ANALYSIS OF DIAGNOSTIC PROCESS OF CHEST PAIN PATIENTS ON WAITING TIME, PROCESSING TIME, TEST PERFORMANCE, COSTS AND COST CONSEQUENCES

THE FAST TRACK OUTPATIENT CLINIC OF THE ERASMUS MEDICAL CENTRE

Master Thesis

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PREFACE

This thesis is written to complete the Master Health Economics, Policy and Law. Cardiogenx has commissioned this paper. CardioGenx was founded in 2012 as a spin-off company of the Thoraxcenter of the Erasmus Medical Center Rotterdam, the Netherlands. CardioGenx aims to develop novel therapeutics and early diagnostic tests for cardiovascular diseases. The company exclusively licensed a patent family on the use of biomarkers involved in blood vessel formation and repair for diagnostic and therapeutic applications. Dr. H.J. Duckers, chief scientist at CardioGenx and cardiologist at the University Medical Centre Utrecht, has developed a blood test called Angioprint, which determines if the heart suffers from (early) ischemia. This test can identify cardiovascular disease in an early stage. The accuracy and the specific costs of the blood test are not yet established.

The purpose of this study was to map the current diagnostic care process of chest pain patients at the Fast Track outpatient clinic of the Erasmus Medical Centre. The potential of the new blood test to improve the current process for chest pain patients is explored. Furthermore, preliminary information for a future economic evaluation of the added value of the blood test is provided. The economic evaluation will be initiated when the accuracy and costs are established.

My supervisor from CardioGenx who really helped me to achieve this goal is Kim Bruin. I would like to thank her for her commitment and for her support and advice.

I would also like to thank my supervisor Hans Severens for his kind and professional support, tremendous dedication and his positive attitude, which really helped me through this process!

I also would like to thank all people of the Erasmus MC, especially MS. Ten Hoor and Mr. Muster, for their cooperation and the time they have invested to help and advise me.

TABLE OF CONTENTS

ABSTRACT

Background: A new blood test has been developed which can determine coronary artery disease (CAD). The blood test indicates whether the heart suffers from a lack of oxygen. The current diagnostic process to determine CAD is complex. The degree of certainty about the diagnosis of chest pain is low and golden standards are scarce. The hospitals average waiting period before the tests take place is usually two months, while the Dutch norm is four weeks. There is also a wide variation in care processes that are completed by the patients and a variation in the order of the tests. It is also proven that at least 70% of the referred patients to the cardiologist do not have CAD. This leads to unnecessary costs and inefficient work. Therefore the current diagnostic process of chest pain patients of the Fast Track outpatient clinic (FTP AP) of the Erasmus Medical Centre (EMC) is analysed in this study. This project forms an initial exploration and is intended as a tool for a future economic evaluation of the added value of the blood test compared to the current diagnostic process.

Methods: Both 1. qualitative, including participatory observations, literature review and interviews and 2. quantitative research methods including analyzing patient statuses and cost-consequences analysis (CCA) were used. Three participatory observations are done; four articles were used from PubMed/Medline; and four interviews were conducted, mainly with Mr. P.J. Musters. Also conversations were conducted with the laboratory technician, the cardiac technician and the radiologist. In total 54 patient statuses (54 +/- 12 years, 36 males) have been analyzed of patients who visited the FTP AP with chest pain, referred by the GP or an internal department of the EMC. For the CCA the information from the EMC site and the site of the Dutch Federation of University Medical Centers (NFU) were used. Also the results of the analyses of the current diagnostic process have contributed to this analysis.

Results: There is hardly any variation in the standard care program of chest pain patients visiting the FTP of the EMC. Most of the patients undergo all standard examinations. After the diagnostic process, 8 of the 54 patients (14,8%) were identified with CAD. 45 of the 54 patients (83,3%) completed all tests in one day. The average processing time was 3 days. However, it is a very labor-intensive process. There are a lot of different specialists present during the tests. The time elapsed from the first visit to the outpatient clinic to the final diagnosis letter stays within the norm of 4 weeks for 50 of the 54 patients (92,6%), with an average of 12 days. The average waiting time for the FTP AP is well above the norm, more than 35 days. The waiting time was within the Treek standard for 19 of the 40 patients (47,5%). The accuracy of the current tests is sufficient in relation to the literature. Two exercise ECGs (XECG) were false-negative and two false-positive. The MSCT scan demonstrated no false-positive or false-negative values. In total 9 of the 51 XECGs were inconclusive, due to patients who not reached the Target Heart Rate. 1 MSCT scan was inconclusive. Moreover, 2 patients were wrongly diagnosed. The new blood test will be 1/3 cheaper than current diagnostics. The new blood test is also less labor intensive and is probably able to reduce the waiting time within the Treek standard.

Conclusion: There is a possibility for the new blood test to improve the current diagnostic process. One way to accomplish this is by reduction of the current waiting time. The current waiting time is far above the Treek. The GP can perform the new blood test and is considered to be able to exclusively refer CAD suspected patients (20%), which will decrease the inflow and thus the waiting time. So the new blood test can be a solution for the long waiting time. Therefore the blood test can result in a tremendous cost saving for health care expenditures. In addition to cost saving from less unnecessary referrals, the new diagnostic process will be less labor intensive and more convenient for the patient. Last, the new blood test is probably 1/3 cheaper than the current diagnostic process. Although the first results are promising, much more has to be investigated about the blood test to determine its possible contribution to the current process or to even replace the current process in the future.

ABBREVIATIONS

AP:	Angina Pectoris
CABG:	Coronary artery bypass grafting
CAD:	Coronary artery disease
CAG:	Coronary angiography
CBA:	Cost-benefit analysis
CCA:	Cost-consequences analysis
CEA:	Cost-effectiveness analysis
CI:	Confidence interval
CUA:	Cost-utility analysis
CVD:	Cardiovascular disease
DBC:	Diagnosis treatment combination
DOT	Diagnosis treatment combination on their way to transparency
ECG:	Electrocardiogram
EMC:	Erasmus Medical Centre
FTP AP:	Fast Track outpatient clinic Angina Pectoris
GP:	General Practitioner
HDL-cholesterol:	High density lipoprotein
LDL-cholesterol:	Low density lipoprotein
MSCT:	Multi slice computer tomography
NFU:	Dutch Federation of University Medical Centers
PCI:	Percutaneous Coronary intervention
RCT:	Randomized controlled trial
S:	Standard deviation
S.E.:	Standard error
QALY:	Quality-adjusted life-year
XECG:	Exercise Electrocardiogram

1. INTRODUCTION

1.1 INTRODUCTION

The prevalence of people with chest pain is high, 4% of all new episodes in primary care concerns chest pain (van Weert et al. 2002). Chest pain is experienced as one of the most frightening symptoms a person can have. A possible cause of chest pain is cardiovascular disease (CVD). The differential diagnosis of chest pain is very extensive and there are several pathophysiological mechanisms that can underlie. Chest pain has a wide range of possible causes (annex 1). Only when the heart is the cause of the pain, it is called Angina Pectoris (AP). The likelihood of AP is predicted by key elements of a patient's history of chest pain, the typicality of these symptoms and other risk factors.

The type of symptoms can be classified into three groups: typical, atypical and non-anginal symptoms. A typical angina symptom has all three characteristics: retrosternal pain[1] and/ or pressure, provocation of pain by exercise and decrease of pain after rest. If only two of the three symptoms are present, the complaints are atypical angina. The complaints are non-anginal if only one symptom is present.

Regardless of age and gender the risk of coronary ischemia varies from 16% in non-anginal symptoms to 50% with atypical symptoms and almost 90% at typical symptoms (table 1).

Table 1: Risk of coronary stenosis in relation to age, gender and type of pain.

	asymptomatic		**Non-anginal pain**		**Atypical pain**		**Typical pain**	
Age	Men	Women	Men	Women	Men	Women	Men	Women
30 – 39	1,9	0,3	5,2	0,8	21,8	4,2	67,7	25,8
40 – 49	5,5	1,0	14,1	2,8	46,1	13,3	87,3	55,2
50 – 59	9,7	3,2	21,5	8,4	58,9	32,4	92,0	79,4
60 – 69	12,3	7,5	28,1	18,6	67,1	54,4	94,3	90,6

The majority of the symptoms of AP arise when blood vessels in the coronary artery system develop a stenosis[2], as a result of calcification, called coronary heart disease.

[1] Pain behind the sternum that usually occurs on swallowing

[2] A narrowing or constriction of the diameter of a bodily passage or orifice

In this thesis, coronary artery disease (CAD) is defined as a narrowing of the coronary artery, also referred to as stenosis. This restricts the blood circulation to sections of the heart muscle, which consequently suffers from a lack of oxygen (Knottnerus 2007). Atherosclerosis leads to narrowing of the blood vessel caused by a deposit of fat. Infection and thrombosis (clotting) may also be involved. The material that is deposed in the wall is called ‘plaque’. Plaque arises in most arteries in the body, but especially in ones within the brains, the heart, the legs (called peripheral arterial disease), and in the aorta. The main consequences of the growth of plaque in the coronary vessels are narrowing and occlusion. Constrictions which reduces the cross-section of the coronary artery by more than 70% leads to complaints caused by insufficient blood flow by burden of the heart, especially on exertion and emotion. The patient feels crushing pain in the chest, and has AP. "Stable" AP occurs repetitively and predictably while exercising and stops if patients are at rest. "Unstable" AP results in unusual and unpredictable pain not totally relieved by rest, or pain that actually occurs at rest (Devroey 2005; van Weert et. Al 2002).

The diagnosis of AP is a complex clinical interaction, with the patient describing their pain or their symptoms and the clinician recognising the characteristics of the pain in such a way that they are led to think of AP. A quarter of the patients are referred to a specialist by the GP. Further research is required to examine if the heart causes the chest pain. This takes place in the hospital after referral by the GP, but this is only possible after a waiting period of up to two months, while the Dutch norm of the waiting period for diagnosis and assessment of chest pain patients is four weeks. After the waiting period the processing time takes several weeks of investigation (kiesbeter 2012). The maximum acceptable processing time, also called Treek standards, is also four weeks (Busch 2006).

Cardiologist Eric Duckers has developed a blood test, called Angioprint, which determines if the heart had ischemia.

CardioGenx, a spin-off of Erasmus Medical Centre (EMC), has selected several genes that are involved in vascularization of the heart. By the new technology,
The blood test may result in notable timesavings for several key stakeholders including the patients and the cardiologist. Furthermore, diagnosis of CAD patients can be done at the physicians practice. It is assumed that this test enables AP diagnosis in an earlier stage, and decreases the waiting time of the care process. Therefore, the efficiency of the diagnostic process will be enhanced. Therefore, this study focuses on the current diagnostic care process.

The specific tests that are performed, the results, the waiting and processing time and the costs and consequences of chest pain patients at the EMC are investigated. Based on the results of this study it will be possible to make a future economic evaluation of the added value of the blood test prior to all other tests.
The ambition CardioGenx is to refer only diagnosed CAD patients to the hospital and to possible replace current expensive, inconvenient diagnostic practice by a simple blood test at the physicians practice

1.2 ERASMUS MEDICAL CENTRE

The EMC is established in 2003 by a merger of the Academic Hospital Rotterdam and the Faculty of Medicine and Health Sciences. The EMC is the largest University Medical Centre in the Netherlands, with three main cores; patients care, teaching and research. The EMC employs more than 10.000 people and there are 1.237 beds (www.erasmusmc.nl). The hospital is internally composed of seventeen relatively independent operating clusters. The cardiology department is within Cluster 9: The Thorax Centre. The Thorax Centre is founded in 1971 and is an integrated organization of the Cardiology and Cardiothoracic Surgery departments. The Thorax Centre is divided into six medical units and three academic units (www.thoraxcentrum.nl).

