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INAUGURAL LECTURE

Hartfalen is Topsport

EINDHOVEN UNIVERSITY OF TECHNOLOGY

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INAUGURAL LECTURE PROF.DR. HARELD KEMPS

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Prologue

Dear Rector Magnificus, Executive Board of Eindhoven University of Technology, Board of Directors of Máxima Medical Center, colleagues, family and friends, esteemed audience.
Today, I stand before you in the Blauwe Zaal of Eindhoven University of Technology, approximately two kilometres away from my high school and my favorite football stadium, just a few hundred meters from the place I have been working as a cardiologist for over 13 years, and a few steps from the place where I defended my dissertation in 2009. It goes without saying that I feel strongly connected to the city of Eindhoven and this university. It is with due pride and great pleasure that I accept my learning assignment:

Remote Patient Management in chronic cardiac care

In my speech, I would like to take you into the past, present and especially the future of care for patients with chronic heart disease and, in particular, chronic heart failure. I hope to clarify why living with heart failure can be compared to high-performance sports, but also why providing tailor-made care to these patients requires a high-performance sports approach and how technology and design will increasingly play a crucial role.

Heart failure is a high-performance sport

Imagine having to compete in a sports competition every day without the option of giving up. You can hardly drink, often feel dizzy, and your daily form varies greatly, only discovering it when you get up and have to start the match. That is a brief summary of the life of someone with severe heart failure. This is not an exaggeration, as studies show that the exercise capacity of patients with severe heart failure is very low, often just enough to complete essential daily activities. For example, it has been demonstrated that putting on two socks, two shoes, and a vest for someone with severe heart failure requires roughly the same amount of energy as running for a trained endurance athlete.[1] This dramatic limitation of exercise capacity is caused by the fact that the heart is no longer able to deliver oxygen efficiently to tissues involved in exertion. However, the heart itself is not the only problem; due to chronic oxygen deficiency in tissues, abnormalities occur throughout the body (Figure 1):[2]

- The function of blood vessels in the muscles deteriorates; both the number of blood vessels and the size of the vascular bed becomes smaller, while the remaining vessels do not dilate sufficiently during exertion or emotion.
- The function of skeletal muscles deteriorates, affecting both the quality of muscle fibers and the enzymes in the muscles involved in generating energy from oxygen.
- The endurance and strength of respiratory muscles decrease and the efficiency of breathing also decreases, making breathing even more energy-consuming.
- The hormone balance changes, resulting in a high heart rate that varies less and cannot rise adequately during exertion.
- Ultimately, with the progression of the disease, the function of vital organs such as the kidneys, liver, and gastrointestinal system will also be affected.

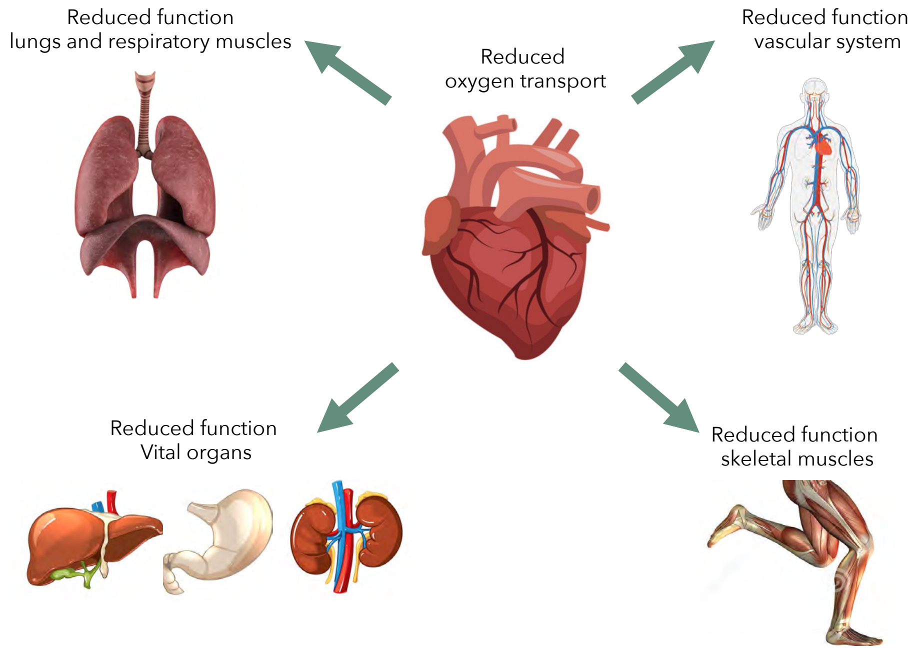

Figure 1. The consequences of heart failure for other organ systems.

A crucial factor contributing to the progression of heart failure is a decrease in physical activity. Inactivity leads to a chronic reduction in blood supply to respiratory and skeletal muscles, thereby accelerating the process of the decline in exercise capacity. As a result, the motivation and energy to engage in physical activity further decrease, often accompanied by a fear of exertion. To break this vicious cycle, analogous to high-performance sports, meticulous coaching is required: an exercise program tailored to individual physiological limitations and fitness with sufficient intensity to be effective but not too heavy to prevent overtraining; a prescribed protein-rich diet to promote recovery and muscle building; psychological support if anxiety or depressive symptoms are present; and finally, precise and frequent monitoring of the disease itself so that deterioration can be quickly recognized and treated and training intensity and fluid intake can be adjusted appropriately.

