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Evaluation and improvement of integrated cardiac care: efficient and effective care in patients with chronic coronary artery disease and chronic heart failure

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Efficient and effective care in patients with chronic coronary artery disease and chronic heart failure

Marijke P.M. Vester

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Marijke Vester

Colophon

The studies described in this thesis were conducted at the Department of Cardiology of the Leiden University Medical Center, Leiden, the Netherlands

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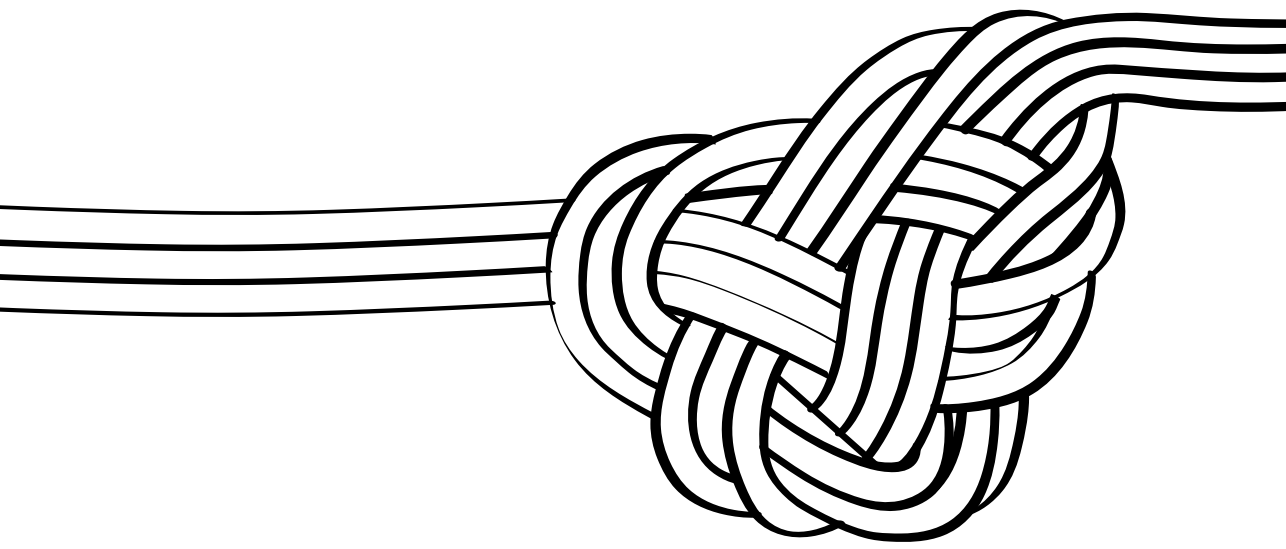

CHAPTER 1

GENERAL INTRODUCTION

INTRODUCTION

Access to healthcare is a basic human right. From a governmental perspective, it is, therefore, necessary to identify how much healthcare is needed for a given population. Also, it is necessary to identify trends to predict future healthcare needs and make sure the supply can meet the demand. Recently, the Dutch government investigated the healthcare demand and came to the conclusion that the demand is rising sharply (1), and identified the following main drivers for this rise:

- Immigration
- Ageing population
- Increase in chronic diseases
- Increase in psychological disorders
- Increase in required healthcare for youth

Currently, the required healthcare resources are increasing at a higher rate than the economic growth, meaning the burden of healthcare on society is increasing. Extending resources on healthcare is in itself a good thing, but it is important to use the resources effectively and efficiently. In this thesis, we will focus on the ageing population and the increase in chronic diseases.

It is expected that in 2050 one in every five people will be aged 60 years or older. (2) Europe experiences a more drastic development of population ageing; the old-age dependency ratio, which reflects people aged 65 years and above relative to those aged 15 to 64 years, will increase from 29.6% in 2016 to 51.2% in 2070. The very old-age dependency ratio, which reflects people aged 80 years and above relative to those aged 15 to 64 years, will increase from 8.3% in 2016 to 22.3% in 2070.(3) A combination of lower birth rates and a longer life expectancy explains the increase in the elderly population.(3, 4) A longer life expectancy is partly the result of achievements made in human health. These achievements induce a shift from infectious and parasitic diseases to noncommunicable diseases and chronic conditions, as the leading causes of illness and death. With increased longevity, the risk of developing multiple chronic conditions in a single person at the same time, i.e. multimorbidity, increases.(5) Other factors that contribute to the increase in the estimated prevalence of chronic diseases and conditions, are improved early detection and advances in treatment.(5) In the Netherlands, 25% of the population has one chronic condition, 13% has 2 chronic conditions and 14% has 3 or more chronic conditions. Of the people who are 75 years or older, almost 66% have 3 or more chronic conditions.(6) Because multimorbidity raises clinical complexity in a patient, it is associated with the increased use of inpatient and ambulatory care.(7)

The increase in chronic diseases and the ageing population has an especially big impact on cardiac diseases, since they increase both due to the ageing population, and due to the rise in chronic diseases. Cardiac diseases are the third most prevalent chronic diseases in the Netherlands.(8) Treatment of cardiac diseases accounts for 1.5% of the total health expenditure in the Netherlands.(9) Globally, the same trends are identified. The Global Burden of Disease study reported a prevalence of approximately 423 million patients suffering from a form of cardiovascular disease (CVD) in 2015.(10) In western Europe the age-adjusted prevalence rate of CVD is 5106 per 100.000, this is comparable with the prevalence rate of 5302 per 100.000 in high-income North America. Ischemic heart disease has a prevalence rate of 1.244 per 100.000 and 1.226 per 100.000 in western Europe and high-income North America, respectively. (10) Zooming in more closely to the Netherlands, the most prevalent and therefore resource-intensive cardiac diseases are coronary artery disease (CAD) and heart failure (HF). (11, 12) One expects that the prevalence of patients with CAD and HF will increase by 49% and 88% from 2018 to 2040, respectively. (13, 14) Similar observations are also done outside of the Netherlands. Khavjou et al. stratified the prevalence of CAD and congestive HF per year in America. They report a prevalence of 6.8% (N= 16.835.804) for CAD and 2.3% (N=5.781.675) for congestive HF in 2015.(15) The demographic trends underlying the rise of cardiac diseases (ageing population, increase of chronic diseases) are interrelated and very difficult to change.

Cardiac care in the Netherlands

Striving for efficient and effective use of healthcare resources is not new. In the 1970s, the Dutch government implemented the current 'tiered' healthcare setup, comprising primary, secondary, and tertiary care. Primary care is the most accessible to the patient. For healthcare, the primary care provider is the general practitioner. When the complexity of the disease increases, the primary care provider can transfer the patient to secondary care, which is usually a regional hospital. Similarly, the secondary care provider can transfer the patient to tertiary care. When the condition of the patient becomes less severe after the appropriate care is received, the patient is transferred back to secondary and primary care. Each increasing tier is more specialized and can perform more resource-intensive diagnostics. I.e. a general practitioner can perform many diagnostic tests, but for an MRI you have to go to the hospital. But, an MRI is only performed if the general practitioner transfers the patient to a higher tier. This way, the number of MRI scans performed is limited to only the necessary amount. To provide cost-effective care, this concept hinges on the role of the different levels of care providers to know which tier of care is fit for the patient. In 2006, to further increase the cost-effectiveness of the healthcare system, controlled market competition between healthcare providers and between health insurers was introduced. In this system, the health insurers buy services from healthcare providers, who in turn can compete with each other to provide the best care for the best price.

Transition in healthcare

The goal of healthcare is not only to provide high-quality care, but also to provide affordable care. Determining the effectiveness of a treatment by looking at outcomes is different from looking at the quality of care as a whole. For instance, for the last 10 years, the Dutch population feels the quality of care is declining, despite better treatments being available and increasing expenses.(16) Evidently, to provide high-quality care requires a better definition than 'how effective was the treatment?'. Furthermore, with the ageing population which suffers from multimorbidity and chronic conditions, 'being healthy' is becoming very rare. The WHO defines health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity". Yet, as ageing with multimorbidity is the norm last decades, this definition becomes obsolete. Huber came up with a new concept of health.(17) It defines health as a dynamic phenomenon; it is about resilience and self-management. This definition makes us reconsider what health is, what the most suitable way of delivering healthcare is, and how we should measure it. Porter et al. described the necessary changes in healthcare delivery and measurement in 2010: more attention should be made to the individual patient, their disease trajectory, and their quality of life. The paradigm is shifting from evidence-based medicine toward value-based medicine. There is still no consensus on the definition of "value" because it is determined by the perspective of the patient, provider, or payer.(18, 19) However, the most general definition is "the health outcomes achieved that matter to patients relative to the cost of achieving those outcomes"(Equation 1).(20) As value-based healthcare emphasizes the importance of quality of life, one could say that it takes evidence-based medicine to a higher level.(19)

$$\text{VALUE} = \frac{\text{QUALITY OF CARE}}{\text{COSTS}} = \frac{\text{OUTCOMES + PATIENT EXPERIENCE}}{\text{DIRECT COSTS + INDIRECT COSTS}}$$

Eq 1. The value equation. The definition of value should include outcomes, patient experience, and costs.

Quality in care

The Institute for Healthcare Improvement (IHI), is a not-for-profit organization and a leading innovator in health and healthcare improvement worldwide based in Boston. It developed a framework of three goals (21), the Triple Aim, which should be pursued equally and simultaneously by a healthcare system to achieve high value in care on a population level:

1. Improve the individual experience of care
2. Improve the health of populations
3. Reduce per-capita costs of healthcare

To improve the quality of care on an individual level, the following three principles are important:(22)

1. The main goal is value for patients
2. Results are measured
3. Care delivery is organized around medical conditions and care cycles

In providing value-based healthcare, the outcomes and experiences that matter to the patient define the quality of care. Ideally, those outcome measurements are not only measured during one intervention or one individual service but over the full cycle of the patient's care.(22) Patient-reported outcomes measures (PROMs) are a way to measure patient experience. These are very specific questions about the patient's condition at several intervals during the course of treatment.(23) Interpretation of these PROMs is important to provide efficient healthcare. The same applies to the measurement of cost information: the costs of the complete care cycle of the patient should be measured. This means calculating all costs during patients' care, in particular direct and indirect costs of each clinical service. The recommended methodology to determine patient-level resource expenditure is time-driven activity-based costing (TD-ABC).(24) This bottom-up micro-costing method consists of calculating two parameters per activity: the costs per time unit to perform each activity and the overall time units spent performing the activity.(25, 26) Porter underlines the importance of measuring and analyzing outcomes to improve healthcare delivery. (22) When results are systematically tracked, the quality of healthcare will improve while costs will be reduced.(21) Today, the tiered healthcare system is by definition fragmented. A single patient with multimorbidity often receives care from multiple clinicians who work in different facilities e.g. primary care, secondary or tertiary care, diagnostic centers, and pharmacies.(27) Also, different caregivers treat a single patient within each facility, but need to coordinate with each other as well. The high number of individual healthcare professionals that treat a single patient leads to a high risk of losing individual patient information along the care pathway. To create a continuum of care, treatment delivery should be organized around a patient's medical condition (patient-centered care), instead of individual specialties or procedures (disease-centered care).(28, 29) Different studies have shown that patient-centered care improves disease-related outcomes and QoL. (30) Achieving patient-centered care, especially in patients with chronic conditions, requires close collaboration and coordinated care between multiple physicians and other health professionals in an integrated care system.

Integrated care

A review from Armitage et al. about 'integrated care' resulted in 175 different definitions and concepts.(31) When considering integrated care, it is best understood as an organizing principle for care delivery to achieve improved patient care through better coordination of services provided.(32) This should be distinguished from integration,

which is the combined set of methods, processes, and models that facilitate integrated care.(33) The concept of integrated care models is complex and characterized by the dimensions of integration. Integrations can be distinguished by type, mechanism, level, and intensity.(32, 34) One way to describe integration is as horizontal or vertical. Horizontal integration occurs when organizations at the same stage in the process of delivering healthcare collaborate aiming to make healthcare equally accessible across populations (population-based care). (Figure 2)(35) An important and recent example is the merging of primary care facilities. Today, most general practitioners work in multidisciplinary teams in the Netherlands.

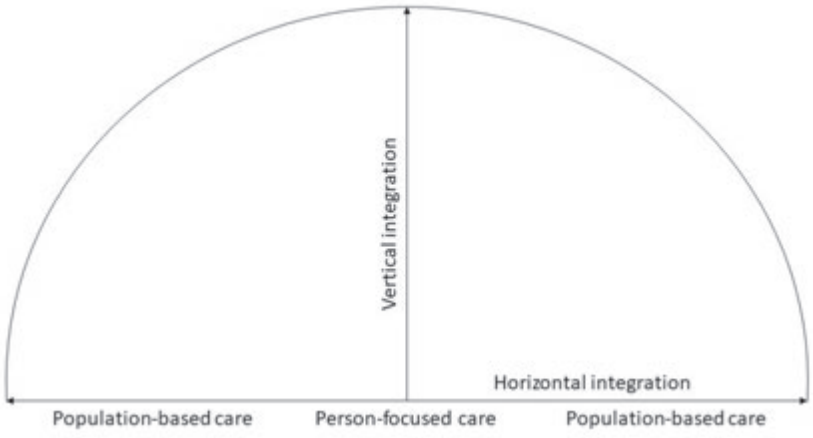

Figure 2. The distinction between vertical and horizontal integration.(37)

Vertical integration has a more disease-focused view. It involves the integration of care across healthcare facilities that are at different stages in the process of delivering care. (Figure 2) Multiple studies show the efficiency and effectiveness of vertical integration in healthcare delivery.(36, 37) A good example is the implementation of transfer points in most Dutch hospitals. These transfer points employ transfer nurses and social workers who provide home care or social services when a patient is discharged. Partly due to this, the Netherlands has the lowest hospital bed occupancy in Europe and the mean length of hospital stay ranks below average.(38) Another example of vertical integration is disease management programs for chronic conditions, for example, the Chronic Care model of Wagner, proposed in the 1990s.(39) The chronic care model comprises six fundamental principles that improve outpatient care delivery: self-management support, decision support, delivery system design, clinical information systems, community, and health system. It aims to enhance the self-empowerment of the patient and the delivery of evidence-based care. Vertical integration is also implemented in the joint, multidisciplinary triage system by general practitioners, emergency departments in hospitals, and ambulances, which results in fewer referrals to the emergency department.(40)

Patients with chronic conditions have ongoing requirements for health services. Higher requirements, in an already tight financial climate, increase the need to deliver care more cost-effectively and reduce the burden on hospitals and caregivers. A review from Stephenson et al. shows that integrated care for people with chronic conditions reduces the utilization of hospital services.(41) Also, a study from McKinsey confirms that integrated care is an effective delivery model for people with chronic conditions, leading to improved patient outcomes and experiences, and reductions in avoidable hospital utilization.(42)

Aims and outline of the thesis

It is discussed that the current healthcare system is under pressure to deliver more care, at a high quality, without further increasing the costs. Chronic cardiovascular diseases are a very important part of the puzzle in this respect as they form a large part of healthcare expenditures and these are expected to increase. From the previous discussion, it is also clear that there may be a possibility to improve healthcare quality by looking at integrated healthcare systems, compared to the fragmented system currently in use in the Netherlands.

To make the discussion tangible, this thesis will focus on chronic CAD and chronic HF. The specific research questions are:

1. *Are chronic CAD and chronic HF care efficient and effective in the Netherlands?*

2. *What are potential areas of improvement in Dutch cardiovascular healthcare delivery?*

Possible improvements are explored by looking at data from a practical setting in primary, secondary and tertiary care. **Chapter 2** focuses on primary care, by evaluating an integrated care model for non-acute suspected cardiac complaints. **Chapters 3 and 4** focus on secondary care, first by investigating the efficiency of chronic HF care in secondary care (Chapter 3), and then giving insight into healthcare utilization and corresponding costs of patients with non-acute chest pain in secondary care (Chapter 4). **Chapter 5** provides insight into complex chronic HF care in a tertiary care center. **Chapter 6** provides a summary of the conclusions of the different chapters and future perspectives.

A brief summary of chronic coronary artery disease and chronic HF is found in Appendix I.

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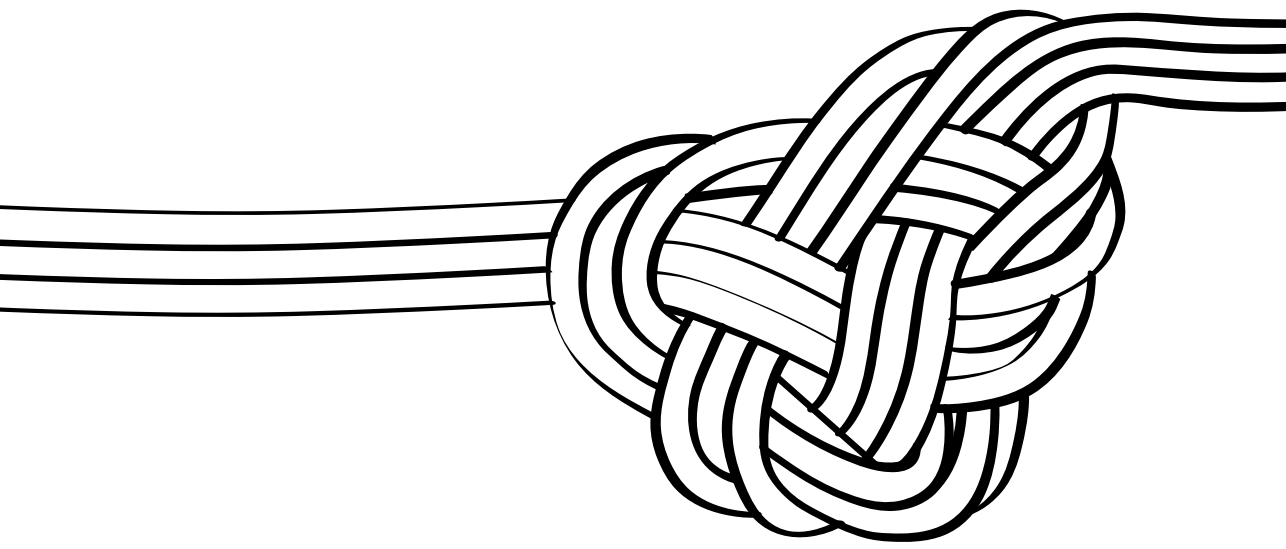

CHAPTER 2

IMPLEMENTATION OF AN INTEGRATED CARE MODEL BETWEEN GENERAL PRACTITIONER AND CARDIOLOGIST: THE SUPPORT CONSULTATION CARDIOLOGY

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ABSTRACT

Objective: Integrated care models have shown to deliver efficient healthcare, but implementation has proven to be difficult. The Support Consultation is an integrated care model, which enables full integration by bundled payment, insurer involvement, pre-defined care pathways and strengthening of primary care. This study aims to provide an indication of the improvements in healthcare delivery after implementation of this proposed model and to create a base for extension to similar interfaces between primary and secondary care.

Design and methods: A retrospective study was used to compare the effect on the number of referred patients with non-acute cardiac complaints and the cost-effectiveness before and after implementation of the Support Consultation. Patients who previously would have been referred to the cardiologist, were now discussed between GP and cardiologist in a primary care setting.

Results: The first consecutive 100 patients (age 55±16 years, male 48%), discussed in the Support Consultation, were analysed. Implementation of the Support Consultation resulted in a net costs (program costs and referral costs) reduction of 61% compared with usual care. All involved parties were positive about the program.

Conclusion: The Support Consultation has the ability to provide more effective healthcare delivery and to reduce net costs. The setting of the current study can be used as an example for other specialties in countries with a similar healthcare system.

INTRODUCTION

Since the last decade, increasing healthcare expenditures have demanded us to look critically at the way we utilize healthcare resources. Despite being able to control a further increase in healthcare expenditures, governments stated that the current healthcare system still lacks efficiency and effectiveness.(1, 2)

Currently, fragmentation characterizes the way healthcare is delivered: a single patient receives care from different healthcare providers and could be referred to different facilities i.e. primary, secondary and tertiary care. The goal of this system is to enable the gatekeeper role, i.e. the general practitioner (GP) only refers those patients with potential underlying cardiac causes to the cardiologist. This should keep the cost down, and give specialized care to those who need it. However, due to limited diagnostic resources and risk averseness of both patient and GP, the threshold to refer patients with a possible cardiac complaint to the cardiologist is low. Research shows that in most cases no cardiac cause of the complaint is found after consultation with the cardiologist.(3-5) One can conclude that healthcare fragmentation hinders communication and collaboration between the healthcare providers and, therefore, is not an efficient way to use healthcare resources. To meet the needs of the patients and, also, provide continuity of care, healthcare ideally should be delivered in an integrated way. (6, 7)

Collaboration between primary and secondary care is a way of integrated healthcare delivery, which has been proven beneficial and more efficient in previous studies. (8-11) An earlier trial has been conducted on integrated collaboration between primary care and cardiology, which resulted in more accurate referrals.(12) In this trial, patients were randomly assigned to joint consultation or to usual care. A total of 49 GPs with 13 cardiologists participated in monthly joint consultations. Comparing joint consultation with usual care, fewer patients were referred and patients underwent fewer diagnostic procedures. Another similar model was implemented in the region of Utrecht (the Netherlands) in 2009. (13) A total of 72 patients were seen by an internist, pulmonologist, orthopedist or ophthalmologist in a primary care setting. Compared to the control group, a reduction of 53% referred patients to secondary care was seen after the one-year follow-up. Despite the promising results of these trials, similar care models have not been implemented on a broad scale in healthcare systems. A possible cause for the lack of widespread adoption is the singular nature of these studies. Therefore, we developed and implemented an integrated care model: The Support Consultation. This study aims to provide an indication of the improvements in healthcare delivery after implementation of this integrated care model for cardiology. Furthermore, it aims to provide and to create a base for implementation of this integrated care model for similar interfaces between primary care and secondary care.

METHODS

Concerning parties

All Dutch citizens are covered by basic mandatory insurance for GP consultations, therefore patients are not charged for consulting a GP. This stimulates the gatekeeping role of the GP. This doctor-patient relationship plays a central role in healthcare provision in the Netherlands and numerous other western countries.

The program took place in the city of the Hague, the Netherlands. The Support Consultation was developed by four cardiologists of the Haaglanden Medical Center (HMC), six surrounding primary care facilities, and the regional health insurer. The six primary care facilities were responsible for 8% of the cardiac referrals to the HMC. Each primary care practice employed 1 to 11 GPs. Close collaboration with a healthcare insurer was a main advantage of the Support Consultation. This resulted in a clear cost focus and a transparent costing of the Support Consultation. To ensure transparent costing, and a cost focus throughout the process, the insurance company paid the GP, and the GP paid the specialist. This clear money path fostered a joint financial incentive.

The Support Consultation

The Support Consultation was implemented in October 2017. Every cardiologist was assigned to 1 or 2 primary care facilities, depending on the schedule of the cardiologist. Patients with a suspected non-acute cardiac complaint, who would usually be referred to secondary care, were now discussed during the Support Consultation. Every four weeks the assigned cardiologist visited the primary care practice, where the registered patients were discussed in a face-to-face setting. We deliberately choose communication in a face-to-face setting because this enables closed-loop communication and mutual trust. These are both cornerstones of effective teamwork. (14) The threshold to discuss doubts and different opinions is lower with familiar colleagues than with strangers. To discuss each patient, 10 minutes were scheduled between GP and cardiologist.