In September 2006, the outpatient clinic of the EMC anticipated to the trends and demands of accessibility, efficiency and quality of health care, by developing the Fast Track outpatient clinic Angina Pectoris (FTP AP) (annex 2). In this new set-up, all the tests and results are reviewed and discussed with the patient in one day (Coupler et al 2008). Before September 2006 the average waiting time for patients with chest pain was 58 days (Tijdhof 2005), while the maximum permitted waiting is 28 days (Treeknorm.nl). There was also no clear process of care in the outpatient clinic Cardiology. The EMC was the first hospital in the Netherlands who developed an outpatient clinic for AP. Also unique in the Netherlands is that the FTP AP of the EMC use the MSCT scan (Tijdhof 2005). Therefore it is interesting to analyze the EMC diagnostic process and effectiveness of the tests for chest pain patients.

1.3 ANALYSIS OF THE PROBLEM

In the Netherlands, CVD is still the leading cause of mortality and morbidity, accounting for about 48.000 deaths per annum. This means that one death in three can be ascribed to disorders of this type. Of the current population of the Netherlands, one million individuals have experienced symptoms of CVD at some point in their lives.

On an annual basis, well over 150.000 individuals develop a complication in relation to these diseases (Knottnerus 2007). Although a large proportion of the CVDs is preventable, they continue to rise mainly because preventive measures are inadequate.

Table 2: incidence- and prevalence numbers cardiovascular disease the Netherlands (2000). (Source: Dutch Heart Association 2005 (Nederlandse Hartstichting))

disease	**age**	**incidence**	**prevalence**
Ischemic heart disease	All ages	82 000	668 000
Infarction	All ages	28 500 – 36 000	-
Infarction	>55 year		277 300*
CVD	>55 year	27 100 – 34 500	120 900 – 190 100
Heart failure	All ages	43 000	176 400
Heart failure	>55 year	37 400	163 800
Congential heart disease	Live births	1 200	
Congential heart disease	All ages	-	38 500 – 50 000
Abdom aneurysm, aortic	>50 year	-	86 100 – 213 000

*This regards only to the number of symptomatic infarcts. In addition, an infarct can occur without symptoms (silent infarction); if these are also included the prevalence 156 000 rises to a total of 433 000 persons

In the Netherlands, chest pain occurs in 4% of all patient contacts. In two third of the cases this pain is presented as the main complaint (Vermeire & Wens 2009). The initial purpose for patients presenting chest pain is to determine if the patient needs to be referred for further investigation to establish if the patient has acute coronary syndrome or myocardial infarction. The physician should consider patient characteristics and risk factors to determine initial risk (Mc Conaghy & Oza 2013).

370.000 people are registered with AP in the Netherlands in 2009. Only 50% of this group is direct correctly diagnosed. Golden standards are scarce.
Sometimes, it is even difficult for a doctor or other medical professional to tell what is causing chest pain and whether it is life-threatening. GPs have to find their way among a multitude of arguments and hypotheses by patients with chest pain. Often, the physician cannot define a specific diagnosis, but reaches solutions at the level of the symptoms.

The degree of certainty about the diagnosis of chest pain is low, 33% of the GPs are confident about the diagnosis. There is a clinically relevant difference in 9% of the consultations between the working diagnosis at an initial consultation and the follow up diagnosis one or two months later. This is a high percentage, regarding to incorrect distinction between gastrointestinal pathology and AP and between pulmonary and cardiac pathology (Vermeire & Wens 2009).

It has been established that there is neither a clear process of care in several hospitals for patients with chest pain. There is a wide variation in care processes that are completed by the patients and a variation in the order of the tests (Tijdhof 2006).

In addition to this, it is also proven that 70% of the referred patients to the cardiologist do not have CVD (Bremmer 2011).

This results in unnecessary costs and inefficient work. For the patient there is also a period of uncertainty about the physical health, and considerable tension/ discomfort. With the new developed blood test, however, the diagnosis can be made rapidly. The blood test shows if the heart has oxygen deficiency, and identifies cardiac patients in a fast and efficient way. Furthermore, the GP can perform the blood test instead of the cardiologist (Bremmer 2011). So if the test would be performed by a GP and he ensures that only actually diagnosed cardiac patients will be referred, the care process will be substantially improved. There is evidence that an improved and enhanced cooperation between primary and secondary care in the cardiology sector lead to more efficient use of hospital facilities (Wijkel 1986). Diagnostics on application by the first line would result in better medical policy which result in a better indication for referral. In this way, in the first line patients can be treated who traditionally would be referred to the second line. This leads to health care quality improvement. There are also benefits for the specialist, part of their work is performed by GP. Therefore the specialist can focus on actually diagnosed patients and the execution and interpretation of specialized research (Remkes 1997).

Prior to calculation of the exact added value of the new blood test and improvement of the current diagnostic process, it is necessary to analyze the current diagnostic process. This regarding to the tests included in the care process and the results of the tests, the waiting and processing time of the process and the costs and consequences of patients with chest pain. It will also be analyzed whether the percentage of patients not identified with CAD after the care process, according to literature 70%, is correct. This is important information for future economic evaluation. Qualitative and quantitative research methods will be used in this study to analyze this, including participatory observations, literature review, interviews and the analysis of patient statuses of the FTP AP. In addition a cost-consequence analysis[3] (CCA) will be performed.

[3] A form of analysis that compares alternative interventions or programs in which the components of incremental costs and consequences are listed without aggregation.

1.3.1. SCIENTIFIC RELEVANCE

CVD has a major impact in most developed countries, not only by its impact on mortality but also by its associated morbidity. Analysing the range of treatments available for CVD patients over the years, demonstrates a steady and occasionally rapid increase in the number of treatments and interventions available and in actual use.

A cause of this increase is the growing incidence of CVD. This trend is associated with the aging of the population, as more elderly age groups experience a higher incidence of CVD. In addition, there is an increasing incidence of specific disorders, such as diabetes mellitus, which in turn further exacerbates the risk of CVD.

There is also a much greater focus on opportunities to improve the quality of the remaining life period for individuals with heart disease. This applies, for instance, to patients in the final stages of chronic heart failure, which also results in an increase of the number of patients with CVD (Knottnerus 2007).

On the other hand, the increased number of interventions for CVD is also a result of an increase in the range of technical options available and the success of these therapeutic options, particularly in the past ten years (Knottnerus 2007). An extension of the indication also increases the demand for treatment (Remkes 1997). This has enabled larger numbers of elderly patients and patients with additional diseases (comorbidity) who are treated more prudently and effectively. In addition, the timing of the intervention has shifted. These days, it is much more likely that the intervention take place at an earlier stage in the disease process. These developments will create an increase in inpatient and outpatient care, which in the conventional approach is not soluble and results in irresponsible long waiting times (Remkes 1997).

The less rapid increase in the number of cardiologists contributes to this trend. Since 1984, the number of admissions of the specialty cardiology increased by almost 60% (Remkes 1997). From 1984 to 1992, the number of cardiologist increased from 421 to 593. After 1993 this number declined. According to the Dutch Society of Cardiology, the number of practicing cardiologists is 555 in 1995. After 1995, the number of cardiologist increased again significantly to 957 cardiologists in 2013 in the Netherlands.

Regarding the increase in CVD, it will be important to work as efficient as possible, resulting in an early stage of diagnosis before invasive treatments are needed for treatment.

The question is to what extent the current diagnostics enables this. It is relevant to investigate this, and to demonstrate the percentage of referred patients suffering from CVD.

Consequently, it can be scientifically demonstrated using a cost-consequence analysis if unnecessary costs are made and if the process is inefficient, providing the basis for a future economic evaluation regarding the new blood test. Therefore, it is relevant to map the current diagnostic process for chest pain patients.

1.4. RESEARCH QUESTION

1.4.1. MAIN QUESTION

The purpose of this thesis is to analyze the current diagnostic process of chest pain patients at the FTP AP of the EMC. Several aspects will be addressed including the techniques used, the results of the tests and the processing and waiting times of patients with chest pain. Furthermore, the relationship between patient characteristics and waiting time will be established and a cost-consequence analysis will be conducted. The main research question of this study is as follows:

What is the performance of the current process of care for chest pain patients at the Fast Track outpatient clinic of the Erasmus Medical Centre, from the perspective of test accuracy, waiting and processing times and costs, and taking into account differences in performance for patient characteristics

1.4.2. SUB-QUESTIONS

In addition to the main research question, the study consist of several sub questions:

1) Which tests are conducted in chest pain patients at the Fast Track outpatient clinic of the Erasmus Medical Centre?
    a. Which and how many specialists are present per examination?
2) What is the average processing time between referral by the GP or an internal department of the Erasmus Medical Centre and diagnosis in the Erasmus Medical Centre?
    a. What is the waiting time between referral by the GP or intern and start of further research in the Erasmus Medical Centre?
    b. Is there an association between the characteristics of the patient[4] and the waiting time?

[4] The patient characteristics includes: age; gender; type of complaints and number of risk factors.

3) What is the percentage of patients with chest pain where stenoses are found during the diagnostic process?
    a. What is the percentage of patients where stenoses are found after the completion of the standard research process?
    b. What is the percentage of patients where a (diagnostic) cardiac catheterization is conducted?
    c. What is the percentage of patients where stenoses are found after catheterization?
4) What are the costs and consequences of current diagnostic process compared with the new developed blood test?

1.5. STRUCTURE MASTER THESIS

In chapter 2 the theoretical framework of the thesis will be described. This chapter focuses on the economic evaluation including cost-consequences analysis of a diagnostic process, what type of economic evaluations are possible. Thereafter, the standard tests and their effectiveness , the Treek standards and the risk factors of AP will be explained. Chapter 2 ends with hypotheses based on the risk factors of AP, which will be evaluated in the result section. In chapter 3 will be explained: the research methods, both quantitative and qualitative including participatory observations, interviews, literature review, the analyses of patient statuses, calculation of correlations between patient characteristics and waiting time and the power of that associations, and a CCA will be explained. Thereafter the patient selection and research objective will be described. Then the data collection and data analysis will be explained including processing times and missing values. Finally, the validity and reliability of the study will be explained. In chapter 4 and 5 the results will be described. The first part of the results will be described in chapter 4, where a description of the current diagnostic process will be given, using the qualitative research methods. The second part of the results will be presented in chapter 5 using the information of the patient statuses. First the study population is described, then the waiting time and processing time of the sample will be presented. Thereafter, the tests en the results of the tests of the patients will be described. Next associations between the waiting time and characteristics of the patients will be calculated. The results chapter concludes with an indication of a CCA of the current diagnostic process compared with the new blood test. In Chapter 6 the discussion with the interpretation of the results and the strengths and limitations of the research is elaborated. Also recommendations for future studies will be formulated. Finally, in chapter 7 conclusions will be formulated based on the sub-questions.

2. THEORETIC FRAMEWORK

First, the theory how to evaluate a diagnostic process will be described, followed by a cost-consequence analysis. Then the process analysis will be described including the standard tests for patients with chest pain and their effectiveness. Then an explanation of the Treek standards will be given including a description of the relevance of these standards. Next the characteristics of AP, partly already addressed in the introduction, will be described. This chapter concludes with 4 hypotheses, based on the risk factors of AP, which will be evaluated in the result section.

2.1. ECONOMIC EVALUATION OF A DIAGNOSTIC PROCESS

Economic evaluation is important because resources – people, time, facilities, equipment and knowledge – are scarce. Choices must and will be made. Two features characterize economic analysis, regardless of the activities (including health services) to which it is applied. First, it deals with both the inputs and outputs, sometimes called costs and consequences of activities. Second, economic analysis concerns itself with choices. Resource scarcity, and our consequent inability to produce all desired outputs. Necessitates that choices must, and will, be made in all areas of human activity. These choices are made on the basis of many criteria, sometimes explicit but often implicit. Economic analysis seeks to identify and to make explicit one set of criteria that may be useful in deciding among different uses for scarce resources. These two characteristics of economic analysis leads to define economic evaluation as *the comparative analysis of alternative courses of action in terms of both costs and their consequences.* Therefore, the basic tasks of any economic evaluation are to identify, measure, value, and compare the costs and consequences of the alternatives being considered. In fact, these two characteristics of economic analysis may be employed to distinguish and label several evaluation situations commonly encountered in the health care evaluation literature (Drummond et al 2004).