Such an interdisciplinary or preferably integral treatment can only be successful in the long term if its content and form align with the needs and preferences of the individual, leading to actual behavioral changes. It is evident that achieving this is a great challenge, requiring a combination of expertise: a heart failure cardiologist with specific knowledge of the disease; a specialized nurse for monitoring, adjusting medication, and guidance in coping with the disease; a sports physician or sports cardiologist for testing exercise capacity and prescribing an exercise program; a physiotherapist for the implementation and supervision of the exercise program; an occupational therapist for advice on energy distribution; a psychologist for diagnosing and treating anxiety and depression; and a dietitian for prescribing a balanced diet and fluid intake.
All these professionals require information and measurements. If we shape this care in the traditional way, i.e., in the hospital, it implies that the patient has to come to the hospital frequently to tell the same story, undergo numerous tests, and fill out questionnaires. And that's only for the heart condition, as there is a high likelihood that the patient will also suffer from other chronic diseases requiring similar attention.
From the perspective of the healthcare provider, this approach is not sustainable due to the growing number of patients and the already full schedules and waiting lists. Throughout my speech, I will attempt to explain that "high-performance support" for heart failure patients does not have to be a utopia. I will delve into the crucial central role that technology can play in achieving this, on the one hand by making it easier for the patient in such a way that the majority of care can be provided in a much more personal manner in the home environment and, on the other hand, by providing the healthcare professional with more relevant information and assistance in treatment decisions, ultimately reducing the workload.

The three revolutions

To provide you with a clear understanding of where we are now and where we are heading with the care of patients with chronic heart failure, I would first like to give you a brief overview of the history.
The earliest descriptions of decompensated heart failure can be traced back to China and Egypt, dating from 3000-4000 years before our era.[3] In the 5th century BC, Hippocrates first described how congestion in the lungs could be heard by placing the ear against the chest, characterizing the sound he heard as the boiling of vinegar. One proposed treatment at that time involved drilling a hole in the ribcage to drain the fluid. In the Middle Ages, patients with heart failure, then known as 'dropsy', were treated with bloodletting, leeches, and the insertion of tubes into the abdomen to drain excess fluid. However, the mechanism was still not well understood.
It was only in the early 17th century that more knowledge about the pathophysiology of heart failure gradually emerged after William Harvey demonstrated that blood is not stationary but is pumped by the heart. Until then, the heart was considered an organ circulating warm air. The pharmacological treatment of heart failure began in the 18th century after the introduction of foxglove, or digitalis, and the pharmacological treatment consisted mainly of digitalis and diuretics until the 1970s. Additionally, bed rest and fluid restriction were considered the cornerstones of treatment. After the first 'pharmacological revolution,' which demonstrated the effects of new drugs such as beta blockers and ACE inhibitors, the first 'technological revolution' began in the 1990s with the introduction of the implantable cardioverter-defibrillator, or ICD, followed by a special pacemaker that enhances the efficiency of the heart's pumping, known as resynchronization therapy, and later the left ventricular assist device, a mechanical pump that partially takes over the heart's function.
Both revolutions, the pharmacological and the technological, had a significant impact on the prognosis of chronic heart failure. Unfortunately, the 'lifestyle revolution' was still awaited at that time. In the prominent cardiology textbook Braunwald, often referred to as the bible for cardiologists during my training period, the following lifestyle recommendations were included in 1992:

- Heart failure without symptoms: cease intensive sports and heavy work.
- Heart failure with mild symptoms: stop full-time work and incorporate rest periods during the day.
- Heart failure with moderate symptoms: stay at home.
- Heart failure with severe symptoms: confine to chair and bed.

Rest was also an important pillar of the treatment of heart patients in the clinic. For example, treatment for a heart attack consisted of medication and six weeks of strict bed rest (Figure 2).

Figure 2. Cardiac monitoring unit in the 1960s.