The GP requested additional diagnostic tests according to predefined care pathways. If such tests were necessary, the patient underwent those tests in the hospital before the patient was discussed in the Support Consultation. In this manner, the cardiologists had easy access to the results of the tests and the results were known before the concerning patient was discussed. During the Support Consultation the results of the additional diagnostic tests, the need for referral to secondary care or the need for more diagnostic tests were discussed. A possible outcome was that a patient would be discussed a second time after extra diagnostic tests (resulting from the previous discussion) were performed.

In order to create efficient and effective healthcare delivery, care pathways were designed by GPs and cardiologists. These healthcare pathways were based on the most common cardiac complaints and reasons for referral to secondary care:

1. Chest pain
2. Palpitations
3. Atrial fibrillation
4. Suspected cardiac murmur

The difference between the care pathways 'palpitations' and 'atrial fibrillation' was that patients with palpitations did not have the diagnosis atrial fibrillation whereas patients with atrial fibrillation were known with this arrhythmia and became symptomatic despite treatment. To be sure that the care pathways were well-understood by the different primary care facilities for an efficient referral to secondary care and active re-referral to primary care, cardiologists offered training in the care pathways to each primary care practice before the implementation of the Support Consultation. These care pathways were all in accordance with European guidelines. (15-17) During implementation, it was found that not all patients' complaints fitted the care pathways. This led to the addition of the fifth category 'Other' in the further discussion of the patient.

In collaboration with the Information and Communication Technology (ICT) department a specific electronic tab and treatment code for the Support Consultation was created in the hospitals' electronic patient file. This code enabled the secretary to plan additional diagnostic testing and block sufficient time in the agenda of the cardiologist to visit the concerning primary care practice. Furthermore, during the Support Consultation digital notes could be written down in this tab of the patients' file. With the treatment code in the electronic patient file, it was ensured that the concerning patients underwent the additional tests before the next Support Consultation. Care according to the Support Consultation did not take longer than usual care.

Level of integration

The spectrum of integration within an organization ranges from completely fragmented to full integration of different systems.(18) Full integration exists when professionals collaborate on a personal level in the same organization with a joint financial incentive. (19, 20) The Support Consultation ensured collaboration among primary and secondary care on a personal level through monthly face-to-face communication. The joint financial incentive was ensured because the healthcare insurer reimbursed the GP and the GP subsequently paid the cardiologist: a 'bundled payment'. By these definitions, the Support Consultation is a fully integrated model.

Business case

The developing parties created a business case for the Support Consultation. In this business case, it was assumed that 360 patients per year would be treated. Treating them via usual care would have cost €450 per patient. This was estimated based on data supplied by the healthcare insurer. (Table 1) This €450 included all costs incurred from referral to secondary care, including diagnostic tests. For the Support Consultation, the program costs were established at €112 per patient. This was based on the specialist's fee, the GP's fee, the administrative costs at the hospital and at primary care, the educational hours from the cardiologist and GP and registration costs. (Table 2) The fees from the specialist and GPs were based on an hourly rate. It was assumed that as part of the Support Consultation program, 60% of the treated patients would require additional diagnostic testing, at an average of €194 per patient (based on financial diagnosis codes for low complex additional testing). It was also assumed that 40% of the patients treated via the Support Consultation would be referred to secondary care, at €450 per patient. The per-patient cost for the Support Consultation was estimated to be (40%*450 + 60%*194 + 112=) €408, corresponding to a saving of 10%.

Table 1. Overview of used declaration codes and diagnosis codes of 2017

Diagnosis code and description	Declaration codes	Product	Description
101 No cardiac pathologies	15E316 15E318	099599004 099599011	No indications for cardiac pathology, ambulatory No indications for cardiac pathology, light ambulatory
201 Thoracic complaints	15E311 15E313	099499016 099499022	Cardiology, Thoracic complaints, ambulatory Cardiology, Thoracic complaints, light ambulatory
202 Angina pectoris, stable	15A610 15A611	099499015 099499019	Cardiology, ischemic without injury, ambulatory Cardiology, ischemic without injury, light ambulatory
401 Atrial fibrillation, flutter	15A779 17A786	099899063 099899072	Cardiology, supraventricular rhythms, ambulatory Cardiology, supraventricular rhythms, light ambulatory
402 Other supraventricular arrhythmias	15A779 15A786	099899063 099899072	Cardiology, supraventricular rhythms, ambulatory Cardiology, supraventricular rhythms, light ambulatory

Table 2. Costs Support Consultation

Declaration parts of Support Consultation	Costs
Specialists fee (based on an hourly rate) €140	€47
General practitioners fee (based on an hourly rate) €100	€33
Administrative costs hospital	€12
Administrative costs general practitioner	€8
Hours of education cardiologist and general practitioner	€4
Registration costs	€8
In total per consultation *	€112

Study design and data collection

This paper presents a pre- and post-implementation study of real-life data which was retrospectively analyzed. Included were the first 100 consecutive patients who were discussed according to the Support Consultation. Firstly, baseline characteristics were collected from the electronic records from the moment of the Support Consultation. Baseline characteristics included gender, age, cardiac risk factors and reason for referral according to the established care pathways. Secondly, the performed diagnostic tests, the amount and costs, and final diagnosis were evaluated from the electronic patients' records. (Table 3)

During a follow-up period of 5 months, the number of patients that were referred to the cardiologist, the number of cardiac events and mortality were noted. A cardiac event was defined as a myocardial infarction or another unexpected admission due to a cardiac cause. The realized costs of the patients of the Support Consultation were compared with the estimated costs of usual care in which patients would have been referred to the cardiologist without any other form of consultation. Afterward, a questionnaire was administered to the GPs and cardiologists in order to evaluate the satisfaction of the Support Consultation after implementation. This questionnaire contained 13 questions of which the answer options were positive or negative or a rating from 1 to 10, with 1 related to the lowest level of agreement whereas 10 was the highest level agreement. This study was approved by the Haaglanden Medisch Centrum (HMC).

Table 3. Costs of additional diagnostic testing

Diagnostic test	Costs
ECG	€43,49
Chest X-ray	€38,55
Exercise test	€112,88
Holter monitor	€134,42
Cardiac ultrasound	€81,83
Cardiac CT scan + calcium score	€127,90

ECG = Electrocardiography; CT scan = Cardiac Computed Tomography

Analysis

Continuous variables are expressed as mean ± standard deviation when normally distributed. Categorical data are presented as frequencies and percentages. Statistical analysis was performed using SPSS for Windows (version 23.0 IBM, Armonk, NY, USA).

RESULTS

Patients

Between October 2017 and February 2018, a total of 100 consecutive patients were discussed in the Support Consultation. Table 4 shows the distribution of the discussed patients per primary care practice, GP and cardiologist. There was a large spread of Support Consultation referrals per GP. There has been no further investigation for this reason. Of the four cardiologists, two were assigned to two primary care practices and discussed respectively 32% and 33% of the patients. The two cardiologists who were assigned to one primary care practice discussed respectively 24% and 11% of the patients. The baseline characteristics of this group have been summarised in Table 5. The mean age was 55 (±SD 16) years and almost half of the population was male (48%). Based on the patients' complaint the care pathways were followed: Chest pain (n=39), Palpitations (n=31), Cardiac murmur (n=7), Atrial fibrillation (n=2) and Other (n=21). 'Other' included questions about cardiac medication (n=12), dyspnea (n=6) and syncope or dizziness complaints (n=3).

Table 4. The distribution of patients discussed during the Support Consultation per primary care practice, general practitioner and cardiologist

Primary care practice	GP (n)	Cardiologist	Discussed patients (n)	Patients per GP (n)	Total patients per cardiologist (n)
1	7	A	15	2	32
2	11	A	18	2	
3	9	B	32	4	33
4	3	B	7	2	
5	4	C	24	6	24
6	1	D	11	11	11

GP = General practitioner

Table 5. Baseline characteristics

	Total N=100	Chest pain N=39	Palpitations N=31	Cardiac murmur N=7	Atrial fibrillation N=2	Other N=21
Age (year)	**55±16**	55±9	48±18	53±22	72±5	65±15
Male, n (%)	**48**	22 (56%)	13 (42%)	1 (14%)	1 (50%)	11 (52%)
History, n (%)						
HT	**31**	12 (31%)	6 (19%)	3 (43%)	2 (100%)	8 (38%)
HC	**13**	9 (23%)	1 (3%)	0 (0%)	1 (50%)	2 (10%)
DM	**19**	9 (23%)	3 (9%)	1 (14%)	1 (50%)	5 (24%)
CVA	**4**	2 (5%)	0 (0%)	0 (0%)	0 (0%)	2 (10%)
SBP (mmHg, ±SD)	**136±18**	135±17	133±18	130±7	140	143±23
DBP (mmHg, ±SD)	**78±11**	79±11	77±9	74±9	80	78±17

HT = Hypertension; HC = Hypercholesterolemia, DM = Diabetes Mellitus; CVA = Cerebrovascular Accident; SBP = Systolic blood pressure; DBP = Diastolic blood pressure

Additional diagnostics

Table 6 shows the number of referred patients and the performed additional diagnostics tests including the corresponding costs per diagnosis. The performed additional diagnostics testing contained: Electrocardiography (n=29), chest X-ray (n=1), cardiac exercise test (n=11), holter monitoring (n=13), cardiac ultrasound (n=21), cardiac Computed Tomography (CT) scan with calcium-score (n=11).

Table 6. The number of patients per diagnosis and additional diagnostic tests per diagnosis with the corresponding costs

N=100	**Total**	Chest pain (N=39)	Palpitations (N=31)	Cardiac Murmur (N=7)	Atrial fibrillation (N=2)	Other (N=21)	Costs
ECG	**29**	12	12	2	0	3	€1.261,21
Chest X-ray	**1**	0	0	1	0	0	€38,55
Exercise test	**11**	9	1	0	0	1	€1.241,68
Holter monitor	**13**	0	11	1	0	1	€1.747,64
Cardiac ultrasound	**21**	3	4	6	2	6	€1.718,43
Cardiac CT scan + calcium score	**11**	10	0	0	0	1	€1.406,90
Total costs additional testing							€7.414,41
Referred to secondary care	**13**	6	2	3	0	2	

ECG = Electrocardiography; CT scan = Computed Tomography

Follow-up

After discussion in the Support Consultation, a total of 13 (13%) patients were referred to secondary care. (Figure 1) Of those 13 patients, 8 patients received a cardiac diagnosis. For 87 (87%) patients who were discussed in the Support Consultation referral to secondary care was not necessary. During a follow-up period of 5 months, a total of 7 patients of this group still needed to be referred to secondary care. Of these 7 patients, one patient had an acute myocardial infarction. The severity of this event warranted a further investigation into the diagnostic course for this patient. After the Support Consultation, this particular patient was referred to the cardiologist to perform a cardiac CT scan with calcium-score for cardiovascular risk assessment. Due to a low calcium-score (25), it was decided that follow-up of this patient by a cardiologist was not indicated. Primary prevention according to cardiovascular risk management seemed the best treatment.(21) Unfortunately, despite the low indicated risk, this patient had an acute myocardial infarction 6 weeks after the Support Consultation. Of the remaining 6 patients with persistent chest pain complaints, one other patient was diagnosed with a cardiac cause. During follow-up, no patients died.

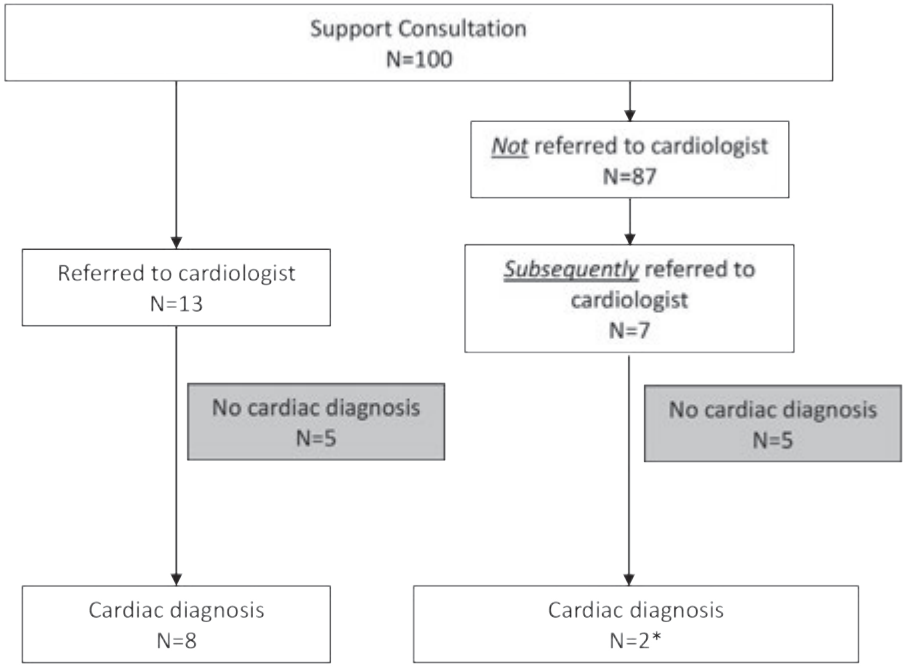

Figure 1. Flow chart of the outcome after implementation of the Support Consultation at 5 months follow-up.* Including acute myocardial Infarction (n=1)

Costs

The total program costs of the Support Consultation are shown in Table 7. The costs were broken down in program costs (€11.233), referral costs (€5.837), and additional diagnostic costs (€7.414). The total costs for the Support Consultation were €24.484, or €245 per patient. The program costs and referral costs together can be thought of as the 'net costs'. Considering just these net costs, the Support Consultation costed €17.069. If the patients would have been treated via usual care, the referral costs would have been €44.897. The program costs are not applicable, and the additional diagnostic costs for the usual care cannot be determined due to the nature of the study. Therefore, it is only possible to compare net costs, with the Support Consultation costing €27.828, or 61% less. Compared to the estimations in the business case, the number of referrals and the money spent for additional diagnostic testing was much lower, leading to much lower costs per patient than initial estimations: €245 realized vs. €408 in the business case model.

Table 7. Costs of usual care compared with the costs after implementation of the Support Consultation

		Usual care		Support Consultation	
Patients (n)		100		100	
Referred to secondary care (n)		100		13	
Program costs Support Consultation	€112	x 0		x 100	€ 11.233,00
Referral costs consultation cardiologist	€449	x 100	€ 44.897,00	x 13	€ 5.836,61
Total net program costs			€ 44.897,00		€ 17.069,00
Difference		€ 27.828			
Savings		61%			
Costs of additional diagnostic testing					€ 7.414,41
Total costs			€ 44.897,00		€ 24.484,02
Difference		€ 20.413,00			

Evaluation

Afterwards, an evaluation took place among GPs and cardiologists, in which all GPs concluded that the Support Consultation was adding value to the primary care practice. The collaboration between the GP and cardiologist was scored an 8.9 out of 10 by the GPs and 9.2 out of 10 by the cardiologists. A total of 90% of the GPs felt confident enough in maintaining the patient in primary care and in carrying out a clear policy to the patient. GPs indicated indirectly that 94% of the patients were reassured and did not feel the need for referral to the cardiologist after the Support Consultation.

DISCUSSION

The results of this study into integrated care delivery for cardiology patients suggest that the Support Consultation is a way of delivering integrated care with the potential to provide more effective healthcare. We believe that this was mainly the result of two important pillars: education in terms of clear care pathways and close collaboration and communication between primary and secondary care.

Implications

The strength of Support Consultation lied in the localization of the specialist in a primary care setting, as this defragmented healthcare delivery. We chose a setting in which the specialist did not see the patient. Consequently, the specialist solely had a coaching role and the GP remained responsible for the healthcare delivery of the patient. Instead of substituting secondary care to a primary care setting, the function of the GP as gatekeeper was strengthened by the advice of the cardiologist. This resulted in fewer referrals to secondary care, which will result in shorter waiting lists in secondary care.

The current study showed a potential net cost reduction of 61% compared with usual care where all patients would have been referred to a cardiologist. On the long term, the total cost savings are likely to be higher than the reported cost savings: the longer the high secondary care costs can be avoided, the higher the cost savings will be. As the experience of GPs will grow, it is likely that fewer patients are referred to secondary care. Due to the Dutch healthcare system, patients are generally faced with extra costs when they are referred to the hospital, or when additional testing is required. Therefore, saving costs in the interface between primary and secondary care directly benefits the patients as well.

We believe the Support Consultation setup facilitates the implementation of integrated care for the following reasons. The full integration is guaranteed by ensuring face to face communication, and the 'bundled payment' and insurer involvement lead to a joint financial incentive. The care pathways help the GP in initial decision making, and also allows the specialist to prepare for the discussion in the Support Consultation. The coaching role of secondary care keeps the aforementioned doctor-patient relationship intact. Also, the separate treatment code allows the indirect organization to enable the Support Consultation. Lastly, all involved parties were positive about the program. The setting of the current study could serve as an example to other specialists, like dermatology or orthopedics, and eventually may be a way to provide efficient healthcare for all suitable patients in Western countries with a similar primary healthcare system (e.g. UK, Denmark, Sweden).

Future perspectives

The annual number of consultations is 68.5 million in the Netherlands. (22) Just chest pain alone is in 0.7-2.7% the reason for consulting a GP, translating to at least 479.500 (0.7%) to 1.849.500 (2.7%) consultations about chest pain. (4) Increasing efficiency in care delivery by integrated care creates opportunities to make a significant impact.

Before the implementation of the Support Consultation, four different care pathways were established to streamline the process for the most common cardiac complaints seen in primary care practices. A significant amount of patients (21%) treated in the Support Consultation were not treated according to a predefined care pathway. A possible explanation could be that the complaints did not fit in the established pathways. In the future, it could be worthwhile to investigate the possibilities to establish extra care pathways, for example a heart failure pathway, and other frequently observed themes.

To extend the Support Consultation we plan to assign a cardiologist for one year to a primary care practice. The learning curve is expected to reach a plateau after one year, with the GPs being experienced enough. Eventually, the setting of the Support Consultation can change into a virtual setting. To maintain the gained knowledge of the GPs and to reduce referrals in the long term, recurrent educational sessions by the cardiologist should be considered. A pro-active approach is needed to ensure the gained knowledge is not lost.

Limitations

Several limitations are acknowledged. Because this is an observational study patients were not randomized to an intervention group or control group. Therefore, the outcomes of this study should be interpreted as an indication of what implementation of the Support Consultation could achieve in effective healthcare delivery. In addition, evaluating the follow-up of the outcome of the patients of the Support Consultation with usual care is difficult as well. To provide an indication of a control group, only relevant patients with a cardiac complaint who would be referred to cardiologists in usual care were discussed during the Support Consultation. We are aware, that it is possible the threshold to discuss patients in the Support Consultation is lower than the threshold to refer patients to a cardiologist. This could result in an overestimation of the effectiveness in preventing a referral and in total cost reduction of the Support Consultation. Nevertheless, this study aims to focus on the possibilities of implementation of collaborated healthcare delivery between a cardiologist and GP in a real-life situation. By giving an indication in cost-effectiveness, it is possible that an underestimation of the total expenditures is noted. On the other hand, even if twice as many patients would have been discussed in the Support Consultation as compared to usual care, the net program cost of the Support Consultation would still be lower (2x€17.069 compared to €44.897). Lastly, the learning effect of the Support

Consultation for the GPs and cardiologists alike was outside the scope of the current study. Further investigation into this learning effect is recommended in future studies.

Conclusion

The Support Consultation has the ability to provide more effective healthcare with potential in net cost reduction of 61%. Based on the realized net cost reduction and the positive responses of all involved parties we believe the principles of the Support Consultation (insurer involvement, empowering primary care, integrated care), can be used for all primary- to secondary care interfaces.

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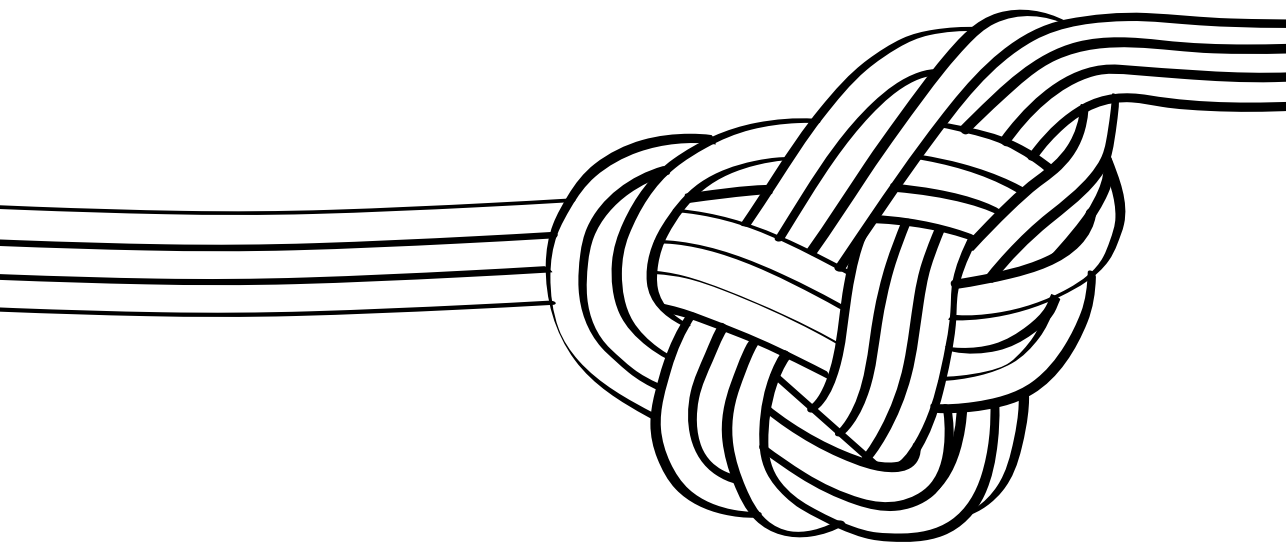

CHAPTER 3

INTEGRATED CARE FOR HEART FAILURE PATIENTS: WHO TO REFER BACK TO THE GENERAL PRACTITIONER? – ACCORDING TO THE "TRANSMURAL CARE OF HF PATIENTS MODEL (LTA)" AND ESC-GUIDELINES

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Submitted

ABSTRACT

Objective: The number of patients with heart failure (HF) and corresponding burden of the health care system will increase significantly. The vertically integrated program, "Transmural care of HF Patients" (LTA) was initiated to manage the increasing prevalence of HF patients in primary and secondary care and stimulate integrated care. It is unknown how many HF patients are eligible for back-referral to GPs, which is important information for the management of integrated care. This study aims to evaluate patients for whom HF care can be referred from the cardiologist to the GP.

Design and methods: All patients registered with chronic HF in two different hospitals were included, subsequently 200 patients were randomly evaluated**.** The following patients were considered eligible for referral to the GP: 1/Stable HF patients with reduced left ventricular ejection fraction (LVEF), 2/Stable HF patients with a recovered LVEF and 3/Stable HF patients with a preserved LVEF.

