's camera to watch and hear about Birgitte Vrou Offersen's research.



THEME

RADIOTHERAPY



Knæk Cancer

2020 marked the ninth time the Danish Cancer Society and TV 2 organised Knæk Cancer, devoting an entire week to inform about cancer and raise funds.

The 2020 fundraising campaign was an overwhelming success in spite of the fact that it took place in the shadow of the COVID-19 pandemic. A total of DKK 139.1 million were raised, allowing the support of 43 projects in the areas of research, patient support and prevention.

DKK 20 million went to a new Danish Center for Targeted treatment of Primary Brain Tumors. It is the 11th research centre established by the Danish Cancer Society with money from Knæk Cancer. The Danish Childhood Cancer Foundation received DKK 6 million of the raised funds, which it has granted to six projects.

Every year, the Danish Cancer Society's Central Board selects a number of research themes to be supported by Knæk Cancer. It is done based on a thorough process with input from a long series of experts and key actors in the field of cancer. This year, 15 themes had been selected beforehand, and 14 of them received funding. Among the themes to get support are 'Early diagnosis', 'Research of strategies towards treatment resistance' and 'Research into rare cancer types',

and a number of research projects can now begin.

A panel of experts from relevant fields of expertise evaluates and names the research projects to be supported by Knæk Cancer.

The evaluation process is led by the Danish Cancer Society's Scientific Committee. Applications for the national research centres are evaluated by an international panel.



Detgårpengenitel.dk

A total of 352 projects have been initiated with the support of Knæk Cancer since the beginning in 2012. The vast majority are research projects. Read about all projects at detgårpengenitel.dk



Carefully arranged umbrellas formed the petals of the Knæk Cancer flower from Aars. Photo: Søren Friis, Foto-Lab Aars



Light bag with a message to someone we lost to cancer. The lights were lit at the 'Light a Candle' event that was held in several places in week 43. Photo: Danish Cancer Society



Denmark's biggest Knæk Cancer flower was made in Aars. Photo: Søren Friis, Foto-Lab Aars

The receivers of funds from Knæk Cancer 2020

The money from the 2020 Knæk Cancer fundraising campaign went to 14 different themes

1. The Danish Childhood Cancer Foundation

Some 200 children under 19 are diagnosed with cancer annually. The Danish Childhood Cancer Foundation gets support for its work to ensure that as many children as possible survive cancer and lead good lives.

2. Danish Center for Targeted treatment of Primary Brain Tumors

A new national research centre is to head the development of diagnostics and new, focused brain cancer treatment. Initially, the centre will focus on glioblastoma, but over time, it will include more brain cancer types.

3. Early diagnosis

The money goes to projects that investigate what can make people get in touch with their doctor early if they suspect they have cancer, how to improve general practitioners' examination methods, and how to improve the process of cancer diagnosis in hospitals.

4. Young talented researchers

The funding goes to support young Danish cancer researchers with great potential as future heads of research.

5. Research into strategies against treatment resistance

Many cancer patients experience that at some point their treatment no longer works. The money goes to projects that can lead to ways in avoiding cancer cells becoming resistant.

6. Less inequality in cancer

Not all patients benefit from the progress made in cancer prevention and treatment, and some of the funding goes to projects to reduce inequality in cancer.

7. Multidisciplinary research into rehabilitation, early palliative efforts and care

We now know that it is a good idea to begin rehabilitation and palliation at an early stage, and the two efforts can support each other. More knowledge is required on how to ensure multidisciplinary cooperation and how to combine rehabilitation, palliative efforts and care.

8. Røgfri Fremtid - No Smoking

The Røgfri fremtid (No Smoking in the Future) partnership receives funds to continue its work to ensure that no children and young people start to smoke in 2030 and to reduce the number of adult smokers to less than 5 %.

9. Further development of Navigator support for socially vulnerable cancer patients

The Danish Cancer Society aims to develop the Navigator project that offers socially vulnerable cancer patients a navigator volunteer to help them navigate the healthcare system, and to provide practical and mental support.