Up until then, there had been only a few individuals with foresight in the field of lifestyle. An example of this is the controversial London physician William Stokes, who had already suggested in 1854 that exercise could be beneficial for heart patients with his statement "the symptoms of debility of the heart are often removable by a regulated course of gymnastics or by pedestrian exercise."
Only in the late 1990s did the general perspective on the role of exercise in the course of the disease gradually change after the first randomized studies showed positive effects of cardiac rehabilitation in patients who had suffered a heart attack and later in patients with heart failure. While medication primarily showed effects on survival and the risk of readmission, cardiac rehabilitation proved to have a positive impact on the quality of life and exercise capacity and an additional benefit on the risk of hospitalization due to heart failure.[4] In the early 2000s, the third revolution finally began, the lifestyle revolution, and cardiac rehabilitation was globally incorporated into guidelines as part of the treatment for patients with heart failure.
A perfect combination and the last missing ingredient for better quality of life and fewer hospitalizations for heart failure patients, one might think. Unfortunately, this is not the reality. The number of hospitalizations remains very high as of 2024, with over 30,000 hospital admissions annually and an estimated total of over 240,000 people with heart failure in the Netherlands.[5] The main causes of this increase are aging (approximately 90% of people with heart failure are over 65 years old) and improved survival after a heart attack; in the last 30 years, a fourfold decrease in mortality from an acute heart attack has been observed. If the numbers continue to rise as predicted, by 2050, one in six people over 65 years old will have heart failure. If nothing changes, this will lead to an even greater shortage of personnel in healthcare and soaring costs because the average annual costs per patient with heart failure worldwide are currently approximately 25,000 euros.[6]
To accommodate this strong growth in heart failure patients, a radical change is needed in the organization of our care, especially for the large group of older patients with heart failure who have already had a hospital admission and for whom there are no more possibilities for the recovery of heart pump function. These are people with a low quality of life due to symptoms and a very limited range of activity, accompanying diseases such as COPD, depression, and diabetes, and, above all, a high risk of hospitalization (the risk of readmission in the first month after discharge is approximately 20%).[7]

Let's take a critical look at the care currently provided to this group. To begin with, what do the most recent guidelines say? The European Heart Failure Guideline, updated in mid-2023, recommends that heart failure patients should come to the hospital frequently, i.e., weekly, for medication adjustment in the first weeks after a hospital admission.[8] On the one hand, these frequent hospital visits are a significant burden for both patients and healthcare providers, while on the other hand, it is questionable whether this frequency is sufficient to actually prevent hospital admissions. Subsequently, once the patient is well adjusted to medication, it is recommended to plan outpatient visits twice a year. At the same time, it is recognized that little is known about the optimal frequency, how these checks should be performed, and in which setting (primary or secondary care). The role of telemonitoring is also not clearly described. Telemonitoring is an approach where patients conduct daily measurements at home and send them to the hospital so that deterioration, such as fluid retention, can be responded to more

quickly. In the European Guideline, telemonitoring has received a class II, level B recommendation, meaning it may be considered but there is conflicting evidence and/or a divergence of opinion about the effectiveness and meaningfulness of the therapy. The Dutch Guideline 'Organization of intramural heart failure care' is more liberal in this regard and states that all heart failure patients in the Netherlands should have the opportunity to choose a form of telemonitoring. The best way to apply telemonitoring and the consequences of its application for the frequency of outpatient visits are not described in either document. I will share my views on this issue during the course of my speech.
Other important recommendations in the most recent guidelines include providing multidisciplinary care consisting of education, lifestyle advice, encouraging self-management, and cardiac rehabilitation. Although the evidence for the effectiveness of these interventions is very strong, cardiac rehabilitation is poorly implemented in this group. Only 5% of heart failure patients in the Netherlands participate in cardiac rehabilitation.[9] The most important reasons for this low participation are the high burden to come to the hospital several times a week, as well as costs and a lack of facilities in hospitals. In addition, regular cardiac rehabilitation programs are often not adequately tailored to the needs and limitations of this specific population.

In summary, we can conclude that the care for older heart failure patients after hospital admission is not well established yet, but it is highly urgent that we search for the optimal care path focused on preventing hospitalizations and optimizing the quality of life at the lowest possible costs and utilization of healthcare professionals.

Remote Patient Management, a game-changer but how?

Telemonitoring and treating patients in their home environment, also known as Remote Patient Management (RPM), is increasingly considered as a crucial solution – if not the key solution – to ensuring the future accessibility of care for patients with chronic conditions. When I asked ChatGPT whether Remote Patient Management is a game-changer, I received the following response:

"Yes, RPM is considered a game-changer in healthcare. It has the potential to profoundly alter how patients access medical care and how healthcare providers deliver care. The benefits of Remote Patient Management include improved access to care, reduced waiting times, continuity of care, time and cost savings, early detection and intervention, enhanced patient engagement, self-management, reduced hospital admissions, more efficient use of resources, and personalized healthcare."

A wonderful answer that certainly indicates a high level of confidence in RPM. But have all these effects been conclusively demonstrated? Numerous studies have been conducted on the effects of RPM in patients with heart failure, but the results vary widely. My colleague Brugts, a heart failure cardiologist at Erasmus MC, recently conducted a meta-analysis with his research group, combining and analyzing all relevant RPM studies.[10] A brief summary of the results of this important work is that RPM leads to an average reduction in mortality of 16% and a decrease in hospital admissions by 15%. This is a very positive and reassuring outcome, but given the significant increase in hospital admissions and the aging population, it is likely still insufficient to cope with the growth in hospital admissions due to heart failure in the coming years. Additionally, it is not yet clear whether the growing and aging group of heart failure patients can and wants to participate in RPM and whether large-scale implementation of RPM truly leads to time and cost savings.[11] For these reasons, my research, building on the work of others and our own research, will focus on the following three themes:

1. The development of the ideal RPM care pathway to improve quality of life and prevent hospital admissions.
2. The optimization of RPM participation and minimization of dropout.
3. The efficient deployment of healthcare personnel.

