Annual report 2024

ProCardio –
Precision Health Center for Optimized Cardiac Care

Norwegian Centre for Research-based Innovation

ProCardio Center for Innovation

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ProCardio – Precision Health Center for Optimized Cardiac Care

Contents

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"I am delighted to see the unwavering committment from all partners and the great plans we have for the upcoming years"

Summary

We are now halfway through the ProCardio period, and we have much to be proud of. In addition to reaching a peak in research activity and employment, 2024 has been a busy year preparing for the Underway assessment with the NRC.

We have performed a thorough self-evaluation, in which we concluded that we are well on track with our original milestone plan. In total, we have published more than 220 articles and delivered more than 280 presentations in various forums—an impressive achievement!

Following the self-evaluation and considering advancements in our field, we have revised our plan for the center's activities for the next four-year period. I am delighted to see the unwavering commitment from all partners and the great plans we have for the upcoming years. We also received valuable feedback from our meeting with the Scientific Advisory Board (SAB) that will guide our focus moving forward. These insights have been valuable in preparing for the meeting with NRC and the expert panel in Q1 2025.

Sesam was brought in as a partner in ProCardio to utilize their cloud solution to extract statistical data to build larger datasets for AI model training. However, due to administrative challenges in accessing necessary OUS infrastructure, it was a mutual decision that Sesam withdrew from the consortium in September. Thank you to Sesam for the collaboration!

Sixteen new talented members joined ProCardio in 2024. This is more than ever. We welcomed twelve new PhD/Postdoc fellows, three study nurses/research coordinator, and one data scientist. Warmest welcome to all.

Foto: Bildmakarna

We organized our two annual ProCardio meetings with great attendance. We were also well represented at a variety of national- and international conferences, where ProCardio members were active with abstracts, presentations, networking, and learning.

In 2024, ProCardio published 80 scientific papers and had 124 scientific communications/ abstracts. These are impressive numbers. Center PhD fellows Anna Isotta Castrini and Ivar M. Salte successfully defended their PhD theses during 2024 and were celebrated accordingly. Congratulations and thanks for your great work for ProCardio.

Thank you all, together we are enriching ProCardio and the field of Cardiology. I look forward to a continued productive, exciting, and joyful collaboration.

Director Kristina Haugaa

Objectives and research plans

The center was established to create a clinically driven, validated ICT(information and communications technology) platform for cardiology that will enable a major change in individualized healthcare, providing the best possible treatment and risk prevention by using big data and artificial intelligence. Based on leading edge research, this platform will facilitate fusion and analysis of rich and diverse data, integrating a wealth of available information into the workflow of clinical cardiology, and tailor individual care to prevent over- and under-treatment.

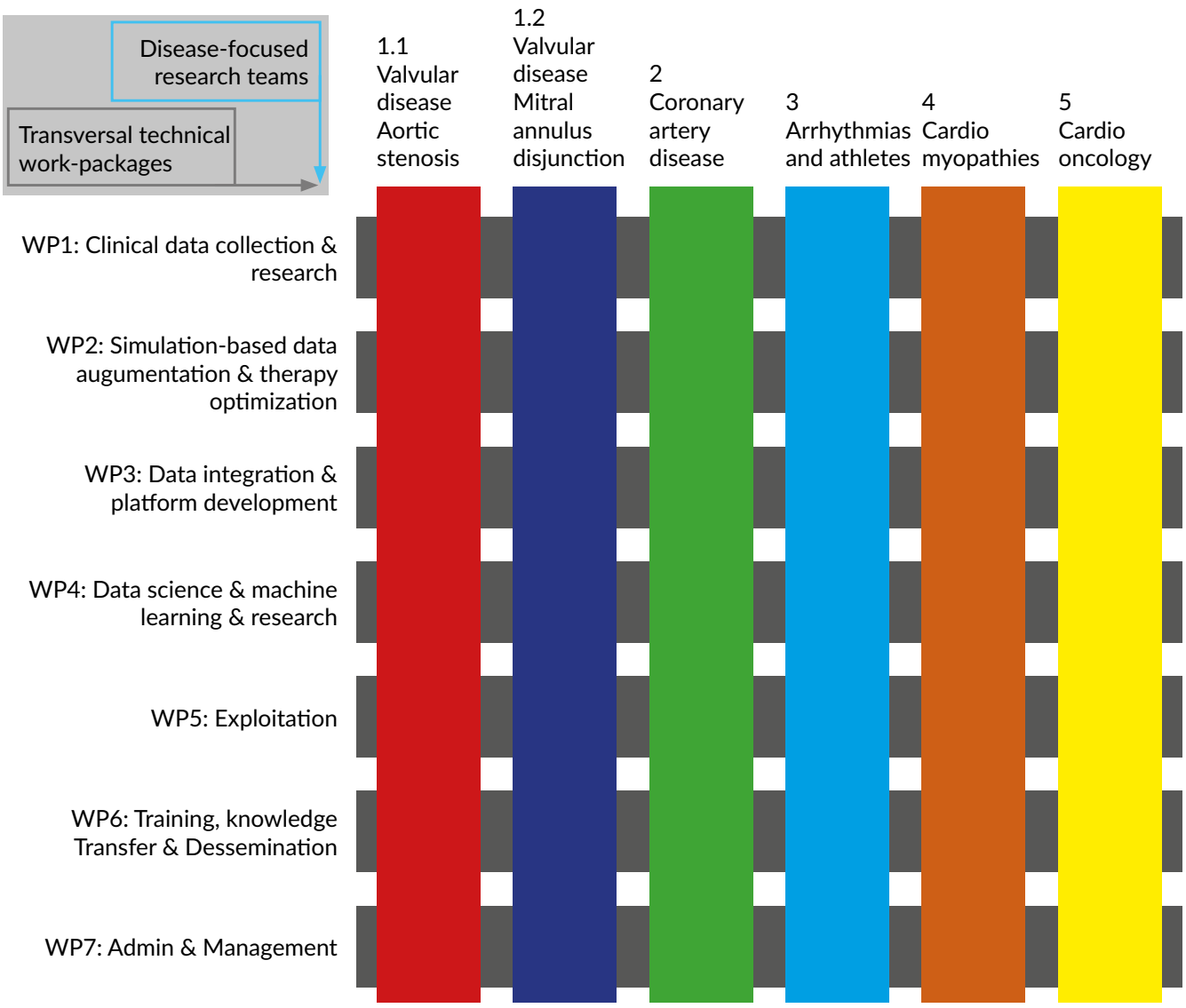
The most substantial impact of the ProCardio on Norwegian and European societies will be its impact on healthcare. In spite of recent advances leading to decreased mortality rates, cardio vascular disease remains the most common cause of death in Norway accounting for more than one in four deaths.

The envisioned uptake of ProCardio tools will have substantial impact for individual patients with metrics such as cost per Quality Adjusted Life Year gained. Even more important, these improvements will benefit patients by

1. Improved selection criteria
2. Individually optimized treatment
3. More accurate follow-ups
4. Reduced hospitalization stays and procedures
5. Personalized advise on health bringing activities e.g. exercise

ProCardio will have governing structures and operating mechanism that will guarantee a targeted effort to produce results that can be exploited by the partners and lead to value creation in Norway, through the engaged industrial end-users. The center is also strongly in line with the strategies of research partners (NTNU, SRL, UiO, OUS) who are all member of the Norway Health Tech cluster. OUS director of Innovation is invited as part of the management team to ensure continuous focus on innovations. Lastly, clinical partners participating in ProCardio will benefit from sizeable value pools from more effective cardiac care.

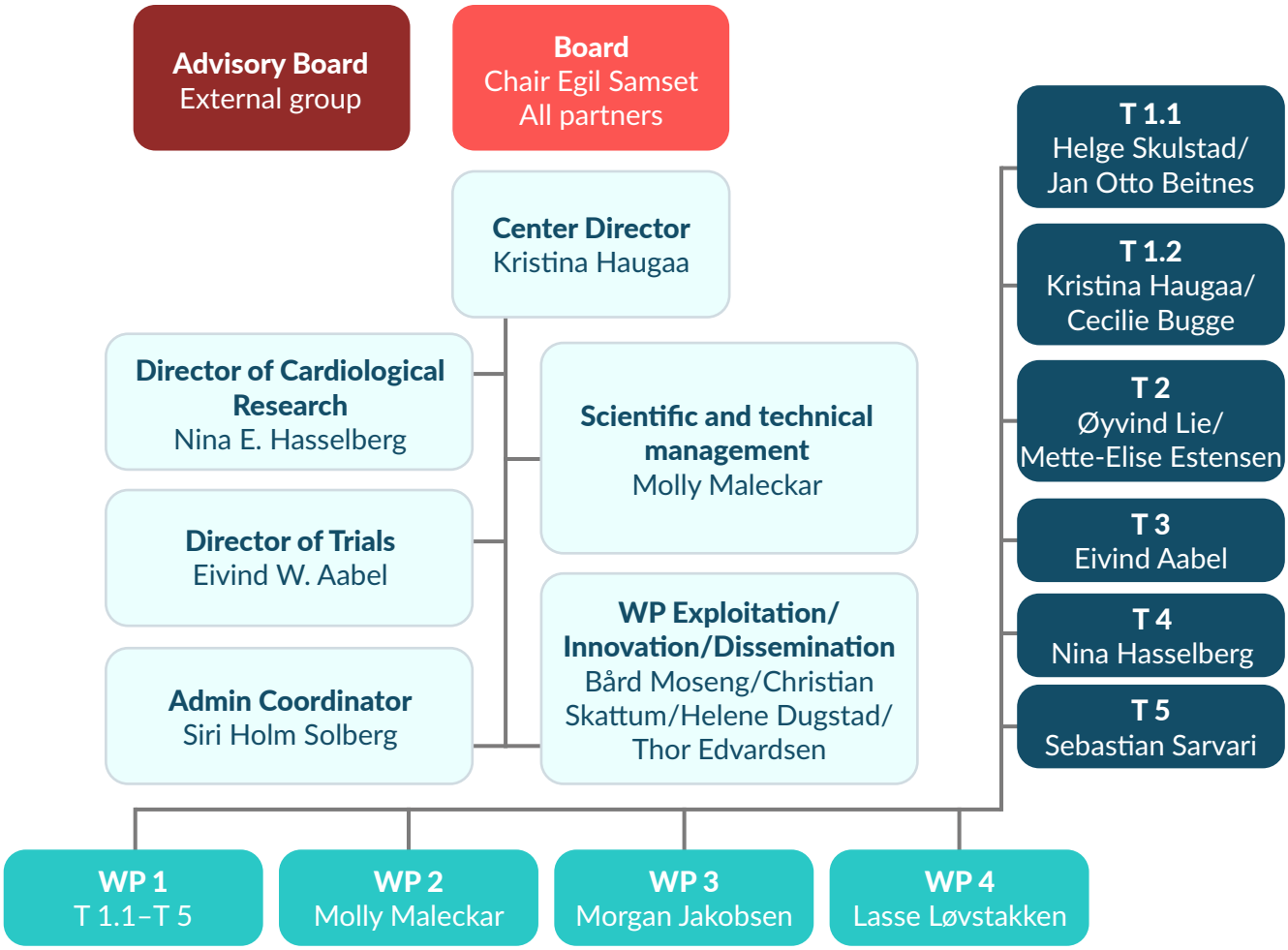
In order to foster an application-driven mindset and to uncap technical synergies across ongoing projects, ProCardio methodology was designed to focus on a bidimensional approach concept of having “vertical” research teams focusing on a target cardiac disease while the technical work will be coordinated “horizontally” to enable crosspollination of breakthroughs and integration of knowledge in a single platform. Lastly, common management, coordination and knowledge-transfer mechanisms will work across the entire center.


Disease-focused research teams
Transversal technical work-packages
1.1 Valvular disease Aortic stenosis
1.2 Valvular disease Mitral annulus disjunction
2 Coronary artery disease
3 Arrhythmias and athletes
4 Cardio myopathies
5 Cardio oncology
WP1: Clinical data collection & research
WP2: Simulation-based data augumentation & therapy optimization
WP3: Data integration & platform development
WP4: Data science & machine learning & research
WP5: Exploitation
WP6: Training, knowledge Transfer & Dessemination
WP7: Admin & Management

Organization

ProCardio is hosted by Oslo University Hospital. In addition to the host institution, the consortium consists of ten partners from both research and industry. ProCardio is located at the Oslo University Hospital, Rikshospitalet, with the physical hub located at Domus Medica (DM4/The University of Oslo) at Sognsvannveien 9 (entrance from Gaustadalléen 34).

The center director, Kristina Haugaa, is responsible for the center management. She is assisted by the management team. Each clinical task group (T) is led by clinical research and innovation deputies, liaising with WP leaders which ensures transversal synchronization of technical work among the different teams. In 2024, there have been some changes in leadership as illustrated in the figure. By the end of 2024, task group leaders are Jan Otto Beitnes (T1.1), Cecilie Bugge (T1.2), Mette-Elise Estensen (T2), Eivind Westrum Aabel (T3), Nina Hasselberg (T4) and Sebastian Sarvari (T5). In parallel exploitation, dissemination and innovation activities will be supervised by designated managers, Bård Moseng (GEVU), Christian Skattum, our representative from OUS Dept. of Innovation and our Key Account Manager Helene B. Dugstad from INVEN2. Molly Maleckar from SRL acts as Scientific & Technical Manager coordinating the work of the technical teams. Siri Holm Solberg functioned as Administrative Coordinator.



Boards of directors

ProCardio is governed by a Board of Directors, for which representatives have been appointed by each of the partners. The Board comes together twice a year to discuss the Center's development, financial aspects, and administrative issues. Many of the board members participate actively in the Center's research activity and their expertise is of uttermost importance for the development of future technology within ProCardio. The Center's Board of Directors consists of the following members appointed by the consortium participants:

- Eigil Samset, GE Healthcare, Chair
- Bjørn Bendz, OUS
- Axel Borge, Sesam
- Liv Bollvåg, DIPS
- Mirco de Melis, Medtronic
- Rune Wiseth, NTNU
- Jan G. Bjålie, UiO
- Samuel Wall, Simula
- Bård Moseng, GE Vingmed
- Harald Brunvand/Daniela Melichova, Sørlandet Sykehus HF
- Tom Marwick, Baker Institute

Partners

The ProCardio Center for Innovation was originally comprised of 11 partners with OUS being the host partner. Each partner represents a unique and required element in the research and development chain leading to the industrial innovations targeted by ProCardio. After Sesam withdrew from the consortium in September 2024, there are now 10 active partners in the center.

OSLO UNIVERSITETSSYKEHUS

Knowledge:

1. Dept of Cardiology at OUS is the largest interventional department in the Nordic countries with more than 4100 PCIs and 1600 ablations every year
2. Front line cardiac research player and world-class clinical expertise;
3. hosted the SFI Center of Cardiological Innovation, which was a highly successful SFI

Resources:

a. Infrastructures to host the ProCardio center

b. administrative support towards daily run of the center

c. image and EMR data (>1000 patients

UiO University of Oslo

Knowledge:

1. Oldest and largest research and educational institution in medicine in Norway
2. K.G. Jebsen Centre for Cardiac Research is a global reference in the field of cardiology, combining outstanding PIs with an extensive international network of research partners

Resources:

a. PhD training for OUS-hosted researchers

Baker HEART & DIABETES INSTITUTE

Knowledge:

1. Outstanding diabetes & cardiac research center, with global visibility, contributing to ProCardio with strong complementary expertise in the field of cardio-oncology

Resources:

a. Extensive clinical database of multi-modal data

NTNU

Knowledge:

1. Acknowledged as a SFI center for Innovative Ultrasound Solutions (CIUS);
2. Extensive know-how on medical imaging technology, in particular ultrasound;
3. expertise in artificial intelligence and machine learning algorithms;
4. Centre of excellence for translational medical research at the interface of epidemiology, genetics, statistics, bioinformatics and systems biology

Resources:

a. Extensive databases with follow up echo-cardiographic studies and outcome data;

b. Computational infrastructure to train and run resource-intensive AI algorithms;

c. Databases on genetic markers to be coupled with cardiac imaging in HUNT database and its digital infrastructure, and

also a substantial number of other omics data such as NMR-based metabolomics, CVD related protein arrays, transcriptomics and other targeted protein biomarkers.

SØRLANDET SYKEHUS

Knowledge:

1. Leading clinical and experimental research expertise in the area of myocardial function;
2. Extensive hands-on experience on clinical trials to assess new diagnostic technologies and therapies (e.g. we established the IMPROVE study)

Resources:

a. Image data and EMR data (>2000 patients);

b. inclusion of cardiac patients with heart failure and myocardial infarction in ongoing and future research projects.

simula

Knowledge:

1. Host of several SFF, SFI, and EU networks focused on excellence in biomedical computing and computing in cardiology,
2. Mathematical growth models for cardiac physiology, growth, and remodeling,
3. data-driven models and analysis for risk prediction;
4. Computational Cardiology Models for biophysical simulation

Resources:

a. Extensive clinical database of multi-modal data

Medtronic

Knowledge:

1. World's largest medical technology company, offering a large breadth and depth of innovative therapies, including forefront treatments for cardiac and vascular diseases;
2. extensive expertise in clinical trial protocol development and implementation;
3. VBHC approaches for therapy optimization and chronic care programs;
4. Manufacturing of devices (both for delivering therapies as well for diagnostic purposes (sensors)

Resources:

a. Access to state-of-the-art medical devices;

b. capable of designing and building custom-made devices addressing the needs of individual or groups of patients according to the specifications provided by a physician/project.