The identification of various types of costs and their subsequent measurement in monetary units is similar across most economic evaluations; however, the nature of the consequences stemming from the alternatives being examined may differ considerably. If the costs are related to a single, common effect that may differ in magnitude between the alternative programmes, are usually referred to as *cost-effectiveness analyses* (CEAs). In this form of economic evaluation the consequences are measured in the most appropriate natural effect or physical units, such as ‘life years gained’ or ‘correctly diagnosed cases’. The results of the studies are expressed in the form of a cost-effectiveness ratio.

This is a particularly useful approach when working within a given budget constraint, as long as the alternatives under consideration are not of radically different scale (Donaldson and Shackley 1997a). However, some CEAs may present an array of output measures alongside cost and leave it to decision-makers to form their own view of the relative importance of these. This variant of CEA called *cost-consequences analysis* (CCA) (Drummond et al 2004). A CCA has been defined by Russell et al (1997) as an analysis '*in which costs and effects are calculated but not aggregated into quality-adjusted life-years or cost-effectiveness ratios*' (Russel et al 1997). When a CCA is performed as a variant of a CEA, it takes an incidence-based perspective and estimates the costs and consequences for an individual or disease cohort for as long as the health condition lasts. The perspective of a CCA should be as broad as possible, since the user of the analysis should be able to view a comprehensive listing of the various costs and consequences of alternative interventions. This type of analysis provides the most comprehensive presentation of information describing the value of a drug therapy or other healthcare intervention, and is also conceptually the simplest. It is a listing of all relevant costs and outcomes or consequences of the intervention, and comprises the following key components:

- direct medical costs;
- direct nonmedical costs;
- indirect costs;
- quality-of-life impacts;
- utility impacts;
- clinical outcomes (Mauskopf et al 1998).

The types of costs included will vary with the condition: for example, for an acute illness such as influenza, direct health care costs and productivity losses are the most important costs to include. For a chronic psychiatric illness such as schizophrenia, social service costs and criminal justice costs will also be important to include. Such an analysis is opportune if it is not feasible or practical to value all costs and benefits in monetary terms

Another form of economic evaluation is *cost-utility analysis* (CUA). In this form of economic evaluation the consequences are adjusted by health state preference scores or utility weights; these are states of health associated with the outcomes who are valued relative to one another. This approach is particularly useful for those health treatments that extend life only at the expense of side-effects or produce reductions in morbidity rather than mortality. The most common measure of consequences in CUAs is the quality-adjusted life-year (QALY). Cost-utility analysis is therefore a broader form of analysis than CEA, but it is a variant of that general approach.

Both CEAs and CUAs are techniques that relate to constrained maximization; that is, where a decision-maker is considering how best to allocate an existing budget.
The third form of economic evaluation is *cost-benefit analysis* (CBA). In this form of economic evaluation the consequences are in money terms, so as to make them commensurate with the costs. Therefore, potentially this is the broadest form of analysis, where one can ascertain whether the beneficial consequences of a programme justify the costs.

In this study the variant of the CEA, a cost-consequence analysis, will be conducted after the analysis of the current care process. This type of cost evaluation has been chosen because here the costs will not be aggregated, and this is not possible in this study because the costs of the new blood test is just an indication, little is known about this. Also the accuracy of the new blood test is not known yet. Therefore the cost-consequences analysis is chosen, the simplest form of economic evaluation. It is even not possible to conduct an entire cost-consequences analysis because the aim of the study was analyzing the current process, and just a small part of the costs have been analyzed, namely the DOT price, a replacement of the diagnosis treatment combination (DBC), including all costs of the entire process of diagnosis to the (possible) treatment. DOT stands for DBCs towards transparency (DBC op weg naar transparantie). DOT is the process to develop an improved declaration system for hospitals, which entered in January 1 2012. The reimbursable services are expressed in DOT care products and other care products. These costs consist of:

- Hospital costs
- Honorarium costs
- Costs Dutch Federation of University Medical Centers (NFU). The NFU is a partnership of eight University Medical Centers in the Netherlands and the general objective of the NFU is to represent the common interests of the UMCs (NFU.nl 2013).

The UMCs are funded differently than general hospitals because of their special public function. Therefore they receive additional funding.

For education and research the UMCs receive a grant from the Ministry of Education. These services comprises money for universities for teaching and research, divided by the faculties. The Faculty of Medicine receives a part of this for the medicine program and medical research.
The top referral care and development and innovation are funded from the so-called academic component by the Ministry of Health. This academic component constitutes about 10% of the total budget of the UMCs.

So these are the NFU costs (NFU 2013), and consists of the following components: patient care; education; research; training; Medical students; promotions; PhD; employees (per FTE); and others.

The costs of the NFU which take part in this study are the patient care cost component and the employees cost component.

So the hospital costs, the honorarium costs and the NFU costs including patient care and employees are included in the cost-consequence table, and are subjected to the direct costs. As a result of the analysis of the current diagnostic process an indication will be given in the cost-consequence table of the utility impact and the clinical outcomes of the current diagnostic process and the expectations of the new blood test. Other components of a consequence-analysis are disregarded.

2.2. PROCESS ANALYSIS

The information obtained from the patient statuses includes; characteristics of the patients including their risk factors related to AP; the waiting time and processing time of the patients, the tests they undergo and the results thereof.

2.2.1. DIAGNOSTIC TRAJECT ANGINA PECTORIS

There is a wide variation in the way AP is determined. There is not one specific care process determined and also the order of the tests varies. A chest pain patient is usually subjected to the following tests:

- Elektrocardiogram

The electrocardiogram (ECG) records the electrical activity of the heart muscle and is displayed in a chart type on registration paper or on screen. The test takes five minutes. The results of the ECG provide information about the cardiac function, the heart rate, the size of the heart and the oxygen supply. Further, old or recent myocardial infarction and abnormalities caused by malfunctioning valves will be obtained. Often, an ECG will be conducted prior to the visit of the cardiologist and/ or the exercise test. It should be emphasized that a normal resting ECG is not uncommon even in patients with severe angina and does not exclude the diagnosis of ischemia. However, the resting ECG may show signs of CAD and may assist in clarifying the differential diagnosis if presence of pain is taken into account. This allowes detection of dynamic ST-segment changes in the presence of ischaemia, or identifying features of pericardial disease (Remkes 1997).

- Blood test

The blood also has to be subjected to some tests in the laboratory prior to the first or second consultation of the patient to the cardiologist. To obtain the proportion cholesterol in the blood, the proportion of fat has to be measured (Aaldijk 2009). If this proportion is too high, the risk for heart disease increases. All three types of cholesterol will be measured.

- Consult Cardiologist/ physical examination

During the consultation with the cardiologist all health related components will be discussed. The anamnesis provides the most important information to establish the diagnosis (Wiersma et al 2009). Thereafter a physical examination takes place. The physician measures the blood pressure, listen to the heart and lungs and inspects the body on outward symptoms of heart exhibits, such as skin discoloration or swelling (Tijdhof 2006).

- Exercise test

An exercise ECG test, also called XECG, attempts to generate a (temporary) lack of oxygen. Sometimes, the XECG is used to see if cardiac arrhythmias appear during the exercise. The exercise test continues until the cyclist can no longer sustain or until the maximum heart rate is achieved. The test takes about thirty minutes. The maximum heart rate is based on age and gender, and is therefore different from person to person. The maximum heart rate of men can be calculated by subtract their age from 220, in case of women from 200. So the maximum heart rate of a man of 25 is 195 beats per minute, for a woman of 50 is that 150 beats per minute. The maximum heart rate is possibly higher for people who sport than for untrained people. The is worldwide used for decades. The XECG is a test with a low risk; myocardial infarction and death occur in approximately 1 in 2500 cases (Remkes 2997).

- Echocardiography

An echocardiography is in most cases not necessary and will only be performed on indication. Echocardiography is a way to create an image of the heart. The blood flow in the heart is determined by means of a Doppler technique, made by ultrasound. A transmitter (called transducer) that is placed on the breast emits waves. This transmitter is simultaneously also the recipient of the waves that are reflected back. The received waves are converted into a signal that is directed to a computer where an image will be composed from all the echoes. This leads to the moving picture on a screen. The test takes about thirty minutes.

- Multislice CT-scan (MSCT)

The EMC also uses the Multislice CT scan, which is unique in the Netherlands. The heart and coronary arteries are visualized with contrast. The technique is validated as effective in the detection of coronary calcium and quantification of the extent of coronary calcification. A calcium score is calculated according to Agatston (a calculation method for the approximate amount of calcification). It is the most commonly used score, based on the area and density of calcified plaques.

It is computed by specific software and is used to quantify the extent of coronary calcification. Calcium is deposited in atherosclerotic plaques within the coronary arteries. No contrast is required and the amount of radiation is low.

Coronary calcification increases with age, and nomograms have been developed to facilitate interpretation of calcium scores relative to the expected values for a given age and gender. The extent of coronary calcification correlates more closely with the overall burden of plaque than with the location or severity of stenoses.

Thus in population-based studies detection of coronary calcium may identify those at higher risk of significant coronary disease, but assessment of coronary calcification is not recommended routinely for the diagnostic evaluation of patients with stable angina.

2.3. EFFICIENCY STANDARD DIAGNOSTIC PROCESS

Part of this study is the analyses of the effectiveness of the current diagnostic process. In particular the sensitivity and specificity of the tests, the duration of the tests and the present specialists play an important role and are taking into account. This will be analyzed in this study by patient statuses. The literature shows the effectiveness of the following examinations:

- ECG

The resting ECG is false-negative in at least 50% of patients with stable AP. A normal ECG does not exclude heart disease. The positive and negative predictive values add little to the information of the anamnesis (Wiersma et al 2009). An ECG in rest can only diagnose extreme cardiac patients, and the significance of the ECG for the diagnosis of AP is low. An exercise ECG is nearly always required.

The sensitivity[5] of the ECG is 76% and the specificity[6] is 88% (Wiersma et al 2009).

- Blood test

The results of the blood tests can deviate per day by 5%, because the body processes fat at one moment faster than the other. A second or even a third blood test might be required by a deviated value (Hartwijzer 2012).

- Exercise-ECG (XECG)

It is considered that the XECG is cost effective, however the test is also known for his modest diagnostic accuracy of only 70%, which in practice leads to multiple testing (Nieman et al 2012).

The study of Sekri et al (2012) has demonstrated that the XECG contributes limited to the prediction of the results. As a result it can be concluded that only a XECG is not sufficient to diagnose patients (Sekhri et al 2012).

The sensitivity of the XECG is 68%, and the specificity is 77%. The positive predictive value is 83% and the negative predictive value is 64% (Nieman et al 2012; Wiersma et al 2009). Despite modest test accuracy, XECG remains the most widely used test to show the presence of ischemic heart disease.

However, for the diagnosis of AP the anamnesis gives in almost all cases the most important information. In case of doubt, the XECG can provided additional diagnostic information. The XECG provides especially meaningful diagnostic information in patients where the anamnesis and physical examination are inconclusive to diagnose AP sufficiently or to exclude it with certainty. The limited incremental value of these large-scale testing emphasizes the need for more effective methods for this group of patients (Sekhri 2008).

- MSCT scan

It can be stated with 99% certainty that there are no abnormalities in the coronary artery when no stenosis is detected on the MSCT. This is demonstrated in studies where invasive coronary angiography was set as the golden standard (Weustink et al 2007). MSCT scan appears to be the most promising technique in terms of non-invasive imaging of the coronary arteries, with preliminary studies suggesting excellent definition and the possibility of examining arterial wall and plaque characteristics. Sensitivity and specificity of CT angiography for the detection of coronary disease has been reported to be 95% and 98%, respectively, using 16-slice CT scan.

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[5] Sensitivity measures the proportion of actual positives which are correctly identified as such (e.g. the percentage of sick people who are correctly identified as having the condition).