1. THE IDEAL RPM CARE PATHWAY

I will now discuss these three themes in more detail, starting with the first theme: the development of the ideal RPM care pathway. An RPM program is effective when it enables patients and healthcare providers to detect and treat disease deterioration early and remotely, long before an emergency room visit or hospitalization is necessary (Figure 3).

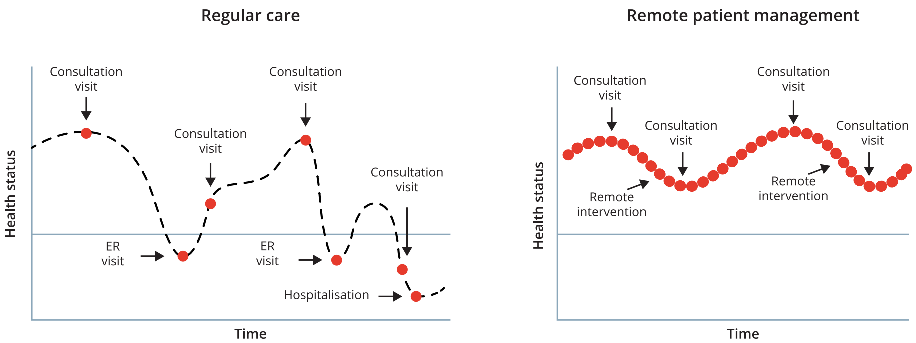

Figure 3. Remote Patient Management: the concept.

Previous research has shown that several factors influence the effectiveness of RPM:[12]

- Firstly, the technology used: the use of a blood pressure monitor, scale, and heart rate monitor, along with the use of a tablet or smartphone, leads to better results.
- Additionally, the type of data collected is crucial: besides the measurements mentioned, the monitoring of complaints and medication use is important.
- Furthermore, the organization plays a role. The involvement of a physician in the RPM care pathway demonstrably improves results.
- Finally, effectiveness is higher when there is an alert system that warns patients and healthcare providers when vital parameters deviate.

The extent to which other factors play a role is the subject of a new systematic literature review that Wessel Nieuwenhuis and Ignace de Lathauwer, PhD candidates in our research group, are currently conducting. They are investigating the impact of, among other things, the use of new sensors and artificial intelligence, the monitoring frequency, and the addition of remote lifestyle guidance as part of the RPM program. In addition to literature research, we have also conducted experiments. A central research question was and still is: which sensor or combination of sensors enables early detection of deterioration? This is an important question because the parameters typically used in RPM (blood pressure, weight, and symptoms) only change a few days before deterioration requiring hospitalization (Figure 4). This means there is little, and sometimes too little, time to detect this and adjust the treatment in a timely manner. If we can detect an increase in filling pressures in the heart earlier, preferably two or even three weeks before deterioration, we can intervene earlier and prevent more hospitalizations.

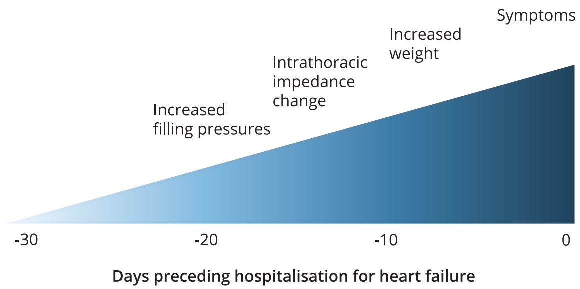

Figure 4. Signs preceding hospitalization due to heart failure.

So far, studies have showed that early detection of increasing filling pressures is feasible with a pressure sensor implanted in the pulmonary artery but not yet with less costly non-invasive sensors that do not require intervention. In her PhD research, Cyrille Herkert investigated new measurements in the KINO and INNOVATE studies and identified three potential future directions.

- One of them is measuring vibrations, or kinetic energy, from the heart; this measurement can be performed with a sensor or even a normal smartphone that is placed on the chest and appears to provide a good indication of changes in filling pressures in the heart.[13,14]

- A second promising measurement is heart rate variability assessed with a smartwatch or smart patch; this parameter has the important advantage of changing much earlier before deterioration than traditional measurements of blood pressure, weight, or symptoms. However, the quality of the measurement with a smartwatch is not yet sufficient for practical use.
- A third measurement is respiration, which can also be measured continuously with a smartwatch.

In a larger study in multiple hospitals, the RM4Health HF study, we will investigate whether adding these measurements will actually lead to quicker interventions and fewer hospitalizations. This study will be performed by Ignace de Lathauwer. We will also examine whether these measurements make traditional measurements of weight and blood pressure redundant so that we do not burden the patient with more measurements than necessary.