GE HealthCare

Knowledge:

1. World class design and manufacturing of diagnostic imaging and monitoring systems;
2. Extensive expertise in cardiology diagnostics, artificial intelligence development for imaging and waveforms
3. Deep market understanding
4. GE's center of excellence on ultrasound engineering;
5. World-class know-how in cardiovascular ultrasound acquisition, processing and analysis, speckle-tracking and strain

imaging, artificial intelligence in ultrasound, 3D visualization and quantification;

6. Extensive insight on regulatory requirements and ultrasound market intelligence

Resources:

a. Fast-track integration of innovations into commercial products and application to other imaging modalities beyond ultrasound

b. provide ultrasound equipment and software to the center to ensure successful execution of clinical projects and data acquisition.

DIPS

Knowledge:

1. Leading supplier of patient electronical medical records software solutions to Norwegian hospitals;

2. Expertise in eHealth, data integration activities and IT platform development

Resources:

a. Access to DIPS Arena - a fully integrated patient record system including closed loop medication, charting, booking and planning, electronic document workflow, CPOE, multimedia and reporting.

sesam

Knowledge:

1. Development of GDPR compliant data management solutions;

2. Data privacy expertise;

3. Creation of interfaces and standards for sharing of data in of Health analytics

Resources:

a. Access to the Sesam Data Integration Hub Platform-as-a-service, via an in-kind platform subscription;

b. consulting services around architecture, along with assistance to connect data sources, transforming data and delivering data where it is needed

Cooperation between partners

The partners at ProCardio bring key competences to the joint projects, enabling everyone in ProCardio to effectively pursue the collective goals. To ensure effective dissemination of management goals and coordination of efforts among the partners, an integrated meeting schedule has been established. This includes weekly meetings within individual project teams, biweekly meetings among management and PhD-students, and bimonthly meetings among T- and WP-leaders. The supervisory board meets bi-annually, in sync with the planned training and dissemination workshops. ProCardio holds two annual workshops, one in the spring and one in the fall, focusing on innovation, research and collaboration.

Spring workshop April 25th

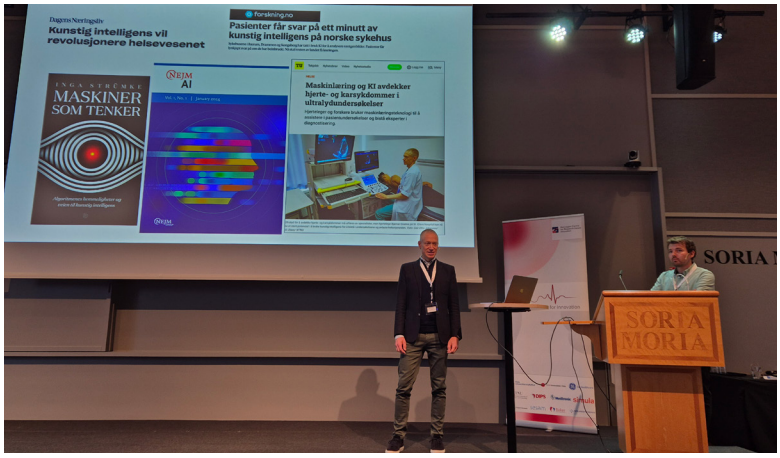
The annual spring meeting was to be held at St.Olavs Hospital/NTNU in Trondheim. However, due to closed airspace in Southern Norway participants from Oslo and Horten were unable to attend the meeting physically, and the meeting had to be held as a hybrid with remote participation. The program included speed updates from the areas Mitral valve segmentation and tracking using ultrasound, MV-prolapse: automatic valuve detection in MRI, MV-prolapse, arrhythmic insights, NeuECG, Vaccine induced myocarditis and the CardioOncology Dashboard. Work on whether large language models can be useful in echocardiography and how CIUS work with innovation were presented and discussed in plenum. Even with a hybrid meeting, the workshops on natural language processing, topics in AI, high frame rate imaging, home monitoring in arrhythmias, genetics and neuECG were very fruitful.

The Oslo crowd was still enthusiastic about the meeting.

Fall workshop September 26th – 27th

The ProCardio Fall meeting took place at Soria Moria Hotel in Oslo.

The workshop featured project updates from all T- and WP-leaders and subsequent group work sessions. Einar Martin Aandahl from Ledidi Core was invited to present their user-driven innovation to meet the need for a user-friendly solution for health data management and collaboration. After a nice update on artificial intelligence in echocardiography, most of day 2 was used for workplans and the upcoming underway assessment. This year, the annual quiz was replaced by the ProCardio games. This change did nothing to temper competitive instincts.



Scientific Activitites and Research

Exercise ECG and Risk of Severe Ventricular Arrhythmias in Mitral Valve Prolapse: A Prospective Study

Five CK, Hasselberg NE, Chivulescu M, Rootwelt-Norberg C, Ribe MP, Dejgaard LA, Castrini AI, Aabel EW, Haugaa KH.

Mitral valve prolapse (MVP) is a common condition with a generally good prognosis, but some patients are at risk of life-threatening ventricular arrhythmias. The ability to predict these arrhythmic events is limited, and the role of exercise testing in risk stratification has not been well studied. This study aimed to explore whether exercise ECG could predict severe ventricular arrhythmias in MVP patients.

A prospective cohort study was conducted, including MVP patients without prior documented severe ventricular arrhythmias who were referred to a tertiary center. Severe ventricular arrhythmias was defined as aborted cardiac arrest, sustained ventricular tachycardia, or non-sustained ventricular tachycardia (nsVT) with hemodynamic instability. All patients underwent exercise ECG testing, and 24-hour ECG monitoring. The primary outcome was the occurrence of severe ventricular arrhythmias during follow-up, detected using an implantable loop recorder or primary preventive implantable defibrillator.

The study included 91 MVP patients of which 8 were lost to follow up yet were confirmed to be alive as of December 2023. One died of cancer, leaving 82 patients (51 ±16 years of age, 63% women. At baseline, 20% of patients had nsVT documented either during the exercise test or 24-hour monitoring. Over a mean follow-up period of 4.3 years, 6% of patients experienced first-time severe ventricular arrhythmias. Notably, 60% of those with severe ventricular arrhythmias had nsVT on the exercise ECG, while 40% had nsVT detected via 24-hour monitoring.

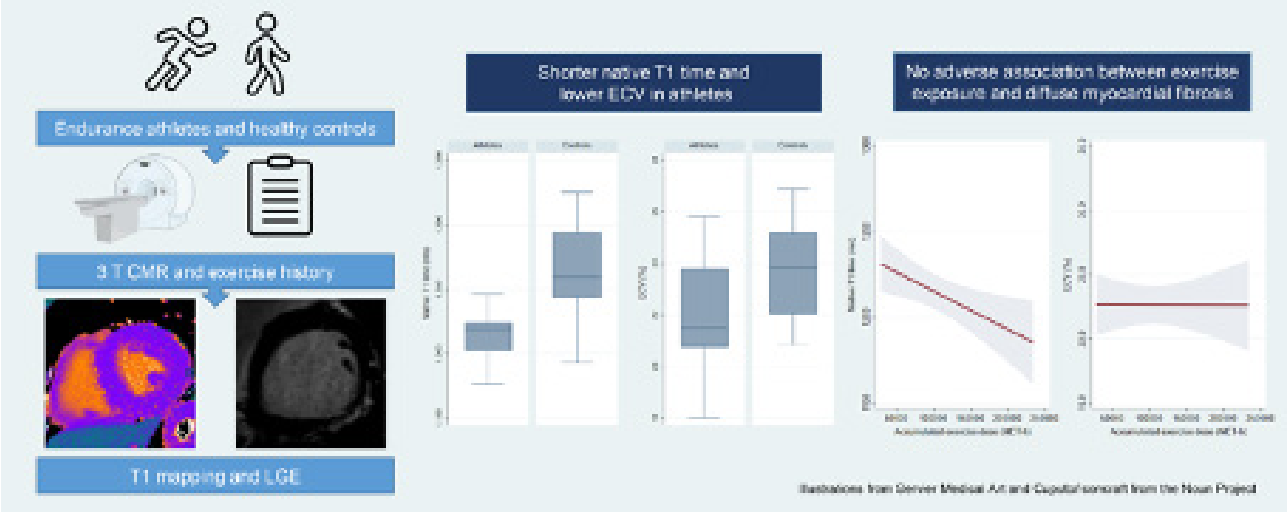
Multivariate Cox-regression analysis showed that nsVT on the exercise ECG was strongly correlated with subsequent severe ventricular arrhythmias (age-adjusted hazard ratio [HR] 28, 95% CI 5-170, $p<0.001$), while nsVT detected on 24-hour monitoring showed a non-significant association with severe ventricular arrhythmias (HR 3, 95% CI 0.6-21, $p=0.175$).

In conclusion, nsVT observed during baseline exercise ECG was significantly associated with the risk of subsequent severe ventricular arrhythmias in MVP patients. Exercise ECG may serve as a valuable tool for identifying high-risk patients. However, the study's small cohort and low event rate limit the generalizability of these findings. Larger studies are needed to confirm these results.

This study was published in Heart Rhythm in Nov 2024 (doi: 10.1016/j.hrthm.2024.04.076).

No adverse association between exercise exposure and diffuse myocardial fibrosis in male endurance athletes

Andresen K, Klæboe LG, Lie ØH, Broch K, Kvaslerud AB, Bosse G, Hopp E, de Lange C, Haugaa KH, Edvardsen T



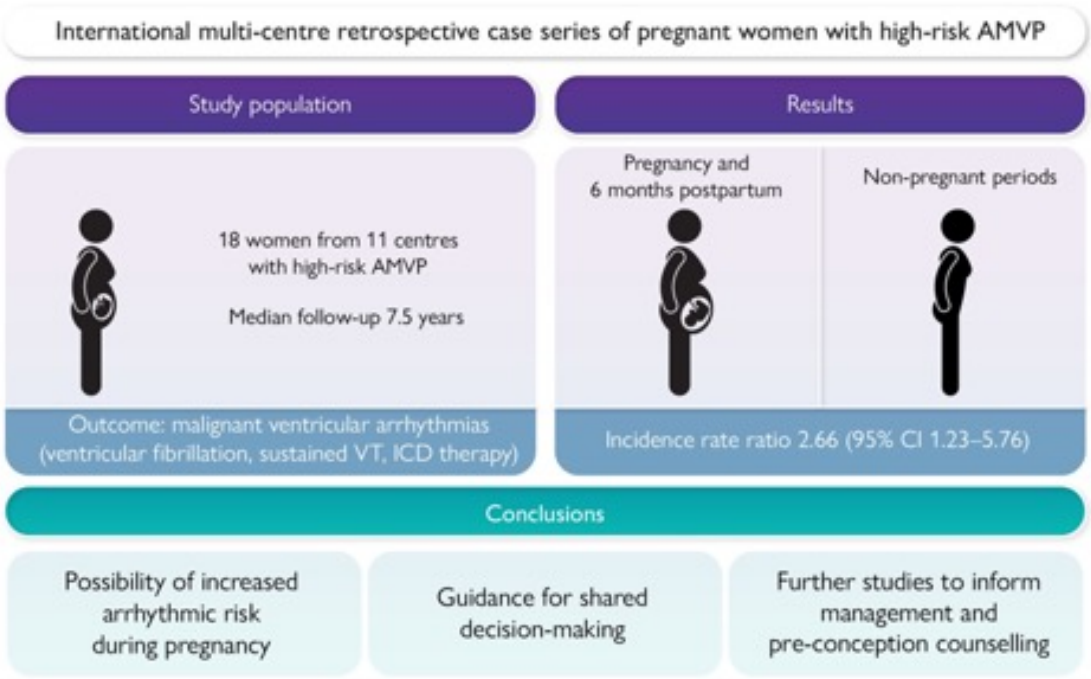
The beneficial effect of physical activity on reducing mortality and risk of cardiovascular disease in the general population is well established. However, it has long been hypothesized that excessive physical activity can induce permanent cardiac damage even in normal hearts. Consequent myocardial fibrosis can be either focal or diffuse, both of which have been found to be associated with increased mortality in clinical populations. Data on exercise exposure and diffuse myocardial fibrosis in endurance athletes are scarce and conflicting. We aimed to investigate the association between exercise exposure and markers of diffuse myocardial fibrosis by cardiovascular magnetic resonance imaging in endurance athletes.

We examined healthy adult male competitive endurance athletes and healthy controls in a cross sectional study using cardiovascular magnetic resonance imaging including late gadolinium enhancement and T1 mapping. Healthy male endurance athletes had lower extracellular volume and shorter native T1 time than controls despite high cumulative exercise exposure and a profound expression of the athlete's heart phenotype. Our results indicate that diffuse myocardial fibrosis is not prevalent in healthy male endurance athletes. Moreover, we did not find any adverse dose-response relationship between exercise exposure and diffuse myocardial fibrosis. These results offer reassurance and might help mitigate concerns regarding the potential for adverse long-term cardiac remodelling of elite athleticism in healthy athletes.

The study was published as an original research article in the journal Scientific Reports in March 2024 (doi: 10.1038/s41598-024-57233-5).

Mitral Valve Prolapse: Arrhythmic Risk During Pregnancy and Postpartum

Sabbag A, Aabel EW, Castrini AI, Siontis KC, Laredo M, Nizard J, Duthoit G, Asirvatham S, Sehrawat O, Kirkels FP, van Rosendael PJ, Beinart R, Acha MR, Peichl P, Lim HS, Sohns C, Martins R, Font J, Truong NNK, Estensen ME, Haugaa KH.



Arrhythmic mitral valve prolapse (AMVP) is associated with life-threatening ventricular arrhythmias (VAs), particularly in young women. While pregnancy poses physiological stress on the cardiovascular system, the arrhythmic risk of AMVP during pregnancy and postpartum remains unclear.

This was a retrospective international multi-centre study including 18 AMVP women from 11 centres, diagnosed with AMVP due to malignant VA and had at least one pregnancy. The incidence of malignant VA (ventricular fibrillation, sustained ventricular tachycardia, or appropriate implantable cardioverter-defibrillator [ICD] therapy). was compared between non-pregnant and perinatal periods (pregnancy and 6 months postpartum).

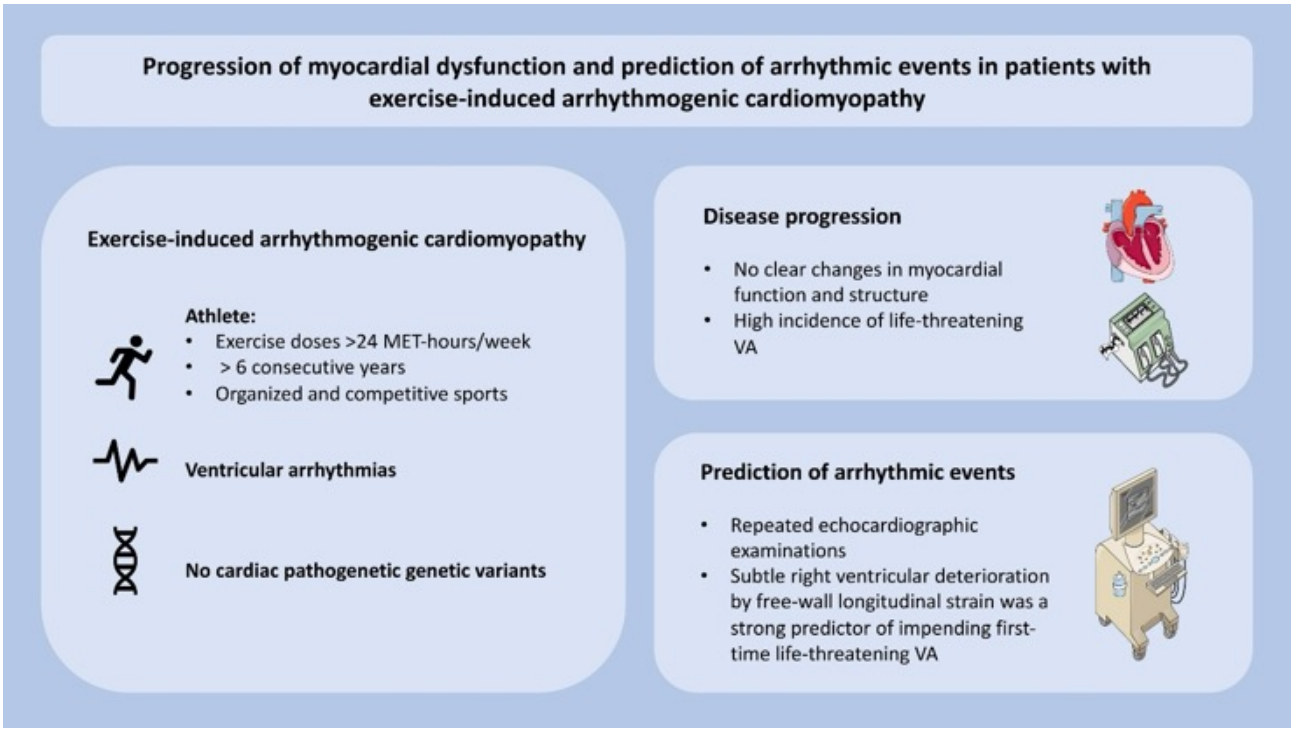
A total of 37 malignant VA events were recorded during a median follow-up of 7.5 years, of which 18 (49%) of these events occurred during the perinatal period, affecting 13 women (72%). The incidence rate of malignant VA was significantly higher during the perinatal period (incidence rate ratio 2.66, 95% CI 1.23–5.76). Beta-blockers were the most commonly used antiarrhythmic medication during pregnancy, and ICD therapy was frequently required. Obstetric complications were rare, and most pregnancies progressed to term.

The study infers that the perinatal period may increase the risk of malignant VA in high-risk women with AMVP. This information is crucial for pre-conception counselling and shared decision-making between patients and clinicians. Given the potential risks, close monitoring and individualized management strategies should be considered for pregnant women with high-risk AMVP.

This study was published in the European Heart Journal in May 2024 (doi: 10.1093/eurheartj/ehae224).

Progression of myocardial dysfunction and prediction of arrhythmic events in patients with exercise-induced arrhythmogenic cardiomyopathy

Aaserud LT, Rootwelt-Norberg C, Five CK, Aabel EW, Hasselberg HE, Lyseggen E, Haugaa KH, Lie ØH.