Results: Of the 200 patients, 17% was considered eligible for referral to the GP. This group consisted of 5% patients with a reduced LVEF, 10.5% patients with recovered LVEF, and 1.5% patients with a preserved LVEF. Main indicators for HF care by cardiologist were: active cardiac disease other than HF (39.5%), recent admission for HF (29.5%) or a recent adjustment in HF medication (7.5%) .

Conclusion: Based on the integrated care program of the LTA and the ESC-guidelines, opportunities for improvement of long term HF care are indicated. These results can be used to keep healthcare for HF patients accessible in the future.

INTRODUCTION

It is expected that in developed countries the prevalence of HF will rise to more than 10%.(1) Due to the ageing population, and improved medical treatment, the number of patients with HF and corresponding expenditures will increase significantly.(2-5) The increasing burden on the healthcare system is an important topic on the political agenda: a minimum level of financial growth for primary and secondary care is allowed in the forthcoming years.(6, 7)

This emphasizes the need to deliver HF care efficiently. Several trials have demonstrated that effective coordination of HF care improves clinical outcomes.(8, 9) Most of these studies focus on the referral of an HF patient from a general practitioner (GP) to cardiologist, but not the reverse. To provide the right care for the right patient at the right time and to maintain healthcare accessible in the future, referral back to the GP is equally important as timely referral to a cardiologist.(10, 11) Also, the ESC-HF Association Standards states that the follow-up and monitoring of chronic HF patients is a neglected area of HF care with only a small amount of literature to guide medical professionals.(12) In response to the above-mentioned trend, the Netherlands Society of Cardiology (Nederlandse vereniging voor Cardiologie) supports national and regional vertically integrated cardiac care programs in the Netherlands.(13) A regional integrated care program is the "Transmural Care of Heart Failure Patients Model " (LTA), initiated by cardiologists, GPs, specialised HF nurses, patients and health insurers. This model, based upon the European Society of Cardiology (ESC) guidelines, aims to optimize the organisation of HF care among GPs and cardiologists and provide integrated care. (1, 14, 15) It provides directions for the transition to a long-term management model of stable HF by GPs. However, it is unknown how many and which HF patients are eligible for back-referral to GPs, which is important information for the delivery of integrated care.

So, the aim of the present study was to evaluate the potential percentage and characteristics of patients in whom HF care can be referred back from a cardiologist to a GP based on the implementation of the LTA and in line with the latest ESC guidelines.

METHODS

Patients

A cross-sectional study was performed in two centers. Center A is a university medical center, where various outpatient clinics are available for HF patients. It provides 'structured tertiary care' for HF patients who are referred by a cardiologist to assess additional tertiary treatment options.(16) Furthermore, it provides 'standard HF care' in an outpatient setting by general cardiologists. Center B is a large regional teaching hospital with a dedicated HF outpatient clinic supervised by HF cardiologists.

In the Netherlands, all treatments and diagnoses supplied by health services are coded according to a national financial coding system. Patients with chronic HF were identified with the diagnosis code '021.302', corresponding with ICD-10 I50, in the year 2015 (when the LTA was implemented). From each center, a random sample of 100 patients was drawn. Data were collected from the departmental cardiology information system (EPD Vision; Leiden University Medical Center, The Netherlands, and Xcare; Nexus Nederland).(17) The following clinical characteristics were collected and analysed: age, gender, HF etiology, comorbidities, cardiac history, clinical characteristics, and laboratory results.

Transthoracic echocardiographic images of the patients were digitally stored in cine-loop format and analysed using commercially available software (GE Vingmed Ultrasound AS, Horten, Norway; EchoPAC version 112.0.1). The Simpson's biplane method was used for assessment of the left ventricular ejection fraction (LVEF) from the apical 2- and 4-chamber views.(18) The present study was approved by the Ethical board of the University of Leiden, written informed consent was waived for this retrospective data analysis.

Definitions

The following definitions were used to determine whether patients were eligible for referral to a GP or if treatment by a cardiologist was deemed necessary.(1, 14) This was based on the LTA and is in line with the 2016 ESC guidelines.

The following patients were eligible for back referral to GP:

- Stable HF, no active cardiac disease, optimal (medical) treatment, reduced LVEF. In particular an LVEF of 40-50% according to the latest ESC guidelines.
- Stable HF, no active cardiac disease, recovered LVEF (>50%)
- Stable HF, no active cardiac disease, optimal (medical) treatment, preserved LVEF
- HF, palliative setting

For the following patients treatment by a cardiologist is recommended:

- Unstable HF-related symptoms
- Stable HF, active cardiac disease, LVEF<50%
- Stable HF, active cardiac disease, LVEF>50%
- Stable HF, no active cardiac disease, LVEF<40% or comorbidity

'Unstable HF' was defined as a hospitalization within the last 12 months either due to decompensated HF or a cardiac intervention or a significant change in HF medication (Angiotensin-Converting-Enzyme inhibitor, Angiotensin-II Receptor Blocker, BetaBlocker or a MineralCorticoid Antagonist) in the last 6 months. An active cardiac disease was defined as: valvular disease, pulmonary hypertension, congenital heart defects, inherited cardiomyopathy, an invasive treatment for arrhythmias within the last 12 months or implantation of a cardiac device (this included a pacemaker (PM), an implantable cardioverter-defibrillator (ICD), a cardiac resynchronization therapy device (CRT-P or CRT-D). Comorbidities were defined according to the LTA, including but not limited to severe renal or pulmonary disease.

Statistical analysis

Statistical analysis was performed using the Statistical Package for Social Science (SPSS) software version 23.0 (IBM, Armonk, NY, USA). All continuous data were normally distributed. Continuous data are reported as mean ±SD or SEM where appropriate, and categorical data as frequencies and percentages. Differences in baseline and clinical characteristics between patients were assessed using the Student *t*-test and Chi-square test. A p-value <0.05 was considered statistically significant, and all tests were 2-sided.

RESULTS

Baseline characteristics

A total of 1923 patients were identified, of which a random sample of 200 unique patients (100 patients in each center) was drawn for the analyses of medical files. Baseline characteristics are summarized in Table 1. Patients from Center A were predominantly male, significantly younger (66±15 years vs. Center B; 78±11 years, P<0.005) and had a lower LVEF compared with patients in center B (Center A; 38±11% vs. Center B; 44±14%, P<0.005). In both centers, almost half of the patients (Center A; n=45 (45%) vs. Center B; n=43 (43%)) had an ischemic etiology of their HF. More patients in Center B had atrial fibrillation as comorbidity (Center A; n=42 (42%) vs. Center B; n=58 (58%), P=0.024). There was a significant difference in implanted devices between the two centers. More patients in Center A had an ICD (Center A; n=20 (20%) vs. Center B; n=5 (5%), P<0.005) or a CRT-D, (Center A; n=22 (22%) vs. Center B; n=9 (9%), P <0.011). Patients in Center A had a better functional capacity according to the NYHA

classification (P<0.005) and had a better renal function (P=0.057). The prescribed HF medication was similar among both centers.

Table 1. Baseline characteristics

	Total (n=200)	Center A (n = 100)	Center B (n = 100)	P value*
Age, years	72 ±15	66 ±15	78 ±11	<0.005
Gender, n (%)				0.046
Male	114 (57%)	64 (64%)	50 (50%)	
Heart failure aetiology, n (%)				
Ischemic cardiomyopathy	88 (44%)	45 (45%)	43 (43%)	0.766
Non-ischemic cardiomyopathy	110 (55%)	55 (55%)	55 (55%)	1.000
Not established	2 (1%)	0 (0%)	2 (2%)	<0.005
Cardiac history, n (%)				
Myocardial infarction	55 (28%)	30 (30%)	25 (25%)	0.428
Revascularisation(PCI or CABG)	74 (37%)	39 (39%)	35 (35%)	0.558
Atrial fibrillation	100 (50%)	42 (42%)	58 (58%)	0.024
Surgery for valvular disease	27 (14%)	15 (15%)	12 (12%)	0.535
Device implantation				<0.005
PM	26 (13%)	9 (9%)	17 (17%)	0.093
ICD	25 (13%)	20 (20%)	5 (5%)	<0.005
CRT-P	1 (1%)	1 (1%)	0 (0%)	0.316
CRT-D	31 (16%)	22 (22%)	9 (9%)	0.011
LVEF (%)	41 ±13	38 ±11	44 ±14	<0.005
NYHA functional class, n				
I	67 (34%)	45 (45%)	22 (22%)	<0.005
II	90 (45%)	43 (43%)	47 (47%)	0.570
III/IV	41 (21%)	11 (11%)	30 (30%)	<0.005
N/A	2 (1%)	1 (1%)	1 (1%)	1.000
Systolic blood pressure (mmHg)	124 ±21	122 ±20	126 ±22	0.310
Diastolic blood pressure (mmHg)	72 ±10	74 ±10	73 ±11	0.448
ECG				
QRS duration (ms)	128 ±36	134 ±36	122 ±35	0.306
Heart rate (bpm)	72 ±14	71 ±14	74 ±13	0.235
Co-morbidity				
Hypertension	84 (42%)	41 (41%)	43 (43%)	0.774
Diabetes	42 (21%)	17 (17%)	25 (25%)	0.165
COPD	29 (15%)	11 (11%)	18 (18%)	0.160
PHT	37 (19%)	26 (26%)	11 (11%)	0.006

Table 1. Continued

	Total (n=200)	Center A (n = 100)	Center B (n = 100)	P value*
Laboratory results				
Haemoglobin (mmol/L)	8 ±6	8 ±3	7 ±3	0.800
Creatinin (umol/L)	110 ±54	99 ±52	121 ±53	0.057
Heart failure medication (n, %)				
ACEi/ARB	146 (73%)	74 (74%)	72 (72%)	0.750
Betablocker	163 (82%)	79 (79%)	84 (84%)	0.363
MRA	63 (32%)	28 (28%)	35 (35%)	0.287
Diuretics	133 (67%)	63 (63%)	70 (70%)	0.294

Continuous data are presented as mean (±SD), categorical data are presented as numbers (%). *P value between Center A and Center B.

ICD = implantable cardioverter defibrillator; PM = Pacemaker; CRT-D = Cardiac resynchronization therapy defibrillator; CRT-P = Cardiac Resynchronization Therapy Pacemaker; NYHA = New York Heart Association; LVEF = Left Ventricular Ejection Fraction; ECG = electrocardiography; COPD = chronic obstructive pulmonary disease; PHT = Pulmonary Hypertension; ACEi = angiotensin-converting-enzyme inhibitor; ARB = angiotensin II receptor blockers; MRA = Mineralocorticoid receptor antagonist

Potential substitution

According to the LTA criteria, a substantial amount of patients (17%) was eligible for follow-up by GP (Figure 1). Of all patients, 5% had stable HF with a reduced LVEF; 10.5% of patients had stable HF with a recovered LVEF and 1.5% of patients had HF with a preserved LVEF. None of the analysed patients were in a palliative setting. No significant differences were observed in the indications for back referral to the GP between the two centers. (Table 2)

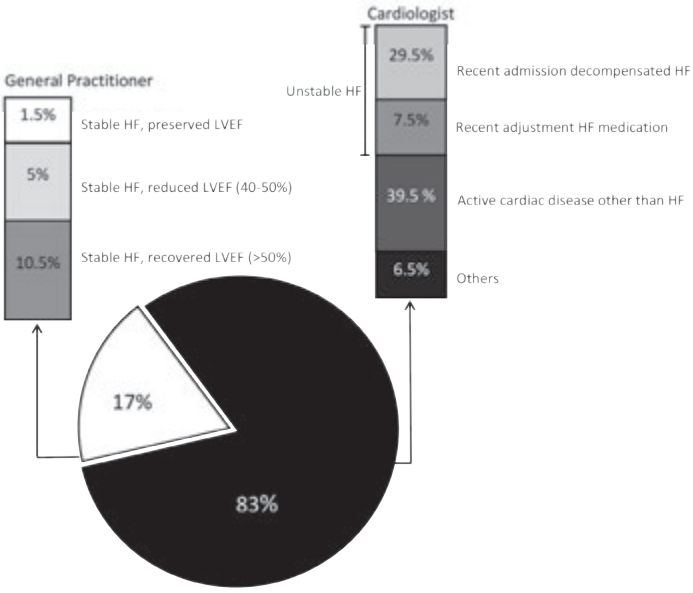

Figure 1. Overview of patients who were eligible for referral to the general practitioner (17%) and for who treatment by cardiologist was justified (83%) based on the "Transmural Care of Heart Failure Patients Model " and in combination with the latest ESC guidelines.
'Others' includes a comorbidity or a left ventricular ejection fraction <40%. HF = Heart Failure; LVEF = Left Ventricular Ejection Fraction

Table 2. Subdivision of heart failure patients based on recommendations of the LTA

	Total (n=200)	Center A (n = 100)	Center B (n = 100)	P-value
Potential substitution to GP				***0.559***
1. Stable heart failure, no active CD, reduced LVEF (40-50%)	10 (5.0%)	6	4	0.516
2. Stable heart failure, no active CD, recovered LVEF (>50%)	21 (10.5%)	9	12	0.489
3. Stable heart failure, no active CD, preserved LVEF	3 (1.5%)	2	1	0.561
Indications follow-up at cardiologist				***0.068***
4. Unstable heart failure	74 (37.0%)	30	44	0.040
5. Stable heart failure, active CD, LVEF <50%	53 (26.5%)	34	19	0.016
6. Stable heart failure, active CD, LVEF >50%	26 (13.0%)	12	14	0.674
7. Stable heart failure, no active CD, LVEF <40% or a comorbidity	13 (6.5%)	7	6	0.774

No significant differences were observed. Unstable heart failure was the main indication for follow-up at secondary care in Center B, whereas an active cardiac device was the main indication in Center A.
GP = General Practitioner; CD = Cardiac Disease; LVEF = Left Ventricular ejection fraction

Follow-up by cardiologist

A total of 83% of the patients had an indication for follow-up by a cardiologist (Figure 1). The majority of these patients had unstable HF (37%) or the presence of active cardiac disease (39.5%). In 6.5% of the patients, the indication for follow-up by a cardiologist was an LVEF <40% or comorbidity. Comorbidities included COPD, renal failure, Duchenne's disease, post-radiation therapy, or permanent atrial fibrillation.

Figure 2 summarizes the indications for follow-up by cardiologist and details the reason for 'unstable HF' and the various cardiac diseases, in the different centers. In both centers, the total number of patients with an indication for follow-up by a cardiologist was equal (Center A and Center B, n=83 (83%)). However, some indications for follow-up by a cardiologist were different among the centers. (Table 2.) First, the amount of patients with unstable HF was lower in Center A than in Center B (Center A; n=30 (30%) vs. Center B; n=44 (44%), P=0.040) and second, an active cardiac disease with a LVEF<50% was more often present in Center A than in Center B (A; n=34 (34%) vs. B; n=19 (19%) , P=0.016).

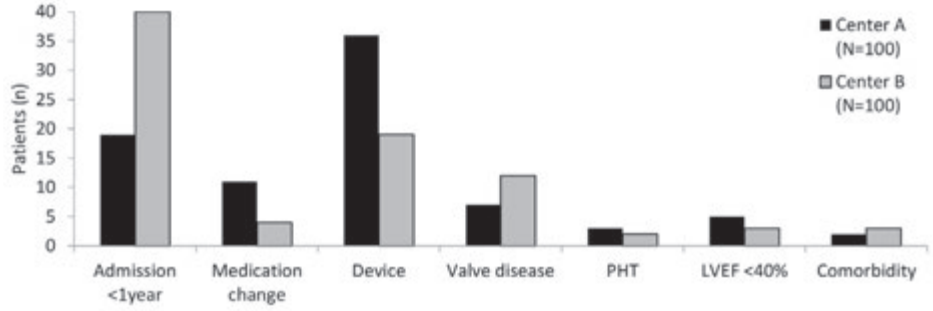

Figure 2. The amount of patients and main indication for follow-up at cardiologist in Center A (N = 83) and in Center B (N = 83) *LVEF = Left ventricular Ejection Fraction.*

DISCUSSION

The key finding of this study was that, based on an integrated care guideline (LTA and the ESC guidelines), 17% of HF patients seen in either a regional hospital or tertiary care center can be referred back to the general practitioner.

Management of HF

The potential to refer 17% of HF patients back to the GP is an important opportunity to further optimize HF integrated care and to deal with the increasing number of HF patients referred to the hospital. Our findings are supported by previous studies. The Northstar-study, a multi-center randomized clinical controlled trial, included clinically stable HF patients in an outpatient setting and allocated them equally to follow-up in the HF clinic or in primary care. It appeared that clinically stable HF patients, on optimal medical therapy can be safely managed in primary care with no additional benefit from long-term follow-up in a specialized HF clinic.(19) In the present study, patients who were hospitalized either due to HF or a cardiac intervention within the past 12 months or who had a significant change in HF medication within the past 6 months were considered 'unstable'. In the Northstar-study patients had at baseline a mean LVEF <35% and approximately 43% of the patients were admitted within the past 12 months. As patients in the present study had an LVEF >35% at baseline and only 29,5% were admitted within the past 12 months, it might imply that the current patient cohort is more stable, for which it might be even safer to refer the patients back to primary care.

Similar results were found in the COACH-2-study, a multi-center randomized controlled trial, in which 189 clinically stable HF patients were randomized and equally allocated to primary care or a specialized HF clinic. (20) Baseline characteristics of this study population were comparable to our population. The study showed that long-term follow in a specialized HF clinic was not superior to follow-up in primary care. Furthermore, the importance of integrated care in providing HF care during the unpredictable clinical course of HF patients was underlined. This aspect of HF care is also emphasized in the LTA, as the LTA strengthens the cooperation between care providers thereby creating a continuum of care.

Also, the study of de la Porte and co-workers confirmed the incremental value of collaboration between cardiologist and GP.(21) However, they observed a reduction in HF readmissions and mortality by an intensified HF management program, compared with usual care. A possible explanation for this finding can be the functional status of the patients. All patients were in NYHA class III or IV, whereas most (45%) of the patients in the current study were functioning in NYHA class II. This suggests that patients with a worse condition benefit more from these intensified HF programs.

Integrated care model

Worldwide healthcare expenditures are increasing rapidly. During the last decades, strategies to maintain access and sustainability of the healthcare systems and controlling rising healthcare expenditures have become important subjects on every governmental agenda.(6, 22) One strategy is to reduce fragmentation in healthcare delivery and increase collaboration and coordination among healthcare professionals. This can be established by working with an integrated care system. Integrated care systems can be understood as an organizing principle for coordinated care delivery where the needs of the patient are the central focus.(23) A way to describe integrated care is in horizontal integration and vertical integration. Horizontal integration happens when health care providers at the same stage of the health system collaborate. (24) Vertically integrated care is defined as the integration of care across different healthcare facilities at different stages in the process of delivering care. (25, 26) Multiple studies show the benefits of vertical integration in healthcare delivery, such as effective clinical care, a better communication process and increased collaboration.(27-30) It appears that successful integrated care programs strengthen the role of primary care. (31) The LTA accommodates the above as it provides clear care pathways for long-term integrated HF management between HF nurses, cardiologists and GPs. With the expected increase of HF prevalence, it is equally important to maintain access in hospitals for the HF patients who really need specialist care. The LTA provides guidance and more awareness to refer stable HF patients back from the cardiologist to GP. As is stated in the ESC-HF Association Standards, HF management should be a network of care pathways for the patient. (12, 19, 21, 32) With the implementation of the LTA, a network with close collaboration and coordination between healthcare providers is established and a continuum of HF care guaranteed.

Study Limitations

Several limitations should be acknowledged. The baseline characteristics were different among the two centers, one could expect this as center A is a tertiary care center and center B a secondary care center. However, only patients who received 'standard' HF care were randomly included. As a result, the potential effect of the LTA on a "real-world HF population" was analysed. What is also interesting is that despite the different baseline characteristics, the reasons for referral were not significantly different. It could either be that this is due to the small number of patients or it is a strong point; the results are both applicable on secondary as tertiary care centers . Another limitation is that follow-up data are not available yet. It will be interesting to study if the implementation of the LTA creates the intended awareness in HF care. Therefore a prospective study is needed to evaluate the true added value of the LTA regarding the referral of HF patients from cardiologist to GP.

Conclusion

This study demonstrates that based on the integrated care program in the LTA and the ESC guidelines, 17% of the HF patients currently treated by a cardiologist can be referred to the GP. The LTA creates awareness and indications in providing efficient HF care in the different phases of patients' disease. By creating a network of integrated care, high quality- and accessible HF care can be sustained in the near future.

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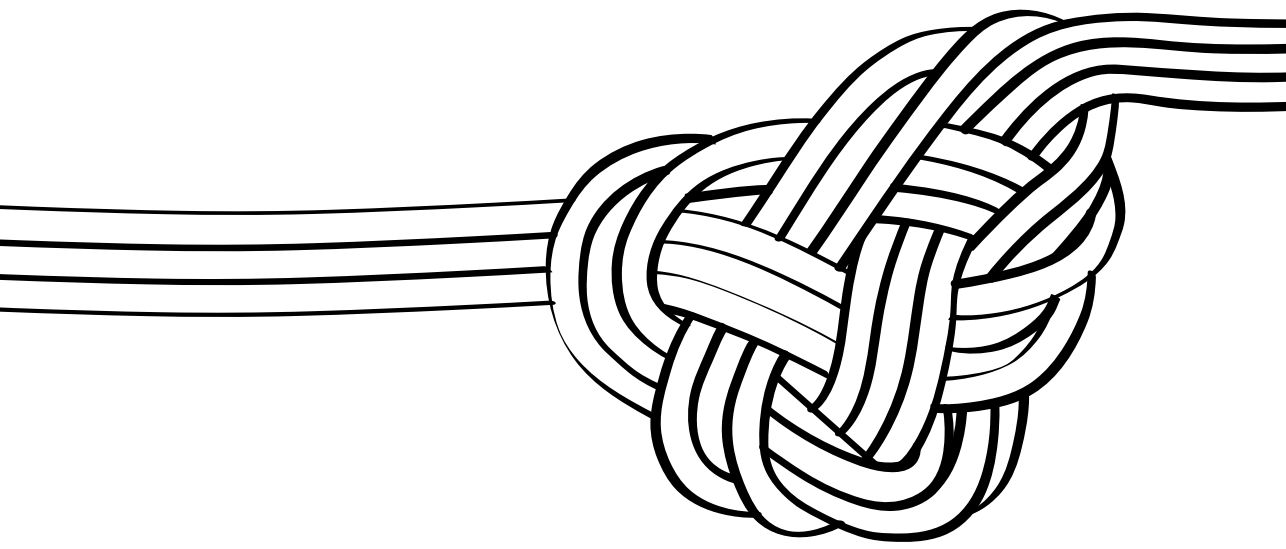

CHAPTER 4

UTILIZATION OF DIAGNOSTIC RESOURCES AND COSTS IN PATIENTS WITH SUSPECTED CARDIAC CHEST PAIN

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ABSTRACT

Objective: Non-acute chest pain is a common complaint and can be caused by various conditions. With the rising healthcare expenditures of today, it is necessary to use our healthcare resources effectively. This study aims to give insight into the diagnostic effort and costs for patients with non-acute chest pain.