Another research question that needs to be answered to develop the ideal RPM program: in addition to monitoring the disease, can other parts of the treatment of heart failure patients also be carried out remotely? This could further reduce the burden for patients to come to the hospital and also strengthen the effect of RPM. Within our research group, the focus is on lifestyle guidance and cardiac rehabilitation. As mentioned earlier, cardiac rehabilitation has proven effects on quality of life and the risk of hospitalization. However, participation in cardiac rehabilitation within this group is low worldwide and dropout is high, mainly because participation is very burdensome, the risk of dropout due to deterioration of the disease is high, and existing cardiac rehabilitation programs are often not well-tailored to the low exercise capacity and specific limitations of this particular patient group. My colleague Ruud Spee, also a cardiologist at MMC, and sports physician Victor Niemeijer have examined the specific limitations of heart failure patients and how training programs can best be tailored to them (Figure 5).
A new insight was that patients with more severe heart failure are often primarily limited by abnormalities in skeletal muscles and that targeted training can achieve substantial improvements.[15] In the FysioCARDSS project, Tom Vromen investigated whether we can support the cardiac rehabilitation physiotherapist in prescribing and implementing such a personalized training program.

Figure 5. Spiro-ergometry with hemodynamic measurements for the determination of exercise limitations.

An important aspect that we have focused on in our research in recent years is the design and evaluation of remote cardiac rehabilitation, or telerehabilitation, in which patients are physically and mentally coached using wearable sensors and remote guidance. The basic principles are always that the telerehabilitation program should be safe and effective. In addition, we consistently involve patients at an early stage in the development phase to ensure that the programs meet the needs and preferences of patients at different stages of their heart disease: the initial stage where there are no symptoms or only mild symptoms, the stage where mild symptoms persist or patients need to recover after an event such as a myocardial infarction, and finally the stage characterized by recurrent hospital admissions due to heart failure (Figure 6).

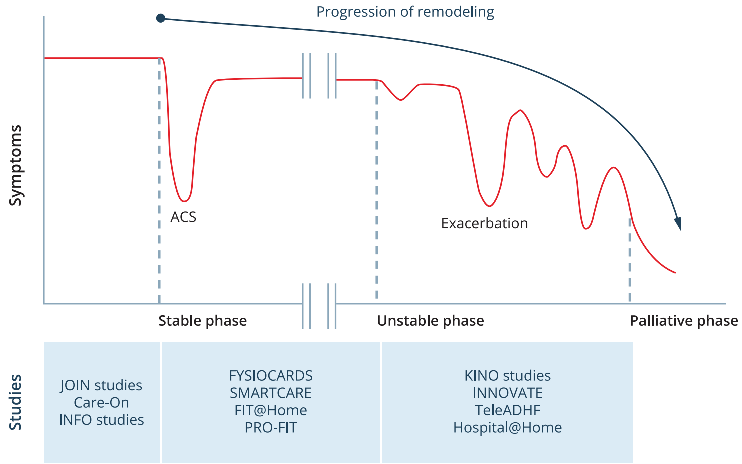

Figure 6. The course of heart failure with ongoing clinical studies.

I will now give you an overview of the main studies in this area within our research group.

- Lonneke Fruytier and Danny van de Sande are working on a safe, tailored tele-rehabilitation program for recreational athletes with arrhythmias or coronary artery disease with mild symptoms or no symptoms. Here, we use the JOIN app, which is already used by thousands of cyclists and has been specially adapted for athletes with heart conditions to be used safely for tele-rehabilitation.
- Mayra Goevaerts and Nicole Tenbult have developed a lifestyle monitoring system that enables patients with a chronic heart condition to self-monitor and improve their lifestyle for an extended period with a smartwatch and a chatbot.[16] Additionally, they have investigated the best mode and timing of providing education to patients about the disease and their lifestyle.[17] Currently, efforts are underway to integrate this system with the Greenhabit app focused on sustainable lifestyle improvement.
- In their doctoral research, Jos Kraal and Rutger Brouwers have worked on a tele-rehabilitation program for patients after a heart attack. Their studies, FIT@Home and Smartcare, have shown that this approach is just as effective and perhaps even slightly cheaper than hospital-based cardiac rehabilitation.[18,19]
- In the PRO-FIT study in 10 hospitals, Joyce Heutinck and Iris de Koning are investigating whether tele-rehabilitation in patients with coronary artery disease and chest pain or angina pectoris is a viable alternative to angioplasty or bypass surgery.[20] A unique aspect of this study is that the rehabilitation program is largely carried out in a primary care setting via the ChronischZorgNet network led by Professor Joep Teijink.
- On the other end of the spectrum, Mayke van Leunen is investigating in the Tele-ADHF study whether tele-rehabilitation is feasible in older patients with severe heart failure and whether it leads to improvement in exercise capacity and quality of life.[21] In this study, not only exercise coaching but also psychological care and nutrition coaching are provided remotely. A unique aspect of this study is that daily telemonitoring to detect early signs of disease deterioration is fully integrated with tele-rehabilitation. This combination of monitoring and rehabilitation allows us to see much better when the patient is stable enough to start tele-rehabilitation and to adjust the training load or dietary advice in response to fluctuations in the disease (Figure 7). We can also continue the rehabilitation in this way for a long time once the guidance has been reduced because we can continue to monitor progress remotely and intervene if necessary.