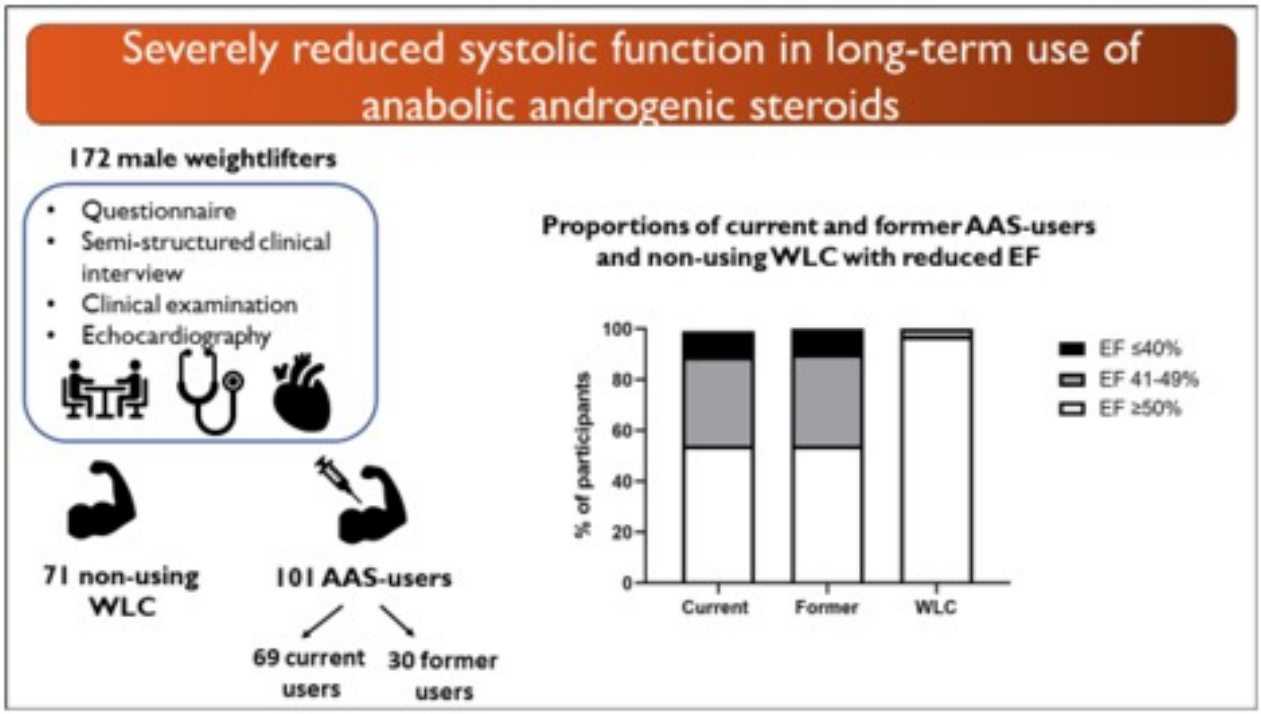


Several reports exist of an acquired exercise-induced arrhythmogenic cardiomyopathy (EiAC), but its progression and arrhythmia risk remain poorly understood. This longitudinal, single-center study followed 41 athletes (15% women, age 45 ± 13 years) with EiAC over a median of 80 months. All participants had a history of life-threatening ventricular arrhythmias (VA), but no family history or known genetic variants associated with cardiac disease. Myocardial function and structure were assessed through repeated echo-cardiographic examinations and life-threatening VA were assessed during long term follow-up. While no clear overall myocardial changes were observed during follow-up, patients exhibited a high incidence and recurrence of life-threatening VA. Importantly, subtle deterioration in right ventricular function, measured by free wall longitudinal strain, was strongly associated with the occurrence of first-time life-threatening VA (odds ratio 1.12 per 1% deterioration, P = .031). These findings suggest that right ventricular functional decline may serve as an early marker of arrhythmic risk, underscoring the need for improved monitoring and risk stratification in athletes with EiAC.

his study was published in Heart Rhythm O2 in August 2024 (doi: 10.1016/j.hroo.2024.08.003)

Severe biventricular cardiomyopathy in both current and former long-term users of anabolic-androgenic steroids

Abdullah R, Bjørnebekk A, Hauger LE, Hullstein IR, Edvardsen T, Haugaa KH, Almaas VM.



Anabolic-androgenic steroids (AAS) are synthetic derivatives of the male sex hormone testosterone, frequently used illegally by male weightlifters to enhance muscle mass or for aesthetic purposes. Epidemiological data suggest that non-medical AAS use is prevalent, particularly among men. Although AAS use has long been associated with cardiovascular pathology, as demonstrated in several case reports, large-scale data on this issue remain limited. To address this gap, we recruited 172 weightlifters for a cross-sectional study, comprising 101 AAS users (both current and former) and 71 weightlifting controls (WLC) with no history of AAS use.

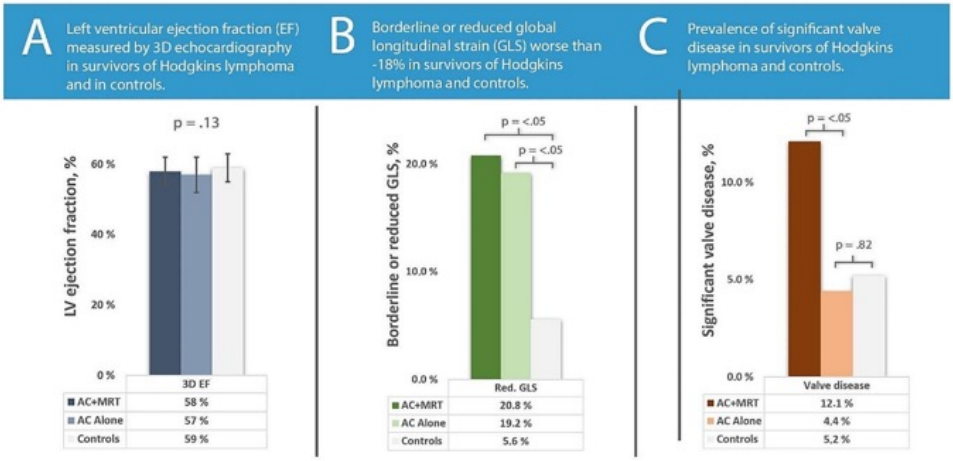
We performed echocardiography on all participants, with offline analysis conducted observer-blinded to AAS status. Our findings revealed that AAS use was significantly associated with left ventricular hypertrophy and biventricular systolic dysfunction, as evidenced by reductions in left ventricular ejection fraction and impairments in both left and right global longitudinal strain.

This article was published in the high-impact journal European Journal of Preventive Cardiology. We are currently conducting a follow-up study to assess the long-term cardiovascular effects in AAS users several years after the initial examination.

This study was published in European Journal of Preventive Cardiology in March, 2024 (doi: 10.1093/eurjpc/zwad362).

Long-term cardiac effects of modern treatment for Hodgkin's lymphoma

Bjerring AW, Smeland KB, Stokke T, Haugaa KH, Holte E, Rösner A, Kiserud CE, Edvardsen T, Sarvari S.



Hodgkin's lymphoma (HL) is a hematological malignancy that affects both children and young adults. Traditional treatment is associated with a lifetime prevalence of cardiac disease exceeding 50%. In the late 1990s, protocols were changed in order to decrease cancer therapy-related adverse cardiac effects. Our main objective was to assess the long-term impacts of the modifications in treatment protocols on cardiac health of HL survivors (HLS). We included retrospectively 246 HLS treated between 1997 and 2007 with anthracycline-based chemotherapy in 3 centers in Norway. Of these, 132 had also received mediastinal radiotherapy. HLS were compared to 58 healthy controls matched for sex, age, smoking status, and heredity for coronary artery disease. All subjects underwent echocardiography, clinical assessment, and blood sampling.

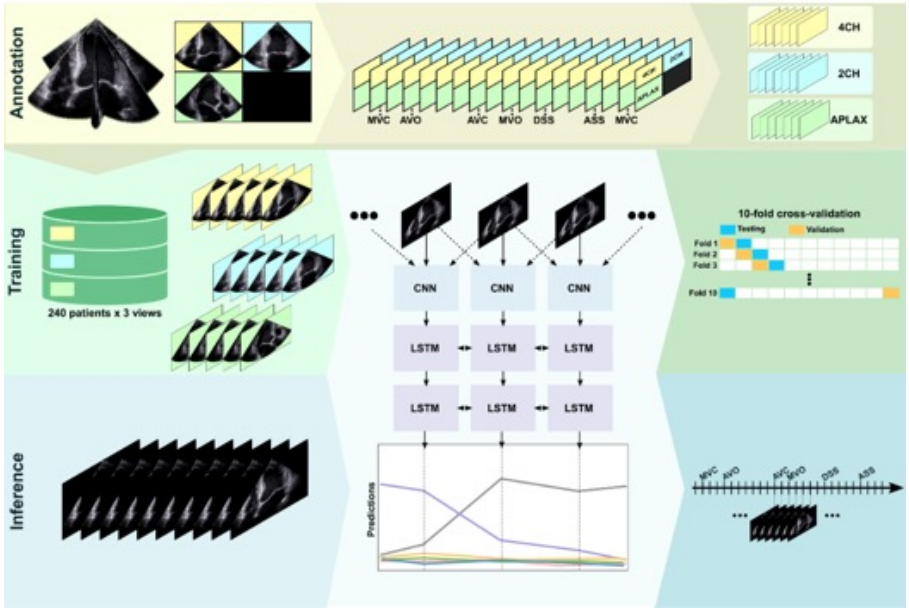
The HLS were 46 ± 9 years old and had been treated 17 ± 3 years before inclusion in the study. There was no difference between HLS and controls in ejection fraction or prevalence of heart failure. HLS treated with both anthracyclines and mediastinal radiotherapy had slightly worse left ventricular global longitudinal strain than controls, but those treated with only anthracyclines did not. HLS treated with anthracyclines and mediastinal radiotherapy had a higher prevalence of valve disease than those treated only with anthracyclines (12% vs. 4%, $p < 0.05$).

Our study demonstrated that HLS treated with anthracyclines after the late 1990s have similar cardiac function and morphology as age-matched controls. Importantly, HLS who underwent mediastinal radiotherapy had higher rates of valvular disease compared to those who did not.

The study was published in Cardiooncolog in April 2024 (doi: 10.1186/s40959-024-00222-4).

Cardiac Valve Event Timing in Echocardiography Using Deep Learning and Triplane Recordings

Fermann BS, Nyberg J, Remme ER, Grue JF, Grue H, Håland R, Lovstakken L, Dalen H, Grenne B, Aase SA, Snare SR, Østvik A.

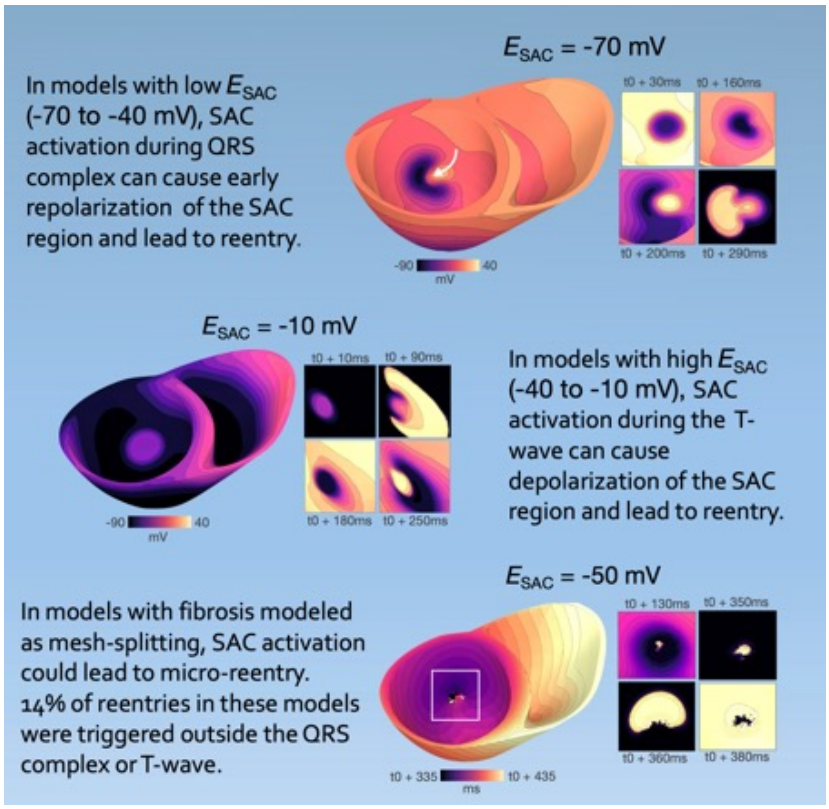


Cardiac valve event timing plays a crucial role when conducting clinical measurements using echocardiography. However, established automated approaches are limited by the need of external electrocardiogram sensors, and manual measurements often rely on timing from different cardiac cycles. Recent methods have applied deep learning to cardiac timing, but they have mainly been restricted to only detecting two key time points, namely end-diastole (ED) and end-systole (ES). In this work, we propose a deep learning approach that leverages triplane recordings to enhance detection of valve events in echocardiography. Our method demonstrates improved performance detecting six different events, including valve events conventionally associated with ED and ES. Of all events, we achieve an average absolute frame difference (aFD) of maximum 1.4 frames (29 ms) for start of diastasis, down to 0.6 frames (12 ms) for mitral valve opening when performing a ten-fold cross-validation with test splits on triplane data from 240 patients. On an external independent test consisting of apical long-axis data from 180 other patients, the worst performing event detection had an aFD of 1.8 (30 ms). The proposed approach has the potential to significantly impact clinical practice by enabling more accurate, rapid and comprehensive event detection, leading to improved clinical measurements.

The study was published in IEEE J Biomed Health Inform. In May 2024 (doi: 10.1109/JBHI.2024.3373124).

Stretch of the papillary muscle insertion triggers reentrant arrhythmia

Myklebust L, Monopoli G, Balaban G, Aabel EW, Ribe M, Castrini AI, Hasselberg NE, Bugge C, Five C, Haugaa KH, Maleckar M, Arevalo H.



Motivation. The electrophysiological mechanism connecting mitral valve prolapse (MVP), premature ventricular complexes and life-threatening ventricular arrhythmia is unknown. Recent clinical studies propose that pathological traction of the papillary muscles (PMs) induce irregular electrical activity via stretch activated channels (SACs).

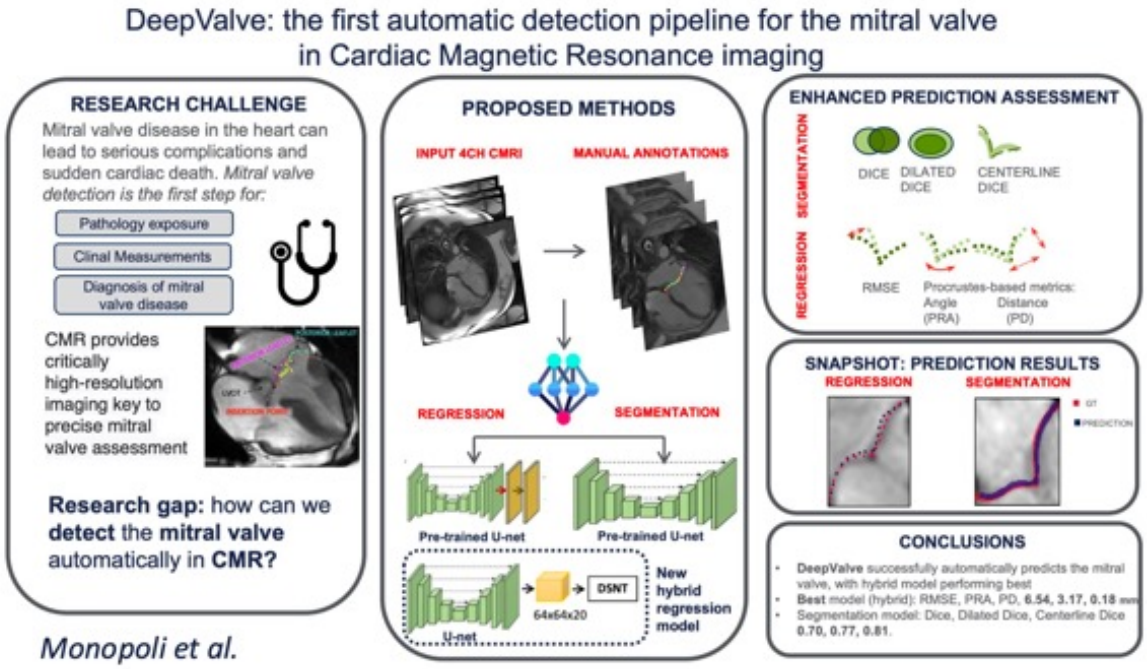
Methods. We modeled the effect of PM traction by activating SACs in the PM insertion region of an image-based, electrophysiological ventricular model. We varied the SAC reversal potential (ESAC) and size of the region with simulated stretch (SAC region). Model variations with healthy tissue, global fibrosis or fibrosis in the SAC region were created. By systematically incrementing the time of SAC onset in 1 ms steps following sinus rhythm, we identified vulnerability windows for reentry initiation.

Conclusions. Stretch of the PM insertion region following sinus rhythm can induce reentry in patients with MVP, with or without fibrosis. Reentry can be triggered by either SAC-induced depolarizations or SAC-induced early repolarization, determined by the SAC reversal potential. Depending on SAC-properties, potential fibrosis and timing of PM stretch in an MVP patient, the above-mentioned mechanisms could be responsible for ventricular reentry in these patients.

This is an ongoing project. The actual study was published in Frontiers in physiology in Aug 2024 (doi: 10.3389/fphys.2024.1447938. eCollection 2024).