Design and methods: Financial data of patients without a cardiac history from 4 hospitals (January 2012-October 2018), who were registered with the national diagnostic code 'No cardiac pathology' (ICD-10 Z13.6), 'Chest wall syndrome' (ICD-10 R07.4) or 'stable angina pectoris' (ICD-10 I20.9) were extracted.

Results: In total, 74.091 patients were included for analysis and divided into the following final diagnosis groups: No cardiac pathology: N= 19.688 (age 53±18), 46% male), Chest wall syndrome: N= 40.858 (age 56±15), 45% male), and stable angina pectoris: N= 13.545 (age 67±11), 61% male). A total of approximately €142,7 million was spent during diagnostic work-up. The total expenditure during diagnostic effort was €1.97, €8.13, and €10.7 million respectively for no cardiac pathology, chest wall syndrome, and stable AP per year. After 8 years follow up ≥95% of the patients diagnosed with no cardiac pathology or chest wall syndrome had an (cardiac) ischemic free survival.

Conclusion: The diagnostic expenditure and clinical effort to ascertain non-cardiac chest pain is high. We should define what we as society find acceptable as 'assurance costs' with an increasing pressure on the healthcare system and costs.

INTRODUCTION

Chest pain may be a symptom of ischemic heart disease.(1) Every year 0,7-2,7% of the general population consult the general practitioner for having chest pain.(2-5) Multiple underlying causes have been described varying from a musculoskeletal origin, gastro-oesophageal reflux disease to potential life-threatening events such as coronary artery disease (CAD). Fortunately, only a minority of patients have chest pain symptoms due to ischemic heart disease.(6)

Because of limited diagnostic resources in a primary care setting, patients suspected of a cardiac cause of chest pain are often referred to a cardiologist for additional diagnostic testing. However, of the referred patients with chest pain, no cardiac cause has been found in 55% to 90%.(5, 7) As the health expenditures are increasing, so does the need to spend the available resources sparingly.(8) Ideally, healthcare providers aim to offer the highest quality of care and use the minimal required additional diagnostic procedures to make the correct diagnosis. On the other hand, in the diagnostic trajectory of a patient with chest pain, a wide variety of diagnostic tests are available and it appears that besides the use of guidelines, the choice of diagnostics depends on the opinion of the consultant doctor and the location of the consultation.(9-11)

Numerous studies have investigated the final diagnosis of patients with chest pain in primary care.(2, 3, 5, 12) However, to our knowledge, studies examining the healthcare trajectory of patients with non-acute, or chronic, chest pain in a hospital setting are scarce. A recent study verified that financial databases are a valid source of information in the evaluation of a patient's care chain.(13) Given the high prevalence of chest pain and high healthcare expenditures on CAD, investigating this care chain is of relevance for the everyday cardiology practice. The current study aims to gain insight into the amount of referred patients, utilization of diagnostic resources and costs, and clinical outcome in patients with non-acute chest pain in a hospital setting using financial data.

METHODS

Patient population and data sources

All Dutch citizens are covered by a basic mandatory insurance. Treatments and diagnoses supplied by health services are coded according to a national financial coding system (DOT: Diagnose Behandeling Combinatie (DBC) Op weg naar Transparantie) combined with the World Health Organization (WHO) International Classification of Diseases (ICD). Declaration data from unique patients of 18 years and older with a new onset of suspected cardiac chest pain seen in the outpatient clinic were extracted from the financial database of Performation-HOT*flo* from January 2012 until October 2018.

Performation-HOT*flo* (Bilthoven, the Netherlands) is a healthcare consultancy company that provides patient-level costing and benchmarking products for different healthcare services across Europe.(14) Hospital selection was based on the region of South-Holland (Zuid-Holland) and the availability of cost-price information by Performation-HOT*flo*. The relevant hospitals were requested to give consent for using their data for this study. Four hospitals, of which one academic hospital and three regional hospitals, gave consent.

Suspected cardiac chest pain was defined by the following three diagnosis codes 'No cardiac pathology' (DOT code 0320.101 similar to ICD-10 Z13.6), 'Chest wall syndrome' (DOT code 0320.201 similar to ICD-10 R07.4) or 'stable angina pectoris' (DOT code 0320.202 similar to ICD-10 I20.9). The diagnosis code was recorded after the first diagnosis. Subsequently, patients with an ischemic cardiac history or with another cardiac history were excluded from the analysis. The remaining patients were divided into three different groups based on diagnosis code:

- Group I: No cardiac pathology. Also defined as chest pain of no cardiac origin.
- Group II: Chest wall syndrome. Also defined as chest pain of no cardiac origin.
- Group III: Stable Angina Pectoris. Also defined as cardiac chest pain.

In a combination of two or more previously mentioned diagnosis codes within the same patient, the code Stable Angina Pectoris had priority above Chest wall syndrome and No Cardiac Pathology. The code Chest wall syndrome had priority above No Cardiac Pathology.

Activities

The following characteristics were retrieved after first diagnosis registration: age, gender and all healthcare utilization with the associated admission. To gain more insight into the care process and expenditures, the used resources were divided into the following categories: 'Cardiac Invasive Diagnostics or Treatment', 'Cardiac non-

invasive diagnostics', 'Emergency Department', 'Inpatient care', 'Outpatient care' and 'Other'. Other included i.e. the use of materials and administrative costs. (Supplemental Table 1) .

Cost analysis

By using Time-Driven Activity-Based Costing (TD-ABD) methodology costs were calculated at patient level resource utilization.(15) TD-ABD is a micro-costing method, and calculates two parameters per activity: the costs per time unit to perform each activity and the overall time units spent performing the activity. As cost price calculations are standardized by Performation-HOT*flo*, it was possible to compare participating hospitals. The database contained information about the period of treatment, the differently registered diagnostics and the registered interventions. All available data from January 2012 until October 2018 were obtained and the most recent cost price model was used for calculations. Therefore differences in the cost price calculations due to inflation were avoided.

Statistical analyses

Continuous data are presented as mean and 95% CI when normally distributed. Categorical data are presented as numbers and percentages. A chi-square test was used for comparing the baseline characteristics of the different patient groups. P-values <0.05 were considered statistically significant. The duration of follow-up was calculated from the date when the first diagnosis code was registered, the inclusion of the patient until the last date activity for one of the above-mentioned diagnosis or resource code was registered. The time to an ischemic event after the inclusion of a patient is presented in a Kaplan Meier plot. An ischemic event was based on diagnosis codes and resource use after the first registration:

- Unstable angina pectoris or Infarction: patients who developed unstable angina pectoris (DOT code 0320.11.203 similar to ICD-10 I20.0), a Non-ST-Segment Elevation Myocardial Infarction (NSTEMI) (DOT code 0320.11.205 similar to ICD-10 I21.4), a ST-Segment Elevation Myocardial Infarction (STEMI) (DOT code 0320.11.204 similar to ICD-10 I21.9) or who were followed up after acute coronary syndrome (DOT code 0320.11.801 similar to ICD-10 Z86.7).

- Percutaneous Coronary Intervention (PCI) or Coronary artery bypass grafting (CABG): patient who underwent a PTCA or a CABG (DOT code 0320.11.802 or 0320.11.810 similar to ICD-10 Z09.0) and the cardiothoracic declaration codes from the Performation Hot*flo* database (Cardiothoracic (CTC) codes for a CABG coded as 2320, 2400, 2415, 2425 or 2470 similar to ICD-10-PCS codes based on procedure).

Statistical analyses were performed using SPSS (version 23.0, IBM SPSS Statistics).

Ethical considerations

Performation-Hot*flo* is ISO 27001 and NEN 7510 certified, meaning that all patient data are used in strict confidence. All members of the research team signed a statement of confidentiality for processing the data. The participating hospitals formally consented to participate. The local medical ethics committee of the Leiden University Medical Center, in its capacity as the coordinating center of this retrospective study, approved the study design and waived the need for individual patient informed consent.

RESULTS

Population

In total, 90.436 unique patients in four hospitals between January 2012 until October 2018 were included. Patients with a history of ischemic cardiac disease (N=7.805, 9%) or another cardiac history (N=8.540, 9%) were excluded from analysis. Subsequently, a total of 74.091 (mean age 57±16, 48% men) with no cardiac history and new onset of cardiac chest pain remained. Of these patients, 19.688 (27%) had no cardiac pathology, 40.858 (55%) had chest wall syndrome and 13.545 (18%) had stable angina pectoris as the final diagnosis (Fig. 1). The stable AP patients (age 67±11, men 61%) were older and consisted of more men in comparison to both other patient groups (non-cardiac chest pain, no cardiac pathology (age 53±18, 46% men) and chest wall syndrome (age 56±15, 45% men). (Table 1)

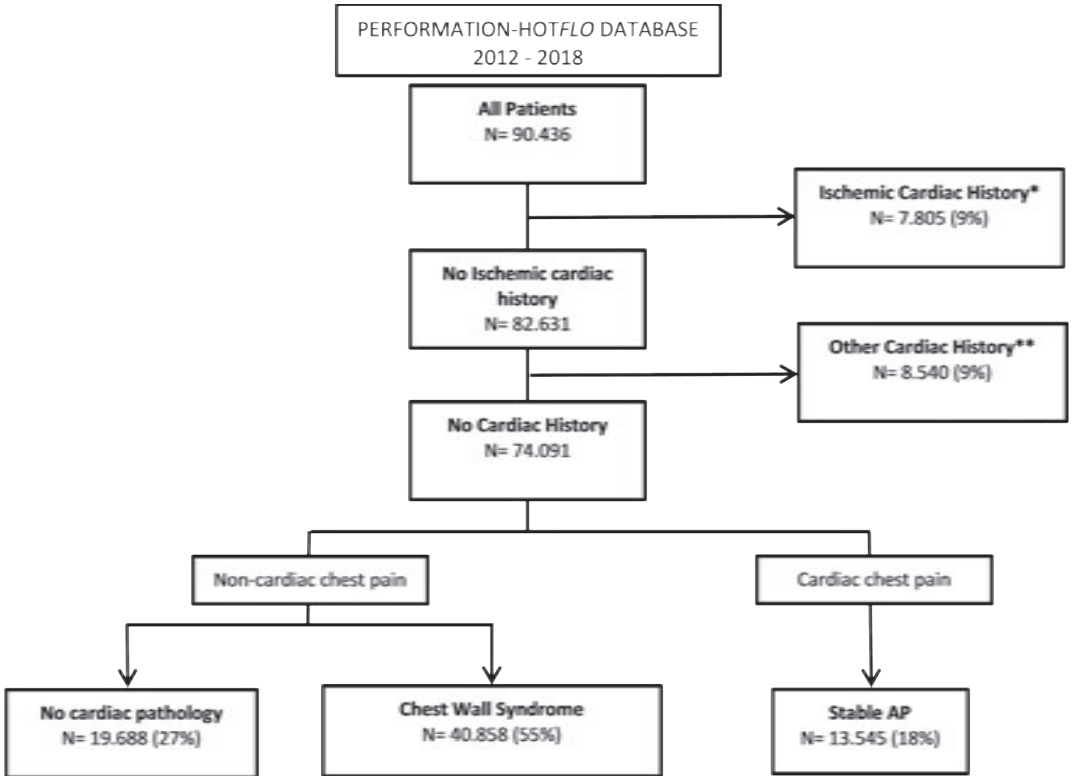

Figure 1. Flow chart of included patients. Patients were subdivided into groups, based on the different diagnostic codes: No cardiac pathology' (coded as 0320.101 similar to ICD-10 Z13.6), Idiopathic thoracic complaints (coded as 0320.201 similar to ICD-10 R07.4) and stable angina pectoris (AP) (coded as 0320.202 similar ICD-10 I20.9).
*Ischemic Cardiac History: see Table S1.
**Other Cardiac History: see Table S2

Table 1. Baseline characteristics

	No Cardiac Pathology N = 19.688 (27%)		Chest Wall Syndrome N = 40.858 (55%)		Stable AP N = 13.545 (18%)		Total N = 74.092		P-value
Age (mean±SD)	53	±18	56	±15	67	±11	57	±16	P<0.001
Gender (n, % male)	8.971	46%	18.477	45%	8.203	61%	35.651	48%	P<0.001

Stable AP = stable angina pectoris

Activities and costs

A total of €142.702.110 was spent during the diagnostic work-up period. The group with no cardiac pathology covered 9% (€13.485.941) of the total costs, the group with chest wall syndrome 39% (€55.557.410). The majority of the expenditures were covered by the group with stable AP (52%, €73.658.759). Fig. 2a shows the overall costs per year per diagnosis: €1.973.552 in the no cardiac pathology group, €8.130.352 chest wall syndrome group and €10.779.330 in the stable AP group. This corresponds with a mean expenditure of €685, €1.360 and € 5.483 per patient with no cardiac pathology, chest wall syndrome and stable AP, respectively. (Fig. 2b) As is shown in Table 2, most money was spent on 'Inpatient Care'(€ 50.428.212, 35%) followed by 'Cardiac non-invasive diagnostics'(€ 39.924.124, 28%), 'Cardiac invasive diagnostics or treatment'(€ 28.627656, 20%), 'Outpatient Care' (€ 13.535.585, 10%), 'Emergency Department' (€ 8.275.256, 6% and 'Other' €1.911.276, 1%). The no cardiac pathology group and the chest wall syndrome group spent more money in the Emergency department, compared with the stable AP group. A possible explanation could be that because of more uncertainty and concern these patients are referred to the emergency department to rule out an acute coronary syndrome. Table 3 shows the percentage of patients per group who underwent non-invasive diagnostic tests. In all groups, almost every patient underwent a non-invasive diagnostic test. The most applied non-invasive diagnostic test was a ECG in no cardiac pathology, chest wall syndrome, and stable AP, 80%, 87%, 79%, respectively. Followed by laboratory tests in the group with chest wall syndrome (76%) and stable AP (76%) and cardiac ultrasound in the group with no cardiac pathology (54%). The proportion of applied diagnostics in the groups with chest wall syndrome and stable AP were comparable with each other.

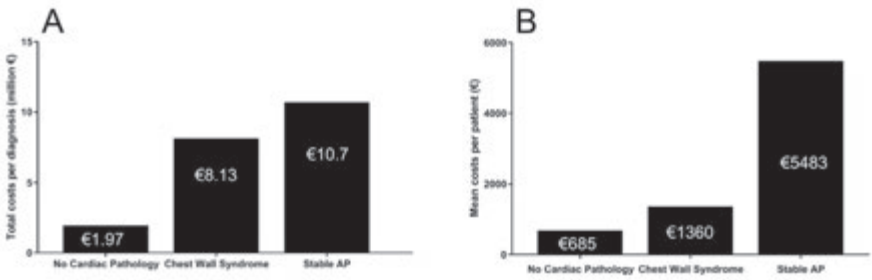

Figure 2. A total of €142.702.110 (2011-2018) was spent between January 2012 until October 2018. Panel A shows the total costs in the group with no cardiac pathology (N=19.688), chest wall syndrome (N=40.858) and stable AP (13.545) in millions (€) per year. Panel B shows the mean costs (€) per patient per group. Stable AP: Stable angina pectoris.

Follow up

Fig. 3 shows a Kaplan Meier plot of the patient with an ischemic free survival. After one year 99% of the patient in the group with no cardiac pathology and chest wall syndrome, had an ischemic free survival. The one-year ischemic free survival of the group with stable AP was 77%. The percentage of patients with an ischemic free survival at 5 and 8 years follow-up included 99% and 98% in the group with no cardiac pathology, respectively. In the group with chest wall syndrome, the ischemic free survival was 96% at 5 years follow-up and 95% at 8 years follow-up. In the group with stable AP the ischemic free survival was lower, with 66% at 5 years and 63% at 8 years. There seemed to be a slightly lower chance of developing cardiac symptoms for the 'No cardiac pathology' when compared to the 'Chest wall syndrome' group. This is surprising, since both groups are considered to not have any cardiac issues after discharge. It might be that cardiologists are more likely to give a 'No cardiac pathology' diagnosis when there is more clarity on the cause of the chest pain.

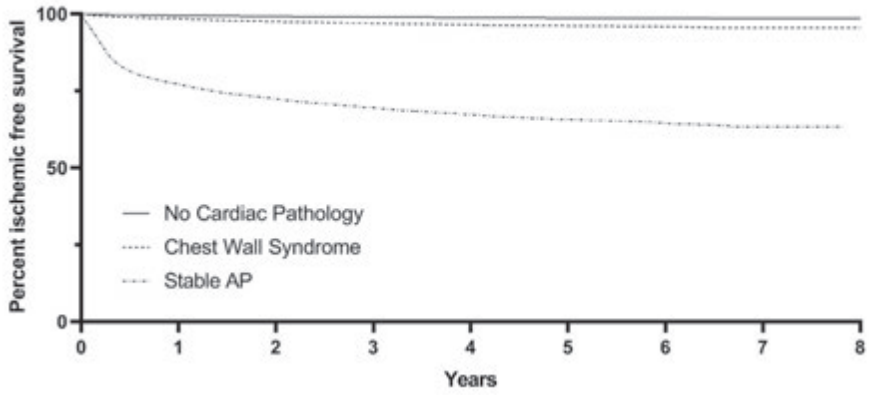

Figure 3. Kaplan Meier ischemic free survival curve for eight years follow-up

Table 2. Overview of healthcare expenditures per group

Category (N,%)*	No Cardiac Pathology N = 19.688 (27%)		Chest Wall Syndrome N = 40.858 (55%)		Stable AP N = 13.545 (18%)		Total	
Cardiac Invasive	€ 1.112.551	8	€ 4.054.831	7	€ 23.460.274	32	€ 28.627.656	20
Cardiac Non Invasive	€ 4.945.849	37	€ 19.902.132	36	€ 15.076.143	21	€ 39.924.124	28
Emergency Department	€ 1.682.815	13	€ 4.881.403	9	€ 1.711.038	2	€ 8.275.256	6
Inpatient Care	€ 3.498.977	26	€ 20.832.042	38	€ 26.097.193	35	€ 50.428.212	35
Outpatient Care	€ 2.142.629	16	€ 5.743.350	10	€ 5.649.606	8	€ 13.535.585	10
Other	€ 103.119	1	€ 143.653	0	€ 1.664.504	2	€1.911.276	1
Total	€ 13.485.941	9	€ 55.557.410	39	€ 73.658.759	51	€ 142.702.110	100

Stable AP = Stable angina pectoris
*Distinction of the different categories can be seen in Supplemental Table 1.

Table 3. The amount of patients (in percentages) that underwent a non-invasive diagnostic test per group

	No Cardiac Pathology N = 19.688 (27%)		Chest Wall Syndrome N = 40.858 (55%)		Stable AP N = 13.545 (18%)	
Non Invasive Diagnostics (N, %)	18.783	90	40.461	99	12.545	93
ECG	15.682	80	35.646	87	10.734	79
Cardiac ultrasound	10.678	54	16.216	40	8.672	64
Laboratory	7.762	39	30.857	76	10.232	76
Exercise test	3.780	19	19.638	48	7.217	53
X-Ray	2.562	13	14.986	37	5.628	42
Holter monitor	2.440	12	3.907	10	1.731	13
Cardiac CT scan	1.233	6	9.845	24	3.256	24
Cardiac Nuclear/SPECT scan	510	3	3.585	9	2.787	21
Rhythm monitoring	469	2	4.154	10	2.732	20
Cardiac MRI	268	1	1.793	4	1.331	10
ABPM	135	1	62	2	447	3

Stable AP = Stable angina pectoris; ECG = electrocardiogram; Cardiac CT scan = Cardiac Computed Tomography scan; SPECT = Single Photon Emission Computed Tomography; MRI = Magnetic Resonance imaging; ABPM = Ambulatory Blood Pressure Monitoring

DISCUSSION

This study was conducted to gain insight into the diagnostic effort for patients with non-acute chest pain in the hospital. The findings of this study can be summarized as follows: (i) 82% of the patients referred to the hospital with suspicion of cardiac chest pain had a non-cardiac origin; (ii) a total of € 142,7.- million has been spent on 74.091 patients, of which €67 million was spent on non-cardiac patients; (iii) after 8 years follow up ≥95% of the patient diagnosed with no cardiac pathology or chest wall syndrome had an ischemic free survival. Data from one tertiary and three general hospitals was analysed. Two of the four hospitals were percutaneous coronary intervention-centers. A total of 180.000 patients without a cardiac history are observed with chest pain per year in the Netherlands.(9) In this study, 74.091 patients were included over a period of 5,7 years. This represents approximately 13.000 patients per year amounting to 7% of the national population. Patients with a cardiac history (18%, Fig. 1) were excluded, this will lead to an underestimation of the total incidence of non-acute cardiac chest pain. These patients were excluded to facilitate interpretation of the data obtained, as patients have the same cardiac history (i.e. none). Compared with previous studies of chest pain in a non-acute setting baseline characteristics were comparable. (5, 16)

Since the cohort can be considered representable for the national population, we believe that the findings in this study are representable too.

The accuracy of patient referral

The current study showed a high incidence of non-cardiac chest pain in the referred patients (82%): 27% of the patients were diagnosed with no cardiac pathology and 55% of the patients were diagnosed with chest wall syndrome. As the patients were referred to the hospital with the suspicion of a cardiac cause, the 'hit rate' of an actual cardiac cause, for non-acute cases, seems low.

A study from Dumville et al. studied the long-term outcome of patients with chest pain who were referred from primary care towards a Rapid Access Chest Pain clinic in a non-acute setting.(17) A total of 52% had non-cardiac chest pain after a follow-up of 6 months. Similar results were found in a study by Byrne et al., where 633 patients were referred to a rapid access chest pain clinic.(16) An incidence of low risk or non-cardiac chest pain in 51% of the patients was found after 8 months. In the current study, an incidence of 82% was found. The large difference can have several causes. For instance, the current study included patients based only on the initial diagnosis. In contrast, both other studies allow for a change in diagnosis during follow-up (i.e. from non-cardiac to cardiac). Furthermore, both studies by Dumville et al. and Byrne et al. were performed in the UK. It is possible that the country-specific circumstances with regard to referral to hospitals in the case of non-acute chest pain are different, resulting in a seemingly higher hit-rate of the British GPs in the described situation.

Costs and healthcare utilization.

The total cost to obtain the diagnoses 'no cardiac pathology' was €13,5 million (€685 per patient). For 'chest wall syndrome' the total diagnostic expenditure was €55,5 million (€1360 per patient). A study from Mourad et al. analyzed the extent of costs in secondary care, incurred by patients (N=199) with non-cardiac chest pain and compared this with the costs of patients with acute myocardial infarction and AP.(18) The annual cost per patient with non-cardiac chest pain was €10.068, which included also costs in primary care, indirect costs on productivity, loss due to sick-leave and medical costs. In the current study, only the direct costs (TD-ABC) were calculated per patient and could explain the lower costs found in the current study.