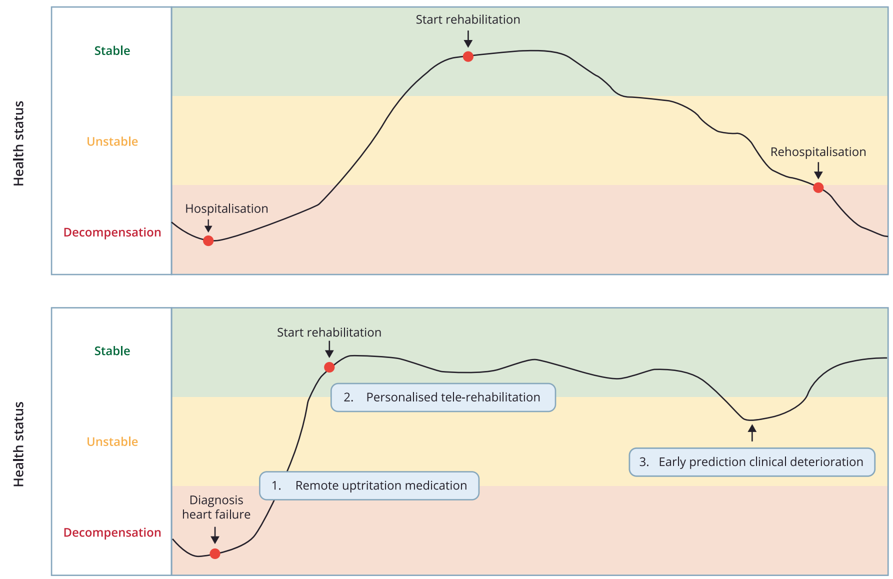

Figure 7. The course after hospitalization due to heart failure: the traditional care path versus Remote Patient Management.

- A next step currently being prepared at Máxima Medisch Centrum to strengthen the RPM program is Hospital@Home. Led by Mylene Frankfort and Mayke van Leunen, a care path has been designed where patients can be admitted at home instead of in the hospital. A patient who is admitted to the emergency department does not go to the nursing ward but goes home with an infusion of medication. The patient is visited at home every day by a specialized nurse and is monitored remotely. The cardiologist supervises the treatment from the hospital. Significant advantages of this approach include a much lower risk of infections, a lower risk of sudden confusion due to a change in environment (delirium), and a consequently faster recovery and less deconditioning. All these factors increase the likelihood that someone can continue to live independently after hospitalization. This is a very impactful project that can ultimately lead to a win-win situation for both the patient and the hospital, especially if we succeed in applying this care path to other medical conditions and combinations and expanding it to other hospitals.

2. OPTIMIZATION OF PARTICIPATION IN RPM AND MINIMIZATION OF DROPOUT

The second research theme concerns the optimization of participation in RPM. While remote care is often seen as a solution to the growing demand for healthcare, there are also doubts about its applicability to older adults. Commonly heard critical remarks about RPM include:
- Elderly patients lack digital skills, so most of them cannot participate in RPM.
- Elderly patients do not want remote care at all and prefer face-to-face contact with the healthcare provider.

These statements, or perhaps assumptions, are not well supported by data. Several studies in different countries show that the majority of people over 65 have sufficient skills to participate in an eHealth program. Also, the majority of older patients express interest in remote care as a replacement for face-to-face contacts. In collaboration with the research groups of Professor Paul Dendale, a cardiologist in Hasselt, and Wijo Kop, Professor of Psychology at Tilburg University, we specifically investigated participation in RPM among older patients with heart failure. In a group with an average age of 80 years old, 66% were willing to participate in the program. Reasons for not participating included a lack of technical skills and a lack of confidence in their own abilities. Age and cognitive skills, i.e., memory, intelligence, and concentration, did not predict participation.

Thus, participation can be further increased if we succeed in training digital skills and increasing self-confidence. For this reason, our future research will focus on a better onboarding procedure consisting of education and training to optimally prepare the patient and their environment for RPM. Additionally, it is important that RPM systems and sensors are better tailored to the skills and preferences within this group and that thorough research on user-friendliness is conducted before implementation.

3. EFFICIENT DEPLOYMENT OF HEALTHCARE PERSONNEL

One of the greatest challenges for the coming years is to keep healthcare accessible and affordable. Predictions indicate that by 2040, one in four people will need to work in healthcare to meet the demand, whereas it is currently one in seven. Therefore, action is urgently needed. Research and innovation are no longer free of obligations; not only is speed important but also the way in which we conduct research. Every new intervention must be designed with efficiency in mind and the implications for the deployment of healthcare personnel must be critically evaluated. When discussing RPM, we must immediately question how much involvement of healthcare professionals is necessary and, importantly, what can be omitted. On one hand, RPM requires more input for education and training of patients, daily monitoring of data, and contact with the patient in case of abnormal values. On the other hand, we will need less nursing staff in the long term because we can prevent and shorten hospital admissions. However, we also need to reconsider the existing care path. Does the patient participating in RPM really need to see the specialist at the outpatient clinic multiple times a year? Are the standard tests we routinely perform still necessary? Rigorous real-time cost-effectiveness studies with innovative research methods are needed to enable us to quickly evaluate small changes in the RPM care path. Within the Dutch Heart Network, a collaboration of cardiologists from regional hospitals and general practitioners in the Southeast Brabant region, we have been working on a joint RPM care path and data collection so that we can implement this in practice in the near future. Moreover, the wealth of data we can collect in this way will enable us to develop artificial intelligence algorithms and decision support, eventually reducing the need for healthcare personnel.