[6] Specificity measures the proportion of negatives which are correctly identified as such (e.g. the percentage of healthy people who are correctly identified as not having the condition.

The 64-slice CT scan reports sensitivities and specificities of 90- 94% and 95-97%, respectively, and importantly, a negative predictive value of 93-99%.

2.3.1. ESTABLISHED CORONARY ARTERY DISEASE

The literature indicates that 70% of the referred patients do not have CVD (Bremmer 2011). When this high percentage will be determined in practice as well, it forms fundamental information for possible cost savings in the future. This leads to cost savings from less necessary referrals, because the GP is considered to be able to exclusively refer CAD suspected patients, and filtered the patients with no CAD out of the process. Whether this is possible depends on the accuracy of the tests and is not yet determined. This has to be determined before an economic evaluation can be conducted. Therefore the percentage of patients with no established CAD after the standard diagnostic process are important to evaluate, even as the percentage of patients with no established CAD after catheterization.

2.3.2. TREEK STANDARDS

In general, waiting for (non-acute) care is normal and basically not a cause of concern, as long as it does not cause health damage or unnecessary absenteeism. In the Treek discussion health providers and health insurers have agreed acceptable waiting times and processing times in health care (Treeknorm.nl). The maximum acceptable waiting times are established by sector and sometimes by health care product (see annex 3). The standards who are relevant in this study are the access time for outpatient clinic and the waiting time for diagnosis and indication. The maximum acceptable access time for an outpatient clinic is set at 4 weeks. The norm of the waiting time for diagnosis and indication is also 4 weeks (Busch 2006). Many health care institutions fail to retrieve the Treek standard. In 2012, 15,4% of the hospital departments exceeds the Treek norm for waiting time. Between 2008 and 2012 the waiting time decreased for almost all specialties (RIVM 2012). The average waiting time for all outpatient clinics Cardiology was 20 days in 2008 and 15 days in 2012 (see annex 5). Before the introduction of the FTP AP in the EMC in 2006, the average processing time per patient was 58 days, which is far above the Treek standard of 28 days (Tijdhof 2006). Therefore it is interesting to analyze the impact of the FTP AP of the EMC on the waiting time and processing time, and determine whether they are compliant with the standards.

2.4. RISK FACTORS ANGINA PECTORIS

Age is the strongest risk factor for CAD. Hypertension is another risk factor of CAD and influenced by age. Blood pressure increases with age. In case of an under pressure of at least 90 mmHG and an upper pressure more than 160 mmHg, hypertension can be established. People with hypertension have a more than 2 times higher risk of arterial thrombosis than those with healthy blood pressure (Nederlandse Hartstichting).

Another important risk factor is hypercholesterolemia. Hypercholesterolemia is an increase in the total amount of cholesterol and LDL cholesterol. The total cholesterol consists of the LDL, HDL and VLDL cholesterol. The ratio between these three types has a major influence on the risk of CAD (optimalegezondheid 2010). The LDL cholesterol determines for 75% the total cholesterol and the remaining 25% is divided by HDL and VLDL. LDL cholesterol increases the risk of CAD and HDL levels decrease the risk of CAD (see annex 4). Therefore the cholesterol ratio largely determines the risk of heart disease. An increase in the total cholesterol level by 10% increases the risk of CAD by 20% (ConsuMed 2013). Hypercholesterolemia is affected by four other risk factors for CAD, namely: smoking, overweight/ obesity, diabetes and gender. Smoking strongly reduces the HDL cholesterol.

The protective effect of HDL against atherosclerosis reduces by smoking, which increases the risk of CAD with 50% (Nationaal Kompas Volksgezondheid 2013). Overweight/ obesity or diabetes also increases the cholesterol. Patients with diabetes suffer more frequently from oxygen deficiency in the heart muscle, causing AP (Nederlandse Hartstichting). Gender also influences the cholesterol levels and thereby also the risk to develop CAD. Naturally men have a lower HDL cholesterol, and are partly less well protected against atherosclerosis. This lower HDL cholesterol is caused by the male sex hormone testosterone and the lack of the female hormone estrogen. Estrogen increase the HDL cholesterol level and ensure that the risk of CAD in women under 50 is lower than for men in the same age group (MediStart 2011).

Two other risk factors related to cholesterol influence the risk of CAD is dyslipidemia and hyperlipidemia. The risk factor dyslipidemia refers to disturbed blood fats. The increased risk of CAD is dependent on the type and severity of the disturbance (Stichting Medisch Centrum Jan van Goyen 2013). In case of hyperlipidemia both LDL and VLDL cholesterol are increased. VLDL cholesterol refers to very low-density lipoprotein, a transporter of cholesterol and triglycerides within the body. It is created in the liver and it is thought to take part in the development of atherosclerosis. Ways to lower this type of cholesterol include lifestyle changes and certain medications (Schoenstadt 2009).

The type of symptoms also predict the likelihood of AP. Regardless of age and gender the risk of CAD varies from 16% in patients with non-anginal symptoms to 50% in patients with atypical symptoms and almost 90% in patients with typical symptoms. This is a large difference and therefore an important risk factor.

The last risk factor that affects the risk of CAD is family history. If a relative have CAD there is an increased risk for other people in the family to develop CAD (Gezondheidsnet 2011).

Part of this study is the identification of the risk factors of the patients of the sample, using the patient's statuses. Most important is to analyze what the most common risk factors are in patients with CAD, to determine which risk factors are most CAD.

2.5. HYPOTHESES

In response to the above risk factors for AP, a number of hypotheses are established, which will be evaluated using the information of the patient statuses in the result section. Age is the strongest risk factor of CAD. It can also be concluded that CAD is more common in men than in women. Therefore it is chosen to evaluate if age and gender are associated with waiting time. It is expected that aging is related with a decrease in waiting time, and that the waiting time of men is shorter than for women because of a higher risk of CAD. The more risk factors, the higher risk of CAD. Therefore is also chosen to evaluate the association between waiting time and risk factors, expected the more risk factors, the shorter the waiting time. The last hypothesis is arbitrary. Cholesterol, smoking, family history and type of complaints are also important risk factors of CAD. But it is chosen to evaluate the association between type of complaints and waiting time because the difference in risk of CAD between patients with non-anginal symptoms and patients with typical symptoms are very high. Regardless of age and gender, which are two very important risk factors. Therefore it is interesting to analyze the relationship between waiting time and type of complaints.

In all four hypotheses an association is expected between the waiting time and the characteristics of the patient. The null hypothesis always means that there is no association between the variables, which is expected to be rejected after calculation of the association.

Hypothesis 1:

- *There is no association between waiting time and age.*

Hypothesis 2:

- *There is no association between waiting time and number of risk factors of AP.*

Hypothesis 3:

- *There is no association between waiting time within the Treek standards and gender.*

Hypothesis 4:

- *There is no association between waiting time within the Treek standards and type of complaints.*

3. METHODOLOGY

This chapter describes how the research was conducted to determine the current care process of chest pain patients from the FTP AP of the EMC. First the research methodology is described. Then the patient selection is described. Thereafter the aim of the study has been explained. Next the data collection en data analyses is described. Finally the validation and reliability of the research is presented.

3.1. THE RESEARCH METHODOLOGY

The research design was a case study. In case of a study in one organization or case and if the research has been conducted using a combination of data collection methods, case study can be established (Hoogers 2011). The research setting in this study is the FTP AP of the Erasmus Medical Centre. This research consisted of both qualitative and quantitative research methods.

3.1.1. QUALITATIVE RESEARCH METHODOLOGY

In chapter 4 a description of the current diagnostic process of chest pain patients in the FTP AP has been given. This is done by three qualitative research methods; participatory observations, literature review and interviews.

In participatory observations direct observation is due to involvement of the researcher in the social life of the respondents. A participatory observation means that the person is involved in the situation of the observation. Non-participatory observations take place outside the position of the observer. The observation can be structured or unstructured. A structured observation means that a given purpose is determined prior to the observation. Unstructured is the opposite of a structured observation. The observation may thus have different shapes (Wikipedia 2013). In case of participatory observations there are three things that have to be observed (Boeije 2005):

- What people do: cultural behavior such as events and interactions;
- What people know: cultural knowledge and beliefs;
- The things or objects that people use: objects, clothes, buildings and equipment (Boeije 2005).

In this study both unstructured- and structured participatory observations were used. They are used to see how the specialists work, to see their knowledge and to see what tests (materials) they work with, so to see how the process proceeds in practice. Particularly the nurse specialist and the patients have been observed.

Prior to the participatory observations different documents and sites about the FTP AP are consulted to create a framework.

Literature performs an important function in the design and implementation of the study. Literature facilitates the analysis. A (multi) disciplinary framework is created by literature and delineates the study (Boeije 2005). For the literature review the articles provided by the supervisor from CardioGenx, K Bruin, are used. Additionally scientific articles are searched on Google Scholar and PubMed/Medline. The following terms are used: Fast Track Policlinic, chest pain, Angina Pectoris, diagnostic process, waiting time, Erasmus Medical Centre, care process, diagnosis, heart disease, ECG, XECG and MSCT. These terms are used separately and in combination with each other.

In addition, a number of conversations/interviews have been conducted with Mr. P.J. Musters, nurse specialist on the FTP. Boeije (2005) determined three types of interviews, characterized by:

- the degree of structuring of the content of the questions,
- the formulation,
- the order of the questions and
- choices of answers.

If none of the four characteristics is entered, it is an unstructured interview. If the characteristics are not completely open but preparations have been done which led to a list of topics and/or questions it is a semi- or half structured interview. When all the four characteristics are met it is a structured interview (Boeije 2005). In this study all three types of interviews are considered.

Using these three research methods an answer could be given to sub-question 1.

3.1.2. QUANTITATIVE RESEARCH METHODOLOGY

The second part of the results is presented in Chapter 5, using quantitative research methods. The data collected from the patient statuses are mainly quantitative descriptive. The status describes how often a particular event occurs (Bouter & van Dongen 2000; Imbos 1996). Therefore it was possible to determine what percentage of patients underwent which test.

Usually, the date of referral and the date of examination and diagnosis were found in the patient file. Therefore the waiting time and processing time of the patients of the FTP AP could be analyzed, which allows answering sub-question 2.

Furthermore, the outcomes of the tests were very important. These outcomes were also stated in the patient files.

The percentage of patients who are diagnosed with CAD after completion of the care process could be determined. Therefore sub-question 3 could be answered.

Thereafter possible associations between the waiting time and characteristics of the patients are calculated including: age; risk factors; gender; and type of complaints. The correlation coefficient and the chi-squared test were used to calculate the associations. Waiting time is a continuous variable, as well as age and risk factors. As a result, these associations could be calculated using the correlation coefficient (Kirkwood & Sterne 2008).

The correlation coefficient measures the linear relationship between the variables x and y. the correlation coefficient is always a number between -1 and +1, and equals 0 if the variables are not associated. The closer the absolute value of R is located to 1, the stronger the linear relationship. It is positive if x and y tend to be high or low together, and the larger its value the closer the association. For values of R close to 0, there is virtually no linear relationship (Kirkwood & Sterne 2008).

Risk factors are classified in categories and only go up to six in this study. Therefore risk factors are actually discreet. But they can take any value, patients can basically have 1,5 risk factor, for example because they have smoked in the past or just are a little bit overweight. This is not used in this study, but would in principle be possible and that is important. Therefore risk factors are still considered as continuous and the correlation calculated using the correlation coefficient and not the chi-squared test.

Gender and type of complaints are dichotomous variables. For the calculation of the correlation of a continuous and a dichotomous variable a logistic regression have to be performed (de Haan & Twisk 2013).