DeepValve: the first automatic detection pipeline for the mitral valve in Cardiac Magnetic Resonance Imaging

Monopoli G, Haas D, Singh A, Aabel EW, Ribe M, Castrini AI, Hasselberg NE, Bugge C, Five C, Haugaa KH, Forsch N, Thambawita V, Balaban G, Maleckar M.

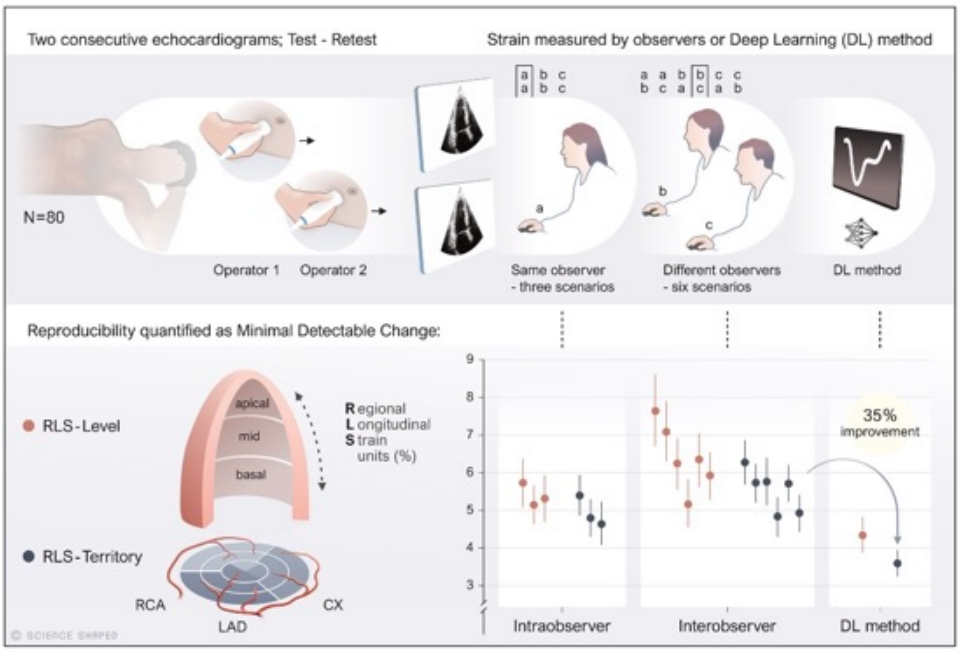


Mitral valve (MV) assessment is key to diagnosing valvular disease and to addressing its serious downstream complications. Cardiac magnetic resonance (CMR) has become an essential diagnostic tool in MV disease, offering detailed views of the valve structure and function, and overcoming the limitations of other imaging modalities. Automated detection of the MV leaflets in CMR could enable rapid and precise assessments that enhance diagnostic accuracy. To address this gap, we introduce DeepValve, the first deep learning (DL) pipeline for MV detection using CMR. Within DeepValve, we tested three valve detection models: a keypoint-regression model (UNET-REG), a segmentation model (UNET-SEG) and a hybrid model based on key-point detection (DSNT-REG). We also propose metrics for evaluating the quality of MV detection, including Procrustes-based metrics (UNET-REG, DSNT-REG) and customized Dice-based metrics (UNET-SEG). We developed and tested our models on a clinical dataset comprising 120 CMR images from patients with confirmed MV disease (mitral valve prolapse and mitral annular disjunction). Our results show that DSNT-REG delivered the best regression performance, accurately locating landmark locations. UNET-SEG achieved satisfactory Dice and customized Dice scores, also accurately predicting valve location and topology. Overall, our work represents a critical first step towards automated MV assessment using DL in CMR and paving the way for improved clinical assessment in MV disease.

This is an ongoing project. This particular study is now in revision for publication as a peer-reviewed journal article.

Deep learning improves test–retest reproducibility of regional strain in echocardiography

Nyberg J, Østvik A, Salte IM, Olaisen SH, Karlsen S, Dahlslett T, Smistad E, Eriksen-Volnes T, Brunvand H, Edvardsen T, Haugaa KH, Lovstakken L, Dalen H, Grenne B



Graphical abstract from published article. https://doi.org/10.1093/ehjimp/qyae092

Echocardiographic measurements of regional strain in the left ventricle (LV) are underused due to low reproducibility. We evaluated the test-retest reproducibility of regional longitudinal strain (RLS) per coronary artery perfusion territory (RLS – Territory) and per basal-to-apical level of the LV (RLS – Level) by a novel deep learning-based method.

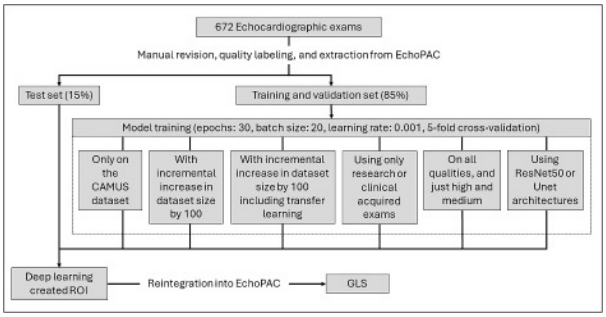
Strain measurements were performed in 40 controls from the general population and 40 patients previously admitted with suspected myocardial infarction. Consecutive echocardiograms were acquired in all patients by two different echocardiographers. In addition to the deep learning-based measurements, three experienced operators measured strain using a semi-automatic method to provide inter- and intraobserver data for comparison.

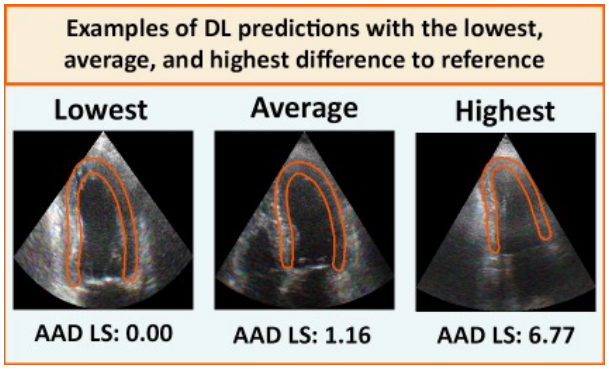
The minimal detectable change (MDC) in strain units was lower for the deep learning-based method across all measurements, ranging from 3.6 to 4.3%, corresponding to a 33-35% improvement compared to inter- and intraobserver assessments. The deep learning-based method also showed lower variance in test-retest differences (all P <0.001) and superior reproducibility in Bland-Altman analyses.

This fully automated deep learning-based approach significantly enhances the reproducibility of regional strain measurements, achieving reproducibility levels comparable to global longitudinal strain (GLS) measured by conventional semi-automatic methods. These findings suggest that deep learning-based methods could facilitate the broader clinical adoption of regional strain assessment in echocardiography.

A deep learning based method for left ventricular strain measurements: Repeatability and accuracy compared to experienced echocardiographers

M Rogstadkjernet, S.Z. Zha, L.G. Klæboe, C.K. Larsen, J.M. Aalen, E Scheirlynck, BJ Singstad, S Droogmans, B Cosyns, O.A. Smiseth, K.H. Haugaa, T Edvardsen, E Samset & P.H. Brekke





Speckle tracking echocardiography (STE) provides quantification of left ventricular (LV) deformation and is useful in the assessment of LV function. STE is increasingly being used clinically, and every effort to simplify and standardize STE is important. Manual outlining of regions of interest (ROIs) is labor intensive and may influence assessment of strain values.

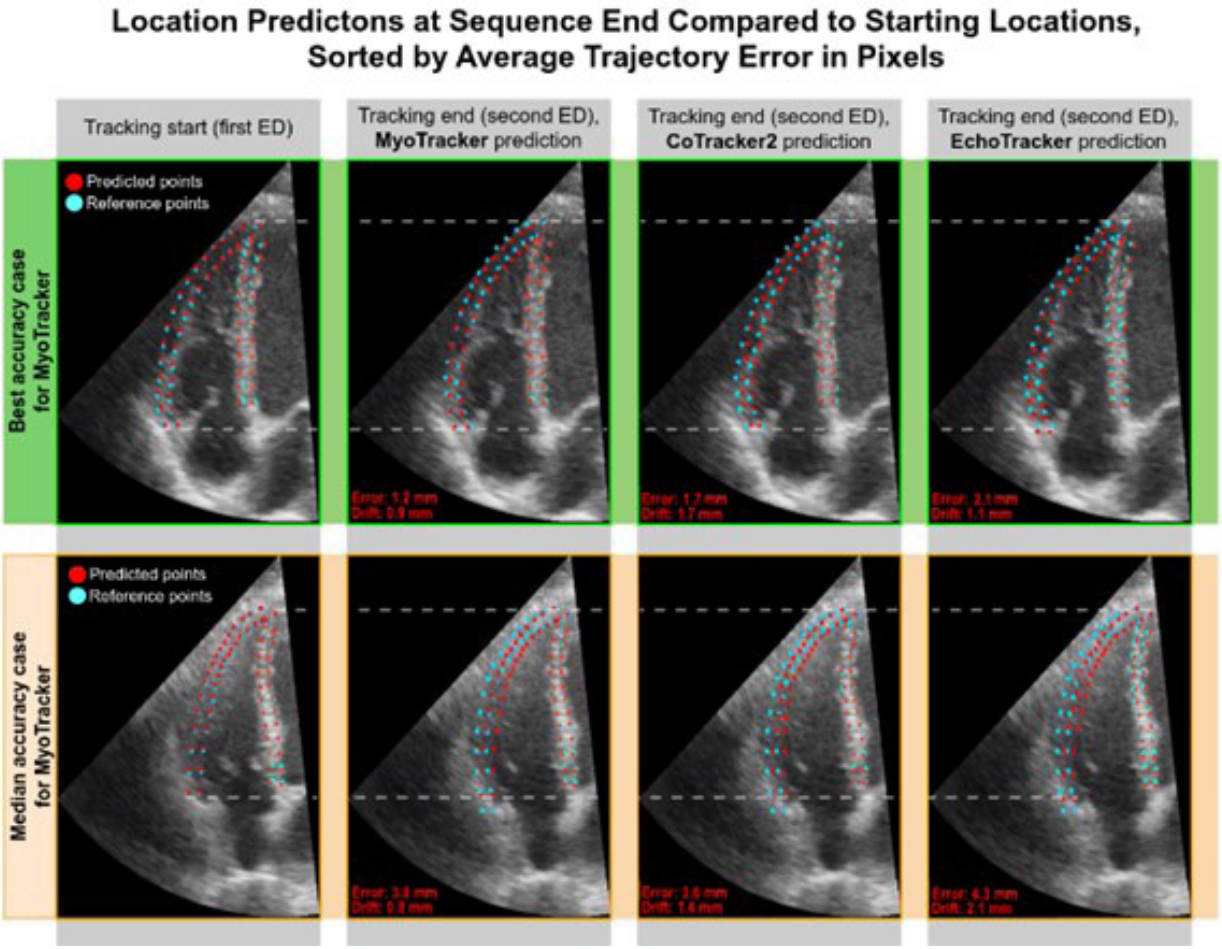
We hypothesized that a deep learning (DL) model, trained on clinical echocardiographic exams, can be combined with a readily available echocardiographic analysis software, to automate strain calculation with comparable fidelity to trained cardiologists.

Data consisted of still frame echocardiographic images with cardiologist-defined ROIs from 672 clinical echocardiographic exams from a university hospital outpatient clinic. Exams included patients with ischemic heart disease, heart failure, valvular disease, and conduction abnormalities, and some healthy subjects. An EfficientNetB1-based architecture was employed, and different techniques and properties including data set size, data quality, augmentations, and transfer learning were evaluated. DL predicted ROIs were reintroduced into commercially available echocardiographic analysis software to automatically calculate strain values.

DL-automated strain calculations had an average absolute difference of 0.75 (95% CI 0.58-0.92) for global longitudinal strain (GLS), and 1.16 (95% CI 1.03-1.29) for single-projection longitudinal strain (LS), compared to operators. A Bland-Altman plot revealed no obvious bias, though there were fewer outliers in the lower average LS ranges. Techniques and data properties yielded no significant increase/decrease in performance.
Activity completed, link: https://rdcu.be/edi72

Low Complexity Point Tracking of the Myocardium in 2D Echocardiography

Chernyshov A, Nyberg J, Holmstrøm V, Azad MA, Grenne B, Dalen H, Aase SA, Lovstakken L, Østvik A



Pre-print: https://arxiv.org/abs/2503.10431

We developed MyoTracker, a deep learning algorithm for tracking the myocardium in 2D echocardiography. It is designed primarily for the right ventricle and uses a simplified deep learning model with only 0.3 million parameters. In tests, MyoTracker showed the lowest average tracking error (2.00±0.53 mm) compared to two similar methods, CoTracker2 and EchoTracker. When we used MyoTracker to measure the right ventricular wall strain (RV FWS), the differences compared to commercial software (the AFIRV tool in GE Healthcare EchoPAC) were -0.3% with 95% limits of agreement from -6.1% to 5.4%.

In practical terms, MyoTracker uses much less GPU memory (67% less than CoTracker2 and 84% less than EchoTracker for sequences of 100 frames) and is much faster (74 times faster than CoTracker2 and 11 times faster than EchoTracker). The key advantage comes from smaller components and from processing the entire sequence simultaneously. Small additional improvements in accuracy can be achieved with further iterative refinement, but at the cost of extra processing time.

International cooperation

ProCardio works with an international perspective where the research methods are of international interest and the innovation projects target the global market. The ProCardio partnership includes two partners outside Norway (Medtronic, the Netherlands and the Baker Heart and Diabetes Institute, Australia) in addition to GE HealthCare, which is a global institution. In 2024 ProCardio both continued its ongoing international business as well as established new international collaborations and partnerships.

- In 2024, ProCardio OUS proceeded with the transatlantic research collaboration with University of Minnesota (UMN) as part of Norwegian Centennial Chair (NOCC) program. ProCardio and UMN are conducting a translational study “LaMinOs”, in Lamin A/C cardiomyopathy. The first patients in “LaMinOs” were included in 2024 and our American colleagues visited OUS and ProCardio in Oslo in August for fruitful project discussions and further planning.

Biomedical engineer (from left) Patrick Ernst and Dr. Forum Kamdar from University of Minnesota visiting ProCardio and the cardiogenetic outpatient clinic at Oslo University Hospital in August 2024. Here with ProCardio phd candidate Bendik Skinningsrud, Nina Hasselberg and prof Kristina Haugaa

- Center leader Professor Kristina Haugaa is assigned Chair of “2025 ESC Guidelines for the management of cardiovascular disease and pregnancy”. The guidelines will be published and presented by Professor Haugaa and co-workers at ESC congress 2025 in Madrid.
- In 2024 ProCardio OUS has continued its participation in the international multicenter pharmacological RCT study “Odyssey”, where the drug Mavacamten is tested in patients with hypertrophic cardiomyopathy – a disease thoroughly investigated in ProCardio. In addition to OUS, GE HealthCare are also involved in the study. Center manager Kristina Haugaa is the study's principal investigator in Norway.
- ProCardio is part of an international research collaboration on Arrhythmogenic mitral valve prolapse, led by Dr. Sabbag from Chaim Sheba Medical Center and Tel Aviv University, Israel. With Dr. Sabbag we have started planning the first international AMVP symposium to be organized by ProCardio in Oslo in 2026, including delegates from Italy, Israel, the Netherlands and others.
- ProCardio has taken part in an international RCT on atrial fibrillation ablation, led by Uppsala University Hospital, Sweden.
- ProCardio OUS has a central part in the Nordic ARVC registry and participates in the two annual meetings with colleagues from Denmark, Finland, Sweden and Iceland.
- In 2024 ProCardio established international collaborations for a Brugada study that will be conducted in 2025 with partners in Italy, Switzerland, Germany, Sweden and Spain.
- The ongoing “DeSPerado” study, looking at the the impact of pregnancy and exercise in titin-related dilated cardiomyopathy, has collaborated with ProCardio and is

led by Johns Hopkins University Hospital, Baltimore, US.

- In 2024, we established an exciting collaboration for GWAS studies to develop a polygenic risk score in titin-related dilated cardiomyopathy with Professor Connie Bezzina, Amsterdam University Medical Center, The Netherlands. This collaboration has made way for exploring further Genome-wide association studies (GWAS) of other genetic heart diseases central to ProCardio.
- In the field of cardiooncology, ProCardio is contributing to the The LYMfit multicenter RCT ongoing and led by Uppsala University Hospital.
- ProCardio OUS participates in an international cardiomyopathy registry established by Dr Lakdawala at Brigham and Women's Hospital, Boston Massachusetts, USA.
- ProCardio is participating in a multicenter international study on the use and importance of CMR in dilated cardiomyopathy, led by DiMarco in Barcelona, Spain.
- The collaboration between Medtronic Bakken Research Center (BRC) in Maastricht, Netherlands on the ProCardio project NeuECG has evolved further during 2024.
- ProCardio, with NTNU and OUS, is thoroughly involved in high frame rate projects at University of Leuven, Belgium.
- In September 2024 ProCardio and the Section of Cardiogenetics, OUS hosted visiting cardiologists, nurses and researchers from Landspitali University Hospital and Iceland University Hospital, Reykjavik. Professor and head of the Cardiology department Davíð O. Arnar leading de renounced deCODE project, and the group discussed potential research collaborations with ProCardio.

Visiting colleagues from Landspitali University Hospital and Iceland University Hospital, Reykjavik, Iceland.