10. Cancer patients with mental diagnoses

Psychiatric patients with cancer are a vulnerable group, who unfortunately have a poorer survival rate than other cancer patients. Conse-

quently, some of the money goes to ensure improved cancer trajectories for patients with mental disorders.

11. Clinical trials

– knowledge and quality targets

Clinical research is one of the most important ways to ensure improved treatments. Some of the funds shall therefore go to information about clinical trials.

12. A healthier alcohol approach among young people

The 'Fuld af liv' (Full of life) partnership will continue to work with forming networks and alliances to ensure a dialogue with young people, parents and relevant players about how to create a healthier alcohol approach in Denmark.

13. Research into rare cancer

Cancer is not just one disease, rather it is some 200 different diagnoses of which some only affect very few people annually. The money goes to projects which are to ensure improved knowledge about diagnosis, treatment, late effects and patient prospects when it comes to rare cancer types.

14. HPV-related cancer in Denmark

Denmark initiated HPV vaccination of girls in 2009 and boys in 2019. Some of the funds go to improving the knowledge of HPV-related cancer types.

The spectacular Knæk Cancer show was a success in 2020. The hosts were Mikkel Kryger, Louise Wolff, and Janni Pedersen. Photo: Per Arnesen ▶



RESULT FROM 2020

T cell therapy across cancer diagnoses

New research shows that immunotherapy with T cells can be tolerated by patients with different types of cancer, and some observe a better effect than others. However, the excellent effect observed on melanoma has not been repeated.

T cell therapy is a type of immunotherapy by which scientists extract immune cells from a patient's cancerous tissue and culture them in the lab. When the T cells have been multiplied, they are infused back into the patient to combat the cancer.

T cell therapy has proved efficient in some patients with advanced melanoma. Therefore, it is obvious to test the treatment on other types of cancer, and in 2020, scientists from Herlev Hospital's Center for Cancer Immune Therapy published results from two studies. Very ill patients with different types of cancer received T cell therapy and checkpoint inhibitors immune therapy.

Different cancer diagnoses

25 patients with head and neck cancer, cervical cancer, intestinal cancer, lung cancer, biliary tract cancer and sarcomas participated in one study. The patients received T cell therapy in combination with brief chemotherapy and two checkpoint inhibitors to boost the immune system's attack on cancer cells.

In some patients the cancer shrank, and in three of the patients the tumours shrank by 30%. Eight patients experienced that the disease was reduced or remained unchanged for at least 4.5 months.

– The aim of the study was to find out whether the treatment was possible and if the patients could tolerate T cell therapy, and the answer is yes. All the patients completed and tolerated the treatment. Some of the patients have experienced improvements, and the improvements will be examined more closely. But unfortunately, nobody became cancer free, says MD and PhD student Anders Kverneland, who made a presentation of the study at the European Society for Medical Oncology, the ESMO Congress, in September 2020.

Ovarian cancer

In the other study, six women with advanced ovarian cancer participated. They also received T cell therapy in combination with checkpoint inhibitors, and also in this

In T cell therapy, scientists extract immune cells from a patient's cancerous tissue and culture them in the lab. When the T cells have been multiplied, they are infused back into the patient. Photo: Tomas Bertelsen



Anders Kverneland

MD and PhD student Anders Kverneland from Herlev Hospital's, Center for Cancer Immune Therapy headed two T cell therapy studies, which have been supported by Knæk Cancer. Personal photo

case, the study demonstrated that the treatment was possible and that the patients tolerated it.

One patient experienced that the disease was reduced, and another one that it remained unchanged for more than a year. Unfortunately, the others experienced no detectable effect of the treatment.

Anders Kverneland is testing the results of T cell therapy across diagnoses in the lab. The ovarian cancer study is followed up by a new one in which patients with metastatic ovarian cancer receive T cell therapy with a new combination of checkpoint inhibitors.