Waiting time is therefore also converted to a dichotome variable; waiting time within the Treek standard yes or no. Two dichotomous variables has been created and the chi-sqaured test is chosen to calculate the relationship between gender and waiting time within the Treek standard and type of complaints and waiting time within the Treek standard (van Geloven 2013). The chi-squared test is used to examine the possible association between the row variable and the column variable, or, in other words whether the distribution of individuals among the categories of one variable is dependent of their distribution among the categories of the other. The chi-squared test compares the observed numbers in each category in the contingency table with the numbers to be expected if there were no differences between men and women and waiting time or typical or atypical complaints and waiting time (Kirkwood & Sterne 2008).

The waiting time is just known for 40 of the 54 patients, the associations are consequently also based on 40 patients.

The results of the correlations are probably based on coincidence. To make reliable statements about the association of patient characteristics and waiting time it is likely that more patients are required

The power of the associations is calculated using the confidence interval of a percentage. The confidence interval around a percentage presents the accuracy of the estimation of the percentage, for example, the percentage of patients whose waiting time is within the Treek standards.

The correlation coefficient has to be transformed to calculate the confidence interval for a correlation coefficient. Confidence intervals for the correlation coefficient can be derived using Fisher's transformation: $Zr = 0.5 \log_e(1+r/1-r)$.
The confidence interval for *Zr* is: 95% CI = *Zr* – 1,96/ √(n – 3) to *Zr* + 1,96 / √(n – 3)
To give the confidence interval for *r* this results have to be transformed back using the inverse of Fisher's transformation (Kirkwood & Sterne 2008). This is done for the current 54 patient, 100 patients, 200 patients, 500 patients and 1000 patients.

Thereafter the power of the association between waiting time and gender has been calculated. The confidence interval for the comparison of two means is therefore used, the mean waiting time for men compared with the mean waiting time for women. It is has been calculated whether this association between gender and waiting time is significant. The difference between the mean outcomes in the men group and women group in our sample provides an estimate of the underlying difference between the mean outcomes in the men and women group in the population. Because both groups are smaller than 30, the method to derive the confidence interval for two means was based on the *t* distribution rather than the normal distribution.
CI = (ẋ1 - ẋ0) – (*t'* * S.E.) to (ẋ1 - ẋ0) + (*t'* * S.E.) d.f.= (N1 + N0 – 2)
With the difference between the means: ẋ1 - ẋ0. And S.E. = S√(1/N1+1/N0)
with S = √[(N1-1)S1^2 + (N0-1)S0^2/ (N1+N0-2)].
All men and women in the sample whose waiting time was known were included for calculation of this confidence interval.

At least, a cost-consequence table has been provided, using the information of the literature, mainly the information from the EMC site and the NFU site about the DOT 'DBC on their way to transparency' and about the additional funding of UMCs.

Also information of the results from the analyses of the current diagnostic process were used. A CCA describes the value of a drug therapy or health care intervention. It is a listing of all relevant costs and outcomes or consequences of the intervention, and comprises the following key components: direct medical costs; direct nonmedical costs; indirect costs; quality-of-life impacts; utility impacts; clinical outcomes (Mauskopf et al 1998).

In this study only the DOT, which are covered by the direct costs, will be reflected including the hospital costs, honorarium costs and the costs of NFU. These three components are the total costs of the whole process. The hospital costs includes the equipment costs for the whole diagnostic process, like the costs of for example ECG, XECG, and the MSCT and the materials which are used, like needles.

The UMCs are financed apart by government for their public function. The cost components which are included in this financing are described in 2.1 of the theoretical framework. These are NFU costs (NFU 2013). The costs components which are applicable in this study are patient care and employees (per FTE).
Honorarium costs also consists of employees costs (per FTE). Government and health insurers finance the employees cost component.

This information about the costs components is obtained through information of the EMC website and the NFU website. Also conversations with the personnel of the EMC were conducted.

An indication of the utility impact, the clinical outcomes of the current diagnostic process and the expectations of the new blood test will be given in the cost-consequence table as a result of the analysis of the current diagnostic process. Other components are disregarded.

3.1.3. PATIENTSELECTION

Besides patients with chest pain, there are also patients with cardiomyopathy, rhythm abnormalities and patients with congenital heart defects at the Cardiology outpatient clinic. This study focused on patients who visited the Fast Track outpatient clinic with chest pain. Age and gender were no selection criteria for the patients. The way of reference was the most important selection criterion to select patients from the database. This study focused on patients who are referred by their GP or an intern specialist of the EMC. The probability that these referred patients had already undergo a lot of cardiological tests was low, because of lack of resources and knowledge.

Patients who were referred by a cardiologist from another hospital or referred themselves are filtered out the database. This occurred by the referral letters which the cardiologist receives. The referral letters were found in the patient files.

Cardiac history affects the outcome of the results, and is therefore an important confounder (Kirkwood & Sterne 2008). Patients who were treated for CAD between 2005 to 2010 were therefore filtered out of the database.

Was the cardiac history more than five years ago, the patient was eligible to the sample. These were the only selection criteria for this study.

To analyze the diagnostic process a sample of 50 patients was taken from the patients who visited the FTP AP in 2010. 2010 was chosen because in 2011 a Trial was launched, called the Crescent study, which 'manipulate' the diagnostic process. Therefore it had been decided to analyze the diagnostic process before the trial and took patient files from 2010. The data collection started with patient files of January 2010 of patients who visited the FTP AP. This went on every month until there were 50 patients selected who fulfill the selection criteria. After the month of May there were enough patients selected to carry out the analyses.

The minimum number of 50 patients was also based on the confidence interval of a percentage, explained in 3.1.2. The percentage of patients in the sample whose processing time was within the Treek standards (nearly 93%) was used to calculate the confidence interval. The formula for this is:

0,93 +/- 1,96 * √ (0,93*0,07/ number of patients)

Based on statistical theory (the binomial distribution), a minimum value and a maximum value were calculated for this percentage, the lower limit and the upper limit of the confidence interval. It was known with some certainty (it is assumed 95%) that the 'true' percentage is in the confidence interval (www.rogatio.nl). This is done for 30 patients, 50 patients, 100 patients, 500 patients and 1000 patients.

3.2. DATA COLLECTION AND DATA ANALYSES

This research consisted of different research methods, both quantitative and qualitative, explained in 3.1. The main method of research was quantitative, analyzing a sample of the database of patient statuses of chest pain patients from the FTP of the EMC.

Qualitative research methods were conducted to give an answer to sub-question 1; '*What tests are conducted by chest pain patients at the FTP and which and how many specialists are present at each test'*. Therefore the current diagnostic process could be described. This first part of the results is presented in chapter 4.

Chapter 4 started with a justification of the qualitative research methods. Than the description of the current care process is given, including the phases of the process, the present specialists and processing time per test.

In chapter 5 the quantitative descriptive analyses of a sample of the patient statuses were conducted to give an answer on the sub-questions 2 and 3;

'*What is the average processing time between referral by the GP or an internal department of the Erasmus Medical Centre and diagnosis in the Erasmus Medical Centre?'* and *'What is the percentage of patients with chest pain where stenoses are found during the diagnostic process?*

The database used is called Elpado. This database includes all data of patients who visited the FTP. A data extraction form has been prepared to obtain the required information in a quick and easy way (annex 6). The answers of the questions of the data extraction form were found in the patient files. For each patient in the sample a form is filled in. The code book of the data extraction from is attached in annex 7.

The first part of the data extraction form addressed the specific characteristics of the patient, such as age, sex, weight, type of symptoms and risk factors for CAD.

Subsequently, all important data were listed on the data extraction form, such as the date of referral, who the referrer is, date of first visit, date of last consultation and the date of final results. These data are all calendar data. If applicable, also the date of catheterization was included. This allowed calculation of processing times and waiting times, which made it possible to answer sub-question 2. To answer sub-question 2b the associations have been calculated, using the correlation coefficient and the chi-squared test.

Thereafter, all the standard tests were included in the data extraction form with the question if and when the patient has undergone the test. This examined how many patients perform each test.

Finally, the results of prognostic procedures were very meaningful. Were the results of the test positive or negative and is the patient diagnosed with CAD, based on the information of the patient files. Sub-question 3 was answered by the results of this part of the data extraction form.

There have been examined how many patients after completion of the care process have received a negative result, so do not have CAD, and how many patients are established with CAD. Also the false-negative and false-positive values are examined based on the information of the patient statuses, so the specificity and the sensitivity of the tests is determined. The number of patients where no abnormalities are detected after cardiac catheterization and sent home, so unjustly catheterized, are also examined.

The collected data collected were put into an Excel spreadsheet. The descriptive analyses have been performed in Excel. The CCA was conducted after the analysis of the patient statuses to answer sub-question 4.

Chapter 5 started with a description of the patient population, based on the criteria of 3.1.3.

The number of men and women in the sample, the average age of the sample and the highest and the lowest values are described. The number and kind of risk factors have also been described as well as type of symptoms.

Then the processing time and waiting time of the patients in the sample have been analyzed, and the percentages of patients whose waiting time and processing time passed within the Treek standard.

Next, an overview is given of the percentage of patients who have undergone a particular test, because not all patients undergo all (same) tests. Thereafter, the results of the tests have been described.

Then associations of the waiting time and the patient characteristics have been calculated, explained in 3.1.2, tested the hypotheses of the theoretical framework. Thereafter the power of the correlations using the confidence interval for a percentage and the confidence interval for the comparison of two means have been calculated, also explained in 3.1.2. The chapter concludes with the cost-consequences table.

3.2.1. PROCESSING TIMES

In sub-question 2, the processing times, the following definitions have been used.

Waiting time (access time):	Time elapsed from time of referral by GP or intern specialist to the first visit of the outpatient clinic Cardiology.
processing time A (diagnosis time):	Time elapsed from the first visit to the outpatient clinic Cardiology to the time of the consult where the Cardiologist inform the patient about the diagnosis.
processing time B (letter to GP/ intern specialist):	Time elapsed from the first visit to the outpatient clinic Cardiology to the final diagnosis letter to the GP or internal department of the EMC.

Mentioned in the theoretical framework, the maximum acceptable waiting times, also called Treek standards, are four weeks for an outpatient clinic in the Netherlands. The Treek standard for the processing time is also four weeks (Busch 2006).

For this purpose, processing time B have been used. In this study, this mean that the time between referral and first visit to the outpatient clinic (access time) may be up to four weeks and that the time between first consultation to the final diagnosis letter to the GP or intern department according to the Treek standards also may be up to four weeks.

3.2.2. MISSING VALUES

Missing values, for example the date of referral was not known, were coded 99999 in Excel. These missing values have been filtered from the spreadsheet in Excel before the analyses occurred. Questions which were not applicable, for example the date of catheterization because no CAD is established in the patient, were coded 88888. These values were arbitrary.

3.3. VALIDITY AND RELIABILITY OF THE STUDY

3.3.1. VALIDITY

The validity indicates if there is measured what was intended to measure (Imbos, 1996). It refers to the extent the research design enables the researcher to establish valid conclusions. The validity can be divided into two types: internal validity and external validity. Internal validity is the extent to which the arguments flawed in relation to the data (Boeije 2005). The internal validity is high if the resulting conclusions are valid for the studied population. Internal validity was applied in this study, because research occurs in the practical situation. External validity is the extent to which the statement is generalizable (Boeije 2005). This research focused on the process of care of chest pain patients on the FTP of the Erasmus MC. These results applied only for the Erasmus MC and generalization to other hospitals is not possible. However, with the aid of the research design the research can simply be reproduced for the same patient population in another hospital.

3.3.2. RELIABILITY

Reliability is also divided into two types, internal and external reliability. The reliability is the degree of internal consistency (Boeije 2005). The research results are then as little as possible dependent on random errors (Bouter & van Dongen 2000). Applying method triangulation has increased the internal reliability. Qualitative and quantitative methods were used. The external reliability is the extent to which the research is reproducible (Boeije 2005). To increase the external reliability the research design has been followed as well as possible.

4. RESULTS DIAGNOSTIC CARE PROCESS

4.1. JUSTIFICATION QUALITATIVE RESEARCH METHODS

In this Chapter the current care process of chest pain patients of the FTP AP is described, using the three qualitative research methods which are also described in the methods section; participatory observations, literature review and interviews/ conversations.