To extrapolate these costs to the total Dutch population, data from Dutch National Healthcare Institute is used.(9) In this report, the annual amount of new patients with diagnostic codes 201 and 202 were reported to be n = 180.000. In this report, the diagnostic codes 201 (55%), 202 (18%), and 101 (27%) were included. To accurately compare the data, the mentioned 180.000 only represents 73% of the hypothetical national cohort as considered in this study. The total cohort would then be n = 247.000. The annual diagnostic cost for 'no cardiac pathology' is then €45,6 million, and the

annual diagnostic cost for 'chest wall syndrome' is €184,4 million. The total annual expenditure to ascertain the absence of a cardiac cause for chest pain is then €230 million. We could call these 'assurance costs'.

In the current study, referred patients were subjected to a wide variety of diagnostic tests. Furthermore the utilization rate of non-invasive diagnostics was high in all groups: ≥90%. Hoornweg et al. investigated the utilization of diagnostic tests in an observational study, by including patients (N=281) with acute and non-acute chest pain in primary care.(5) A total of 44% of the patients underwent diagnostic testing. The higher utilization rate of the current study might be explained by the secondary care setting and the focus on non-acute chest pain: the clinical presentation might not be as clear as in an acute setting and therefore requires more diagnostic tests. In addition, the high utilization rate emphasizes the need to increase the compliance with the current guidelines. The ESC-guidelines recommend no non-invasive testing in patients with a pre-test probability (PTP) score of <15%.(19, 20) The guidelines do leave room for testing below 15% in particular when symptoms are limiting, but this should only apply to a small part of the cohort.(20) The present study showed a diagnosis of cardiac chest pain in 18% of the total cohort. Under the assumption that the total incidence of cardiac chest pain of 18% implies an average PTP score of 18%, it is highly unlikely that more than 90% of the cohort had a PTP of more than 15%. Over investigation is a well-known problem and paralleled with high healthcare expenditures, hence an important factor in reducing healthcare costs.(21)

Clinical outcome and follow up

The current study showed that ≥95% of the patients in the group with no cardiac pathology and the group with chest wall syndrome had an ischemic free survival after 8 years. A total of 68% of the patient with stable angina pectoris had an ischemic free survival after 8 years. It can be concluded that the current system is very effective in distinguishing those that have an underlying cardiac cause for their chest pain and those that have not.

Limitations

Some limitations should be acknowledged. First, this is an analysis based on a large-scale financial database. Previous studies showed a correlation between medical charts and financial data.(13) However, in this study, this was not verified and might result in over- or under-diagnosis. For similar data, the Dutch National Healthcare Institute used a 15% extrapolation factor. Since TD-ABD costing is used in this study, there is no available data to come to a similar extrapolation factor. Since we do not use an extrapolation factor, we are confident our costing data is conservative. Secondly, there is currently no universal definition for non-acute chest pain. Depending on the doctor, a patient with non-cardiac chest pain can be diagnosed with 'no cardiac pathology' or with 'chest wall syndrome'. For this reason, we defined non-acute

suspected cardiac chest pain by including 'no cardiac pathology', 'chest wall syndrome' or 'stable angina pectoris'. The diagnosis 'no cardiac pathology' can also be given to patients that are not referred due to chest pain. This might also be reflected in Table 3, where a different amount of diagnostic resources are used among the group with 'no cardiac pathology' compared with the groups with 'chest wall syndrome' and 'stable AP'. The focus of this study was to investigate the diagnostic course of non-acute cardiac sounding chest pain, in the outpatient clinic. By careful selection of included diagnostic codes and exclusion of emergency department patients, we are confident that the vast majority of the cohort is from the outpatient clinic. Despite this focus, it is possible that patients were included who came with chest pain in an acute setting. Fourth, information about medication was not available in the database and has not been included in our analysis. This probably leads to an underestimation of the real costs. Fifth, this research analyzed anonymous data from four different hospitals, in case a patient has been treated in multiple hospitals that patient could be included two or more times in the database. Finally, it is worth noting that the incidence of ECGs was not nearing 100%, which one would expect based on diagnostic guidelines (20, 22, 23) It is likely that not all ECGs were accounted for in the declaration database. In fact it can be expected that an ECG was made in all patients.

Future implications

The Dutch National Healthcare Institute showed that the current guidelines were not always followed in obtaining a diagnosis. This might be a reason for the large variety of applied diagnostics. This is also shown in the current study. The variety of applied diagnostics was large and most notably, the amount of performed exercise ECGs was large, even though the sensitivity of this test is quite low at 58% (95% CI 46-69%).(19) The ESC and NICE guidelines clearly underline the importance of a careful history ie. a clear distinction between typical, atypical and non-specific chest pain in the diagnosis of cardiac sounding chest pain.(20, 23) The outcomes in the study by Sekhri et al. supported the distinctions (atypical, typical and non-specific) in these guidelines. (24) It is worthwhile to investigate why guidelines are frequently not followed, as the goal of these guidelines is to deliver effective and efficient healthcare.

The mentioned 'assurance costs' are currently considered a necessary expenditure. As discussed earlier, to stay ahead of the curve with regard to the rising healthcare costs, it follows that we should search for ways to drive the assurance costs down. One such way could be to switch to an integrated care model, which has shown promise in earlier research. (25) Integrated care may play a large role in value based-healthcare; measuring costs in combination with health outcomes and patient experiences. (26) Several previous studies correlated patient-level costs and outcome analyses to improvement in healthcare quality.(27, 28) Nation-wide quality measurement and benchmarking feedback are already conducted in surgery.(28) In future perspective and in the pursuit of improving cardiac care, extending the analysis of this study by

benchmarking the hospitals on a nation-wide level, or benchmarking the performances of healthcare systems in countries can provide useful data. Similar studies such as this study can be performed for other diagnostic courses where there is a high expenditure, and a desire to find out where the effort is spent. Mourad et al. showed that patients with no cardiac chest pain use a significant amount of healthcare resources and costs society a substantially amount of money. (18) To gain insight in the entire diagnostic course of non-acute chest pain and its corresponding costs, it would be interesting to investigate also the behaviour and potential recurrent referrals of patients who were diagnosed with non-cardiac chest pain.

Conclusion

The prevalence of patients with non-acute chest pain is high and a significant amount of €142,7 million is spent on this particular patient group of 74.091 patients. This included a mean expenditure of €685, €1.360 and € 5.483 per patient with no cardiac pathology (27% of cohort), chest wall syndrome (55%) or stable AP (18%), respectively. In the majority (82%) no cardiac cause of chest pain was found. Furthermore, ≥95% of the patients in the group with no cardiac pathology and chest wall syndrome did not develop an ischemic event after 8 years follow-up.

In conclusion, it is found that the Dutch healthcare system is very effective in determining underlying cardiac cause for non-acute chest pain. Extrapolating the data, it is also found that the diagnostic expenditure to ascertain non-cardiac chest pain is €230 million per year in the Netherlands. Not only is the monetary expenditure high, the time expenditure by the healthcare system is also high. In a time where the healthcare workers are under a permanently high workload, and where recent events have shown that the healthcare system needs extra capacity to deal with crises, we should define what we as society find acceptable as 'assurance costs'.

Acknowledgements

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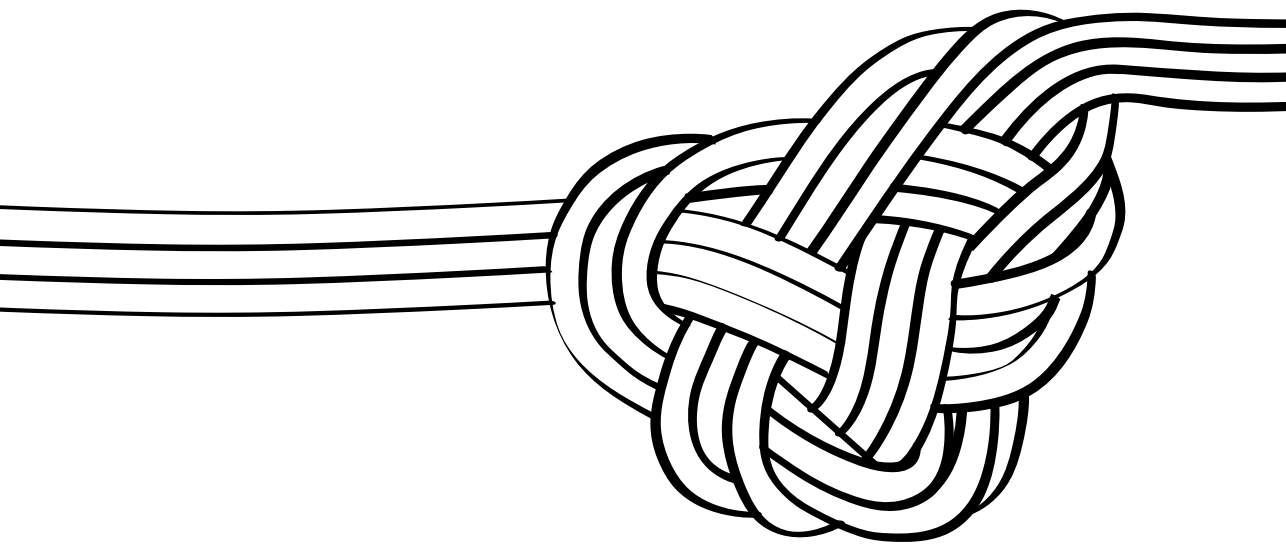

CHAPTER 5

TERTIARY HEART FAILURE CARE IN THE NETHERLANDS: WHAT IS THE ADDED VALUE?

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ABSTRACT

Objective: Ideally, heart failure (HF) care is provided in a multi-professional manner with a seamless transition across primary, secondary and tertiary care. It is essential that the added value of each part of the HF-care chain is clear. The current study aimed to evaluate the added value of a dedicated HF-management program in a tertiary hospital.

Design and methods: HF-patients with a reduced left ventricular ejection fraction (LVEF) referred by a cardiologist to a tertiary HF-outpatient clinic in order to evaluate their HF-treatment options between 2011-2017. Treatment options were assessed systematically and clinical outcome and hospital admissions were evaluated up to 1 year follow-up.

Results: A total of 603 patients (64 years (95%CI 63–65), 70% male) were included. Additional treatment options were identified in 69% of patients, comprising optimisation of medication in 52%, invasive/surgical treatment in 39% and cardiac rehabilitation in 34%. At 1 year, New York Heart Association (NYHA) class improved from 2.3 (95%CI 2.3–2.4) to 1.9 (95% CI 1.8–2.0;P<0.001) and LVEF increased from 30% (95%CI 29–31%) to 35% (95%CI 34–36%;P<0.001). The percentage of patients admitted for decompensated HF decreased from 31% in the 6 months before referral to 13% (P<0.001) in the first 6 months and to 12% (P<0.001) in the 6-12 months period after referral.

Conclusion: A dedicated tertiary HF-management program is of added value since additional treatment options can be identified in the majority of patients paralleled by an improved clinical outcome and reduction in hospital admissions for decompensated HF.

INTRODUCTION

Worldwide, the amount of patients with heart failure (HF) increases due to the ageing population and the prolonged survival of HF patients.(1) Advances in pharmacological treatment as well as percutaneous and surgical therapies have improved survival. In addition, the prevalence of risk factors like diabetes, obesity and hypertension, with a major contribution in developing heart failure still increases.(2, 3) Together these factors ensure HF continues to be a serious burden on the healthcare system which underlines the need to optimise the organization of HF care.

In 2011 the European Society of Cardiology emphasized the need to deliver HF care in a multi-disciplinary manner as this reduces mortality and HF hospitalizations.(4) Nowadays, most hospitals have dedicated HF outpatient clinics. The more recent attention for delivering "the right care at the right place" forces HF cardiologists in secondary and tertiary referral hospitals to improve co-operation with each other and with general practitioners.(5) Ultimately, this co-operation will result in a seamless transition of HF care across primary, secondary and tertiary centers.(6) However, for this to succeed it is essential that the added value of each part of the HF care chain is clear and that opportunities for improved HF management are identified.

The aim of the current study was to evaluate the added value of a tertiary HF management program. This program is especially designed for complex HF patients referred by a cardiologist in a general hospital in order to evaluate additional HF treatment options. The current study describes which treatment possibilities were identified and the subsequent course of symptoms, cardiac function and hospital admissions.

DESIGN AND METHODS

Recruitment

All HF patients referred by a cardiologist to our tertiary HF outpatient clinic in order to evaluate and optimize their HF treatment options were included (n=603). The inclusion period was from 2011-2017. The main criteria for inclusion of patients of the current study were HF patients with a left ventricular ejection fraction <40%. Patients referred by their general practitioner (for example because of new/recent-onset HF) and patients who were referred by a cardiologist for a particular HF intervention were not included in the current analysis. All patients were evaluated and treated according to the institutional MISSION!HF-program.(7)

Study procedure

The MISSION!HF program is based on the European Society of Cardiology guidelines for acute and chronic heart failure and is systematically updated after the release of a new guideline version.(8-10) Data acquired during the baseline out-patient visit included New York Heart Association (NYHA) functional classification, heart rate and blood pressure as well as serum creatinine and N-terminal pro-brain natriuretic peptide (NT-proBNP) levels and co-morbidities. Also quality of life was assessed with the Minnesota Living with HF questionnaire. HF medication and hospital admissions due to decompensated HF in the 6 months before referral and any previous cardiac interventions were recorded. Baseline transthoracic echocardiography was performed to assess biventricular function and the presence of valvular heart disease.(11) In patients with HF and known coronary artery disease and in patients with anginal complaints dobutamine stress echocardiography was performed to evaluate the presence of ischemia and viability.(12, 13)

After the initial visit all patients were discussed in the multi-disciplinary HF team consisting of HF-cardiologists, HF-nurses, imaging cardiologists, interventional cardiologists, electrophysiologists and cardiac surgeons. Potential treatment options and the possibility for initiation or up-titration of HF medication were considered. In patients using optimal HF medication the need for revascularisation, valve surgery, surgical left ventricular (LV) restoration, and/or cardiac resynchronisation therapy was determined in line with the guidelines.(8, 14, 15) Patients who remained in NYHA class IIIb/ IV despite optimal HF medication and who were ineligible for surgery and/or cardiac resynchronization therapy were considered for heart transplant or implantation of an left ventricular assist device (LVAD) as destination therapy. Additionally, a cardiac rehabilitation program was offered.

Follow-up, at 6 and 12 months, consisted of a clinical re-assessment, laboratory testing and echocardiography. Furthermore, admissions for decompensated HF were noted.

Patients were referred back to their original cardiologist if no additional HF treatment could be identified.

Data Collection

Clinical and readmission data were collected from the departmental Cardiology Information System (EPD-Vision®, Leiden University Medical Centre, The Netherlands). Mortality data were collected using municipal civil registries in December 2018.

Statistical Analysis

Statistical analyses were performed using IBM SPSS for Windows (version 23.0, Chicago, Illinois). Continuous variables are presented as mean ± standard deviation when normally distributed. Categorical variables were presented as frequencies and percentages. Log transformation was used in NT-pro BNP for all analyses to reduce the skewed distributions and make the data more interpretable. Mortality data and data on readmissions were available for all patients. For the other remaining clinical parameters, missing values were replaced by predictive mean matching using multiple imputation which was repeated a hundred times. For all clinical parameters, the rate of missing data was <10%. Baseline NYHA functional class, creatinin levels, NT-proBNP level, LVEF, admission rate, heart rate, blood pressure and BMI were used as predictors in the model for multiple imputation. The pooled data was used for analysis. The generalized estimating equations (GEE) model, utilizing an independent working correlation structure, was performed to analyze the clinical characteristics and laboratory results over time. The GEE model took into account the correlations between repeated measurements within the same subject. P-values<0.05 were considered statistically significant.

RESULTS

Study population

Between 2011–2017, 603 HF patients were referred to the MISSION!HF outpatient clinic in order to assess their additional HF treatment options. The demographic and clinical characteristics of the patient population are shown in Table 1. Mean age was 64 (95%CI 63–65) years and 70% of the patient population was male. Mean time between the diagnosis of heart failure and referral to the MISSION!HF outpatient clinic was 3.1 (95%CI 2.7–3.4) years. At baseline, NYHA class was 2.3 (95%CI 2.3–2.4) and LVEF 30% (95%CI 29–31%). In the 6 months before referral to the MISSION!HF outpatient clinic, 31% of patients were admitted due to of decompensated HF.

Risk factors for heart failure

Almost half of the study population had an ischemic etiology of heart failure (49%). Table 1 includes important risk factors for developing heart failure. Mean Body Mass Index (BMI) was 27 kg/m2 (95% CI 26 – 28). Almost half of the patients had a history of

hypertension (47%) and one third an history of hypercholesterolemia (33%). Diabetes Mellitus was also present in nearly a third (28%) of the study population. A total of 40% smoked in their past and 9% was a current smoker. Furthermore, anaemia was present in 30% of the HF patients.

Table 1. Baseline characteristics of the study population

	Mean / n (%)	95% CI
Age (years)	64	62 - 65
Male sex	422 (70%)	
HF aetiology, n (%)		
Ischemic cardiomyopathy	294 (49%)	
Non-ischemic cardiomyopathy	309 (51%)	
Cardiac history		
Myocardial infarction	250 (42%)	
Revascularisation	286 (47%)	
Prior valve surgery	70 (12%)	
Prior device implantation		
CRT-D	122 (20%)	
ICD	126 (21%)	
PM	14 (2%)	
Mean time diagnosis HF and referral (years)	3	3 - 3
NYHA functional class		
I	72 (12%)	
II	289 (48%)	
III	199 (33%)	
IV	28 (5%)	
N/A	15 (2%)	
Heart rate (/min)	74	73 - 76
Systolic blood pressure (mmHg)	114	113 - 116
Diastolic blood pressure (mmHg)	69	68 - 70
BMI (kg/m2)	27	26 - 28
Laboratory assessment		
Creatinine (umol/L)	119	114 - 124
NT-proBNP (ng/L)	4222	3560-4885
Electrocardiogram		
Sinus rhythm	438 (73%)	

Table 1. Continued

	Mean / n (%)	95% CI
Atrial fibrillation/flutter	127 (21%)	
Other rhythm	38 (6%)	
QRS duration (ms)	131	128-134
LBTB configuration	108 (18%)	
Echocardiography		
Left Ventricular Ejection fraction (%)	29	29 – 30
Severe valve disease (AS, AR, MR, TR)	69 (11%)	
Comorbidities		
Hypertension	282 (47%)	
Hypercholesterolemia	197 (33%)	
Diabetes Mellitus	167 (28%)	
History of CVA	81 (14%)	
History of malignancy	79 (13%)	
COPD	56 (9%)	
Anaemia	178 (30%)	
Peripheral vascular disease	72 (13%)	
Smoking		
Current	55 (9%)	
Past	241 (40%)	

Continuous data are presented as mean (SD). Categorical data are presented as numbers (%). HF = heart failure; CRT-D = Cardiac resynchronization therapy defibrillator; ICD = implantable cardioverter defibrillator; PM = Pacemaker; NYHA =New York Heart Association; NT-pro BNP = N-terminal pro B type natriuretic peptide; AS = Aortic Stenosis; AR = Aortic regurgitation; MR = Mitral regurgitation, TR = Tricuspid regurgitation. Anaemia is defined as a haemoglobin concentration of 13.0 g/dL in men and 12.0 g/dL in women.

HF treatment

At referral, HF medication comprised beta-blockers in 78%, ACE inhibitors or angiotensin receptor blockers (ARB) in 82% and mineralocorticoid receptor antagonists (MRA) in 51% patients. A total of 7% (N=42) of the patients received 100% of the target dose of BB at referral. A target dose of 100% of ACE or ARB and MRA was received by 11% (N=66) and 7% (N=40) of the patients, respectively. A target dose of 50% of BB was received by 19% (N=113) of the patients. And 20% (N=118) and 27% (N=162) of the patients received a target dose of 50% of ACE/ARB and MRA, respectively. Prognosis-improving HF medication could be optimised in 52% of the patients (Figure 1). As shown in Figure 2, optimisation of prognosis-improving HF medication consisted of initiation or up-titration of beta-blockers in 6% resp. 17%, initiation or up-titration of ACE inhibitors/

ARBs in 8% resp. 14% and initiation or up-titration of MRA in 13% resp. 4% of patients. Of interest, in 10% of patients loop diuretics were initiated and in 3% of patients the dosage was optimised.

After optimisation of HF medication, structured analysis revealed potential for invasive/surgical treatment in 39% of patients (Figure 1). Invasive or surgical HF treatment consisted of revascularisation (9%), valve surgery (13%), LV restoration (6%), cardiac resynchronisation therapy (21%) and ICD implantation (18%). In total one patient was accepted for heart transplant and in 3% a LVAD was implanted as destination therapy. A cardiac rehabilitation program was completely fulfilled by 34% of the patients (Figure 1). No additional HF treatment options could be identified in 31% of the patients. These patients were referred back to their original cardiologist.

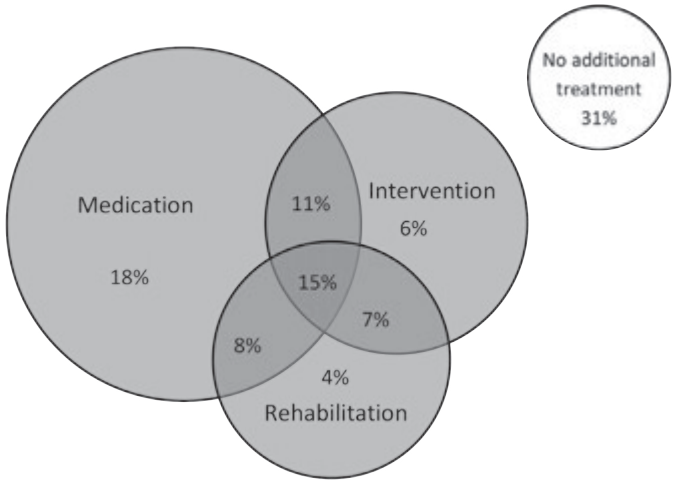

Figure 1. The additional treatment options as identified during the program

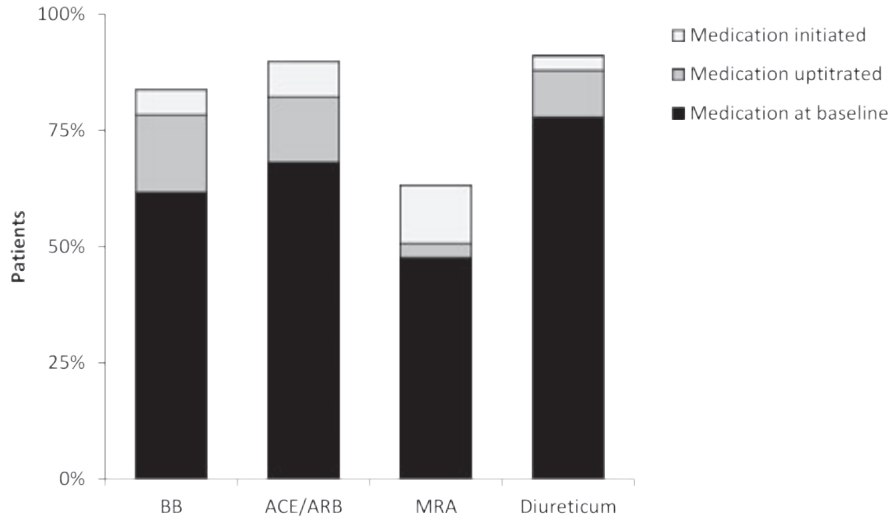

Figure 2. Heart failure medication use. At referral 78% of the patients used a beta blocker (BB), 82% used angiotensin-converting-enzyme inhibitor (ACE) or (ARB) and 51% used a mineral corticoid antagonist (MRA). BBs could be up-titrated in 17%, ACE/ARBs in 14% and MRAs in 4%. There was an initiation of BBs in 6%, of ACE/ARBs in 8% and of MRAs in 13% of the patients.
ACE = angiotensin-converting-enzyme; ARB = Angiotensin II Receptor Blockers; BB = beta blocker; MRA = mineral corticoid antagonist

Follow-up

The survival rate at 6 and 12 months was 94% and 92% respectively. During 12 months follow-up, 51 patients died. The leading cause of death was progressive HF (39 patients, 75%). As shown in Figure 3, patients experienced a significant improvement in NYHA class from 2.3 (95%CI 2.3–2.4) at baseline to 2.0 (95%CI 1.9–2.0) at 6 months (P<0.001) and 1.9 (95%CI 1.8–2.0) at 12 months (P<0.001 vs. baseline) and an increase in LVEF from 30% (95%CI 29–31) at baseline to 34% (95%CI 33–35) at 6 months (P<0.001) and 35% (95%CI 34–36) at 12 months follow-up (P<0.001 vs. baseline). Table 2 demonstrates the improvements in NT-pro BNP levels and shows that optimisation of heart failure medication resulted in a significant decline in heart rate whereas blood pressures and renal function remained unchanged. Furthermore, patients experienced a higher quality of life based on the Minnesota Living with HF questionnaire. The percentage of patients admitted for decompensated HF declined from 31% in the 6 months prior to referral to 13% (P<0.001) in the first 6 months and 12% (P<0.001) in the period from 6-12 months after referral (Figure 4).