- The collaboration project on ischemic heart disease between Procardio and University of Copenhagen, Rigshospitalet, Nationalt Genom Center, Denmark, NTNU and deCODE, Iceland. has been finalized during 2024.
- Kristina Haugaa is a nucleus member of the European council of cardiovascular genetics.
- ProCardio OUS participates in a Nordforsk-funded project on Personalized Medicine with participants from the Nordic countries.
- The cooperation between GE Vingmed Ultrasound and Leuven University Hospital evaluating share wave velocity using high framerate imaging is brought into ProCardio and clinical members of the ProCardio SFI will participate in a multicenter study to evaluate the applicability of this technique.
- Simula has close collaborations with world-class research groups in the US and Europe, including University of California, San Diego (UCSD), University of California, San Francisco (UCSF), University of California, Berkeley, University of Washington, Seattle, King's College London, Imperial College London, the

Turing Institute UK, the University of Utah, INRIA Sophia Antipolis, Karlsruhe Institute of Technology, Germany, and Copenhagen University, Denmark. Simula is now a leading partner in the SEARCH project, an Innovative Health Initiative Joint Undertaking (IHI JU), and part of the European Union Horizon Europe framework. SEARCH kicked off on October 1, 2024 and aims to overcome the traditional barriers in healthcare data sharing, such as privacy concerns, security risks, and institutional silos. By integrating synthetic data generation technologies with federated learning models, SEARCH will ensure that sensitive patient data remains protected while fostering collaboration across public and private sectors.
This platform will empower AI-driven clinical decision support and enable the development of novel healthcare tools, accelerating research, reducing bias, and improving the accuracy of diagnosis and treatment.

- Simula has a particularly extensive collaboration with UCSD (called SUURPh) which focuses on research training and the exchange of PhD candidates within scientific data processing and biomedical applications, primarily related to cardiac physiology, running an annual international summer school which has quickly become a premier venue for education within computational cardiology. In addition, Simula has a close collaboration with UC Berkeley through the project SIMBER (The Simula Berkeley Education and Research Collaboration), funded through the INTPART programme. Collaboration with UC Berkeley has also included development of a spin out company, Organos, working on high throughput human microphysiological systems for drug discovery and cardiac safety.
- NTNU has an ongoing collaboration with KU Leuven and GE Vingmed Ultrasound on high frame rate imaging, and what is called shear wave imaging (SWI) or more broadly mechanical wave imaging (MWI). The aim of the collaboration is to: 1) Research the potential of measuring the velocity of short-lived mechanical waves in the myocardium produced by natural cardiac events such as valve closure and the atrial kick. 2) Innovate by developing measurement analysis tool for clinical use, as an App working in the GE HealthCare system.

International visiting researchers

- Professor Felix C. Tanner, head of echocardiography and vice director of Dept of cardiology at the University Heart Center Zurich, visited ProCardio for 3.5 months during in 2024. He dedicated this time to echocardiographic studies on ARVC, starting an international collaboration project between ProCardio OUS and University Hospital Zürich.
- Research Professor Mary (Molly) Maleckar from partner Simula was again in 2024 invited as a Visiting Scholar to the Alan Turing Institute in London, U.K., where she collaborates with local and international researchers to develop a strategic platform and research on cardiac digital twins designed to advance diagnostic technologies, longitudinal care, and therapies in cardiology.

New Members

Lisa Marie Selmer, OUS
MD, PhD fellow

Focus: Non-invasive techniques for myocardial tissue characterization using high frame rate echocardiography

Paul Anders Sletten Olsen, OUS, MD, PhD fellow

Focus: Dilated cardiomyopathy (DCM) and desmoplakin (DSP) mutations in arrhythmogenic right ventricular cardiomyopathy (ARVC)

Sairam Ghanta, OUS/ GE HealthCare, Data Scientist

Focus: Cardiooncology dashboard

Thea Dalén
Research nurse, OUS

Eline Schjelderup Myrene
Research nurse, OUS

Nicole Due-Tønnessen
Research coordinator, OUS

Julie Bergh, OUS
MD, PhD fellow

Focus: Risk stratification of mitral valve prolapse and surgery of the mitral valve

Anna Sørlie, OUS
MD, PhD fellow

Focus: High-risk cardiovascular diseases in women

Rang Abdullah, UiO
MD, PhD fellow

Focus: Cardiovascular risk associated with long-term use of anabolic-androgenic steroids (AAS).

Sigurd V. Wifstad, NTNU
PhD Engineering, Postdoctor

Focus: Echo-cardiography, mitral valve disease, blood flow imaging, deep learning

David Pasdeloup, NTNU
PhD Engineering, Postdoctor

Focus: Echocardiography, deep learning, improved patient follow-up

Ingvild Adde, Simula /Kristiania Høyskole
PhD fellow

Focus: Physics-informed neural networks for electrophysiology simulation for ischemic and structural heart disease

Javad Sadeghinia, Simula
PhD Engineering, Postdoctor

Focus: Image-based models of cardiac mechanics and long-term growth and remodeling, to create insight into cardiac function, development and disease

Preetraj Bhoodoo, UiO
PhD fellow

Focus: Cardiomyopathy prediction with foundation models

Ingrid Tveten, SINTEF (NTNU)
PhD fellow

Focus: Echocardiography, myocardial function imaging, multimodal machine learning

Communication and dissemination activities

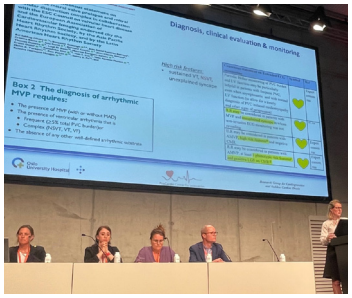
Leuven Meeting on Myocardial Function Imaging 2024

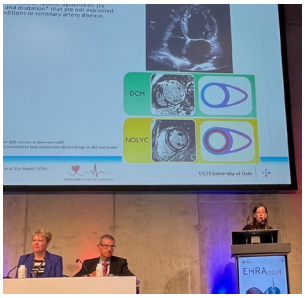
The annual Leuven Meeting on Myocardial Function Imaging is an interactive state-of-the-art symposium focusing on clinical and pre-clinical research in myocardial function imaging. This year's meeting was hosted as a hybrid event with on-site attendance at KU Leuven in Belgium as well as interactive participation for on-line attendees. ProCardio postdoctor, Nina E. Hasselberg, and PhD-fellow, Kristoffer Andresen from OUS, presented ProCardio work on imaging in arrhythmias and the feasibility of imaging intrinsic mechanical waves in the left ventricle of patients with acute coronary syndrome respectively.

EHRA European Heart Rythm Association 2024

The annual meeting of the European Heart Rhythm Association (EHRA) convenes scientists, healthcare professionals and other stakeholders involved in arrhythmia management from all around the world.

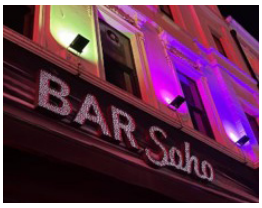
The theme of EHRA 2024 was Innovation and education to overcome arrhythmias.



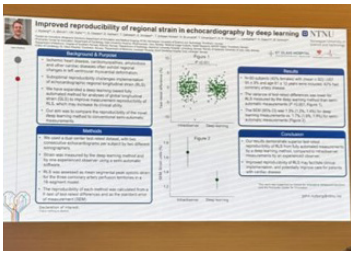


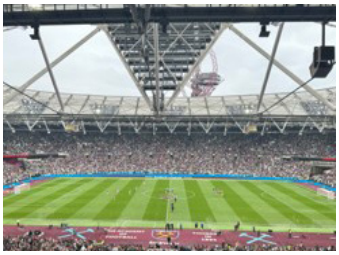
European Society of Cardiology (ESC) Congress 2024

The ESC Congress took place in London from August 30th to September 2nd, gathering more than 30.000 participants. The spotlight of this year's congress was Personalizing Cardiovascular Care. Four new ESC Clinical Practice Guidelines were released on the management of Atrial Fibrillation, Peripheral and Aortic Diseases, Chronic Coronary Syndromes and Elevated Blood Pressure and Hypertension. The ProCardio Center for Innovation contributed to the scientific program by chairing sessions, participating in debates and presenting results from original scientific studies.



ProCardio Center for Innovation were well represented at ESC in London.





EuroEcho 2024

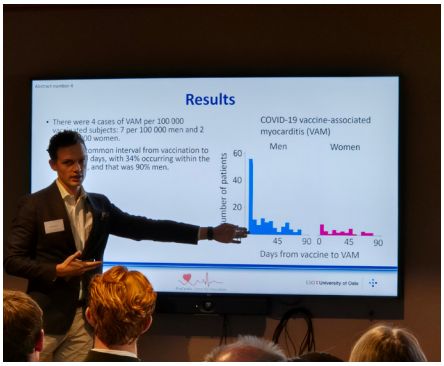
EuroEcho-Imaging is a large conference focusing on cardiac imaging. It is an important forum in which both clinicians and scientists gather to present and discuss the latest research and clinical applications of echocardiography in the context of other relevant cardiovascular imaging modalities. The main themes in 2024 were valvular heart disease and precision medicine. ProCardio was represented by center director Kristina Haugaa, who was invited to give the prestigious Edler Lecture. Both PhD fellow Daniela Melichova (SS) and Postdoctor David Pasdeloup (NTNU) presented their work at EuroEcho.

David Pasdeloup presenting his abstract "Effect of apical foreshortening and transducer angulation on strain measurements: a quantitative investigation".

22nd Annual Norwegian Symposium on Heart Research

The 22nd Annual Norwegian Symposium on Heart Research, organized by Department of Cardiology, Oslo University Hospital in collaboration with ProCardio and Norheart, took place on September 29th and 20th. The expressive frame of Holmenkollen hosted a consistent group of young and senior cardiologists, researchers, and PhD students, who presented their projects during the abstract sessions. Two fellows from ProCardio – Cecilie Bugge and Bendik Skinningsrud - displayed their work with abstracts on the topics arrhythmias in mitral valve prolapse and Vaccine associated myocarditis respectively. In addition, Dr. Marit Kristine Smedsrud (OUS) gave a presentation on Etiologies of cardiac arrest in children. Several ProCardio affiliated doctors/ researchers had important roles both as chairs, moderators and in the panels.

Nina Hasselberg (middle) as chair.



Bendik Skinningsrud presenting his results.

Cecilie Bugge (left) and Nina Hasselberg.

NCS Fall meeting 2024

The fall meeting of the Norwegian Society of Cardiology was held at Scandic Hotel, Holmenkollen Park. The meeting is well attended by cardiologists from all over Norway and includes sessions on relevant clinical topics as well as research presentations and clinical cases. ProCardio was well represented with Cecilie Bugge, Bendik Skinningsrud and Daniela Melichova presenting abstracts, Kristina Haugaa presenting on mitral valve prolapse, Eivind Aabel on wearables, Nina Hasselberg on genetic testing in risk stratification in cardiomyopathies, Håvard Dalen on cardiac structure and function, Mette Estensen on pregnancies in patients with heart disease and Vibeke Almaas on anticoagulation in pregnancy. Bjørnar Grenne, Kristina Haugaa, Eivind Aabel, Thor Edvardsen, Jan Otto Beitnes chaired sessions. Cecilie Bugge won the prize for the best abstract presentation and Helge Skulstad won the prestigious NCS Research Award 2024.

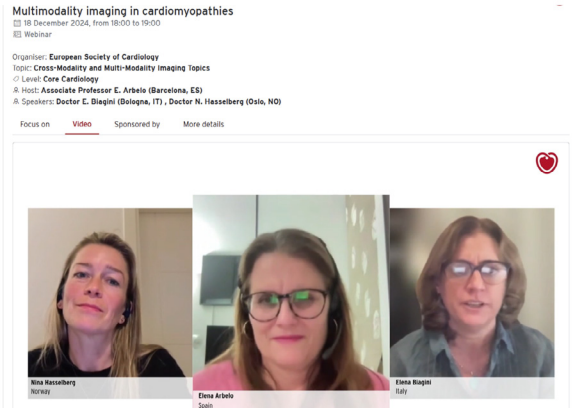
Dr. Håvard Dalen (NTNU)

Nina Hesselberg with Key note speaker Mart Sheppard.

Webinar on "Multimodality imaging in cardiomyopathies"

ProCardio senior researcher Nina Hasselberg, was invited by ESC as speaker in the webinar that took place online December 18th 2024.

The aim of the webinar was to teach the participants the role of multimodality imaging in the diagnosis, risk stratification, and management of cardiomyopathies in patients and their relatives. Dr.Hasselberg presented a case from Oslo University Hospital with a Lamin AC genotype positive dilated cardiomyopathy, taking the participants through the different imaging modalities necessary for full diagnostic and risk stratifying assessment. Prof Elena Arbelo, Barcelona, the chair of the 2023 ESC Guidelines for Management of Cardiomyopathies, hosted the webinar. The webinar's presentations of dilated cardiomyopathy by Dr. Hasselberg and hypertrophic cardiomyopathy by Dr. Biagini, Bologna, lead to discussions giving the audience insights into evidence behind the main changes in the 2023 ESC Guidelines for Management of Cardiomyopathies and to understand how they impact clinical practice.

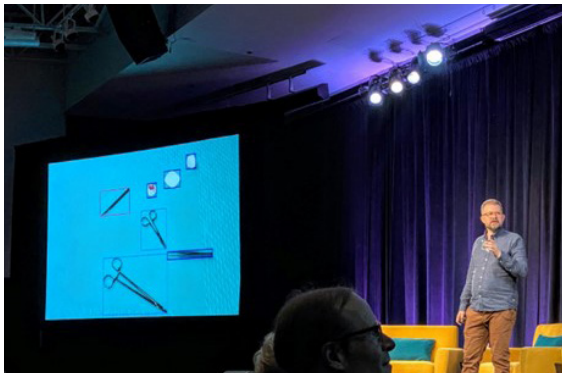


The webinar can be seen at:
Link: *https://esc365.escardio.org/event/1869*

Up close with Heart Researcher Kristina Haugaa

Professor Kristina Haugaa was invited to the podcast "Universitetsplassen". In the episode we learn more about what is driving Professor Haugaa in the search to find answers to why some people experience sudden cardiac death and what she can do to prevent it.

Discover how Professor Kristina Haugaa is unravelling the mysteries of sudden cardiac death and pioneering preventive measures. To read more about her insightful journey into inherited heart diseases and listen to the podcast, *click here.*



Eivind Holt was invited to Imagine 2024 in Mountain View, California to present his work on synthetic data generation for Machine Learning on constrained hardware (Edge AI).

Click on this story about how Eivind Holt from DIPS, who took the stage in Silicon Valley to present his AI innovation using synthetic training data to advance Edge AI models.

Scientific advisory Board meeting

In November ProCardio had very good discussions with and received valuable feedback from our Scientific advisory board; Emma Svennberg, Lars Køber, Robert Jenssen, Bjørn Olstad.

Hjerteløpet 2024

Several ProCardio members participated in “Hjerteløpet”, a 5k race organized in connection with the NCS Fall meeting.

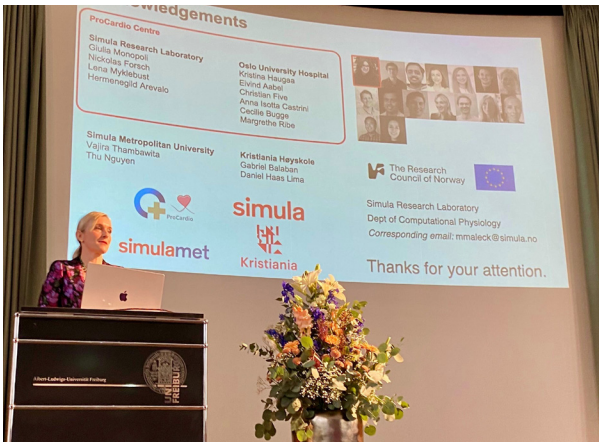
Forsker Grand Prix 2024

PhD fellow Bendik Skinningsrud was one of ten doctoral candidates competing for a spot in the national final of Forsker Grand Prix 2024. Bendik presented his research on the relation of the Covid vaccine to heart inflammation.

The Cardiac Physiome Meeting

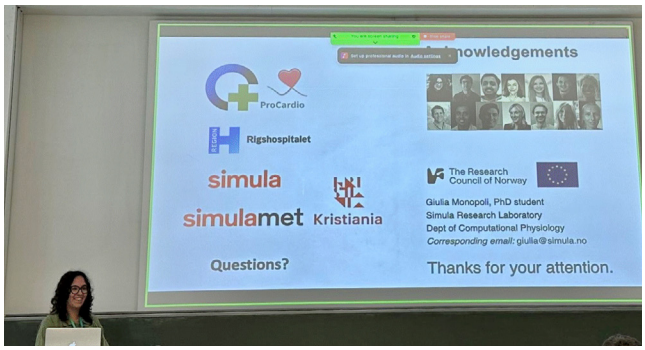
The Cardiac Physiome Society promotes integrative multi-scale simulation and analysis of cardiac physiology in health and disease. The Society aims to encourage and facilitate international collaboration, cooperation, sharing, exchange, and interoperability in basic, translational and clinical research data, models and technology development and organizes the annual Cardiac Physiome Workshop.

Molly Maleckar gave a talk focused on ProCardio's work at the conference. Giulia Monopoli and Hermenegild Arevalo were also present at the conference. Giulia presented a poster.



Computing in Cardiologt Annual Conference in Karlsruhe, Germany

Simula/ProCardio in September 2024, with a clinical team from U Heidelberg (Professor Ben Meder and team) at Computing in Cardiology in Karlsruhe.



Giulia Monopoli and Lena Myklebust presented posters; Nick Forsch, Hermenegild Arevalo, and Molly Maleckar from Simula were also present at this interdisciplinary annual conference.

Explore how AI is revolutionizing heart imaging with portable ultrasound devices, making advanced diagnostics accessible to more health professionals. *Click here to read the full story.*

Simula-NTNU workshop

Simula and NTNU had a day-long workshop and dinner in April of 2024, preceding the ProCardio spring meeting in Trondheim. Research colleagues from both partners offered diverse talks and discussions in an informal and constructive setting. There were deep dives into issues particular to engineering approaches at each partner, in addition to more general discussion around research topics. Simula and NTNU are currently collaborating on a multimodality study on mitral valve disease and arrhythmias (T1.2) for which 3 papers are recently published or accepted and 2 DOFIs will soon be published.