To achieve all these goals – establishing the ideal RPM care path, optimizing participation, and reducing the deployment of healthcare personnel – a pooling of expertise is required (Figure 8). In addition to knowledge of heart failure, expertise in exercise physiology, behavior change, and healthcare organization is needed. Furthermore, I see a crucial role for the industrial designer as a linking pin between all these disciplines and technology, both in designing technology, aligning technology with needs and skills, using technology for behavior change, and visualizing information for healthcare providers and patients. I consider it a crucial task to bring these disciplines together and engage in interdisciplinary research that truly impacts healthcare.

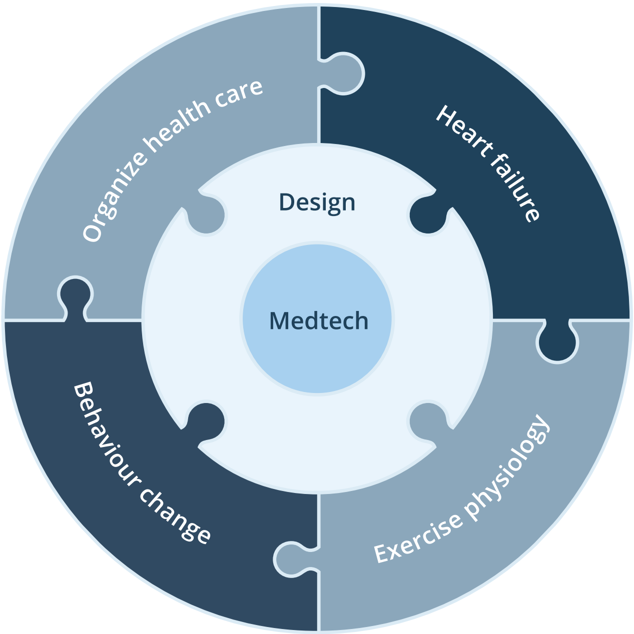

Figure 8. Remote Patient Management: expertise areas and their interconnection.

RPM, what else?

After this overview of completed and ongoing research, it is time to look a little further into the future. This is challenging because the possibilities for technological innovation are rapidly increasing. While we now mainly focus on measurements on the body itself, such as with a blood pressure monitor, a watch, or scales, it would be much better, in view of the burden on the patient, to integrate sensors into the living environment (Figure 9).[22]

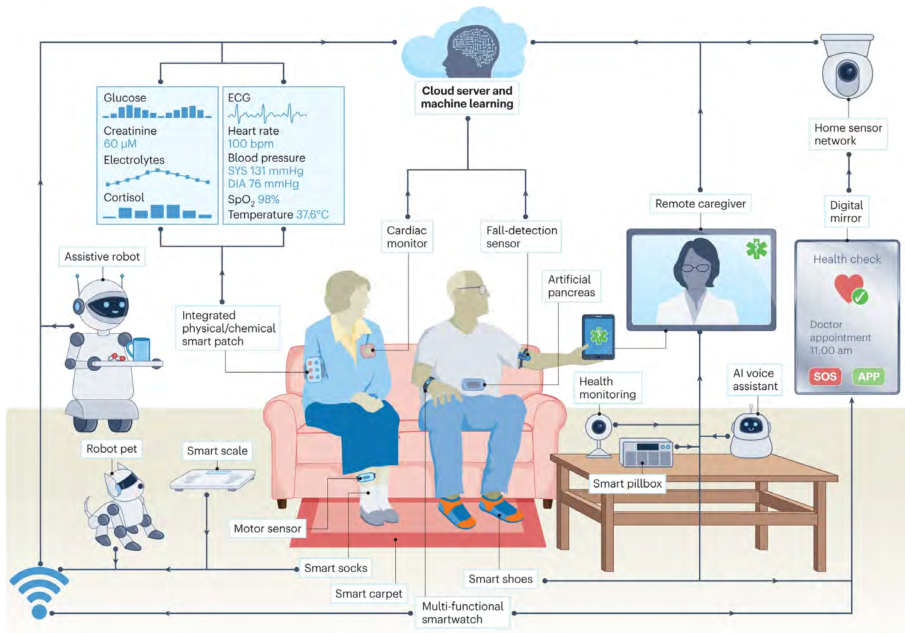

Figure 9. The future of Remote Patient Management.