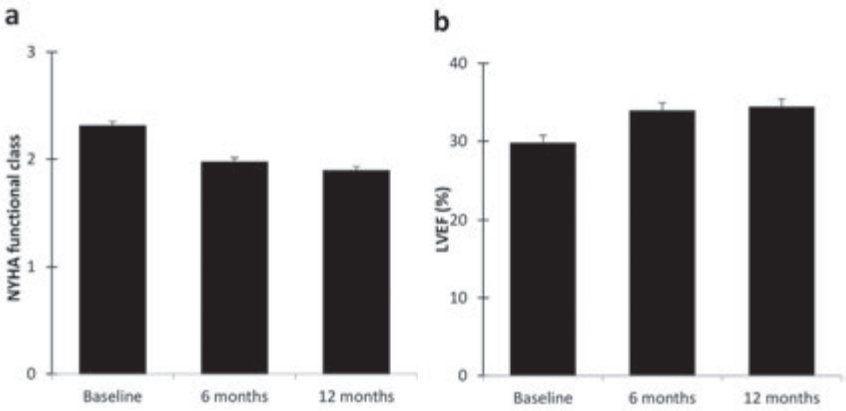

Figure 3. Clinical follow up. Panel a: Changes in NYHA class from baseline to 6 and 12 months follow-up. Panel b: Changes in LVEF from baseline to 6 and 12 months follow-up. Data are presented as mean±standard error of the mean. NYHA = New York Heart Association; LVEF = Left Ventricular Ejection Fraction

Table 2. Clinical outcome at baseline and 6- and 12 months follow up

	Baseline		**6 months**		**12 months**		**P-value***
		95% CI		95% CI		95% CI	
Creatinin (umol/L)	119	114 – 123	119	114 – 124	125	119 – 131	0.007
NT-pro BNP (ng/L)**	3.3	3.2 – 3.3	3.1	3.0 – 3.1	3.0	3.0 – 3.1	<0.001
Heart rate (/min)	74	73 – 76	72	70 – 73	70	68 – 71	<0.001
SBP (mmHg)	114	113 – 116	113	111 – 114	113	112 – 115	0.223
DBP (mmHg)	69	68 – 70	69	68 – 70	70	68 – 70	0.826
Minnesota Living with HF score	33	31 – 55	23	19 – 28	23	20 – 28	<0.001

* P value of 12 months compared with baseline
** Estimated using log transform.
Continuous data are presented as mean (SD). Categorical data are presented as numbers (%). NT-pro BNP; N-terminal pro B type natriuretic peptide; SBP, Systolic Blood Pressure; DBP, Diastolic Blood Pressure

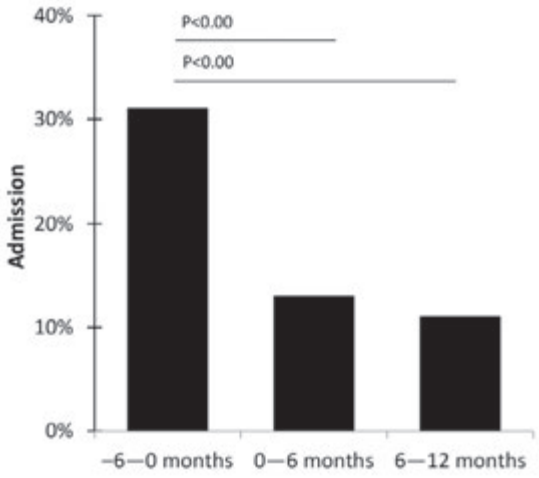

Figure 4. The percentage of patients that was admitted for decompensated HF in the 6 months before baseline and in the 0-6 and 6-12 months after baseline

Subgroup analysis of the 374 non-invasive optimised patients revealed that these patients also had a significant improvement in clinical outcome. In particular, NYHA class improved from 2.3 (95%CI 2.2–2.3) to 2.0 (95%CI 1.9–2.0) at 6 months (P<0.001) and 1.9 (95%CI 1.8–2.0) at 12 months (P<0.001 vs. baseline). The percentage of patients admitted for decompensated HF declined from 30% before referral to 10% (P<0.001) in the first 6 months and to 14% (P<0.001) in the period from 6-12 months after referral.

Subgroup analysis of the 552 survivors at 12 months showed similar results as in the entire study population. NYHA class improved from 2.3 (95%CI 2.2–2.3) to 1.9 (95%CI 1.9–2.0) at 6 months (P<0.001) and 1.9 (95%CI 1.8–1.9) at 12 months (P<0.001 vs. baseline). LVEF increased from 30% (95%CI 29–30) at baseline to 34% (95%CI 33–35) at 6 months (P<0.001) and 35% (95%CI 34–36) at 12 months (P<0.001 vs. baseline). The percentage of patients admitted for decompensated heart failure declined from 30% in the 6 months before referral to 11% (P<0.001) in the first 6 months and 11% (P<0.001 vs. baseline) in 6-12 months after referral.

DISCUSSION

The key finding of the current study is that after referral by a cardiologist to a tertiary referral centre, a structured and multidisciplinary HF management program can identify additional treatment options in 69% of patients. This includes optimisation of HF medication (52%), invasive treatment (39%) and cardiac rehabilitation (34%). At 12 months follow-up, there was an improvement in clinical outcome and a decline in hospital admissions for decompensated heart failure.

The MISSION!HF-program

The current study describes the results of the MISSION!HF-program. This program was designed in response to the growing number of tertiary referred HF patients and the expanding treatment modalities for HF. It provides a structured and guideline-based framework for the treatment of complex HF patients. Typically, cardiologists in general hospitals refer patients to a tertiary care centre when symptoms persist despite optimised management and/or when multiple invasive treatment options are considered. The characteristics of the current patient population reflect this routine. Compared with other HF registries, patients in the current study were relatively young (64, 95%CI 63–65) and were treated quite extensively at baseline. (16-18) Despite this comprehensive treatment in the current population, 31% had a recent admission because of decompensated HF and 38% was in NYHA class III/IV. The observation that 62% of patients had a relatively low NYHA class might at first be somewhat striking. Importantly, however, the recently published "I Need Help" acronym indicates that not only NYHA class III or IV should be taken into account when considering patients with advanced heart failure for tertiary referral.(19) Indeed, renal failure (mean creatinine 119 umol/L), a very low ejection fraction (LVEF<20%: 19%), more than 1 hospitalisation for decompensated heart failure in the last 12 months (7%), and a systolic blood pressure <100 mmHg (30%) were common in the current study.

The current study shows a significant decline in NT pro BNP levels. This biomarker is commonly used in the diagnosis and prognosis of HF.(20) The field of biomarkers is developing and besides NT pro BNP levels, other biomarkers like C-Reactive Protein (CRP), tumor necrosis factor-**α** and interleukins are contributing to the knowledge of HF pathophysiology. In the future to optimize HF management it would be helpful to use a multiple bio marker approach during follow-up.(21)

When a cardiologist refers a patient for advanced HF therapy, a pitfall could be solely focus on invasive treatment options. Numerous studies, however, emphasized that drug therapy is the cornerstone for the HF management.(10, 22) Even though the extensive medication use at referral, the MISSION!HF-program revealed the opportunity to even further optimise HF medication in 52% of patients. It might be assumed that this substantial optimisation in medication partially contributed to the relatively low percentage of patients in whom invasive treatment was indicated. Indeed, subgroup analysis in the non-invasively optimised patients revealed that these patients also had a reduction in HF symptoms and a decrease in hospital admissions. These results underline the importance of drug therapy for HF patients. Optimal patient selection and timing of invasive therapy in HF patients is a major challenge. A range of treatment options exist and cardiac surgery in severe HF patients is not without risk.(23) In the current study, 39% of patients were invasively treated. Previous publications of our centre described the effect of each individual treatment modality.(24-26) However, the focus of the current manuscript is on the results of the entire tertiary HF program,

since we feel that invasive treatment should be considered as an integral part of HF treatment.

Apart from drug and invasive treatment options, another important factor in optimizing the management of chronic HF care is to optimize the nutritional status of the patient. (27) Advanced heart failure is frequently paralleled with cardiac cachexia and chronic systemic inflammatory response, which influence the inadequate intake of nutrients. Malnutrition is associated with higher hospital admission rates and poor prognosis. (28) Future studies should evaluate the role of routine nutritional assessment during follow-up.

Implications for the HF care chain

The identification of additional treatment options and the observed reduction in symptoms and hospital admissions are good news for patients. However, the current data also suggest that the management of HF patients in the Netherlands should be optimised. Especially, the use of HF medication can be improved. In 18% of the patients medication optimisation was all that changed after referral. And, even after optimisation, the rate of MRA use was only 64%. Although numerous previous studies already stressed the importance of up-titrating HF medication, awareness on this topic remains to be accomplished.(6, 29, 30) Setting up a national HF registry could help to create transparency on medication-use in different hospitals and improve the quality of HF care. Sharing experience between general cardiologists and dedicated HF cardiologists on up-titrating HF medication could contribute in optimising the long-term management of HF care.

Furthermore, the referral pattern from general hospitals to tertiary referral hospitals can be optimized. Invasive treatment was performed in only 39% of patients. Education on the (contra)indications for novel invasive treatment modalities as well as accessible contact between cardiologists in general hospitals and in tertiary care hospitals may increase the efficiency of referring patients. And finally, more widespread use of cardiac rehabilitation seems reasonable, as only 34% of the patients in the current registry completed a cardiac rehabilitation program and there is a strong rationale for exercise in HF patients. (31, 32)

Study limitations

There are several limitations that have to be acknowledged. First, this is a retrospective observational single centre study. Consequently, it remains to be shown whether the observed clinical improvement and a reduction in hospital admissions for decompensated HF is directly related to tertiary heart failure care. To overcome this issue, ideally, a randomized study should be performed. However, we feel that to deny tertiary heart failure care from patients with progressive heart failure is unethical. Accordingly, in our opinion, the current study design is the only way to provide insight

in the added value of tertiary heart failure care. Secondly, the fact that the study population is a "real-world" population makes it quite heterogeneous especially with regard to HF treatment modalities. Thirdly, due to the retrospective character of the study, there are missing data during follow-up. To overcome this problem and to increase precision multiple imputation models were used.

Conclusion

A dedicated HF management program in a tertiary referral hospital is of added value in addition to regular heart failure care in general hospitals since additional treatment options can be identified in the majority of patients and may result in beneficial effects on heart failure symptoms and cardiac function paralleled by a reduction in decompensated heart failure hospital admissions.

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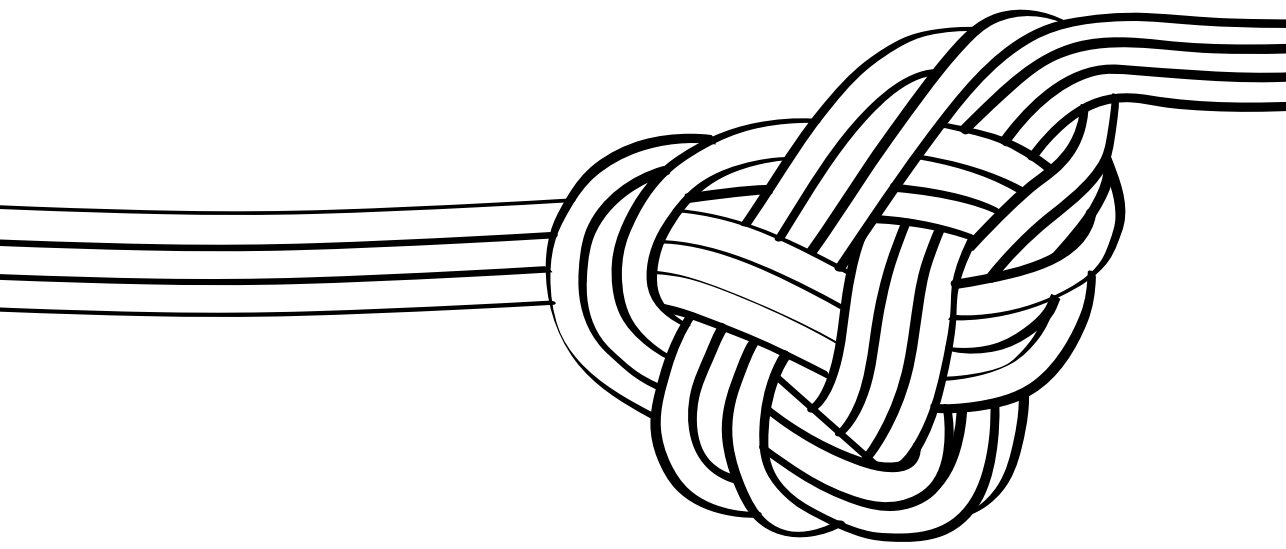

CHAPTER 6

SUMMARY, CONCLUSIONS, AND FUTURE PERSPECTIVES

SUMMARY

The aim of this thesis is to evaluate chronic cardiac care in the Netherlands. It accentuates points of improvement in healthcare delivery of primary, secondary, and tertiary care, by focusing on the treatment of chronic coronary artery disease and chronic heart failure (HF). **Chapter 1** starts with the pressure on the sustainability of the current Dutch healthcare system. Furthermore, the healthcare expenses, and their expected global growth are discussed. This growth can be explained by a demographic change in the population: people are getting older and are suffering from multiple chronic diseases (multi-morbidity). An increase in patients is paralleled by a growing need for care, caregivers, and expenditures: it is a fundamental topic on the political agenda. The agreement between the government and the specialist medical care states a maximum growth on the macro level is possible of 0.8% in 2018 and 0.0% in 2022. (1) For primary care a maximum growth of 2% in 2021 and 2022 possible.(2) We should search for ways to increase efficacy and efficiency in healthcare. In the past few years, more attention has been given to individual patients with their needs and experiences during the disease trajectory. By shifting focus to the experiences of the patient the definition of 'value' becomes more important; 'evidence-based' healthcare in combination with the importance of 'value' evolves into 'value-based' healthcare. To create value in healthcare, it is important to measure the outcomes and experiences of patients and to take the costs of a certain treatment or, ideally, of the complete disease trajectory into account. This allows for the quality of care to be determined by the needs of the individual patient and not by their illness. This patient-centred and value-based healthcare requires collaboration on different levels of healthcare, i.e. integrated care. The opposite of integrated care is fragmented care. Our current healthcare system consists of fragmented care: primary, secondary, and tertiary care. Fragmented care hinders communications and collaboration between the different levels of care. The following questions were addressed in this thesis:

1. Are chronic coronary artery disease and chronic HF care efficient and effective in the Netherlands?

2. What are potential areas of improvement in Dutch cardiovascular healthcare delivery?

A possible way to increase the value of care is to move away from the current fragmented care and implement integrated care models. To investigate the suitability of such a care model for suspected cardiac complaints, the 'Support Consultation' was designed. The 'Support Consultation' is a fully integrated care model between general practitioners, cardiologists, and health insurers in a primary care setting. In this care model, the cardiologist visits the general practitioner and advises him or her without seeing the patient. Instead of substituting secondary care to primary care, the

role of the general practitioner as gatekeeper is strengthened. Patients with suspected cardiac complaints, who would normally be referred to the cardiologist, are now discussed during the 'Support consultation'. In **Chapter 2**, the program results for 100 consecutive patients treated in this particular setup are given. Implementation of the 'Support consultation' resulted in fewer referrals from primary to secondary care and a potential net cost reduction of 61%. As the design of the 'Support consultation' can be used as a base for other integrated care models between primary and secondary care, the first results of the 'Support consultation' provide a possible part of the solution for a more effective healthcare system.

In Chapter 2, an evaluation of the current referral system for cardiac patients is given as well as suggestions for improvement in collaboration between primary and secondary care. **Chapter 3** evaluates the performance of the referral system for chronic HF patients. The number of patients with stable chronic HF in secondary care that could be referred back to primary care was used as the main performance metric. Definitions for stable chronic HF were based on the Dutch vertically integrated care program 'Transmural Care of HF Patients Model" (Landelijke Transmurale Afspraak, LTA) and the 'European Society of Cardiology (ESC)-guidelines. They included: 1/ Stable HF with a reduced LVEF, in particular an LVEF of 40-50%. 2/ Stable HF, with a recovered LVEF(>50%) and 3/ Stable HF with a preserved LVEF. Stable HF was defined as no hospitalizations due to decompensated HF or cardiac interventions in the last 12 months, or no significant change in HF medications in the last 6 months. All patients with chronic HF, registered with DOT-code 021.203, were included from two different hospitals in 2015. Of this group, 200 patients were randomly evaluated. From this group, 17% could be referred back to primary care. Awareness and clear care pathways for referral of HF patients from primary care to secondary care and also clear care pathways for active referral back from secondary care to primary care enable integration of care during the whole disease trajectory of the HF patient.

In **chapter 4** financial data are used to provide insight into healthcare utilization and corresponding costs of patients with non-acute chest pain in secondary care. Data of patients with non-acute chest pain were analysed. These data were gathered in four different hospitals between 2012 and 2018. Non-acute chest pain was defined as pertaining to the following diagnostic codes; 'DBC Op weg naar Transparantie (DOT)'-codes: 'No cardiac pathology' (0320.101 corresponding to ICD-10Z13.6), 'Chest wall syndrome (0320.201 corresponding with ICD-10 R07.4) and 'Stable angina pectoris' (0320.202 corresponding with ICD-10 I20.9). A total of 74.091 patients were included based on the aforementioned DOT-codes. During the diagnostic trajectory a total of €142,7 million was spent. Per year the mean expenditure during diagnostic effort was €1.97, €8.13, and €10.7 million, for 'No cardiac pathology', 'Chest wall syndrome, and 'Stable angina pectoris', respectively. In ≥95% of the patients with no cardiac chest pain, no ischemic event took place during 8 years follow-up. It can be concluded that

the Dutch healthcare system is very effective in determining whether chest pain is of cardiac origin or not. However, in times of increasing healthcare expenditures and a permanently high workload for health professionals, we have to ask ourselves what we are prepared to pay to determine the origin of non-acute chest pain, and how we can increase the care-related value of the money spent.

In primary and secondary care, efficient utilization of healthcare is vital to allow the healthcare system to cope with the annual amount of patients. In tertiary care, the number of patients is lower, but each patient requires more care. To provide effective care it is important to know the patients' care needs and outcomes. In this way, a 'continuum of care' for the individual patient can be realized. **Chapter 5** gives insight into the added value of complex chronic HF care in a tertiary care centre. Patients with complex HF (n=454) with impaired left ventricular ejection fraction <40% who were referred from secondary care to the tertiary care centre were included. All patients were treated according to the MISSION!HF!-program. This program offers structural and multi-disciplinary treatment based on the ESC guidelines for HF. When no additional treatment options were proposed, patients were referred back to secondary care. In 52% of the patients, HF medication could be optimised, 39% underwent a cardiac invasive treatment and 34% followed cardiac rehabilitation. After one year of follow-up, a significant improvement was seen in NYHA-class, and hospital admission due to acute cardiac decompensation also decreased significantly. Treatment according to the MISSION!HF-protocol gives promising results. However, the current data also show that chronic HF care can be optimised. Points of interest are optimising HF medication to the maximum dose and giving more attention to cardiac rehabilitation programs.

CONCLUSIONS AND FUTURE PERSPECTIVES

Due to the expected increase of patients with multiple chronic diseases the complexity of care and the healthcare expenditures will increase. This could eventually compromise the accessibility of healthcare delivery. In order to maintain accessibility we should use our medical resources as effectively as possible. This thesis shows that there is still much to gain in delivering the right cardiac care for the right patient in the right place. Improvements can be made in primary, secondary, and tertiary care. **Chapters 2 and 3** demonstrate that a significant number of cardiac patients are referred or treated in secondary care, while they can safely (and should) be treated in primary care. Vertically integrated care models or programs, which increase collaboration and communication between the general practitioner and the cardiologist, help to coordinate the flow of patients to the right care provider, namely primary, secondary or tertiary care provider. **Chapter 4** provides us insight into the high costs of the determination of an underlying cardiac cause for non-acute chest pain in secondary care. In the context of the rising expenditures, we should aim to lower these costs. A possible way is again by vertically integrated care models, which could lead to a lower influx of (non-cardiac) patients in

secondary care. As a consequence, more time and medical resources are available for patients who have a cardiac problem and really should be treated. Chapter 5 draws our attention to the possible improvements of advanced HF care in a tertiary care center. It appears that also the referral pattern from secondary to tertiary care can be optimized, as only 39% of the patients underwent invasive treatment in the tertiary care centre. Better communication and collaboration between cardiologists in secondary and tertiary care could lead to a more efficient patient referral, thereby creating accessibility for the severe HF patient who needs tertiary HF care and time for the cardiologists to provide it. In conclusion, on all levels of cardiac care delivery improvements can be made. We believe that vertically integrated care is the answer to managing and allocating the expected patient flow over primary, secondary and tertiary care, meanwhile keeping the increasing healthcare expenditures under control.

The increasing need to change

The healthcare expenditures comprised €106 billion in the Netherlands in 2019. (3) One-third was spent on hospital or specialist care. With 1.5% of the total healthcare expenditures, cardiac diseases are the third-most costly diseases in the Netherlands. (4) Coronary artery disease and HF are two important items of expenditures; a total of €2.3 billion was spent on coronary artery disease and €817 million was spent on HF, in 2017. (5, 6) As is mentioned earlier, these high expenditures are a major topic on the political agenda and minimal growth on the macro level is available for primary and secondary care for the coming years. (1, 2) Despite these agreements, an enormous influx of patients will be expected. The prediction is that the year prevalence of patients with coronary artery disease will increase by 49% and of patients with HF will increase by 88% from 2015-2040. (7, 8) Subsequently, all these patients need access to care. This requires useful and effective process innovations. The government provides funding that local caregivers could use for projects thriving effective care delivery.