GE HealthCare's Samset on how deal led to building Caption AI for Vscan and securing FDA approval

August 27, 2024 • 0 Comment

Discover how AI is revolutionizing cardiology care. To listen to the episode of Devicetalks where Eigil Samset will tell you more about GE HealthCare's innovative strategies and partnerships, *click here.*

Simula Summer School in Computional Physiology

The University of California, San Diego (UCSD) has promoted long-standing research collaborations with the University of Oslo (UiO) and Simula Research Laboratory (Simula), focused on multiple aspects of computational physiology. This joint summer school, now in its 11th year, has emerged based on the complementary expertise and shared educational goals. The core goal of the summer school, also central to ProCardio, is to promote successful research collaboration among the host institutions, with particular emphasis on the training of excellent Ph.D. candidates.

The summer school is designed to give PhD students the opportunity to perform cutting edge research with the world's leading researchers in their fields. This school includes both targeted research lectures and a practical project component. The lectures are conducted over 2 weeks in Oslo in June, where a project component is also introduced. Students work on teams remotely in the interim and the summer school culminates with 10 days of project work, keynote lectures, and project presentations in San Diego in August. In 2024, the summer school focused on mathematical modeling in (principally cardiac) electrophysiology and biomechanics.

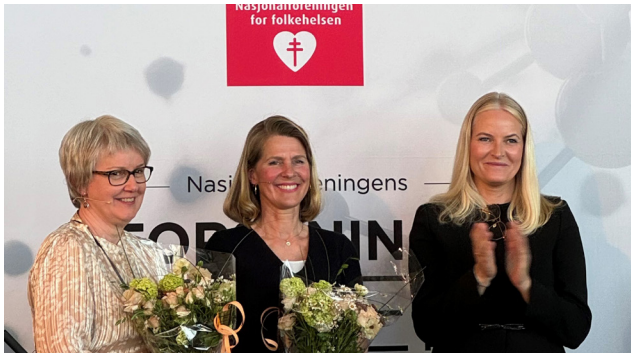
Awards

Health Research Prize 2024

Center leader, Prof. Kristina Haugaa received The Heart Research Prize 2024 for her groundbreaking work on severe genetic heart disorders and the prevention of sudden cardiac death.

The Heart Research Prize is awarded annually by The Norwegian Health Association to a researcher in Norway who maintains high professional standards and can demonstrate significant achievements in the field of cardiology.

Professor Kristina Haugaa was presented with the award by H.R.H Crown Princess Mette-Marit during a formal ceremony at the Norwegian Theatre on April 15.



Award winners Saltvedt and Haugaa together with HKH Crown princess Mette-Marit. Photo: The Norwegian Health Association.

NCS Research Award 2024 to Helge Skulstad

Dr. Helge Skulstad was awarded the 2024 Norwegian Society of Cardiology (NCS) Research Award. The award recognizes his 25 years of dedication to cardiovascular research. His work, which spans cardiac ultrasound, hemodynamics, and mechanistic approaches, has made a significant impact on both translational and clinical cardiology. This award highlights his contributions to improving heart disease diagnostics and treatment.

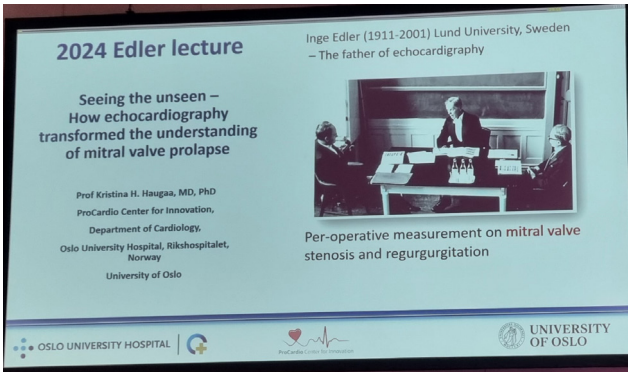
Helge Skulstad(right) recieves the Research Award at NCS.

NCS Best Abstract 2024

During the Research Session at the NCS Fall Meeting 2024, Cecilie Bugge, a PhD-fellow from ProCardio, was awarded Best Abstract. Cecilie presented her work on the correlation between ventricular ectopy and heart rate in patients with mitral valve prolapse.

Cecilie Bugge recieves the award "Best Abstract" of the NCS Fall Meeting 2024. Photo: Private

EACVI´s Edler Lecture 2024

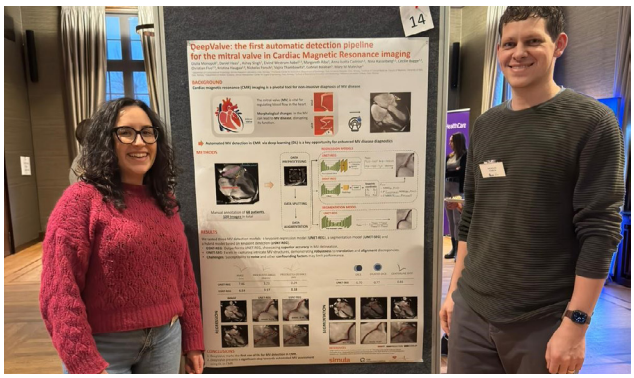


Professor Kristina Haugaa was invited to hold the honourable Edler Lecture at EuroEcho 2024. The Edler Lecture celebrates the pioneering spirit and continued advancement in the field of cardiovascular imaging. It honours Dr. Edler's legacy and underscores the importance of innovation in improving patient care. The lecture serves as both a tribute to past milestones and an inspiration for ongoing advancements in cardiovascular imaging.

Diploma MMIV Conference

During the Annual MMIV (Mohn Medical Imaging and Visualization) Conference ProCardio PhD fellow Giulia Monopoli from Simula was awared with a diploma for 3rd place in the Poster Competition. The MMIV was held in Bergen for the Seventh time, in collaboration with PRESIMAL (a national network for precision imaging and machine learning). Giulia presented a poster titled "Deepvalve: The First Automatic Detection Pipeline for the mitral valve in Cardiac Magnetic Resonance".

ProCardio PhD fellow Giulia Monopoli(middle) from Simula recieves her Diploma for 3rd best Poster presentation. Photo: Private



Giulia Monopoli(left) and Nick Forsch from Simula in front of Giulia´s awarded poster.

Dissertation

Anna Isotta Castrini

Pregnancy and progression of cardiac disease in genetic cardiomyopathies

May 27, 2024

Adjudication committee

- First opponent: Professor Jacob Tfelt-Hansen, University of Copenhagen, Denmark
- Second opponent: Professor Charlotte Bjørk Ingul, NTNU - Norwegian University of Science and Technology
- Third member and chair of the evaluation committee: Professor Torbjørn Omland, University of Oslo

Chair of the Defence
Associate Professor John-Peder Escobar Kvitting, University of Oslo

Principal Supervisor
Professor Kristina Haugaa, University of Oslo

Co-supervisors
Øyvind Haugen Lie, Oslo University Hospital
Mette-Elise Estensen, Oslo University Hospital

Summary

Genetic cardiomyopathies are hereditary cardiac diseases often diagnosed in young patients and are characterized by live-threatening arrhythmias and heart failure. Among them are arrhythmogenic (AC) and Lamin A/C cardiomyopathy. At genetic diagnosis, penetrance of the disease is often incomplete and factors promoting the disease progression are poorly recognized. Physical exercise is a hemodynamic stress and was previously associated with higher disease penetrance in AC and Lamin A/C cardiomyopathy. Pregnancy is also a hemodynamic stress, therefore with a potential detrimental effect on cardiac disease for patients with a genetic predisposition; however, the role of pregnancy as a factor potentially promoting disease progression in AC and Lamin A/C cardiomyopathy is poorly identified. The results of this thesis contributed to increase our knowledge in the field, showing no significant effect of pregnancy on long term structural and functional disease progression by echocardiography, and no major effect on arrhythmias, in AC and Lamin A/C cardiomyopathy. Additionally, we described the stages of disease progression in Lamin A/C cardiomyopathy, showing a high prevalence of electrical disease at young age, followed by left and right ventricular dysfunction, where the latter was independently associated with adverse prognosis.

Isotta Castrini successfully defended her PhD.

Ivar Mjåland Salte

Artificial intelligence to improve measurement reproducibility of left ventricular function in echocardiography

May 28, 2024

Adjudication committee

- First opponent: Professor Partho P. Sengupta, Rutgers Robert Wood Johnson Medical School, United States
- Second opponent: Professor Maja-Lisa Løchen, UiT - The Artic University of Norway, Norway
- Third member and chair of the evaluation committee: Associate professor John-Peder Escobar Kvitting, University of Oslo

Chair of the Defence
Professor Emeritus Odd Geiran, University of Oslo

Principal Supervisor
Professor II Thor Edvardsen, University of Oslo

Co-supervisors
Bjørnar Grenne, NTNU
Harald Brunvand, Sorlandet Hospital

Summary

The left ventricle plays a pivotal role as a dynamic pump supplying blood to the systemic circulation under pressure. Accurate assessment of left ventricular function is crucial in diagnosing and managing patients with various cardiovascular conditions. Ultrasound imaging of the heart (echocardiography) is cost-effective, easily accessible and harmless, and therefore a preferred diagnostic tool for assessing left ventricular function.

Left ventricular Global longitudinal strain (GLS) is a key measurement for quantification of left

ventricular function, reflecting the longitudinal shortening of the left ventricular wall during the cardiac cycle. GLS is traditionally performed using a semi-automatic computer program, in which the operator annotates the relevant images and defines the region of interest. Such semi-automatic measurements can be time-consuming, as there is often a need for several manual adjustments. Moreover, these manual adjustments may cause clinically significant measurement variability between different operators.

In this thesis, Salte and colleagues developed and explored the use of novel artificial intelligence (AI) methods, including deep learning technologies, for fast and fully automated measurements of left ventricular GLS in echocardiography.

The results demonstrated the technical feasibility of employing AI for automated GLS measurements in echocardiography. The AI method surpassed the accuracy of a traditional computer algorithm, when estimating motion in ultrasound images. AI-based GLS measurements displayed strong agreement with one of the most widely used and clinically available semi-automatic programs. Moreover, AI-based measurements demonstrated superior reproducibility compared to two different operators using a semi-automatic method.

In summary, AI could successfully measure left ventricular GLS in ultrasound images, resulting in efficient measurements and improved reproducibility compared to conventional semi-automatic methods relying on human input.

Appendix

Funding	Amount*
The Research Council	15 244
The Host Institution (Oslo University Hospital)	4 297
Research Partners	
University of Oslo	472
Simula Research Laboratory	519
Norwegian University of Science and Technology	1316
Sørlandet Hospital	-
Baker Heart and Diabetes Institute	43
Enterprise partners	
GE Healthcare	520
GE Vingmed Ultrasound	4 717
Medtronic	617
Sesam AS	74
DIPS AS	1 665
Other Public Funding	3 411
Total	**32 895**

Cost	Amount*
The Host Institution (Oslo University Hospital)	14 770
Research Partners	
University of Oslo	1 525
Simula Research Laboratory	2 651
Norwegian University of Science and Technology	5 517
Sørlandet Hospital	-797
Baker Heart and Diabetes Institute	42
Enterprise partners	
GE Healthcare	520
GE Vingmed Ultrasound	4 717
Medtronic	617
Sesam AS	74
DIPS AS	1 665
Total	**32 895**

Personnel

Key Researchers		
Name	**Institution**	**Main research area**
Kristina Hermann Haugaa	OUS	Cardiomyopathies,arrhythmias, cardiogenetics
Thor Edvardsen	UiO	Cardiac imaging
Helge Skulstad	OUS	Cardiac imaging
Jan Otto Beitnes	OUS	Cardiac imaging, valvular heart disease
Eivind Aabel	OUS	Arrhythmias, cardiomyopathies and clinical trials
Sebastian Sarvari	OUS	Cardiac imaging, Cardiooncology
Øyvind Haugen Lie	OUS	Coronary artery disease, Athletes and arrhythmias/ Invasive cardiology and intensive coronary care
Mette-Elise Estensen	OUS	Pregnancy in heart disease
Eigil Samset	GEHC	Data integration & platform development
Morgan Jakobsen	GEHC	Data integration & platform development
Attila Vojtek	GEHC	Data integration & platform development
Olivier Gerard	GE Vingmed	Data integration & platform development
Jurica Sprem	GE Vingmed	Data integration & platform development
Sten Roar Snare	GE Vingmed	Data integration & platform development
Benjamin Fermann	GE Vingmed	Data integration & platform development
Gunnar Hansen	GE Vingmed	Data integration & platform development
Bård Moseng	GE Vingmed	Data integration & platform development
Cristiano Tiago	GE Vingmed	Data integration & platform development
Tormod Selbekk	GE Vingmed	Data integration & platform development
Molly Maleckar	Simula	Simulation-based data augmentation and therapy optimization
Joakim Sundnes	Simula	Simulation-based data augmentation and therapy optimization
Samuel Wall	Simula	Simulation-based data augmentation and therapy optimization
Gabriel Balaban	Simula/ Kristiania University College	Simulation-based data augmentation and therapy optimization
Hermenegild Arevalo	Simula	Simulation-based data augmentation and therapy optimization
Nickolas Forsch	Simula	Simulation-based data augmentation and therapy optimization
Trond Bertil Barstad	Sesam	Data integration & platform development
Stein Håvard Pedersen	Sesam	Data integration & platform development
Geir Atle Hegsvold	Sesam	Data integration & platform development
Ellis Igneri	Sesam	Data integration & platform development
Liv Bollvåg	DIPS	Data integration & platform development

Pål Haugar Brekke	OUS/DIPS	Data integration & platform development
Eivind Holt	DIPS	Data integration & platform development
Lasse Løvstakken	NTNU	Data science and machine learning
Håvard Dalen	NTNU	Data science and machine learning
Bjørnar Grenne	NTNU	Data science and machine learning
Kristian Hveem	NTNU	Data science and machine learning
Andreas Østvik	NTNU	Data science and machine learning
Espen Holte	NTNU	Data science and machine learning
Eivind Coward	NTNU	Data science and machine learning
Nikhil Arora	NTNU	Data science and machine learning
Harald Brunvand	SS	Coronary artery disease
Daniela Melichova	SS	Cardiomyopathies
Jarle Jotvedt	SS	Valvular disease
Richard Cornelussen	Medtronic	Biomedical engineering
Per Christiansen	Medtronic	Biomedical engineering
Mirco de Melis	Medtronic	Biomedical engineering
Anders Milch	Medtronic	Biomedical engineering
Gunnar Morne	Medtronic	Biomedical engineering
Kaspar Broch	OUS	Echocardiography and heart failure
Richard Massey	OUS	Echocardiography and heart failure
Lars Aaberge	OUS	Invasive cardiology, Acute cardiovascular care
Thomas Helle Valle	OUS	Myocardial function and Cardiac imaging
Finn Hegbom	OUS	Electrophysiology and cardiovascular function
Klaus Mubræch	OUS	Echocardiography and heart failure
Christian Eek	OUS	Invasive cardiology and acute cardiovascular care
Njord Nordstrand	OUS	Myocardial function and cardiac imaging
Kari Melberg	OUS	Myocardial function and cardiac imaging
Lars Dejgaard	OUS	Echocardiography and heart failure
Stian Ross	OUS	Electrophysiology and cardiovascular function
Erik Kongsgård	OUS	Electrophysiology and cardiovascular function
John Aalen	OUS	Myocardial function and cardiac imaging
Torbjørn Holm	OUS	Electrophysiology and cardiovascular function
Kristin Nordvoll	OUS	Cardiomyopathies
Elin Bjurstrøm	OUS	Cardiomyopathies
Margareth Ribe	OUS	Myocardial function and cardiac imaging
Roger Håland	OUS	Myocardial function and cardiac imaging
Thea Dalén	OUS	Across all research areas
Eline Schjelderup Myrene	OUS	Across all research areas
Nicole Due-Tønnessen	OUS	Across all research areas
Helen Storaker	OUS	Myocardial function and cardiac imaging

Eystein Skjølsvik	OUS	Cardiomyopathies
Sairam Ghanta	OUS	Scientific programmer
Hans Gerhard Suheyl Boss	OUS	Cardiac imaging
Isotta Castrini	OUS	Cardiomyopathies
Erik Lyseggen	OUS	Electrophysiology and cardiovascular function
Ida Skrinde Leren	OUS	Cardiomyopathies
John-Peder Kvitting	OUS	Ventricular arrhythmias in patients with arrhythmic valve syndrome
Vibeke Marie Almaas	OUS	Cardiomyopathies
Tom Marwick	Baker Institute	Cardiooncology

Visiting Researchers

Name	Affiliation	Nationality	Sex M/F	Duration	Topic
Felix C. Tanner	University Heart Center Zurich	Swiss	M	3.5 months	Echocardiographic studies on ARVC

Postdoctoral researchers with financial support from the Centre budget

Name	Nationality	Period	Sex M/F	Topic
Nina Hasselberg	Norwegian	01.05.2021-30.04.2025	F	Disease progression and risk assessment in familial cardiomyopathies and arrhythmogenic mitral valve prolapse
Sigurd V. Wifstad	Norwegian	01.06.2024 – 29.11.2026	M	Echo-cardiography, mitral valve disease, blood flow imaging, deep learning
Davis Pasdeloup	French	01.06.2024 – 29.11.2026	M	Echocardiography, deep learning, improved patient follow-up

Postdoctoral researchers working on projects in the centre with financial support from other sources