The results are published here: Kverneland AH. et al.: Adoptive cell therapy in combination with checkpoint inhibitors in ovarian cancer. Oncotarget 2020, Jun 2



The Danish Cancer Society supports the research

The project 'Clinical Development of Adoptive Cell Transfer with Tumor-Infiltrating Lymphocytes for patients with Advanced Ovarian and Kidney Cancer' received DKK 3 million from Knæk Cancer in 2014.

The project 'Exploring the potential of T-cell therapy in solid tumors' received DKK 3 million from Knæk Cancer in 2016.



RESULT FROM 2020

Study maps out the risk of eye disease following stem cell transplant

14,000+ patients contribute to a new study that can identify groups of patients who should be observed closely before a stem cell transplant.

The study, which includes all patients who had stem cell transplants at Rigshospitalet in 1980-2016, maps out the extent of the GVH (graft versus host) eye disease. It can be a side effect of the stem cell transplant, involving that the donor cells attack the patient's cells.

According to the study, 13 % of the patients experience eye dryness before the stem cell transplant. The specification shows that a low Schirmer's test score, estimating the ability to produce lachrymal fluid, before the stem cell transplant causes a greater risk of GVH.

18 % of the patients who received a high dose of chemotherapy pretreatment have GVH five years after the stem cell transplant, whereas no less than 35 % of the patients who received a low pretreatment dose have GVH.

In the patients who got a high dose of chemotherapy, the scientists observed an increased risk of GVH

if the stem cells came from a female donor or from a donor who was not related to the patient.

Among the patients who received low dose pretreatment, the risk of GVH increased with age.

Today, all patients are examined by an ophthalmologist before the stem cell transplant, and they are subsequently kept under observation for up to five years.

– The study supports the things we are already doing, and it identifies some groups that we must keep an extra eye on and perhaps see earlier than we do today, such as elderly patients and patients with a low Schirmer's test score who may need preventive treatment to reduce the nuisance, says the study's lead author, MD Helene Jeppesen; who is employed by Rigshospitalet's Eye Department.

The results are published here: Jeppesen H et al.: Chronic ocular graft-versus-host disease after allogeneic haematopoietic stem cell transplantation in Denmark - factors associated with risks and rates in adults according to conditioning regimen. Bone Marrow Transplant. 2020, Jul 12



The Danish Cancer Society supports the research

The project 'Ocular graft versus host disease' received DKK 1,200,000 from the Knæk Cancer fundraising campaign in 2014.

◀ Photo: Danish Cancer Society

Improved survival for cancer patients with psychiatric disorders

The survival rate of cancer patients with psychiatric disorders is markedly lower than that of other cancer patients. Scientists aim to take a closer look at the causes, hopefully paving the way for an improved trajectory for this group so more patients survive cancer.

People with psychiatric disorders who get cancer are typically worse off than cancer patients with no psychiatric disorders. This also means that they are less likely to survive the disease. However, it is unclear why this is so. A new research project from FEAP (a general practice research unit) in Aarhus will now try to identify some of the causes, supported by Knæk Cancer.

– Cancer is often discovered later in patients with psychiatric disorders than in others. But we do not know for sure why this is so or whether there are other differences, such as in the treatment process. These are some of the things that we will take a closer look at, says PhD Line Flytkjær Virgilsen, who is responsible for the new research.

In connection with the new project, Line Flytkjær Virgilsen will cooperate with researcher colleagues and a patient representative, Anne Margrethe Gad Jørgensen,

who is the day-to-day head of the Danish Association for Mental Health, SIND's relatives advice service.

– I am looking forward to continuously discussing the project and the results with Anne Margrethe. Her knowledge of the problems of people with psychiatric disorders will be of great value to ensure that our study becomes as relevant and useful as possible, says Line Flytkjær Virgilsen.

Line Flytkjær Virgilsen will initiate the project in January 2021. In order to ensure improved survival, she hopes that the results can identify the aspects of the cancer trajectory that are particularly important in connection with patients with psychiatric disorders.