In total, three mornings participatory observations were done. The first morning the observations were unstructured, to analyze the procedures of the nurse specialist who leads the FTP AP.

The way the tests conducted in practice, how the morning proceeds for the patients, was explained the second morning. The anamnesis and MSCT scan were also attended this morning. During the observation of the anamnesis the questions the nurse specialist proposes to the patient were observed. Information was still missing after elaboration of these data, because only the anamnesis and the MSCT scan were attended. The other tests have been observed the third morning, following one patient and using structured observations. The patient's view of the process has been determined by these observations. All tests the patient underwent have been attended. Questions were addressed to the patient and the attended specialists during the tests.

A literature review occurred in addition to the participatory observations. The articles delivered by K. Bruin were Nieman et al (2011) and Koppelaar et al (2008). Two relevant articles were found on Google with the keywords 'Angina Pectoris' 'ECG' 'heart disease' and 'diagnostic process'. The articles were from Nienhuis et al (2002) and Aaldijk (2009).

Finally, conversations/ interviews were conducted during and after the participant observations. The conversations were mainly with Mr. P.J. Musters, nurse specialist of the FTP AP. Also conversations were conducted with the laboratory technician, the cardiac technician and the radiologist. These conversations were conducted during the three mornings. One additional morning was spent interviewing Mr. P.J. Musters.

In total four interviews were conducted. The first interview was completely unstructured. None of the four features of structuring were present. After elaboration of this interview, there were still questions unanswered. Prior to the second interview questions and the order of the questions were prepared. This is defined as a semi- or half structured interview (Boeije 2005).

During the last interview only information to complete the data collection on the current diagnostic process was requested. This interview was defined as a structured interview.

Three research methods were used in combination with each other and a literature review were done prior to the observations. Therefore, only three participatory observations and four interviews were necessary to describe the entire diagnostic process for chest pain patients and to answer sub-question 1.

4.2. DESCRIPTION CARE PROCESS

The GP or specialist registers the patients. A written invitation of the FTP AP is sent to the patient with the program of the FTP AP (table 3) after determination of the correct criteria. In addition, the patient receives a questionnaire, which should be completed before the visit. The questions are about complaints of chest pain and their (medical) history (Aaldijk 2009). The FTP-AP takes place twice a week, on Wednesdays and Fridays.

The nurse assesses if there are certain preparations necessary for the patient in connection with their personal situation (eg comorbidity, specific questions) based on the information provided by the referring physician. The use of medication that could affect the outcome of a test (eg beta-blockers in the XECG) or the safety of the test (eg use of metformin or contrast sensitivity in relation with the administration of X-ray contrast fluid at MSCT) is also important information to know.

Table 3: Route Fast Track outpatient clinic Angina Pectoris (Koppelaar et al 2008).

Phase 1	- Blood test - ECG - Including measuring blood pressure, weight, height and waist circumference
Phase 2	Standardized anamnesis by nurse specialist - Medical history - Identifying symptoms of chest pain - Identify risk factors for cardiovascular disease - Calculation of pretest probability of coronary artery disease
Phase 3	- Physical examination - (Echocardiogram)
Phase 4	- Exercise test (XECG)
Phase 5	- Dual source 64 Slice Computer Tomografie (MSCT)
Phase 6	- Discuss results

4.3. PHASE 1: BLOOD TEST AND ECG

The day of the visit, the patient has to be sober at the FTP-AP at 8:00 am. Patient information and test forms are ready the morning before consultation starts. The patient must report to the main desk, and is forwarded to the waiting room for the blood test and ECG, including measuring height, weight, waist circumference and blood pressure (Phase 1). Table 4 shows the average processing time of each test and the specialists who are present at each test. The patients are randomly sent to the blood test and the ECG. In one patient first a blood sample is obtained and the other person first undergo an ECG. Therefore the sequence between these two tests may vary by patient (Aaldijk 2009).

The blood sample is immediately taken to the laboratory to analyze renal function, cholesterol and blood sugar. Adequate renal function is essential for CT examination, which will be conducted the same morning. Therefore priority treatment is required for this analysis and should be agreed with the laboratory. The blood samples with priority are marked with a red cap. Within the hour of collection, the results are known at the Cardiology department.

Using the ECG, the left ventricular function and the presence of aortic valve stenosis will be examined in particular. Also the weight, waist circumference, blood pressure and the length of the patient will be examined by the ECG technician in this room. After the blood test, ECG and determination of patient characteristics, the first phase is completed.

The patient is requested to return to the waiting room at the main desk and is now allowed and even recommended to eat. Drinking coffee, tea, chocolate or other drinks with caffeine is not permitted in relation to the influence of the XECG.

4.4. PHASE 2: ANAMNESE

With the information of the first tests the patient visits the nurse specialist Cardiology for review of the questionnaire and medical history. The standardized anamnesis consists of several parts: the medical history and an analysis of the risk factors for heart disease (Aaldijk 2009). In addition, the symptoms of chest pain are classified in non-anginal AP, atypical AP or typical AP complaints. The risk of significant CAD (stenosis greater than 50%) can be calculated using this format combined with age and gender (Nienhuis et al 2002).

4.5. PHASE 3: PHYSICAL EXAMNINATION

A brief physical examination will sometimes be conducted after the consultation, consisting of listening to the heart and lungs. This only occurs if the consultation provides insufficient clarity for the nurse specialist about the symptoms of the patient, or if there is uncertainty about the severity of the symptoms. This can be due to a language barrier or another reason why the patient cannot express their complaints. Another reason is a not completed filled in questionnaire.

An echo is not included in the standard procedure for the Fast Track patients, and only occurs on indication.

4.6. PHASE 4: XECG

the XECG will be obtained after the physical examination according to the standard procedure. The nurse specialist accompanies the patient to the waiting area for the XECG. The XECG illustrates the condition of the patient, whether exertional chest pain arises, the course of the blood pressure and heart rate, and whether there are signs of hypoxia on the ECG. The ECG is continuously monitored and blood pressure is measured periodically (Nienhuis et al 2002).

4.7. PHASE 5: MSCT

The standard procedure concludes a MSCT, whereby the heart and coronary arteries will be visualized with contrast (Aaldijk 2009). A calcium score will be calculated according to the Agatston method (a calculation method for the approximate amount of calcification). This requires no contrast administration and the amount of radiation is low. During the complete scan the presence or absence of significant stenoses will be examined using illustrations obtained with contrast fluid. The load of radiation is higher here. Afterwards, the radiologist immediately reviews the scan.

4.8. PHASE 6: OUTCOME DIAGNOSTIC PROCESS

The Fast Track team discusses the results after finishing the tests early in the afternoon. This team consists of a cardiologist, possibly a cardiologist in training, the nurse specialist and a secretary. The cardiologist and the nurse specialist then discuss the results and follow-up with the patient. If there are no stenoses seen at the MSCT, it is stated with 99% certainty that there are no abnormalities in the coronary artery.
This has been sufficiently demonstrated in scientific research involving invasive coronary angiography as golden standard (Weustink et al 2007).

If the MSCT demonstrates deviations, the follow-up depends on the extent of the defect in relation with the results of the other tests and complaints. When there are no significant stenosis or lesions then drug treatment is decided. In case of a significant stenosis at an important place a coronary angiography (CAG) will usually be performed. This is in order to determine the extent of the abnormalities. Also a proposal for further treatment will be determined: Percutaneous Coronary intervention (PCI[7]), Coronary Arterial Bypass Grafting (CABG[8]), medical treatment or no treatment.

A PCI is preferred for patients with one or two vessel stenoses, because in these cases PCI gives the same results as CABG, and because of the simplicity of the procedure and the low risk of mortality and complications. A CABG gives better results for some patients with multivessel stenoses, more improvement in survival, and repeated interventions are avoided due to restenosis.

Table 4: present specialists and processing time per test (Tijdhof 2006).

	Duration of the test (in minutes)	**Present specialists**
Blood test	10	Laboratory technician
ECG (including determining blood pressure, height, weight and waist circumference)	15	Laboratory technician
Consultation/ physical examination	20	Nurse specialist
Exercise test (XECG)	30	2 cardiac technician
MSCT	20	Radiologist and 2 assistants
Echo	30	Echo technician and physician assistant/ Cardiologist

[7] The management of coronary artery occlusion by any of various catheter-based techniques, such as percutaneous transluminal coronary ANGIOPLASTY, ATHERECTOMY, angioplasty using the excimer laser, and implantation of coronary STENTS and related devices.

[8] A form of bypass surgery that can create new routes around narrowed and blocked coronary arteries, permitting increased blood flow to deliver oxygen and nutrients to the heart muscle. Coronary artery bypass graft is an option for selected groups of patients with significant narrowings and blockages of the heart arteries.

5. RESULTS ANALYSES PATIENT STATUSES

5.1. DESCRIPTION OF THE POPULATION

The study population consists of 54 patients of which 67% males (N=36) and 33% women (N=18). The average age of the selected patients is 54 years with a minimum of 26 years and a maximum of 79 years and a standard deviation of almost 12 year. Of these patients, 61% (N=33) referred by the GP and 39% (N=21) by an internal department within the EMC. 20,4% (N=11) of the 54 selected patients are classified with typical anginal symptoms, 68,5% (N=37) with atypical angina and 11,1% (N=6) with non-cardiac symptoms. The average BMI of the study population is 26,8 with a minimum of 18,8 and a maximum of 39,4. The risk factor which occurred the most in the sample is hypertension (N=25), and the least common risk factor is hyperlipidemia (N=3). All these data are summarized below (table 5).

Table 5: Characteristics of the study population

Variables	**Number**	**Percentage %**
Gender:		
- Men	36	67%
- Women	18	33%
Way of referral:		
- GP	33	61%
- internal	21	39%
Age:	average 54 year	Standard deviation 11,8
- (minimum –maximum)	(26 – 79) jaar	
BMI:	average 26,8	Standard deviation 4,4
- (minimum –maximum)	(18,8 – 39,4)	
Type of complaints:		
- typical	11	20,4%
- atypical	37	68,5%
- Non-cardiac	6	11,1%
Risk factors:		
- Smoking	16	29,6%
- Overweight	7	13%
- Obesity	13	24,1%
- Hypertension	25	46,3%
- Family history	20	37%
- Dyslipidemia	14	25,9%
- Hyperlipidemia	3	5,6%
- Diabetes	7	13%
- hypercholesterolemia	14	25,9%

5.2. WAITING TIME

The waiting time is the time elapsed from time of referral by GP or intern specialist to the first visit of the outpatient clinic Cardiology. In 14 patients, the date of referral is unknown and is defined as missing and is therefore disregarded for the analysis of the waiting time. As a result, there are 40 patients included for the analysis of waiting time, 22 patients referred by GP and 18 patients referred by an internal department.

Table 6: Waiting time of the study population

Waiting time (in days)	GP (N=22)	Internal department (N=18)	Overall (N=40)
Mean	28,7	43,3	35,3
Highest value	85	107	107
Lowest value	2	9	2
Standard deviation	19,5	27,5	24,3

The average waiting time is more than 35 days, with a standard deviation of 24,3. The average waiting time for the GP is almost 29 days and for the internal department more than 43 days. The average of the internal department is considerably higher than the average of the GP. The same applies for the standard deviation, here is also a large difference between internal department and GP. By the internal department are two outliers[9] for waiting time, one of 107 days and one of 101 days. The next highest waiting time is 66 days, which is a large difference with 107 and 101 days. By the GP is one outlier of 85 days. The next highest waiting time for the GP is 58 days.

The large differences in average and standard deviation could have two causes. It might be due to the limited number of patients redirected internally by which the analyzes could be performed because of the missing links. The larger the number of patients the more reliable the statements are.

Another reason for the high average of the internal department could be the presence of outliers. At the internal department are 2 outliers measured, which includes also the highest overall value measured.