Imagine a smart mattress that can measure sleep quality, a bathroom mirror that can measure blood pressure, a microphone that can detect congestion in the lungs through voice analysis, a smart camera that can detect changes in heart rate variability and breathing patterns, or a smart toilet that can monitor salt excretion in urine. Patients could then receive advice from an interactive voice assistant and be assisted by a robot companion rather than a laptop. This may seem futuristic,

but all these examples are based on existing prototypes or even commercially available products. So, in the future, perhaps we should not only arrange home care upon discharge from the hospital but also redesign the patient's home. However, in addition to the home of the future, we also need to think about the neighborhood of the future. The range of action and social networks of older patients with heart failure and other chronic diseases are severely limited. Research has shown that social isolation and loneliness are actually linked to a higher risk of readmission.[23] Furthermore, in a collaboration between MMC and several departments at TU/e, including Biomedical Engineering and Built Environment, we have recently demonstrated that a green environment has a positive impact on heart rate variability, a key predictor of the risk of readmission.
Therefore, it could well be that a green living environment with more opportunities for social interaction can contribute to a higher quality of life and lower healthcare costs.
To truly realize these future visions, we need to take a few important steps. Firstly, it is crucial that new technology is developed based on the clinical need to make healthcare accessible and affordable. Researchers, developers, patients, and clinicians need to collaborate on this. Currently, it is too often the case that a developer comes up with a solution for which a problem must be found. If the match is not perfect, the marriage will sooner or later end. Secondly, the speed at which good ideas come into practice needs to increase. We not only need to better navigate complex legislation such as the Medical Device Regulation (MDR) and the General Data Protection Regulation (GDPR) but also need to implement smarter research methods in practice, allowing us to quickly generate large-scale real-world evidence on the effects and efficiency of new technology. Thirdly, healthcare institutions must also be ready for implementation. This requires adaptation within the organization and new financing models because costs often precede benefits. A crucial link in implementation is also the role of the healthcare professional. In the future, the medical specialist might engage less in traditional outpatient visits but have an advisory role in multidisciplinary teams with highly educated nurses who act as case managers for older patients with multiple chronic diseases. Ward nurses will have fewer patients in the hospital and will visit some of the admitted patients at home. Paramedics such as physiotherapists, occupational therapists, and dietitians will coach patients much more remotely based on data collected at the patient's home (Figure 10).

Figure 10. Telerehabilitation during COVID-19.

This requires knowledge and, above all, trust in technology and artificial intelligence. This has significant consequences for the design of basic education for new doctors, nurses, and paramedics, but there will also need to be training and education for working healthcare providers.
To achieve all this – optimal alignment of technology with clinical needs, rapid innovation, and preparing healthcare institutions for the future – collaboration is absolutely essential. It is fantastic to see that this is already being worked on in the Southeast Brabant region with very successful collaborations such as Brainport, the Dutch Heart Network, Chronisch ZorgNet, the Eindhoven MedTech Innovation Center (e/MTIC), and the Center for Innovation in Clinical Care (CICLe). With my chair, I hope to strengthen the collaboration between all these important stakeholders and further increase enthusiasm so that together, we can ensure that our heart failure patients can deliver a top-level performance every day.

Epilogue

Research is not done alone, especially when one aims to make a real difference. In unity there is strength, as sung in the PSV club anthem. Over the past years, I have met many people who have inspired and supported me, not only scientists but also colleagues from the hospital, executives, and individuals from the business world. Most importantly, I am grateful to the patients: without them, there would be no research and no meaningful innovations. I want to express my immense gratitude to all patients who participated in studies and contributed to new ideas for their dedication and trust.

I also thank the Executive Board of TU/e and the board of the Department of Industrial Design for this appointment and the opportunity to strengthen and expand my research. In particular, I want to thank Berry Eggen and Lin-Lin Chen for their pleasant and personal guidance and valuable advice throughout this journey. I also express my gratitude to the current executives of Máxima Medisch Centrum and their predecessors, Jan-Harm Zwaveling and Christianne Lennards, for their support.

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'Ik heb gezegd.'

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Curriculum Vitae

Prof.dr. Hareld Kemps was appointed as a part-time professor of Remote Patient Management in Chronic Cardiac Care at the Department of Industrial Design at Eindhoven University of Technology (TU/e) on July 1, 2023.

Hareld Kemps (1972) obtained his medical degree at Utrecht University in 1997. In 2002, he was registered as a sports physician and, in 2009, he completed his training as a cardiologist. He received his PhD degree at TU/e in 2009 on the subject of 'Oxygen Uptake Kinetics in Chronic Heart Failure'. He started working as a cardiologist at Máxima Medical Center in 2010, specializing in cardiac rehabilitation, sports cardiology and heart failure. Throughout this period, he combined his clinical work with research. During the early years, he worked as a part-time researcher at the department of Medical Informatics at Amsterdam University Medical Center and he became chair of the Working Group of Cardiac Prevention and Rehabilitation of the Dutch Society of Cardiology. In 2019, he was appointed as an associate professor at the Department of Industrial Design at TU/e and he joined the Eindhoven MedTech Innovation Center (e/MTIC). His research focuses on the design and implementation of new technology and care pathways that assist patients in managing their disease in their home environment and guiding healthcare professionals in tailoring treatment strategies.

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