PhD Line Flytkjær Jensen conducts new research that can hopefully improve the survival of cancer patients with mental disorders. Personal photo



The Danish Cancer Society supports the research

The project 'Diagnosis and treatment of cancer in patients with psychiatric disorders' received DKK 500,000 from the Knæk Cancer fundraising campaign in 2020.

Can a new method detect lung cancer earlier?

Lung cancer is the major cause of cancer-related deaths in Denmark. The diagnosis is generally made too late, and the cancer is difficult to find in its early stages. A new research project aims to establish whether a new method can be used to identify lung cancer earlier and more gently.

In too many cases, lung cancer is discovered late, but Christian B. Laursen, Clinical Professor and Consultant of Respiratory Medicine at the University of Southern Denmark and Odense University Hospital aims to change that. Today a lung cancer diagnosis requires both a scan and a biopsy of the changed lung tissue that can be observed in the scan. This will typically require an endoscopy, and scientists now aim to find out whether even more knowledge can be derived from the endoscopy.

– We will use the endoscope to introduce salt water into the lungs and subsequently suck it up again. This will allow us to check the rinsing fluid for DNA from cancer cells. It is a very gentle method, particularly for patients with COPD or frail lungs due to other diseases, says Christian B. Laursen.

Slightly less than 4,600 Danes are diagnosed with lung cancer annually, and the disease is the major cause of cancer-related deaths in Denmark.

Christian B. Laursen and his colleagues also aim to take blood samples from the patients to search for DNA from a cancer tumour, if any. In previous studies, circulating tumour DNA in blood samples has proven to be able to identify cancer. However, small tumours without metastasis will not always excrete sufficient DNA for it to be detectable in the blood. Therefore, it is relevant to find out if cancer DNA can be identified in rinsing fluid from the lungs.

The scientists hope that a rinsing fluid sample or a blood sample will be more accurate than existing methods for identifying patients with lung cancer:

– With a rinsing fluid sample that includes DNA from a cancer tumour, we might be even more sure of whether a tumour includes lung cancer, and hence avoid that some patients are subjected to unnecessary examinations and worries, says Christian B. Laursen.

The new research project will begin in January 2021 and go on until the summer of 2023. It will include patients from several hospitals throughout Denmark.

Slightly less than 4,600 Danes are diagnosed with lung cancer annually, and the disease is the major cause of cancer-related deaths in Denmark.



The Danish Cancer Society supports the research

The project 'Early and minimally invasive detection of lung cancer by circulating tumor DNA in bronchial lavage' received DKK 1,610,000 from the Knæk Cancer fundraising campaign in 2020.

Denmark gets its first national brain cancer research centre

The new Danish Center for Targeted treatment of Primary Brain Tumors will initially focus on aggressive glioblastoma brain cancer, but over time, it is to involve several types of brain cancer. The centre is supported by DKK 20 million from Knæk Cancer.

– The new centre will work to prolong life and ensure improved quality of life for the about 1,500 Danes who get brain cancer annually, according to the head of the centre, Ulrik Lassen, Professor of Clinical Oncology and Personalised Medicine, and Lead Consultant at Rigshospitalet's Department of Oncology.

National cooperation is the key to the new centre to ensure that all patients with brain cancer get the best treatment, and that both Danish and foreign experts cooperate closely and exchange knowledge concerning research and methods.

One of the initiatives involves that all patients with glioblastoma will be offered complete sequencing of the tumour's genetic material, also known as full genome sequencing.

– Full genome sequencing allows us to identify any experimental treatments fit for individual patients. Moreover, we will have systematic collection of knowledge about genetic change in brain tumours. We can use this as a basis for developing new treatments, and it could provide us with knowledge about the most

Efforts to benefit patients

With the new research centre, a long series of efforts are in the pipeline. 20 projects are now listed, ranging from improved diagnostics, over improved treatments, such as surgery and radiotherapy, to the development and testing of new treatments based on knowledge about the biology behind brain tumours. The centre will also work systematically with the major quantity of data that exists in different registries.

efficient treatment according to the patient's genetic profile or about the patients' risk of late effects in connection with specific treatments, says Ulrik Lassen.