[9] An outlier is a statistical observation that is markedly different in value from the others of the sample (Merriam-Webster 2013)

At the GP is 1 outlier measured, which is lower than both outliers of the internal department. This might explain why the standard deviation at the internal is much higher than of the GP.

Figure 1: Overall waiting for patients at the FTP AP

Table 7: Waiting period within the Treek standards

Waiting period within the Treek standards	Number of patients (N)	Percentage (%)
GP (N=22)	13	59,1%
Internal department (N=18)	6	33,3%
Total (N=40)	19	47,5%

For 19 patients of the 40 patients included was the waiting period within the Treek standards, of which 33,3% (N=6) of the internal department and 59,1% (N=13) of the GP. This is in line with the expectations after the analysis of the previous table; the average waiting time of the internal department (43,3 days) went well above the norm of 28 days. The average waiting time of the GP is only almost 1 day (28,7 days) above the Treek standard. Given the lower number of patients is optimal comparison not possible.

5.3. PROCESSING TIME

5.3.1. PROCESSING TIME A

Processing time A does not contain missing data, so all 54 patients were included. Processing time A is the time elapsed from the first visit to the outpatient clinic Cardiology to the time of the consult where the Cardiologist inform the patient about the diagnosis.

Table 8: Processing time A

Processing time A (in days)	GP (N=33)	Internal department (N=21)	Overall (N=54)
Mean	3,4	3,5	3,4
Highest value	39	36	39
Lowest value	0	0	0
Standard deviation	9,5	9,1	9,3

The average overall processing time is 3,4 days. The lowest value is 0 days, which means that all tests were conducted and the results are communicated to the patient in 1 day. The highest processing time A is 39 days, of a patient referred by the GP. The second highest value is 36 days, for a patient referred by an internal department of the EMC. The patient with the longest processing time A, 39 days, is due to allergy to contrast which is used during the MSCT scan. Therefore the scan occurred some weeks later after treatment with prednisone. The patient of the internal department with the longest processing time of 36 days is due to the occurrence of the echo another day than the other tests. The cause is not known. This might explain the large standard deviation of 9 days.

Nevertheless, the average of the GP with as three highest values 39, 35 and 20 days is slightly lower than the average of the internal department with the three highest value 36, 22 and 10 days for processing time A. This has probably to do with the number of observations. The analysis of processing time A consists of 33 patients referred by GP and 21 referred by an internal department of the EMC. An increase in the number of patients with a processing time of 1 day, will decrease the average. This explains the higher standard deviation of the GP than for the internal department.

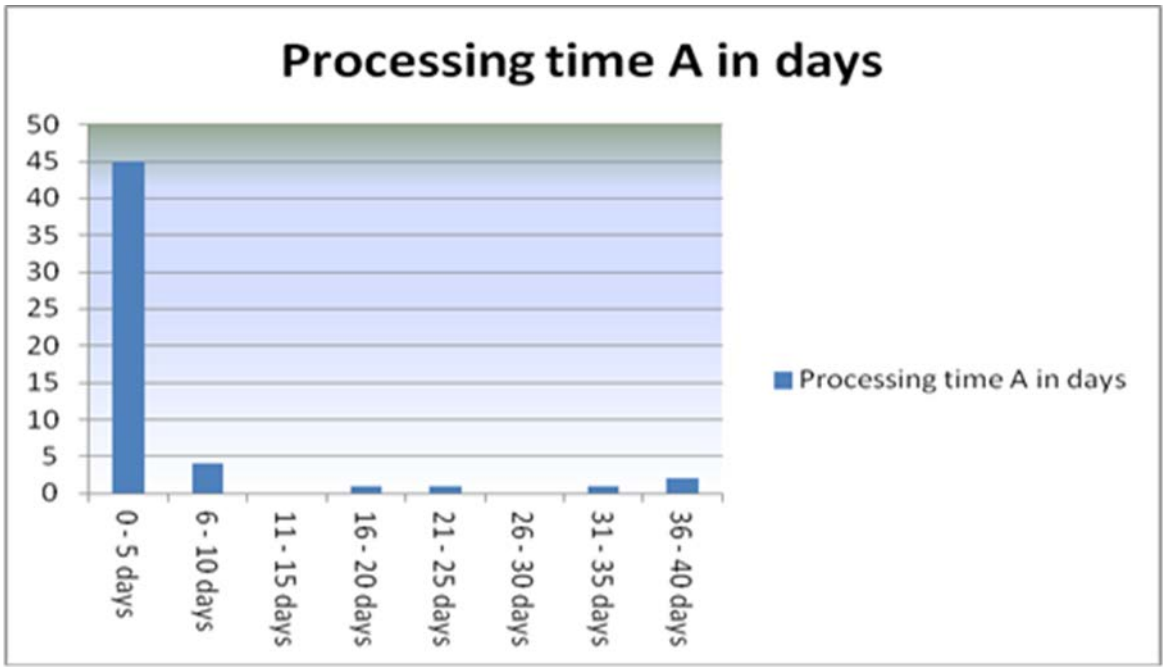

Figure 2: Processing time A for patients of the FTP AP

Table 9: Fast Track within 1 day

Fast Track within 1 day	Number of patients (N)	Percentage (%)
GP (N=33)	28	84,9%
Internal department (N=21)	17	81%
Total (N=54)	45	83,3%

There is a slightly difference between the average processing time of the GP and the internal department. But there is a large variation within processing time A of the patients of the GP and internal department. 45 of the 54 patients (83,3%) passed the Fast Track within one day. 28 of the 33 patients referred by the GP (84,9%) and 17 of the 21 from the internal department (81%) passed the Fast Track within 1 day.

5.3.2. PROCESSING TIME B

Processing time B is, also described previously, the time elapsed from the first visit to the outpatient clinic Cardiology to the final diagnosis letter to the GP or internal department of the EMC. The Treek standard of the processing time is also four weeks. This relates to processing time B. For all patients in the study it was possible to determine the processing time out of the patient file. As a result, all 54 patients are involved in the analysis of processing time B.

Table 10: Processing time B

Processing time B (in days)	GP (N=33)	Internal department (N=21)	Overall (N=54)
Mean	10,9	12,3	11,5
Highest value	44	48	48
Lowest value	0	0	0
Standard deviation	12,3	11,9	12,1

The processing time B varies from 0 days to 48 days. The average processing time is about 12 days. For patients of the GP, this is from 0 to 44 days with an average of almost 11 days and for the internal department 0 to 48 days, with an average more than 12 days. 0 days also means here that the time elapsed from the first visit to the outpatient clinic Cardiology to the final diagnosis letter to the GP or internal department of the EMC were conducted within 1 day.

There is almost no difference between the processing time of GP and internal department of the EMC. By the waiting time this was not the case.

The longest processing time B for GP is 44 days. This period is for the same patient with the longest processing time A of 39 days. For the internal department this also applies. The patient with the longest processing time B of 48 days also has the longest processing time A of 36 days.

The standard deviation is a bit higher for processing time B than for A, this applies for both the GP and intern. This is also due to the large variation in the highest and lowest values (see table 10).

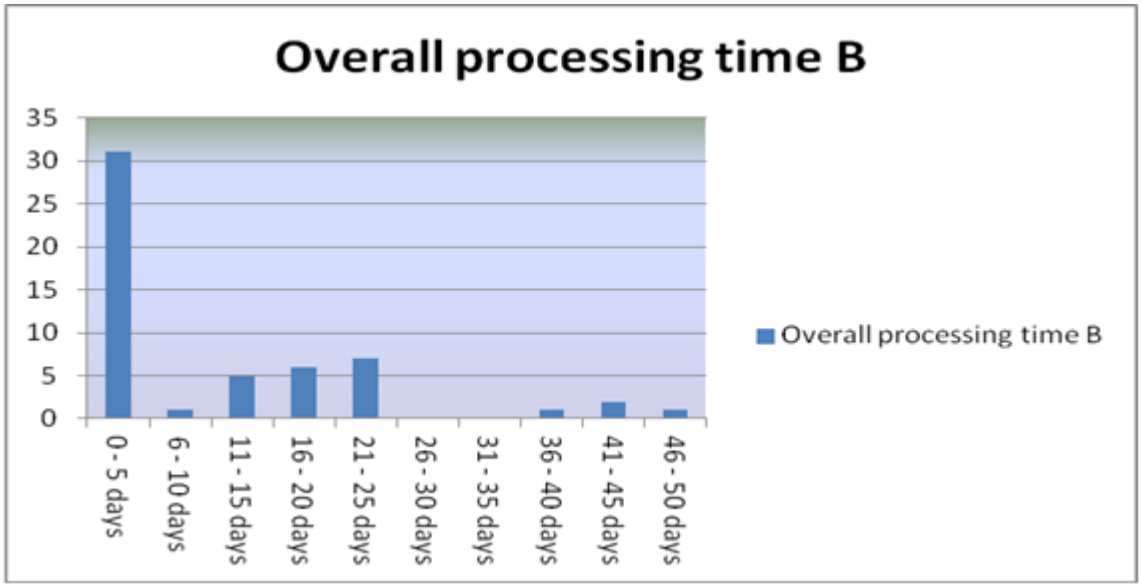

Figure 3: Processing time B for patients of the FTP AP

Table 11: Processing time within the Treek standards

Processing time B within the Treek standards	Number of patients (N)	Percentage (%)
GP (N=33)	30	90,9%
Internal department (N=21)	20	95,2%
Total (N=54)	50	92,6%

Processing time B is for 50 of the 54 patients (92,6%) within the Treek standards; 95,2% (N=20) of the internal department and 90,9% (N=30) of the GP. This is in line with the expectations given the previous table. The average processing B is for both the GP and internal department far below the Treek standard. The highest values for both groups are well above the norm, but given the wide standard deviation and findings, this is caused by the outliers. This results in a large number of patients progressed the process within the Treek standards.

5.4. THE CARE PROCESS

The diagnostic process consists of several steps. But not every patient undergo each examination. This table provides an overview of the number and percentage of patients who undergo a particular examination.

Table 12: Overview of the number and percentage of patients that passed a test.

Tests	Number	Percentage (%)
Lab	54	100%
ECG	53	98,2%
Echo	13	24,1%
Consult	54	100%
XECG	52	96,3%
MSCT	54	100%
2e consult	54	100%

Only 13 patients undergo an echo. 1 patient did not undergo an ECG. 2 patients did not an XECG. Furthermore, all patients completed all tests.