Name	Funding	Nationality	Period	Sex M/F	Topic
Marit Kristine Smedsrud	OUS	Norwegian	01.04.21-28.03.25	F	Early detection of genetic heart diseases – Prevention of sudden cardiac death in children
Eivind Westrum Aabel	UiO/NFR	Norwegian	01.03.23-13.06.24	M	Arrhythmias, cardiomyopathies, and clinical trials
Javad Sadeghinia	Simula/NFR Dynacomp	Norwegian	14.08.23 – 13.08.26	M	The Dynamic Heart - Computational Tools for Studying Cardiac Growth and Remodeling.
Pål Brekke	HSØ	Norwegian	23.03.24 – 30.09.24	M	Artificial intelligence analysis and interpretation of echocardiographic contraction patterns in ischemic heart disease

PhD students with financial support from the Centre budget				
Name	**Nationality**	**Period**	**Sex M/F**	**Topic**
Christian Kullmann Five	Norwegian	06.09.2021-05.09.2024	M	Disease progression and risk assessment in familial cardiomyopathies and arrhythmogenic mitral valve prolapse
Linda Tangen Aaserud	Norwegian	01.11.2021-21.07.2025	F	Athletes and arrhythmias
Artem Chernyshov	Russian	06.09.2021-05.09.2024	M	Functional Analysis of the Right Ventricle with Deep Learning
Mali Sæther	Norwegian	01.02.2021-31.01.2024	F	Cardiooncology
Henrik Agerup Kihdahl	Norwegian	01.01.2022-31.12.2027	M	Valvular disease, automated measurements, 50% PhD
Sverre Høie	Norwegian	21.11.2022-20.11.2028	M	Valvular disease 50%
Giulia Monopoli	Italian	16.11.2022-15.11.2025	F	MAD, image-based diagnostics, and mechanistic simulation 1
Cecilie Bugge	Norwegian	30.04.23-30.04.26	F	Ventricular arrhythmias in patients with arrhythmic valve syndrome
Paul A.S. Olsen	Norwegian	01.04.24 – 31.03.27	M	Desmoplakin (DSP) mutations in arrhythmogenic right ventricular cardiomyopathy (ARVC), and especially on echocardiographic findings, exercise and pregnancy.
Anna Sørlie	Norwegian	01.10.24 – 30.09.27	F	High-risk cardiovascular diseases in women
Julie Bergh	Norwegian	01.12.24 – 30.11.27	F	Risk stratification of mitral valve prolapse and surgery of the mitral valve

PhD students working on projects in the Centre with financial support from other sources					
Name	**Funding**	**Nationality**	**Period**	**Sex M/F**	**Topic**
Kristoffer Andresen	OUS/HSØ	Norwegian	01.06.2020-31.05.2026	M	Triplane speckle-tracking echocardiography of the right ventricle
Marianne Inngjerdingen Forså	OUS/HSØ	Norwegian	05.02.2018-30.08.2025	F	Cardiac remodelling in children and adolescents
Jorun Tangen	OUS/UIO	Norwegian	15.04.20-30.01.2025	F	Improved prediction of clinical outcome in patients with myocardial infarction and heart failure
Mi Nguyen	OUS/HSØ	Norwegian	01.12.2020-31.08.2024	F	Outcome after myocardial infarction
Isotta Castrini	UiO/NFR	Italian	01.08.2019-12.02.2024	F	ARVC in pregnancy
Tove-Elizabeth Hunt	OUS/HSØ	Norwegian	01.09.2016--30.06.2025	F	Atrial fibrillation and sleep apnea
Sigrun Skarstad Ådnegard	OUS/NFR	Norwegian	06.09.23-05.09.26	F	Manganese as intracellular contrast medium in cardiac MRI
Bendik Skinningsrud	OUS/FHI/SLV	Norwegian	19.09.23-01.10.26	M	Covid-19 vaccine associated myocarditis in Norway

John Nyberg	NTNU	Swedish	25.08.2021-24.08.2024	M	Automated Measurements of Regional Left Ventricular Strain Based on Echocardiography and Artificial Intelligence in Patients with Ischemic Heart Disease
Benjamin Fermann	GE Vingmed/ UiO	Norwegian	01.05.2020-30.04.2024	M	Noninvasive analysis of cardiac function using automated workflows
Müjde Akdeniz	GE Vingmed/ MARCIUS	Turkish	01.04.2020-31.03.2024	F	Pattern recognition of functional disease characteristics
Jireh Tang	UiO	Norwegian	01.08.23-24.09.27	M	Use of myocardial strain in patients with MI and HF
Lena Myklebust	SRL/NFR	Norwegian	12.11.2020–11.11.2024	F	Computational modeling of mitral annular disjunction (MyVirtual HF)
Daniela Melichova	HSØ	Norwegian	01.04.14 -	F	Improved prediction of ventricular arrhythmia in heart failure by echocardiography
Lisa Marie Selmer	OUS/HSØ	Norwegian	03.01.24 – 02.01.27	F	Developing and refining non-invasive diagnostic techniques for myocardial tissue characterization using high frame rate echocardiography
Ingrid Tveten	SINTEF (NTNU)	Norwegian	01.09.23 – 31.08.27	F	Holistic AI in echocardiography for improved measurements of cardiac function
Ingvild Adde	Kristinia (SRL)	Norwegian	05.03.24 -05.03.27	F	Physics-informed neural networks for electro-physiology simulation for ischemic and structural heart disease, driving towards speed ups for clinically-relevant timescales.
Håvard Dahlbom	NTNU	Norwegian	01.09.23 – 31.08.27	M	Progresjon av aortastenose
Rang Abdullah	UIO	Norwegian	Xxx	M	Cardiovascular risk associated with long-term use of anabolic-androgenic steroids (AAS).

Master degrees

Name	Sex M/F	Period	Topic
Emil Ofir Jettli	M	08.2022 – 05.2024	Identifying early colorectal cancer signals risk prediction and potential biomarker discovery from serum microRNA using machine learning methods for survival analysis
Adam Jakobsen	M	08.2022 – 08-2024	Pathological electrical wave simulation in the heart using physics informed neural networks
Aksel Try Lenz	M	01.2024 – 06.2024	Ultrasound image generation and inpainting by leveraging diffusion models

Publications

1 Abdullah, R., Bjørnebekk, A., Hauger, L. E., Hullstein, I. R., Edvardsen, T., Haugaa, K. H., & Almaas, V. M. (2024). Severe biventricular cardiomyopathy in both current and former long-term users of anabolic-androgenic steroids. Eur J Prev Cardiol, 31(5), 599-608. https://doi.org/10.1093/eurjpc/zwad362

2 Almeida, A. G., Grapsa, J., Gimelli, A., Bucciarelli-Ducci, C., Gerber, B., ..., Haugaa, K. H., ...Cosyns, B. (2024). Cardiovascular multimodality imaging in women: a scientific statement of the European Association of Cardiovascular Imaging of the European Society of Cardiology. Eur Heart J Cardiovasc Imaging, 25(4), e116-e136. https://doi.org/10.1093/ehjci/jeae013

3 Almaas, V. M., Abdullah, R., Edvardsen, T., Haugaa, K. H., & Bjørnebekk, A. (2024). Comment on 'Anabolic-androgenic steroids and cardiac function'. Eur J Prev Cardiol, 31(13), e97-e98. https://doi.org/10.1093/eurjpc/zwae183

4 Andresen, K., Klæboe, L. G., Lie Ø, H., Broch, K., Kvaslerud, A. B., Bosse, G., Hopp, E., de Lange, C., Haugaa, K. H., & Edvardsen, T. (2024). No adverse association between exercise exposure and diffuse myocardial fibrosis in male endurance athletes. Sci Rep, 14(1), 6581. https://doi.org/10.1038/s41598-024-57233-5

5 Bjerring, A. W., Smeland, K. H., Stokke, T., Haugaa, K. H., Holte, E., Rösner, A., Kiserud, C. E., Edvardsen, T., & Sarvari, S. I. (2024). Long-term cardiac effects of modern treatment for Hodgkin's lymphoma. Cardiooncology, 10(1), 19. https://doi.org/10.1186/s40959-024-00222-4

6 Carrick, R. T., De Marco, C., Gasperetti, A., Bosman, L. P., Gourraud, J.-B., ... Hasselberg, N.E., ... Haugaa, K.H., ... Cadrin-Tourigny, J. (2024). Implantable cardioverter defibrillator use in arrhythmogenic right ventricular cardiomyopathy in North America and Europe [Vitenskapelig artikkel]. European Heart Journal, 45(7), 538-548. https://doi.org/10.1093/eurheartj/ehad799

7 Cosyns, B., & Haugaa, K. H. (2024). Multiparametric Approach to Asymptomatic Aortic Stenosis: New Surrogate Markers Are Welcome. JACC Cardiovasc Imaging, 17(3), 246-247. https://doi.org/10.1016/j.jcmg.2023.10.011

8 Daelman, B., Van Bulck, L., Luyckx, K., Kovacs, A. H., Van De Bruaene, A., Ladouceur, M., ... Estensen, M.E., ...Goossens, E. (2024). Frailty and Cognitive Function in Middle-Aged and Older Adults With Congenital Heart Disease. J Am Coll Cardiol, 83(12), 1149-1159. https://doi.org/10.1016/j.jacc.2024.01.021

9 Dalen, H., Letnes, J. M., Høydal, M. A., & Wisløff, U. (2024). Diastolic function and dysfunction in athletes [Vitenskapelig artikkel]. European Heart Journal-Cardiovascular Imaging, 25(11), 1537-1545. https://doi.org/10.1093/ehjci/jeae155

10 Deneke, T., Kutyifa, V., Hindricks, G., Sommer, P., Zeppenfeld, K., ... Haugaa, K., ..., Antz, M., & Westwood, M. (2024). Pre- and post-procedural cardiac imaging (computed tomography and magnetic resonance imaging) in electrophysiology: a clinical consensus statement of the European Heart Rhythm Association and European Association of Cardiovascular Imaging of the European Society of Cardiology. Europace, 26(5). https://doi.org/10.1093/europace/euae108

11 Erevik, C. B., Kleiven, Ø., Frøysa, V., Bjørkavoll-Bergseth, M., Chivulescu, A. M., Klæboe, L. G., Dejgaard, L., Auestad, B. H., Skadberg, Ø., Melberg, T. H., Urheim, S., Haugaa, K. I. H. H., Edvardsen, T., & Ørn, S. (2024). Echocardiographic assessment of myocardial efficiency predicts exercise performance [Vitenskapelig artikkel]. European Journal of Sport Science (EJSS), 24(3), 319-329. https://onlinelibrary.wiley.com/doi/full/10.1002/ejsc.12082

12 Erevik, C. B., Kleiven, Ø., Frøysa, V., Bjørkavoll-Bergseth, M., Chivulescu, M., Klæboe, L. G., Dejgaard, L., Auestad, B., Skadberg, Ø., Melberg, T., Urheim, S., Haugaa, K., Edvardsen, T., & Ørn, S. (2024). Exercise-Induced Cardiac Troponin I Elevation Is Associated With Regional Alterations in Left Ventricular Strain in High-Troponin Responders. J Am Heart Assoc, 13(16), e034382. https://doi.org/10.1161/jaha.124.034382

13 Eriksen-Volnes, T., & Dalen, H. (2024). Reply: Body Surface Area Calculation and Its Impact on Indexed Echocardiographic Measurements. JACC Cardiovasc Imaging, 17(7), 842. https://doi.org/10.1016/j.jcmg.2024.04.011

14 Fermann, B. S., Nyberg, J., Remme, E. W., Grue, J. F., Grue, H., Haland, R., Lovstakken, L., Dalen, H., Grenne, B., Aase, S. A., Snare, S. R., & Ostvik, A. (2024). Cardiac Valve Event Timing in Echocardiography Using Deep Learning and Triplane Recordings. IEEE J Biomed Health Inform, 28(5), 2759-2768. https://doi.org/10.1109/jbhi.2024.3373124

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16 Forså, M. I., Smedsrud, M. K., Haugaa, K. H., Bjerring, A. W., Früh, A., Sarvari, S. I., Landgraff, H. W., Hallén, J., & Edvardsen, T. (2024). Distinguishing left ventricular hypertrophy from hypertrophic cardiomyopathy in adolescents: a longitudinal observation study. Eur J Prev Cardiol, 31(5), 591-598. https://doi.org/10.1093/eurjpc/zwad361

17 Gaylard, B., Montaño-Krawczuk, A., Haugaa, K., & Bäck, M. (2024). Tricuspid annular disjunction with varying degrees of tricuspid regurgitation in the setting of Takotsubo syndrome. ESC Heart Fail, 11(3), 1790-1794. https://doi.org/10.1002/ehf2.14704

18 Giri, S., Tronvik, E. A., Dalen, H., Ellekjær, H., Loennechen, J. P., Olsen, A., & Hagen, K. (2024). Migraine and risk of atrial fibrillation: A 9-year follow-up based on the Trøndelag Health Study [Vitenskapelig artikkel]. Cephalalgia, 44(5). https://doi.org/10.1177/03331024241254517

19 Giri, S., Tronvik, E. A., Dalen, H., Ellekjær, H., Olsen, A., & Hagen, K. (2024). Headache disorders and risk of stroke. A register-linked HUNT study [Vitenskapelig artikkel]. Cephalalgia Reports, 7, 11. https://doi.org/10.1177/25158163241295735

20 Gregersen, I., Scarth, M. E., Abdullah, R., Thorsby, P. M., Hauger, L. E., Haugaa, K. H., Sagen, E. L., Michelsen, A. E., Ueland, T., Edvardsen, T., Aukrust, P., Almaas, V. M., Bjørnebekk, A. K., & Halvorsen, B. (2024). Elevated interleukin 8 and matrix metallo-proteinase 9 levels are associated with myocardial pathology in users of anabolic-androgenic steroids. Eur J Prev Cardiol, 31(12), 1469-1476. https://doi.org/10.1093/eurjpc/zwae126

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Disseminations

1	Andresen, K; Espeland, T; Fadnes, S; Løvstakken, L; Skulstad, H; Haugaa, KH; Edvardsen, T.	Mechanical wave velocities by clutter filter wave imaging detects myocardial dysfunction in acute coronary syndrome	ESC Congress 2024, London.
2	Balaban, B; Jakobsen, A; Maleckar, MM.	Cardiac Electrical Wave Simulation with Patient MRI Using Physics Informed Neural Networks	NORA AI Annual Conference 2024
3	Bazilchuk, N; Pasdeloup, D; Dalen, H; Løvstakken, L; Måsøy, SE.	Kunstig intelligens hjelper til med å se hjertet ditt	Gemini.no Forskningsnytt fra NTNU og SINTEF
4	Bazilchuk, N; Pasdeloup, D; Dalen, H; Løvstakken, L; Måsøy, SE.	Peering into your heart – with the help of AI	Norwegian SciTech News
5	Bertrand, A; Yamamoto, C; Monopoli, G; Schrotter, T; Myklebust, L; Uv, JJ; Arevalo, H; Maleckar, MM.	Augmentation of Cardiac Ischemic Geometry for Improving Machine Learning Performance in Arrhythmic Risk Stratification.	Computational Physiology: Simula Summer School 2023
6	Bugge, C; Five, CK; Castrini, AI; Hasselberg, NE; Dejgaard, LA; Haugaa, KH; Aabel, EW	Linking ventricular ectopy to heart rate: Unveiling the hidden rhythm in mitral valve prolapse	NSC Høstmøte 2024
7	Bugge, C; Five, CK; Castrini, AI; Ribe, M; Hasselberg, NE; Hegbom, F; Dejgaard, LA; Haugaa, KH; Aabel, EW	Correlation between heart rate and premature ventricular complexes in patients with mitral valve prolapse	The 22nd Annual Symposium on Heart Research, 2024
8	Bugge, C; Five, CK; Castrini, AI; Ribe, M; Haugaa, KH; Aabel, EW	Premature ventricular contractions increase with heart rate in patients with mitral valve prolapse	EHRA 2024 Berlin
9	Castrini, AI	Pregnancy and progression of cardiac disease in genetic cardiomyopathies	Doctoral thesis at UIO
10	Castrini, AI	Genetisk Kardiomyopatier	Vestre Viken Hf Bærum Sykehus
11	Chernyshov,A; J.F. Grue, J. Nyberg, B. Grenne, H. Dalen, S. A. Aase, A. Østvik, L. Lovstakken	Automated Contouring and Quantification of the Right Ventricle in 2D Echocardiography	Presimal research school im medical AI
12	Dalen, H.	CT i kardiologi	GE Brukermøte i CT
13	Dalen, H.	Forbedret hjertediagnostikk ved kunstig intelligens	NorPreM konferanse
14	Dalen, H.	Forskning som endrer klinisk praksis	Regional forskningskon-feranse
15	Dalen, H.	Hjertefysiologi og rehabilitering	Årsseminar for Faggruppe hjerte- og lungefysioterapi
16	Dalen, H.	Sharing of sensitive data	CIUS conference
17	Dalen, H.	Sharing sensitive data	CIUS conference
18	Dalen, H.	Improving cardiac diagnostic imaging by artificial intelligence	Symposium on Public Service Innovation
19	Dalen, H.	Klaffesykdom i Etiopia	Midt-Norsk Kardiologisk Førjulsmøte
20	Debonnaire, P; Delgado, V; Edvardsen, T; Popescu, BA; Bax, JJ.	The ESC Textbook of Heart Failure; Chapter: 7.3.1 Echocardiography	
21	Dukes, JW; SA, Saha; EW, Aabel; NVK, Pothineni; M, Deus; S, Sarkar; G, Rajagopal; SR, Landman; JL, Koehler; DL., Lustgarten	Premature ventricular contraction burden measured by an insertable cardiac monitor and the incidence of ventricular tachycardia and fibrillation	ESC Congress 2024