Self-management

An integrated care system comprises multiple levels. This thesis illustrates how integrated care on a primary care level and secondary level results in cost reductions and effective use of medical resources (chapter 2 and 3). Besides professional and organizational caregivers, the patient himself has an important role in his health, too.(9) After all, an integrated care system is focused on the individual patient. To contribute to their healthcare pathway, patients need to be equipped with knowledge on his or her disease. Self-management is defined as a patient deliberately workings on his or her condition and is involved in decisions concerning his or her treatment.(10, 11) It appears that involvement of the patient during its disease trajectory, is associated with a better prognosis.(11, 12) Additionally, in today's society we are used to prompting access to all kinds of information resources and self-sufficiency 24/7. Patients have a growing interest in their disease.(13) The emergence of the internet, and related E-health, increase self-management.

E-health

The Internet changed the way how we communicate drastically. It also enabled us to save and exchange large amounts of data.(14) The term E-health was first introduced by industry and marketing. (15) Nowadays, the term is frequently used within academic centres, healthcare professionals, and science. However, the term E-health is still broad and lacks a clear definition.(16) Eysenbach et al. use the following definition: '*an emerging field in the intersection of medical informatics, public health, and business, referring to health services and information delivered or enhanced through the Internet and related technologies. … the term characterizes not only a technical development, but also a state of mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology.* (15) One of the aims of E-health is to improve integration between different healthcare providers, - authorities, and – users. For example, one could think of the implementation of the first electronic health records, this strengthened the horizontal integration between general practitioners. Or e-health through telemedicine or telecare, which facilitates communication at a distance and supports vertical integration. (9, 17, 18) A large amount of health-related E-health applications enables the patient to gain control, participate, and make choices in his or her health. One could think of IT tools that provide treatment at home, mobile health, or the use of digital access to a patient portal.(19) Despite these promising results, some studies lack the beneficial effects, like effectiveness or increasing self-management, of E-health. (20, 21) This could be explained due to various reasons; the e-health applications are not sufficient supported by a functioning IT infrastructure or a joint financial incentive is missing.(22) With the implementation of the integrated care model the Support consultation (chapter 2), we tried to respond to these conditions: an IT infrastructure was developed that facilitated clear scheduling of additional diagnostic testing and a joint financial incentive was ensured as the healthcare insurer paid the general practitioner, and subsequently the general practitioner paid the cardiologist.

Chapter 3 and 5 evaluate chronic HF care in the Netherlands. Chapter 5 shows that only 34% of the patients who received tertiary HF care, followed cardiac rehabilitation. Hamilton et al. assessed the use of mobile health (mHealth) on cardiac rehabilitation and HF care. (22) MHealth has the potential to be effective for HF patients in terms of acceptance, practice, and compliance with guidelines. It might be possible that by applying mHealth, HF patients could be referred back to primary care even sooner (chapter 3) or the participation of cardiac rehabilitation can be optimized (chapter 5). These are interesting questions that need further investigation.

During the covid-19 pandemic, a lot of experience is gained in the use of e-health applications in a very short period. (23) This increasing use can lead to the following developments: consultation will take place by telemedicine, additional diagnostics will be cheaper and more easily executed, and more decisions will be made with help from

software models, which have the latest academic literature and big data analyses at their disposal.(10) Subsequently, basic additional diagnostics will not be performed in hospitals anymore but will be transferred to primary care facilities or other healthcare centers and the treatment of complex care will take place in hospitals (chapter 5, figure 3). Collaboration between primary, secondary, and tertiary care (chapter 2 and 3) will intensify, and, in other words, the importance of vertical integration will increase.

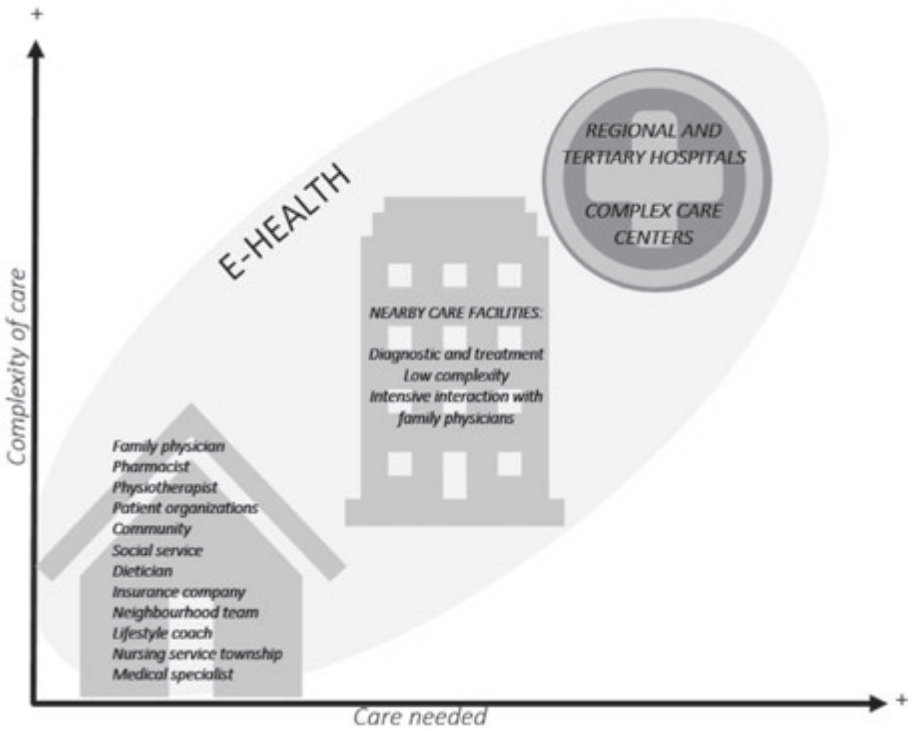

Figure 1. Due to the increased use of e-health basic additional diagnostics will take place in primary care facilities or other healthcare centers instead of in hospitals. This allows more time and opportunities for complex care in hospitals.

Data registration

Chapter 2 uses financial data to evaluate the efficiency and effectiveness of the diagnostic trajectory of non-acute chest pain in secondary care. National registered data, like financial or claim data, are an important source in improving the quality of healthcare.(24, 25) In pursuing quality improvement in healthcare it is also important to be transparent with quality data. Sweden is a pioneer regarding the publication of quality data: multiple hospitals in this country register quality data since 1987 and they provide their cardiac clinical data within one register, the 'SWEDEHEART'-register, since 1995. Because all cardiac data are within one register, comparison of results of different procedures and hospitals are easily made which subsequently improves

quality in the healthcare delivery.(26) In the Netherlands surgeon gained valuable insight by registering quality data in a national database; due to benchmarking the quality of colorectal cancer surgery improved and the corresponding costs decreased. (27) In 2018 cardiology followed in this mutual comparison of delivered quality in healthcare by establishing the 'Netherlands Heart Registration' ('Nederlandse Hart Registratie' (NHR)): a fusion of three established registration organizations aiming at quality monitoring and – improving .(28) Big (national) databases allow performing 'Registry-based randomized controlled trials' (RRCT). (29) A relatively new way of conducting research, which adds extra advantages to a regular randomized controlled trial because it is more cost-effective and less hard to perform. (30)

Communication

The spectrum of integration within an organization ranges from completely fragmented to full integration of different systems. (31) One of the conditions of a fully integrated organization is that professionals collaborate on a personal level.(10) Abovementioned developments within eHealth and increasing self-management of patients provide ways to simplify communication, however, we believe that in defragmenting healthcare delivery, face-to-face communication (or consulting a familiar face) and close collaboration are essential. 'Interprofessional learning' has been proven effective in improving collaboration between healthcare professionals.(32) It refers to moments when different healthcare professionals learn with and from each other to improve quality of care, preferably in a face-to-face setting.(33, 34) Just like the Support Consultation we believe that integrated care models which provide personal communication are a possible solution for making healthcare delivery more effective.

In the past years, we are already on the right track: a lot of innovations with integrated care models are happening.(10) The Netherlands Society of Cardiology has started to optimize and intensify regional integrated cardiac care projects since 2017.(35) To translate the current momentum into actual quality steps forward in healthcare delivery, it is necessary that the obtained results of the different initiatives are measurable and transferable. Nowadays, achieved improvements are reported against current care pathways, in the context of the existing healthcare systems. However, it is hard to put the obtained results and setups of these initiatives into a broader context of another healthcare system, as the care pathways and healthcare systems vary from country to country. In other words, it is hard to reproduce an initiative with its corresponding proven improvements of a certain healthcare system into another healthcare system. Subsequently, this also complicates a scientific discussion on an international level. That is why it is important to devote time and attention to an accepted system that is able to quantify quality of care in an independent way. In chapter 1, 'transition in healthcare' and 'Quality in care', different approaches are described which can serve as a basis for 'quality in care- quantification'.

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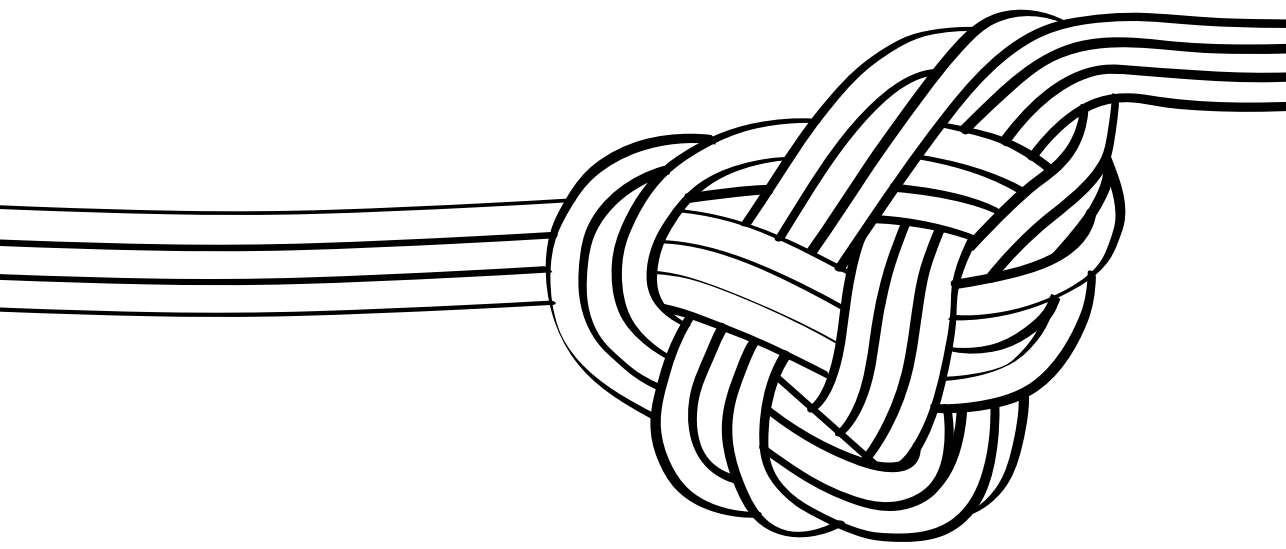

CHAPTER 7

NEDERLANDSE SAMENVATTING, CONCLUSIES EN TOEKOMSTPERSPECTIEVEN

SAMENVATTING

Het doel van dit proefschrift is om chronische cardiale zorg in Nederland te evalueren. Het geeft mogelijke verbeterpunten binnen de behandeling van stabiel coronairlijden en chronisch hartfalen in zowel de eerste-, tweede- als derde-lijn. **Hoofdstuk 1** begint met de toenemende druk op de houdbaarheid van het huidige Nederlandse zorgstelsel. Ook worden de huidige kosten in de gezondheidszorg besproken en de verwachte mondiale groei in deze kosten. Deze groei is oa. te verklaren door een demografische verschuiving in de populatie: mensen worden ouder en hebben meerdere chronische aandoeningen (multi-morbiditeit). Een toename van patiënten gaat parallel met een toenemende vraag naar zorg, zorgverleners en daardoor uitgaven. Dit alles maakt het een belangrijk topic op de politieke agenda. In het onderhandelaarsakkoord van medisch-specialistische zorg staat dat op macro niveau een maximale volume groei van 0.8% in 2018 tot 0.0% in 2022 beschikbaar is.(1) Voor eerstelijnszorg is een maximale volume groei van 2% in 2021 en in 2022 mogelijk.(2) We zullen onze beschikbare medische middelen kritisch en bedachtzaam moeten gaan gebruiken. Afgelopen jaren gaat steeds meer aandacht naar de individuele patiënt met zijn of haar belevingen gedurende ieders ziektetraject. Met meer aandacht naar het perspectief van de patiënt, krijgt de term 'waarde' in de gezondheidszorg een steeds prominentere rol; de gezondheidszorg die 'evidence based' is wordt in combinatie met het belang van 'waarde' naar een hoger niveau getild, oftewel 'value based'. Om waard creatie in de gezondheidszorg te genereren, is het belangrijk om de uitkomsten en de ervaringen van de patiënten te meten en te weten wat een bepaalde behandeling gekost heeft. Idealiter wordt dit gemeten voor een volledig zorgpad van de patiënt. Hierdoor wordt kwaliteit in zorg gedurende het ziekteproces bepaalt door de behoefte van de mens en niet door zijn of haar ziekte. Deze mensgerichte waarde creatie vraagt om samenwerking op verschillende niveaus in de zorg: integrale zorg. Het tegenovergestelde van integrale zorg is gefragmenteerde zorg. Ons huidige zorgsysteem is gefragmenteerd opgebouwd: een eerste-, tweede- en derdelijn. Gefragmenteerde zorg bemoeilijk zowel communicatie als samenwerking tussen de lijnen. Specifieke onderzoeksvragen in dit proefschrift waren:

1. *Is de chronische zorg voor coronairlijden en hartfalen efficient en effectief in Nederland?*

2. *Welke verbeterpunten zijn er in de cardiovasculaire zorg van Nederland?*

Een manier om de waarde in de zorg te vergroten is om af te buigen van het huidige gefragmenteerde zorgstelsel en te starten met het implementeren van integrale zorgsystemen. Om de geschiktheid van een dergelijke zorgmodel voor cardiale klachten te toetsen, is het 'Meekijkconsult' ontwikkeld. Het Meekijkconsult is een volledig geïntegreerd zorgmodel tussen huisarts, cardioloog en zorgverzekeraar. Het is zo opgezet dat de cardioloog in de huisartsenpraktijk advies geeft, waarbij hij of

zij de patiënt niet ziet en puur een adviserende/coachende rol inneemt. In plaats van verplaatsing van tweedelijnszorg naar de eerste lijn, wordt de eerste lijn nu versterkt en blijft de huisarts hoofdbehandelaar. Patiënten met een verdenking op niet-acute cardiale problematiek, die normaliter naar de cardioloog werden verwezen, werden nu eerst besproken gedurende het Meekijkconsult. **Hoofdstuk 2** beschrijft de resultaten van 100 opeenvolgende patiënten die zijn behandeld volgens deze setup. Implementatie van het Meekijkconsult resulteerde in minder verwijzingen en in een potentieel netto kostenreductie van 61%. De opzet van het Meekijkconsult kan als voorbeeld dienen voor andere integrale zorgmodellen tussen eerste en tweede lijn. De eerste resultaten van dit integrale zorgmodel bieden een indicatie tot het vergroten van een waarde georiënteerd zorgsysteem.

In hoofdstuk 2 wordt het huidige verwijs-syteem van cardiale patiënten geëvalueerd en tevens mogelijke oplossingen gegeven om de samenwerking tussen de eerste- en tweedelijn te verbeteren. **Hoofdstuk 3** evalueert het (terug)verwijs systeem van patiënten met chronisch hartfalen. Het aantal stabiele patiënten met chronisch hartfalen, die actief konden worden terugverwezen van de tweede naar de eerste lijn zijn hiervoor als maatstaaf gebruikt. Definities voor stabiele chronische hartfalenzorg werden gebaseerd op de Landelijke Transmurale Afspraak (LTA) Hartfalen en de 'European Society of Cardiology'(ESC)- richtlijnen. De definities hielden het volgende in: 1/ stabiel hartfalen met een afgenomen linker ventrikel ejectie fractie (LVEF, met name LVEF 40-50%), 2/ stabiel hartfalen met een herstelde LVEF (>50%) en 3/ stabiel hartfalen met een behouden LVEF. Stabiel hartfalen werd gedefinieerd als geen ziekenhuisopname wegens hartfalen of cardiale interventie afgelopen 12 maanden, of geen significante wijziging in hartfalenmedicatie afgelopen 6 maanden. Patiënten uit twee verschillende ziekenhuizen die in 2015 de financiële diagnose code van chronisch hartfalen (DOT-code: 021.302) hadden gekregen werden geïncludeerd. Vervolgens werden hieruit 200 patiënten willekeurig geëvalueerd. In totaal kon voor 17% van de patiënten de hartfalenzorg in de eerste lijn plaatsvinden. Aandacht en handvatten voor het verwijzen van patiënten door de huisarts naar de tweede lijn enerzijds, en handvatten voor het actief terugverwijzen van patiënten door de cardioloog naar de eerste lijn bevorderen doelmatige integrale samenwerking en zorg gedurende het gehele ziekteproces van een patiënt.

In **hoofdstuk 4** wordt financiële data gebruikt om inzicht te krijgen in de hoeveelheid patiënten die met niet-acute pijn op de borst naar het ziekenhuis worden verwezen, de hoeveelheid diagnostiek die vervolgens wordt ingezet met de bijkomende kosten en de klinische uitkomst. Data van patiënten met niet-acute pijn op de borst klachten is geanalyseerd. Deze data was afkomstig uit 4 verschillende ziekenhuizen in dezelfde regio uit de periode 2012 tot 2018. Niet-acute pijn op de borst werd gedefinieerd met de volgende 'DBC Op weg naar Transparantie (DOT)'-codes: 'Geen cardiale pathologie' (0320.101 overeenkomend met ICD-10 Z13.6), 'Thoracale klachten e.c.i.'

(0320.201 overeenkomend met ICD-10 R07.4) of 'Stabiele angina pectoris' (0320.202 overeenkomend met ICD-10 I20.9). In totaal hebben 74.091 patiënten één van bovenstaande DOT-codes ontvangen. Gedurende het diagnostisch traject is een totaal van €142,7 miljoen uitgegeven. Per jaar werd er gemiddeld €1.97, €8.13 en €10,7 miljoen uitgegeven aan de groep 'Geen cardiale pathologie', 'Thoracale klachten e.c.i.' en 'Stabiele angina pectoris', respectievelijk In ≥95% van de patiënten, waarin een cardiale oorzaak voor de klachten was uitgesloten, vond er geen ischemisch event plaats gedurende 8 jaar follow-up. Concluderend blijkt dat we in Nederland zeer effectief zijn in het onderscheiden van niet-cardiale vs. cardiale pijn op de borst klachten. Echter, in een tijd waarin tijd schaars is,de zorgkosten steeds verder oplopen en een constante hoge werkdruk voor zorgprofessionals, is het de vraag of dit kosteneffectieve zorg is? En moeten we dus bedenken wat we als maatschappij over hebben voor de geruststelling c.q. uitsluiten van cardiale klachten.

In de eerste en tweede lijn is doelgericht gebruik van de gezondheidszorg essentieel voor het toegankelijk houden van de zorg voor het jaarlijks aantal patiënten. In de derde lijn, is het aantal patiënten lager, echter is de patiënt complexer en heeft meer zorg nodig. Om doelmatige zorg te verlenen is het belangrijk om te weten welke patiënt welke zorg wanneer nodig heeft. Op die manier kan een 'continuum of care' gerealiseerd worden om de patiënt heen. **Hoofdstuk 5** geeft inzicht in de toegevoegde waarde van complexe chronisch hartfalen zorg in een tertiair centrum. Complexe hartfalen-patiënten (n=454) met een verminderde linker ventrikel functie van <40% verwezen vanuit de tweede lijn naar de derde lijn, zijn geanalyseerd. Deze patiënten zijn allen behandeld volgens het MISSION!HF-programma. Dit programma biedt een structurele en multi-disciplinaire behandeling voor complex hartfalen op basis van de ESC-richtlijnen. Indien geen aanvullende behandelopties konden worden aangedragen werden ze terugverwezen naar de tweede lijn. In 52% van de patiënten kon de hartfalenmedicatie worden geoptimaliseerd, 39% onderging een cardiaal invasieve behandeling en 34% volgden hartrevalidatie. Na een jaar follow-up was er een significante verbetering in de NYHA-score en het aantal ziekenhuisopnamen als gevolg van acuut hartfalen verminderden. Dat behandeling volgens het MISSION!HF-programma een positief resultaat geeft is goed nieuws, echter laat deze data ook zien dat er nog veel verbetering mogelijk is in de chronische hartfalenzorg. Punten van aandacht zijn het maximaal titreren van de hartfalenmedicatie en het volgen van hartrevalidatie.

CONCLUSIES EN TOEKOMSTPERSPECTIEVEN

Door de verwachte toename van het aantal patiënten met verschillende chronische ziekten zullen de kosten en de complexiteit van de zorgvraag toenemen. Hierdoor kan de toegankelijkheid en betaalbaarheid van de gezondheidszorg in het geding komen. Om de toegankelijkheid en betaalbaarheid van de gezondheidszorg te kunnen blijven waarborgen zullen we onze medische middelen zo effectief mogelijk moeten gebruiken. Dit proefschrift laat zien dat er nog steeds veel winst valt te behalen in het leveren van de juiste cardiale zorg voor de juiste patiënt op de juiste plek. Verbeteringen zijn mogelijk is eerste-, tweede- en derdelijns zorg. **Hoofdstukken 2 en 3** laten zien dat een significant aantal cardiale patiënten worden verwezen of worden behandeld in de tweede lijn, terwijl ze veilig zouden (moeten) worden behandeld in de eerste lijn. Verticaal integrale zorg modellen of programma's, die de samenwerking en communicatie tussen huisarts en cardioloog bevorderen, helpen om de in- en uitstroom van patiënten te coördineren naar de juiste plek, namelijk naar eerste-, tweede of derdelijns zorg**. Hoofdstuk 4** geeft ons inzicht in de hoge kosten van het achterhalen van de onderliggende oorzaak van niet-acute pijn op de borst in de tweede lijn. Met het oog op de stijgende zorgkosten, moeten we ernaar streven om deze kosten te verlagen. Een mogelijke manier is, wederom, door het toepassen van verticale integrale zorgmodellen. Deze kunnen leiden tot een lagere instroom van (niet-cardiale) patiënten in de tweede lijn. Met als gevolg dat meer tijd en medische hulpmiddelen beschikbaar zijn voor patiënten die daadwerkelijk een cardiaal probleem hebben en behandeld moeten worden. **Hoofdstuk 5** vestigt onze aandacht op de mogelijke verbeteringen op geavanceerde hartfalen zorg in een derdelijns centrum. Het lijkt erop dat ook het verwijzen van de tweede- naar de derde lijn geoptimaliseerd kan worden, aangezien slechts 39% van de verwezen patiënten invasieve therapie ondergingen. Betere communicatie en samenwerking tussen cardiologen in de tweede en derde lijn kan leiden tot het efficiënter verwijzen van patiënten, waardoor toegankelijkheid wordt gecreëerd voor de ernstig zieke hartfalen patiënten die derdelijns hartfalenzorg nodig hebben en tijd voor de cardiologen om dit te verstrekken. Concluderend, op alle levels van cardiale zorg verlening kunnen verbeteringen worden gemaakt. Wij geloven dat verticale integrale zorg het antwoord is op het managen en verdelen van de verwachte patiënten toestroom over de eerste-, tweede- en derde lijn, en daarnaast de stijgende zorgkosten onder controle te houden.