The combination of full genome sequencing of all Danish glioblastoma patients – and eventually all brain tumour patients – and data about patient trajectories will provide unique sets of data that do not exist anywhere else in the world. This would be highly valuable to future research and could eventually help patients with many types of brain cancer, including rare types where research opportunities are now limited because there are so few patients, Ulrik Lassen explains.



The Danish Cancer Society supports the research

The Danish Center for Targeted treatment of Primary Brain Tumors received DKK 20 million from the Knæk Cancer fundraising campaign in 2020.

11 national research centres

Since 2017, 11 national research centres have been established thanks to the Danish population's donations to Knæk Cancer. The centres are selected based on a professional evaluation process and established with co-financing from the coordinating regions.

The centres are manned by scientists and clinicians from hospitals and universities throughout Denmark. Together, they develop and employ the most recent knowledge based on the vision that all Danish cancer patients get the best treatment and access to clinical studies. The fact that the research takes place throughout the nation also means that the national research networks are improved. The national centres cooperate closely with the Danish Comprehensive Cancer Center, paving the way for knowledge sharing between centres.

- 1. National Center for Cancer Immune Therapy**
Herlev Hospital
- 2. Danish National Research Centre for Radiotherapy**
Aarhus University Hospital
- 3. National Centre for Cancer Survivorship and General Late Effects - CASTLE**
Rigshospitalet
- 4. National Center for Breast Cancer Survivorship**
Aarhus University Hospital
- 5. National Centre for Research on Survivorship and Late Adverse Effects after Cancer in the Pelvic Organs**
Aarhus University Hospital in close collaboration with Aalborg University Hospital
- 6. Danish Research Center for Precision Medicine in Blood Cancer**
Biotech Research & Innovation Centre (BRIC), University of Copenhagen
- 7. Danish Research Centre for Equity in Cancer (COMPAS)**
Zealand University Hospital, Næstved
- 8. National Centre for Lung Cancer Research**
Lillebælt Hospital, University of Southern Denmark, Vejle Hospital
- 9. National Research Center for cdDNA Guided Cancer Treatment**
Aarhus University Hospital
- 10. National Research Centre for Childhood Cancer**
Rigshospitalet
- 11. Danish Center for Targeted treatment of Primary Brain Tumors**
Rigshospitalet

National research centres to be evaluated

The Danish Cancer Society has supported the setting up of 11 national research centres with DKK 180+ million from Knæk Cancer. The first one was the National Center for Cancer Immune Therapy, which is also the first to be evaluated.

Four years ago, the Danish Cancer Society laid down the first brick of a new, significant pillar in the organisation's research support when DKK 8 million from the 2016 Knæk Cancer fundraising campaign went to the foundation of a National Center for Cancer Immune Therapy headed by Herlev Hospital Consultant and Professor Inge Marie Svane.

After 2016, new centres have received support every year, most recently the Danish Center for Targeted treatment of Primary Brain Tumors, which was awarded DKK 20 million from Knæk Cancer in 2020.

A total of 11 national research centres have now been established with a total support of DKK 183 million from the Knæk Cancer fundraising campaigns and organised under the Danish Comprehensive Cancer Center.

What are the results of the grants?

The majority of the money has been granted over a period of five years so it is time to evaluate the centres, says Bo Andreassen Rix, MD and the Danish Cancer Society's Analysis and Development Manager.

– Of course, the Danish Cancer Society needs to know the results of all the money we have granted to the national research centres. Have they produced the research they promised in their applications, have they provided a structure for national cooperation and knowledge sharing, and have individual centres made an 'impact' in the shape of new clinical guidelines, etc.? These are examples of questions that we will now ask the centres, Bo Andreassen Rix explains.