22	Edvardsen, T	A Patient with Chronic Coronary Artery Disease	Annual meeting. American Society of Echocardiography, Portland, OR.
23	Edvardsen, T	HCM echocardiographic patient cases	European Heart Meeting. ESC.
24	Edvardsen, T	Role of Echocardiography in Risk Stratification of HCM.	EACVI Masterclass in Hypertrophic Cardiomyopathy, Brussels
25	Edvardsen, T	Up-to-date assessment of left ventricular function	Grand round, Oregon Heath and Science University, Div of Cardiovascular Medicine, Knight Cardiovascular Institute. Portland OR
26	Edvardsen, T	Longitudinal strain: how to better understand LV performance	EuroEcho-Imaging 2024, Berlin
27	Edvardsen, T	Echo essentials for hypertrophic cardiomyopathy (HCM): the heartbeat of diagnosis and treatment/ Echocardiographic workup for HCM – making the diagnosis and evaluation of cardiac function	EuroEcho-Imaging 2024, Berlin
28	Edvardsen, T	Cardiovascular imaging in women	EuroEcho-Imaging 2024, Berlin
29	Estensen, ME	Menopause, prevensjon og kvinnehelse	VMH Webinar
30	Estensen, ME	Hjertesykdom og svangerskap. Medfødt hjertefeil.	Fagdager for sykepleiere på Kalnes sykehus i Østfold
31	Estensen, ME	Årskurs i kongenitt kardiologi for kardiologer	
32	Estensen, ME	Hjertesvikt og koronarsykdom i svangerskapet	Kurs i Koronarsykdom og hjertesvikt i Trondheim
33	Estensen, ME	Medfødt hjertesykdom og svangerskap. Prevensjon.	Kurs i medfødt hjertefeil Bergen
34	Estensen, ME	Hjertesykdom og svangerskap	Regional legemid-delkomitekonferanse
35	Estensen, ME	Nasjonal behandlingslingstjeneste for hjertesyke gravide	Internundervisning HLK
36	Estensen, ME	Hvordan håndtere den hjertesyke gravide	NCS Høstmøte
37	EW, Aabel	Wearables - hvordan skal vi takle flodbølgen?	NSC Høstmøte 2024
38	Finsberg, F	"gotranx: Next generation ODE translator "	Github https://github.com/finsberg/gotranx
39	Finsberg, F	"fenics-beat: Cardiac Electrophysiology simulator in FEniCS "	Github https://github.com/finsberg/fenics-beat
40	Finsberg, F	fenicsx-beat: Cardiac Electrophysiology simulator in FEniCSx	Github https://github.com/finsberg/fenicsx-pulse
41	Finsberg, F	pulse: Cardiac Mechanics simulator in FEniCS	Github https://github.com/finsberg/pulse
42	Finsberg, F	cardiac-geometries: Library for creating idealised cardiac geometries in FEniCS	Github https://github.com/ComputationalPhysiology/cardiac-geometries
43	Finsberg, F	cardiac-geometries: Library for creating idealised cardiac geometries in FEniCSx	Github https://github.com/ComputationalPhysiology/cardiac-geometriesx
44	Finsberg, F	cardiac-geometries-core: Library for creating idealised cardiac geometries in GMSH	Github https://github.com/ComputationalPhysiology/cardiac-geometries-core

45	Finsberg, F	fractal-tree: Library for creating ventricular purkinje system	Github https://github.com/finsberg/fractal-tree
46	Finsberg, F	simcardems: Simula Cardiac ElectroMechanics Simulator	Github https://github.com/ComputationalPhysiology/simcardems
47	Finsberg, F	fenicsx-ldrb: Library for assigning myocardial fiber orientations based on the Laplace-Dirichlet Rule Based Algorithm in FEniCSx	Github https://github.com/finsberg/fenicsx-ldrb
48	Finsberg, F	ldrb: Library for assigning myocardial fiber orientations based on the Laplace-Dirichlet Rule Based Algorithm in FEniCS	Github https://github.com/finsberg/ldrb
49	Finsberg, F	smart: Spatial Modeling Algorithms for Reaction-Transport	Github https://github.com/RangamaniLabUCSD/smart
50	Finsberg, F	ap-features: Library for computing Action Potential features	Github https://github.com/ComputationalPhysiology/ap_features
51	Finsberg, F	mps: Library for reading and analysing cardiac MPS data	Github https://github.com/ComputationalPhysiology/mps
52	Finsberg, F	mps-motion: Automatic motion estimation for cardiac MPS data	Github https://github.com/ComputationalPhysiology/mps_motion
53	Finsberg, F	circulation: Cardiac circulation models	Github https://github.com/ComputationalPhysiology/circulation
54	Grenne, B	Hvordan redusere målevariasjon - bør AI overta jobben?	Norsk Cardiologisk Vårmøte
55	Grenne, B; Østvik, A.	Beyond Years: Is Artificial Intelligence Ready to Predict Biological Age and Cardiovascular Risk Using Echocardiography	Journal of the American Society of Echocardiography
56	Grenne, B; Østvik, A.	Kunstig intelligens: Hjertelegens nye superassistent	Trondheim Tech Week
57	Hasselberg, NE.	Arrhythmic mitral valve prolapse – Latest results	Leuven meeting on Myocardial Function Imaging 2024
58	Hasselberg, NE.	New therapeutic strategies	22nd Annual Norwegian Symposium on Heart Research
59	Hasselberg, NE.	When to implant a primary prevention ICD in patients with structural heart disease: interpreting the 2022 SCD ventricular arrhythmia guidelines.	EHRA 2024 Berlin
60	Hasselberg, NE.	Genetics and arrhythmias	22nd Annual Norwegian Symposium on Heart Research
61	Hasselberg, NE.	Cardiac computed tomography: artificial intelligence, radiomics, and more	ESC Congress 2024, London.
62	Haugaa, KH	Hvordan forhindre plutselig hjertedød hos unge	2024 Hjerteforskningspris-en Nasjonalforeningen for folkehelsen
63	Haugaa, KH	2023 ESC Guidelines for the management of cardiomyopathie	Torsdagsakaemin Karolinska universitetss-jukhuset
64	Haugaa, KH	2023 ESC Guidelines for the management of cardiomyopathies	Medtronic annual meeting , Stockholm. Sweden
65	Haugaa, KH	2023 ESC Guidelines for the management of cardiomyopathies - Hypertrophic cardiomyopathy	NCS vårmøte 2024, Trondheim

66	Haugaa, KH	Arrhythmogenic mitral valve prolapse - Risk stratification	Padua anniversary meeting, Padua, Italy
67	Haugaa, KH	Arrhythmogenic risk stratification in ACM	Romanian national meeting 2024, Bucarest
68	Haugaa, KH	Arrhytmic mitral valve prolapse Therapeutic options: from nothing to mitral valve surgery	EHRA 2024, Berlin
69	Haugaa, KH	Echocardiography in ARVC	International task force meeting ARVC, Zurich, Switzerland
70	Haugaa, KH	Framtidens kardiologer Ärftliga arytmisjukdomar – diagnos och handläggning	Stockholm Sverige
71	Haugaa, KH	Management of Arrhythmic mitral valve prolapse	EHRA 2024, Berlin
72	Haugaa, KH	Management of patients with LMNA associated cardiomypathy	International meeting on electrocardiography, Lund Sweden
73	Haugaa, KH	Pregnancy in CMP	Romanian national meeting 2024, Bucarest
74	Haugaa, KH	ProCardio in precision medicine	Symposium Simula, Oslo
75	Haugaa, KH	Rettsmedisin, Diagnose av genetisk hjertesykdom	Rettsmedisinsk institutt
76	Haugaa, KH	Risikostratifisering ved kardiomyopatier – hvordan gjør vi det	NCS vårmøte 2024, Trondheim
77	Haugaa, KH	The Edler lecture: seeing the unseen by echocardiography	EuroEcho-Imaging 2024, Berlin
78	Haugaa, KH	The organization of the cardiogenetic outpatient clinic	Oslo-Icelandic meeting, Oslo 2024
79	Haugaa, KH	Vanliga situationer vid ovanligare tillståndärftliga kardiomyopatier - Graviditet	Svenska vårmøte Gøteborg
80	Haugaa, KH	Great debate: modern medical treatment is better than myomectomy for obstructive hypertrophic cardiomyopathy – discussion	ESC Congress 2024, London.
81	Haugaa, KH	Guidelines in practice: imaging in hypokinetic non-dilated cardiomyopathy	ESC Congress 2024, London.
82	Haugaa, KH	Mitral valve prolapse: a new look at an old disease	ESC Congress 2024, London.
83	Haugaa, KH	Echocardiography in the 2023 ESC Guidelines for the management of cardiomyopathies/ Arrhythmogenic cardiomyopathy	EuroEcho-Imaging 2024, Berlin
84	Haugaa, KH; Broch, K; Lie, Ø.	Hjerte- og karsykdommer: Den nest vanligste dødsårsaken i Norge	Altomdinhelse.no
85	Holmstrøm, V; Smistad, E; Nyberg, J; Østvik, A; Holte, E; Løvstakken, L; Dalen, H; Grenne, BL.	Deep Learning for Fully Automated Echocardiographic Measurements of Left Ventricular Wall Thickness and Chamber Dimensions in the Parasternal Long-Axis View	ESC Congress 2024, London.
86	Holmstrøm, V; Smistad, E; Stølen, SB; Løvstakken, L; Dalen, H; Holte, E; Østvik, A; Grenne, BL.	Improving Time-Efficiency and Accuracy in Echocardiography: Real-Time Automated Measurements of Left Ventricular Global Longitudinal Strain using Deep Learning	ESC Congress 2024, London.
87	Holmstrøm, V; Smistad, E; Østvik, A; Holte, E; Løvstakken, L; Dalen, H; Grenne, B.	Real-Time Analysis of Left Ventricular Global Longitudinal Strain Using Deep Learning	Leuven Meeting on Myocardial Imaging 2024
88	Høie, S.	Aortastenose.	Forskningssamling Sørlandet Sykehus

89	Jakobsen, A; Adde, I; Nguyen, T; Thambawita, V; Maleckar, MM; Balaban, G.	Cardiac Electrical Wave Simulation with Patient MRI Using Physics Informed Neural Networks	PRESIMAL (Nasjonalt Netverk for Presisjonsav-bildning og Maskinlæring) Autumn Research School in Trondheim
90	Jakobsen, A; Adde, I; Nguyen, T; Thambawita, V; Maleckar, MM; Balaban, G.	Enhancing 2D patient-specific electrophysiology with Physics Informed Neural Networks	Computing in Cardiology 2024, Karlsruhe
91	Kaya, E	Early echocardiographic changes and reverse remodeling after transcatheter aortic valve replacement	ESC Congress 2024, London.
92	Kvaal; JN; Wærstad; , J.	Hjerteforsningsprisen til Kristina Haugaa	
93	Lovstakken, L; Grenne, B.	The Road to Robust and Automated Strain Measurements in Echocardiography by Deep Learning	JACC Cardiovascular Imaging
94	Maleckar, MM	In silico modeling of electrophysiology, mechanics, and flow – digital twins for cardiovascular disease	The Alan Turing Institute –Norwegian Artificial Intelligence Research Consortium Strategic Funding Meeting, March 18th, 2024
95	Maleckar, MM	In-silico models and data-driven methods for heart disease	TRIAD Center visit, Tulane University Hospital, September 23 2024
96	Maleckar, MM	New in-silico models and data-driven methods for valvular heart disease	Cardiac Physiome Workshop 2024
97	Melichova, D.	Risikostratifisering etter hjerteinfarkt	Forskningssamling Sørlandet Sykehus
98	Melichova, D.	Fully automated measurements of echocardiographic mechanical dispersion using deep learning: enhanced prediction of ventricular arrhythmias in a large heart failure cohort	ESC Congress 2024, London.
99	Melichova, D.	Clinical validation of a novel fully automated measurement method for echocardiographic mechanical dispersion using deep learning	EuroEcho-Imaging 2024, Berlin
100	Monopoli, G; Haas, D; Thambawita, V; Forsch, N; Balaban, N; Maleckar, MM.	The First Automated Detection pipeline for the mitral Valve in cardiac magnetic Resonance Imaging	Computing in Cardiology 2024, Karlsruhe
101	Myklebust, L; Monopoli, G; Balaban, G; Aabel, EW; Ribe, M; Castrini, AI; Hasselberg, NE; Bugge, C; Five, C; Haugaa, KH; Maleckar, M; Arevalo, H.	Stretch of the Papillary Insertion Triggers Reentrant Arrhythmia	Computing in Cardiology (CinC)
102	Nguyen, M.	All-cause mortality and incidence of appropriate therapy from a primary preventive implantable defibrillator in patients with non- ischemic dilated cardiomyopathy	ESC Congress 2024, London.
103	Nyberg, J; A Ostvik, IM Salte, S Olaisen, S Karlsen, T Dahlslett, E Smistad, T Eriksen-Volnes, H Brunvand, T Edvardsen, KH Haugaa, L Lovstakken, H Dalen, B Grenne	Improved reproducibility of regional longitudinal strain in echocardiography by deep learning	ESC Congress 2024, London.
104	Olsen, PAS; Beitnes, JO.	Klinisk ekkokardiografi	Universitetsforlaget
105	Pasdeloup, D	Left ventricular ejection fraction with Deep Learning: can we move past the status-quo of manual reference values?	PRESIMAL (Nasjonalt Netverk for Presisjonsav-bildning og Maskinlæring) Autumn Research School in Trondheim
106	Pasdeloup, D	Effect of apical foreshortening and transducer angulation on strain measurements: a quantitative investigation	EuroEcho-Imaging 2024, Berlin

107	Pasdeloup, D; Dalen, H; Løvstakken, L; Østvik, A; Olaisen, SH	Challenges and Opportunities in end-to-end Dep Learning for Echocardiography	Leuven Meeting on Myocardial Imaging 2024
108	Pothineni, NVK; EW, Aabel; S, Saha; J, Dukes; M, Deus; S, Sarkar; G, Rajagopal; S, Landman; Y, Cho; D, Lustgarten	Temporal characteristics of premature ventricular contraction burden measured by an insertable cardiac monitor prior to incidence of ventricular tachycardia and fibrillation	HRS Congress 2024
109	Rye, CS; Dalen, H.	Kvalitet på kardiovaskulære diagnoser i sykehus	HKR seminar 2024
110	Sadeghinia, MJ	An open-source tool designed for efficient left ventricle meshing from segmented MR images, ideal for computational modeling	Github
111	Sadeghinia, MJ; Finsberg, HN; Espe, E; Hauge-Iversen, I M; Zhang, L; Nordén, ES; Sjaastad, I; Wall, S; Sundnes, J.	Aortic stenosis and myocardial remodeling: Insights from finite element analysis in a rat model	16th World Congress on Computational Mechanics
112	Salte, IM	Artificial intelligence to improve measurement reproducibility of left ventricular function in echocardiography	Doctoral theses at UiO
113	Samset, E.	GE HealthCare's Samset on how deal led to building Caption AI for Vscan and securing FDA approval	Devicetalks.com
114	Savelev, A; Dahlberg, P; Christensen, A; Bugge, C; Bulatovic, I; Svensson, A; Leren, IS; Kock, TO; Gardovic, T; Roijer, R; Markljung, M; Ringborn, M; Graff, C; Lundin, C; Larsson, N; Bundgaard, H; Haugaa, KH; Platonov, PG	Genetic factors predisposing to cardiac events in concealed long qt patients	Heart Rhythm Society Meeting 2024
115	Skinningsrud, B	Koronavaksine-utløst hjertebetennelse	Forsker Grand Prix 2024
116	Skinningsrud, B; Vlaisavljevic, K; Oppedal, LS; Endresen, J; Mohn, V; Fladseth, K; Lysaker, TM; Dahl, J; Gulseth, HL; Olsen, DB; Ribe, M; Estensen, ME; Broch, K; Haugaa, KH; Hasselberg, NE.	COVID-19 vaccine-associated myocarditis in Norway - a nationwide validation study	ESC Congress 2024, London.
117	Skinningsrud, B; Vlaisavljevic, K; Oppedal, LS; Endresen, J; Mohn, V; Fladseth, K; Lysaker, TM; Dahl, J; Gulseth, HL; Olsen, DB; Ribe, M; Estensen, ME; Broch, K; Haugaa, KH; Hasselberg, NE.	COVID-19 vaccine-associated myocarditis in Norway - a nationwide validation study	ESC Congress 2024, London.
118	Skinningsrud, B; Vlaisavljevic, K; Oppedal, LS; Endresen, J; Mohn, V; Fladseth, K; Lysaker, TM; Dahl, J; Gulseth, HL; Olsen, DB; Ribe, M; Estensen, ME; Broch, K; Haugaa, KH; Hasselberg, NE.	Nationwide validation study of COVID-19 vaccine-associated myocarditis in Norway	NCS Høstmøte
119	Skinningsrud, B; Vlaisavljevic, K; Oppedal, LS; Endresen, J; Mohn, V; Fladseth, K; Lysaker, TM; Dahl, J; Gulseth, HL; Olsen, DB; Ribe, M; Estensen, ME; Broch, K; Haugaa, KH; Hasselberg, NE.	Nationwide validation study of COVID-19 vaccine-associated myocarditis in Norway	NorHeart 22nd Annual Norwegian symposium
120	Smedsrud, MK	Etiologies of cardiac arrest in children	NorHeart 2024
121	Wifstad, SV.	Deep Learning Applications for the Assessment of Valvular Heart Disease using Transthoracic Echocardiography	Doctoral theses at NTNU
122	Wifstad, SV; Kildahl, HA; Holte, E; Berg, EAR; Grenne, BL; Dalen, H; Løvstakken, L	Automated valve quantification using deep learning	Leuven Meeting on Myocardial Imaging
123	Wærstad, J	H.k.H Kronprinsessen hedret vinnerne av Nasjonalforeningens forskningspriser for 2024	Nasjonalforeningen for Folkehelsen
124	Wærstad, J.	Vinner av hjerteforskningsprisen oppdager genetisk forklaring på plutselig hjertedød	Nasjonalforeningen for Folkehelsen

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