De toenemende behoefte aan verandering

Nederland besteedde in 2019, 106 miljard euro aan de gezondheidszorg.(3) Hiervan is één derde gespendeerd aan ziekenhuis- of specialistische zorg. Binnen deze zorg staan cardiale ziekten in de top 3 van duurste ziekten in Nederland: zij zijn verantwoordelijk voor 1.5% van de totale zorguitgaven.(4) Chronisch coronair lijden en chronisch hartfalen vormen binnen deze 12% de twee belangrijke kostenposten;

coronaire hartziekten waren verantwoordelijk voor een uitgaven van 2.3 miljard euro en hartfalen was verantwoordelijk voor een uitgaven van 817 miljoen euro in 2017.(5, 6)

Dit proefschrift geeft inzicht in de effectiviteit en efficiëntie in de cardiale zorg omtrent chronisch coronair lijden en stabiel hartfalen. Transparantie in data en uitkomsten kunnen als maatstaf dienen om huidig of toekomstig beleid te toetsen. Integrale samenwerking tussen de eerste, tweede en derde lijn hebben de potentie om doelmatigere zorg te leveren. We zullen er met z'n allen, regering, ziekenhuizen, huisartsen, zorgverzekeraars en patiënten, naar oplossingen moeten zoeken om de gezondheidszorg betaalbaar en toegankelijk te houden in de toekomst. Zoals al eerder benoemd is, maken deze hoge kosten het een belangrijk topic op de politieke agenda en minimale groei op macro level is mogelijk voor eerste- en tweedelijns zorg in de komende jaren. (1, 2) Ondanks dit akkoord, wordt er een enorme toestroom aan patiënten verwacht komende jaren. De voorspelling is dat van 2015 tot 2040 de jaarprevalentie van patiënten met coronaire hartziekte zal toenemen met 49% en van patiënten met hartfalen met 88%.(7, 8) Deze patiëntenstromen hebben allemaal toegang tot zorg nodig. Dit vraagt om zinvolle en doelmatige proces innovaties. De regering heeft geld beschikbaar gesteld die lokale zorgaanbieders kunnen gebruiken voor projecten die doelmatige zorg nastreven.

Zelfmanagement

Een integraal zorgsysteem kan op meerdere niveaus plaatsvinden. Dit proefschrift laat zien hoe een verticale, integrale zorg tussen de eerste- en tweede lijn resulteert in verminderde kosten en efficiënt gebruik van zorg. (hoofdstuk 2 en 3). Ook heeft de patiënt zelf, naast professionals en organisaties, een belangrijk aandeel in zijn eigen gezondheid.(9) Een integraal zorgsysteem is immers gericht op de individuele patiënt. Om als patiënt een bijdrage te kunnen leveren in zijn of haar eigen zorgpad, moet een patiënt beschikken over kennis en vaardigheden omtrent zijn of haar ziekte. Over 'zelfmanagement' wordt gesproken wanneer een patiënt doelbewust werkt aan zijn of haar eigen conditie en betrokken is bij en besluiten neemt in bij zijn of haar behandeling.(10, 11) Het blijkt dat betrokkenheid van patiënten zijn of haar eigen gezondheid, is geassocieerd met een betere prognose.(11, 12) Daarnaast zijn we in de huidige maatschappij gewend dat we snel en 24/7 toegang hebben tot allerlei soorten informatie en zelfstandigheid. Patiënten zijn in toenemende maten geïnteresseerd in hun eigen ziekte.(13) De komst van het Internet, en daarmee E-health, bevordert zelfmanagement.

E-health

Internet heeft ervoor gezorgd dat de manier waarop we met elkaar communiceren is veranderd. Ook heeft het ervoor gezorgd dat we in staat zijn grote hoeveelheden data op te slaan en uit te wisselen.(14) Als eerste werd de term E-health door de industrie en de marketing geïntroduceerd.(15) Tegenwoordig wordt het vaak gebruikt binnen

academische centra, zorgprofessionals en wetenschap. Echter, het begrip is breed en mist een duidelijke definitie.(16) Eysenbach en collega's hanteren de volgende definitie van E-health: '*an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. … the term characterizes not only a technical development, but also a state of mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology*'.(15) Eén van de doelen van E-health is om integratie binnen de verschillende zorgaanbieders, zorginstanties en zorggebruikers te verbeteren. Als voorbeeld kan hierbij gedacht worden en het eerste elektrische patiënten dossier. Dit heeft ervoor gezorgd dat de horizontale integratie tussen huisartsen werd versterkt. E-health in de vorm van telemedicine of telecare vergemakkelijkt communicatie op afstand en ondersteunt zo verticale integratie. (9, 17, 18) De grote hoeveelheid aan gezondheid gerelateerde E-health toepassingen stelt de patiënt in staat om meer controle te hebben en deel te nemen in zijn of haar eigen gezondheid en in hierin keuzes te kunnen maken. Men kan denken aan ICT tools met de mogelijkheid tot thuis behandeling, mobile health en het gebruik van een patiënten portaal.(19) Ondanks deze veelbelovende resultaten, zijn er ook studies waar het gunstige effect, zoals effectiviteit of toegenomen zelfmanagement, van E-health uitblijft.(20, 21) Verschillende oorzaken kunnen hieraan ten grondslag liggen; de E-health technologieën worden niet voldoende ondersteund door een goedlopende ICT-infrastructuur of er mist een gemeenschappelijke financiële stimulans. (14) Bij implementatie van het integrale zorgmodel Meekijkconsult (hoofdstuk 2) is getracht om aan deze voorwaarden tegemoet te komen: een goedlopende ICT infrastructuur ontwikkeld is om zo de planning en bijkomende diagnostiek van het Meekijkconsult soepel te laten verlopen, tevens was er sprake van een gemeenschappelijke financiële basis waarbij de zorgverzekeraar de huisarts betaalde en de huisarts vervolgens de cardioloog.

In hoofdstuk 3 en hoofdstuk 5 is de effectiviteit van chronische hartfalen zorg in Nederland beschreven. In hoofdstuk 5 bleek dat bij tertiaire hartfalenzorg slechts 34% hartfalenrevalidatie volgden. Hamilton et al. toetsten in een systematisch review het nut van mobile health (mHealth), het gebruik van mobiele apparatuur en dus een tak van eHealth, op hartrevalidatie en hartfalenzorg.(22) MHealth heeft de potentie om effectief te zijn binnen hartrevalidatie en hartfalenzorg in termen van acceptatie, gebruik en het naleven van richtlijnen door patiënten. Mogelijk dat door het toepassen van mHealth hartfalenpatienten eerder kunnen worden terugverwezen naar de huisarts (hoofdstuk 3) of de participatie aan hartrevalidatie kan worden verhoogd (hoofdstuk 5). Beiden interessante vraagstukken om in de toekomst verder te onderzoeken.

Afgelopen jaren veroverde E-health, of digitale zorg, steeds meer plek binnen de gezondheidszorg. Met name afgelopen jaar gedurende de corona-crisis zijn er in

zeer korte tijd veel ervaringen opgedaan in het gebruik van digitale zorg.(23) Deze toenemende verstrengeling kan in de toekomst tot de volgende ontwikkelingen leiden: consultatie zal via telemedicine plaatsvinden, diagnostiek zal goedkoper worden en makkelijker plaatsvinden, en meer beslissingen zullen met hulp van software modellen gemaakt worden, die de laatste wetenschappelijke literatuur en big data analyses tot hun beschikking hebben. (10) Dit leidt ertoe dat diagnostiek niet meer in ziekenhuizen zal plaatsvinden, maar naar de eerste lijn of dichtbij zijnde zorgcentra wordt verplaatst. Complexe zorg zal vervolgens in ziekenhuizen worden uitgevoerd (hoofdstuk 5, figuur 3). Samenwerking en communicatie tussen eerste, tweede en derdelijn (hoofdstuk 3 en 4) zal hierdoor intensiveren, in andere woorden het belang van verticale, integrale zorg neemt toe.

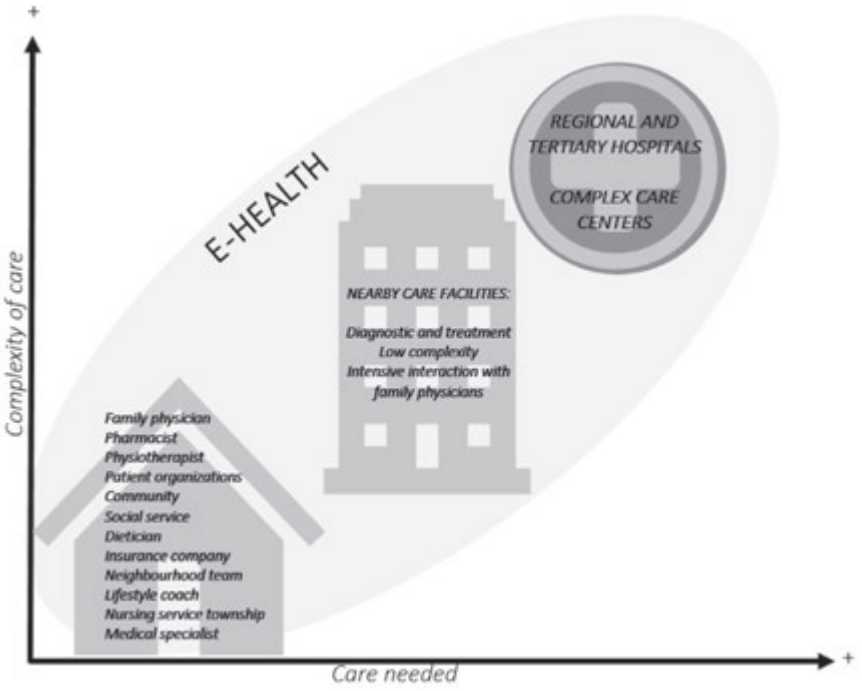

Figure 1. Door het toegenomen gebruik van e-health, zal de uitvoering van aanvullende diagnostiek van ziekenhuizen naar de eerste lijn of andere gezondheidszorg instellingen verplaatsen. Hierdoor zal er meer tijd en ruimte beschikbaar zijn voor complexe zorg in de ziekenhuizen.

Dataregistratie

Hoofdstuk 2 gebruikt declaratie data om de efficiëntie en effectiviteit van het diagnostisch traject van niet-acute pijn op de borst te analyseren. Landelijke geregistreerde data, zoals declaratie data, vormen een belangrijke bron om de kwaliteit in gezondheidszorg te vergroten.(24, 25) In het streven naar kwaliteit binnen de gezondheidszorg is het ook van belang om transparant te zijn in data. Zweden is een pionier betreffende het publiceren van kwaliteitsdata: daar wordt sinds 1987

geregistreerd en sinds 1995 leveren alle ziekenhuizen cardiale klinische data aan op een nationaal level, wat wordt vastgelegd in het 'SWEDEHEART'-register. Doordat alle cardiale data zich binnen één register bevinden is het gemakkelijk om resultaten van verschillende procedures of ziekenhuizen te vergelijken en zo de kwaliteit te verhogen.(26) In Nederland heeft de heelkunde reeds waardevolle inzicht verkregen door het registreren van kwaliteitsdata in een nationale database; als gevolg van benchmarking verbeterde de kwaliteit van colorectale kankerchirurgie en verminderde de kosten.(27) Sinds 2018 volgt ook de cardiologie met het onderling vergelijken van kwaliteit in zorg door middel van de Nederlandse Hart Registratie (NHR): een fusie van 3 gevestigde registratieorganisaties met als doel kwaliteitsbewaking en –verbetering. (28) Grote (nationale) databases geven de mogelijkheid tot het uitvoeren van 'Registry-based randomised controlled trials' (RRCT). (29) Een relatief nieuwe manier van onderzoek doen, die extra voordelen toevoegt aan een regulier gerandomiseerd onderzoek aangezien het kosten efficiënter en minder moeilijk op te zetten is.(30)

Communicatie

Het spectrum van integratie binnen een organisatie varieert van compleet gefragmenteerd tot volledige integratie van verschillende systemen. (31) Een van de voorwaarden voor een volledig integrale organizatie is dat professionals samenwerken op een persoonlijk level. (10) Bovengenoemde ontwikkelingen binnen eHealth en de toename van de zelfmanagement van patienten maken communicatie met elkaar gemakkelijker, echter geloven wij dat face-to-face communciatie (of het consulteren van een bekend gezicht) en nauwe samenwerking essentieel zijn in het defragmenteren van de gezondheidszorg. 'Interprofessionale learning' is bewezen effectief in het verbeteren van de samenwerking tussen zorgprofessionals.(32) Het refereert aan momenten wanneer verschillende zorg professionals, bij voorkeur in een face-to-face-setting, met elkaar en van elkaar leren om de kwaliteit van zorg te verbeteren. Net zoals in het Meekijkconsult geloven wij dat integrale zorgmodellen die persoonlijke communciatie faciliteren, een mogelijke oplossing bieden in het effectiever maken van de gezondheidszorg.

We zijn afgelopen afgelopen jaren al goed bezig geweest: veel innovaties met integrale zorgmodellen worden toegepast.(10) De Nederlandse Verening voor Cardiologie is in 2017 begonnen met het optimaliseren en verbeteren van regionale cardiale integrale zorgprojecten.(33) Om het huidige momentum om te zetten in een werkelijke kwaliteitsstap in de zorg is het nodig dat de resultaten die gehaald worden bij de verschillende initiatieven meetbaar en goed overdraagbaar zijn. Tegenwoordig worden de behaalde verbeteringen aangegeven ten opzichte van het nominale zorgpad, in het kader van het geldende zorgsysteem. Echter, omdat de zorgpaden en zorgsystemen per land erg verschillend zijn is het lastig om de resultaten en de opzetten van deze initiatieven in een breder context te plaatsen van een ander zorgsysteem. In andere woorden, het is lastig om een initiatief met goede resultaten vanuit een bepaald zorgsysteem te reproduceren naar een ander zorgsysteem. Dit maakt het lastig om

een wetenschappelijke discussie te voeren op een internationaal level. Desalniettemin is het noodzakelijk om tot een geaccepteerd systeem te komen om de quality of care onafhankelijk te kwantificeren. In hoofdstuk 1, 'transition in healthcare' en 'Quality in care' zijn meerdere uitgangspunten beschreven die als basis kunnen dienen om tot zo een ' zorgkwaliteit-kwantificatie' te kunnen komen.

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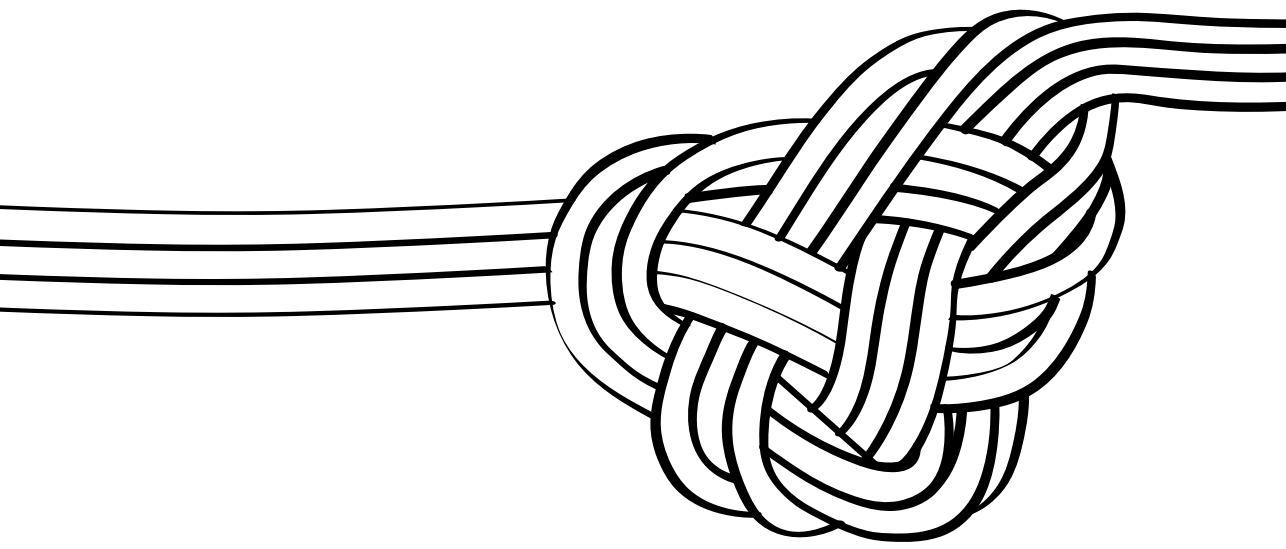

APPENDICES

Summary chronic coronary artery disease and chronic heart failure

Dankwoord

Curriculum Vitae

SUMMARY CHRONIC CORONARY ARTERY DISEASE AND CHRONIC HEART FAILURE

To provide background information in the current best practice in the treatment of chronic CAD and chronic HF, a quick overview for both these conditions is given below:

Chronic CAD

The current understanding is that CAD is the result of a pathologic process, usually atherosclerosis, affecting the coronary arteries resulting in a reduced or blocked blood flow to the myocardium. This can lead to ischemic heart disease, an imbalance between myocardial oxygen supply and demand. The associated diagnoses for ischemic heart disease are 'angina pectoris' and 'myocardial infarction'. Ischemic heart disease or CAD have a chronic and dynamic character: it can have long stable periods (stable angina pectoris) but can also become unstable, resulting in an acute atherothrombotic event (acute coronary syndrome).

The most common symptom of CAD is chest discomfort or angina pectoris. In 1983 the American College of Physicians classified chest pain into three categories, which is of proven value to predict the likelihood of CAD. (Table 1) (1)

Table 1. The classification of the character of chest pain

Typical angina	Discomfort in the front of the chest or the neck, jaw, should or arm Provoked by physical exertion or emotional stress Relieved by rest or nitrates within 5 minutes
Atypical angina	Meets 2 of the above characteristics
Non-angina chest pain	Meets 1 or none of the above characteristics

Treating chronic CAD involves reducing symptoms and ischemia paralleled by preventing myocardial infarction and cardiac events.(2) First of all it is recommended to prescribe antithrombotic drugs, like aspirin or clopidogrel.(3, 4) Second LDL cholesterol levels should be reduced by starting moderate-to-high-intensity statins.(5) Furthermore lifestyle modifications include pursuing a normal blood pressure, weight management, a healthy diet and no smoking. Antianginal therapy focuses on reducing symptoms and improving exercise tolerance.(6) Three standard types of drugs are used: beta-blockers, calcium channel blockers, and nitrates. The main goals for myocardial revascularization are to relief angina and to improve the patients' prognosis. (4, 7). Myocardial revascularization can be performed via two types of intervention: percutaneous coronary intervention (PCI) or coronary-artery bypass grafting (CABG).

Chronic HF

With the increasing age of the population and the prolonged survival due to successes in pharmacological, percutaneous, and surgical therapies, HF is one of the most important cardiovascular diseases.(8) Before the 1980s the understanding of the pathophysiology of HF was based on an impaired left ventricular contractility. Therapy included bed rest and the prescription of digitalis and diuretics. A breakthrough occurred in the 1980s, when HF was considered a neuroendocrine disease rather than a heart disease. This new insight resulted in medication which focused on improving cardiac function by blocking the renin-angiotensin-aldosterone system and sympathetic activation. HF was no longer seen as a disease but as a clinical syndrome. Typical symptoms are dyspnea, fatigue, and fluid retention. Due to the widespread use of noninvasive assessment of ventricular function, it appeared HF was not always paralleled with an impaired ejection fraction. Also, abnormalities in diastole, the valves, pericardium, endocardium, heart rhythm, and conduction could result in HF. This led to a subdivision of HF based on the function of the left ventricle since the 1990s: (9)

- HF with reduced ejection fraction, <40% (HFrEF)
- HF with a mid-range ejection fraction, 40-49% (HFmrEF)
- HF with a preserved ejection fraction, >50% (HFpEF)

The main goals for chronic HF therapy are to improve quality of life and reduce symptoms, mortality, and hospital admissions. First of all the underlying cause(s) and comorbidities of HF, like valvular disease, CAD, hypertension, or diabetes, should be managed. The further approach in therapy is different for HFrEF, HFmrEF, and HFpEF. The treatment of HFmrEF remains a 'grey area' and the search for the optimal management continues. Different studies show that patients with HFmrEF have more in common to those with HFrEF in terms of prognosis and response to therapy.(10) In symptomatic patients with HFrEF first-line pharmacological therapy is a combination of an angiotensin system blocker or angiotensin receptor-neprilysin inhibitor, a beta-blocker, a mineralocorticoid receptor antagonists, a sodiumglucose co-transporter 2 inhibitor, and in case of congestion a diuretic.(9) If a HF patient reaches the advanced phases of the disease, NYHA class III or IV, and becomes unstable despite aforementioned therapies, heart transplantation or mechanical circulatory support are last-resort therapies.

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CURRICULUM VITAE

Marijke P.M. Vester werd op 18 februari 1990 geboren te Nijmegen. In 2007 behaalde zij haar gymnasiumdiploma aan het Mencia de Mendoza Lyceum te Breda, waarna zij met de studie geneeskunde startte aan de Universiteit Leiden. Tijdens deze opleiding werkte zij op de poliklinische afdeling Cardiologie van het LUMC. Na haar doctoraalexamen startte zij in april 2015 als ANIOS op de afdeling Cardiologie in het LUMC. Na vier maanden begon zij haar promotieonderzoek op de afdeling Cardiologie onder leiding van prof. dr. M.J. Schalij. De resultaten van dit onderzoek zijn op verschillende (inter)nationale congressen gepresenteerd en kunt u lezen in dit proefschrift. Gedurende haar baan als arts-onderzoeker is zij actief geweest binnen diverse commissies. In 2019 heeft ze als ANIOS Cardiologie in het Spaarne Ziekenhuis (Haarlem) gewerkt, hierna als ANIOS Ouderengeneeskunde bij AMSTA (Amsterdam). In maart 2021 is zij gestart met de huisartsopleiding aan de Erasmus Universiteit van Rotterdam. Haar eerste jaar stage heeft ze afgerond bij Huisartsenpraktijk Voskamp (Waddinxveen) en Kwintrum (Kwintsheul, opleider: M. Rosenveldt). Haar tweede jaar stage volgt zij momenteel op de spoedeisende hulp van het Ijsselland ziekenhuis.