When the centres are half-way through the grant period, they must make a written self-evaluation in which they answer a series of questions. At the end of the period, the centres will once again make a written self-evaluation statement, and later on they will be visited by an evaluation team. Such a team consists of Danish Cancer Society representatives who will inves-

HRH Crown Princess Mary of Denmark wore a researcher's coat in 2017 when she inaugurated the National Center for Cancer Immune Therapy. MD Morten Orebo Holmström explains his research to the Crown Princess, and in the background, you can see Centre Head, Professor Inge Marie Svane. Stock photo: Tomas Bertelsen



tigate how things have progressed with the setting up of the centres and the establishment of national cooperation, and by international experts in the field who will evaluate the centres' research efforts. The Danish Cancer Society anticipates that the centres will continue to form a well-established and important part of cancer research in Denmark when the Knæk Cancer grants expire.

– We expect that they will be so strongly positioned in research as well as in structure that they can raise funds themselves, says Bo Andreassen Rix.

Immune therapy Government grant

The Center for Cancer Immune Therapy has been successful on two occasions in receiving Government grants for immune therapy research. Immune therapy is a rapidly developing field, and the National Center for Cancer Immune Therapy is given the opportunity to talk about its own role in the development when it will be the first research centre to be visited by the evaluation team in 2021. In 2006, the Herlev Hospital centre employed 14 people. Today, more than 70 people work for the centre.

– The Knæk Cancer grant boosted the centre and promoted the setting up of nationwide immune therapy research infrastructure. We have established the Immunonet multidisciplinary research network in which we hold meetings about immune therapy and particularly focus on young scientists, says Inge Marie Svane, Head of the National Center for Cancer Immune Therapy.

– We wish to embrace all of immune therapy, from basic research, over clinical research to patient involvement, guidelines and new drugs, and we think we have done a good job, Inge Marie Svane adds.

New method is better at identifying bladder cancer

In 2015, Professor and Consultant Jørgen Bjerggaard Jensen received a grant to study a new bladder cancer detection method. In 2020, the results led to a change in the guidelines concerning examination and treatment of bladder cancer.

Known as Narrow Band Imaging (NBI), the new method is basically about a special type of light that can be used to illuminate the bladder mucosa during endoscopy or endoscopic surgery. NBI can be used both in connection with bladder cancer examination and surgery, according to research supported by Knæk Cancer.

Based on the research, NBI was introduced into the Danish guidelines concerning examination and treatment of bladder cancer in 2020. But already in 2019, Aarhus University Hospital began to use NBI in connection with bladder cancer surgery, says Professor and Consultant Jørgen Bjerggaard Jensen, who headed the research.

– Ever more hospitals are switching to NBI, both in Denmark and in Europe where our study is also the centre of attention, says Jørgen Bjerggaard Jensen.

Better and more convenient for patients

Jørgen Bjerggaard Jensen and his team have compared NBI to white light that is used in bladder endoscopy, and fluorescence which is used in endoscopic surgery. Studies demonstrate that NBI is better than white light and just as good at identifying cancer as fluorescence. On the other hand, it is simpler and cheaper to use than fluorescence.

– Fluorescence must enter the bladder via a catheter one hour before the patient is drugged. And if the patient cannot retain it, it does not work. It is troublesome and uncomfortable for patients, and these problems do not exist with NBI. It is more patient-friendly, it is cheaper, and results are coming up which indicate that you can make a safer diagnosis, says Jørgen Bjerggaard Jensen.



Consultant and Professor Jørgen Bjerggaard Jensen performs bladder cancer endoscopic surgery. The room is dark and the bladder is illuminated using the NBI method.

Photo: Aarhus University Hospital



The Danish Cancer Society supports the research

The project 'New imaging modalities utilized in cystoscopic evaluation of the urinary bladder because of bladder cancer' received DKK 1 million from the Knæk Cancer fundraising campaign in 2015.

On behalf of the Danish Cancer Society, we would like to thank everyone whose contribution has made the research possible.

In pursuit of a life without cancer



Danish Cancer Society
Strandboulevarden 49
DK-2100 Copenhagen
Tel +45 35 25 75 00
CBR 55 62 90 13

www.cancer.dk