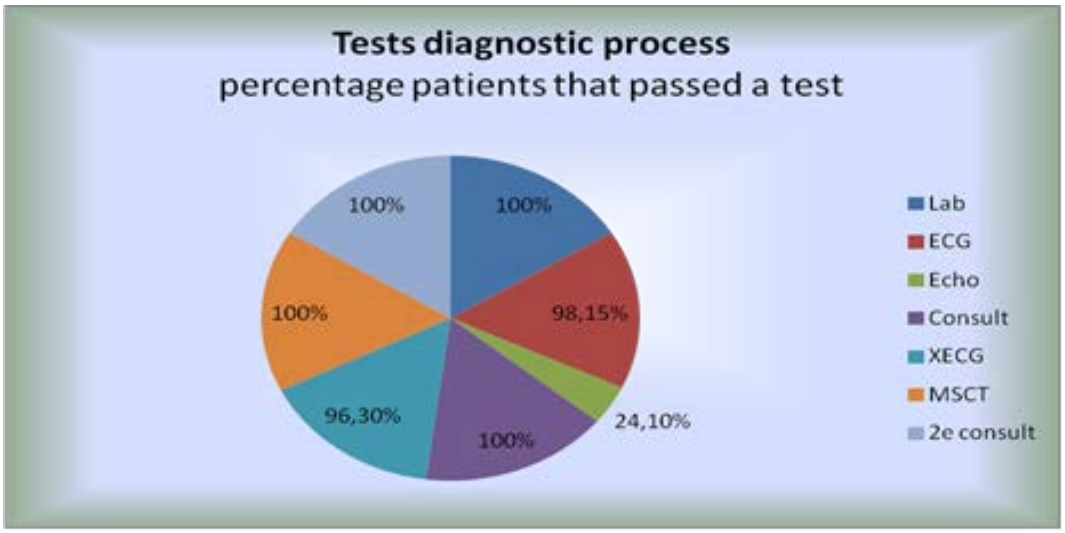

Figure 4: percentage of patients that passed a test of the FTP AP

5.5. RESULTS OF THE TESTS

5.5.1. CHARACTERISTICS OF THE PATIENTS WITH CORONARY ARTERY DISEASE

Table 13: characteristics patients with coronary artery disease

	Number of patients with positive CAD diagnosis (N)	Percentage of patients with CAD pertaining to total study population %	Percentage of patients with CAD pertaining to subgroup%	Percentage of patients with CAD pertaining to number of diagnosed CAD patients %
Determined coronary artery disease	**8**	**14,8%**	**-**	**100%**
Type of CAD: - 1-vessel CAD - 2-vessel CAD - 3-vessel CAD	 4 1 3	 7,4% 1,9% 5,6%	 - - -	 50% 12,5% 37,5%
Gender: - Men (N=36) - Women (N=18)	 6 2	 11,1% 3,7%	 17,1% 11,1%	 75% 25%
Age: - (minimum-maximum) 26 – 50 year (N=23) 51 – 70 year (n=31)	Average 56 year (26 – 70) year 2 6	Standard deviation 14,5 year 3,7% 11,1%	 8,7% 19,4%	 25% 75%
Type of complaints: - Typical (N=11) - Atypical (N=37) - Non-cardiac (N=6)	 5 2 1	 9,3% 3,7% 1,9%	 45,5% 5,4% 16,7%	 62,5% 25% 12,5%
Risk factors: - Smoking (N=16) - Overweight (N=7) - Obesity (N=13) - Hypertension (N=25) - Family history (N=20) - Dyslipidemia (N=14) - Hyperlipidemia (N=3) - Diabetes (N=7) - Hypercholesterolemia (N=14) Risk factors per patient: - 0 – 2 (N=28) - 3 – 5 (N=9) - 6 of meer (N=0)	 2 3 2 6 4 2 1 3 6 1 7 0	 3,7% 5,6% 3,7% 11,1% 7,4% 3,7% 1,9% 5,6% 11,1% 1,9% 13% 0%	 12,5% 42,9% 15,4% 24% 20% 14,3% 33,3% 42,9% 42,9% 3,6% 77,8% 0%	 25% 37,5% 25% 75% 50% 25% 12,5% 37,5% 75% 12,5% 87,5% 0%

8 of the 54 patients are established with CAD after completion of the standard care program. 4 of this 8 patients are suffering from 1-vessel CAD, 1 patient has 2-vessel CAD and 3 patients suffering from 3-vessel CAD. Of the 8 patients were 6 men and 2 women. The average age of the diagnosed patients was 56 years with a minimum of 26 and a maximum of 70.

There is a wide standard deviation of 14,5 years due to this large variation in terms of age. The major part of diagnosed patients (N=5) has typical symptoms, which was also expected because these complaints are part of angina pectoris. 2 patients have atypical symptoms and 1 has patient non-cardiac symptoms. The risk factors, which are most present in the patients with CAD, are hypertension (N=6), hypercholesterolemia (N=6) and family history (N=4) (see table 13).

5.5.2. TYPE OF CAD AND WAITING TIME

The 8 patients with CAD, already discussed above, exists of 4 patients with 1-vessel CAD, 1 with 2-vessel CAD and 3 with 3-vessel CAD. For 1 of this 8 patients is the waiting time missing, and therefore is the analysis based on 3 patients with 1-vessel CAD, 1 patient with 2-vessel CAD and 3 patients with 3-vessel CAD, making the analysis of 2 vessel CAD not possible. The average waiting time of the three patients with 1-vessel CAD is 50,3 with a minimum of 7 and a maximum of 107. 107 days is also the highest overall waiting time. The waiting time of the patient with 2-vessel CAD is 43 days. The average waiting time of the three patients with 3-vessel CAD is 31 days, with a minimum of 13 days and a maximum of 43 days (table 14).

Table 14: waiting time and type of CAD

Waiting time	Mean	Minimum	Maximum	St. Deviation
1-vessel CAD (N=3)	50,3	7	107	51,3
2-vessel CAD (N=1)	-	-	-	-
3-vessel CAD (N=3)	31	13	43	15,9
Total (N=4)	44	7	107	33,7

For only 2 of the 7 patients whose waiting time is known is the waiting time within the Treek standard; for 1 patient with 3-vessel CAD and 1 patient with 1-vessel CAD.

5.5.3. TYPE OF CAD AND PROCESSING TIME B

About the patients with 2-vessel CAD no statements can be made because N=1. The average processing time is two times longer in patients with 3-vessel CAD than patients with 1-vessel CAD. All 4 patients with 1-vessel CAD have a processing time of 5 days. The patient with 2-vessel CAD has a processing time of 4 days. 2 of the 3 patients with 3-vessel CAD also have a processing time of 5 days like the 1-vessel CAD patients, and 1 patient has a processing time of 23 days, which leads to an increase of the average. This also explains the large standard deviation (table 15). So processing time B is for all 8 patients within the Treek standard.

Table 15: Processing time B and type of CAD

Processing time B	Mean	Minimum	Maximum	St. Deviation
1-vessel CAD (N=4)	5	5	5	0
2-vessel CAD (N=1)	-	-	-	-
3-vessel CAD (N=3)	11	5	23	10,4
Total (N=8)	7,1	4	23	6,4

5.5.4. XECG AND MSCT

It is possible that some tests, such as the XECG and the MSCT scan, are inconclusive and therefore cannot provide conclusive answers or conformation for coronary artery disease. The number of inconclusive XECGs and MSCT scans are summarized below.

Table 16: Inconclusive tests

Inconclusive tests	number	Percentage %
XECG (N=51)	8	15,7%
MSCT (N=54)	1	1,9%

In total 9 of the 51 XECGs are inconclusive. The XECG is inconclusive by 1 patient with CAD, and 7 times inconclusive by patients with no established CAD. Not achieving the Target Heart Rate (THR) is in all 9 patients the cause of the inconclusive test. During the test the THR has to be 85% or more relative to the standard. All 9 patients did not comply to this standard.

There is 1 MSCT scan inconclusive. The MSCT is inconclusive in a patient were no CAD is established.

5.5.5. CORONARY ARTERY DISEASE

5.5.5.1. CORONARY ARTERY DISEASE ESTABLISHED

In total there are 8 patients diagnosed with CAD after the standard care process. All these patients have undergo a XECG and a MSCT. In 5 patients the XECG was positive. This was actually in 4 patients, and in 1 inconclusive, but despite the inconclusive XECG, there were signs of ischemia during the test and evaluate the XECG positive. Later it turns out this patient suffers from 3-vessel CAD. This explains why the test despite inconclusive is reviewed as positive. In 2 of the 8 patients the XECG was negative, so afterwards false-negative. The XECG was inconclusive in 1 patient with CAD. The MSCT scan gave a positive result in all 8 patients (see table 15).

Table 17: Results of XECG and MSCT by patients diagnosed with CAD

Patients with positive CAD diagnosis (N=8)	**XECG**	**MSCT**
positive	5 patients	8 patients
negative	2 patients	0 patients
inconclusive	1 patient	0 patients

5.5.5.2. NO CORONARY ARTERY DISEASE ESTABLISHED

In 45 patients there is no CAD determined after the care process, The reason that only in 33 patients both results indicate a negative value, and in 12 patients do not, has a number of reasons:

- In 7 patients the XECG is inconclusive, which is not taken into account.
- 2 patients with a false-positive XECG
- In 2 patients the results of the XECG are unknown
- In 1 patient the MSCT scan is inconclusive.

The sum of that is 12, and 45 minus 33 is 12. (see table 18).

Table 18: Results of the XECG and MSCT by patients without CAD

Patients without CAD (N=45)	**XECG**	**MSCT**
positive	2 patients	0 patients
negative	34 patients	44 patients
inconclusive	7 patients	1 patients
unknown	2 patients	0 patients

2 XECGs can be detected as false-positive. In total there are 7 positive XECG measured. Just 5 of these patients are diagnosed with CAD. This shows that there are 2 false-positive XECGs. This can be confirmed by the information from the medical files. The MSCT scan demonstrates no false-positive or false-negative values (table 19).

Table 19: The XECG and MSCT by patients with and without CAD

Established coronary artery disease	Number **8**	Percentage (%)
XECG + MSCT positive	5	62,5%
XECG positive	5	62,5%
MSCT positive	8	100%
Neither of the 2 positive	0	0%
No coronary artery disease established	**45**	
XECG + MSCT positive	0	0%
XECG positive	2	4,5%
MSCT positive	0	0%
Neither of the 2 positive	33	73,3%

5.5.6. OPTIONS FOR TREATMENT CORONARY ARTERY DISEASE

In total, 15 patients prescribed medication after the diagnostic care process, consisting of all 8 patients with established CAD, 6 patients with no CAD and 1 patient where this is still unknown (table 18). The patient where CAD is still unknown had an inconclusive XECG and inconclusive MSCT, so providing a diagnosis was not possible.

7 patients have been catheterized. In 5 of these patients CAD is established, 1 patient with no established CAD, and by 1 patient it was still unknown. All 7 patients who are catheterized have also been prescribed medication (table 20).

Of the 4 patients with 1-vessel CAD is only 1 patient catheterized followed by a PCI. The other 3 patients only prescribed medication. So 3 patients with CAD only prescribed medication, no invasive treatment.

The patients with 2-vessel CAD undergo a PCI after catheterization.

Of the 3 patients with 3-vessel CAD, 2 patients undergo a PCI and 1 patient a CABG after catheterization. In total, 4 PCI's and 1 CABG's are performed after catheterization.

In total 7 patients are catheterized. 5 of these patients have CAD and undergo a PCI or CABG.

In 2 patients no significant stenosis for which invasive treatment was needed are detected during catheterization. These patients are defined as wrongly diagnosed (table 20).

Table 20: options for treatment

	Number	Percentage (%)
Medication: - CAD established (N=8) - No CAD established (N=45) - CAD unknown (N=1)	Total 15 8 6 1	27,8% 53,3% 40% 6,7%
Catheterized: - CAD (N=8) - No CAD (N=45) - CAD unknown (N=1)	Total 7 5 1 1	13% 71,4% 14,3% 14,3%
PCI: - 1-vessel CAD (N=4) - 2-vessel CAD (N=1) - 3-vessel CAD (N=3)	Total 4 1 1 2	7,4% 25% 25% 50%
CABG: - 1-vessel CAD (N=4) - 2-vessel CAD (N=1) - 3-vessel CAD (N=3)	Total 1 0 0 1	1,9% 0% 0% 100%
Unjustified catheterized*	2	28,6%

**In this study the term unjustified catheterized means that the patient after catheterization is not further treated by PCI or CABG, so an invasive treatment. Drug treatment is not included.*

5.6. CORRELATIONS WAITING TIME AND CHARACTERISTICS OF THE PATIENTS

The correlation between waiting time and the patient characteristics includes gender, age, type of complaints and risk factors. In 14 patients, the date of referral is unknown so there are 40 patients included for the correlation between the waiting time and the characteristics of the patients, consisting of 29 men and 11 women. There are 18 patients among the age category 26 to 50 and 22 patients among the age category of 51 to 79 year. Most patients have atypical symptoms (N=27), and just a few with typical (N=10) or non-cardiac (N=3) symptoms.

The average waiting time for men in the sample is almost 38 days and for women more than 28 days. The maximum is very high for men, 107 days, resulting in a higher standard deviation than for women, where the maximum is 43 days.

The average waiting time for patients in the age group 26 – 50 years is more than 38 days with a maximum of 107 days and for the age group 51 – 79 years this is 33 days with a maximum of 85 days.

The waiting time for patients with typical symptoms is on average almost 30 days, in patients with atypical symptoms more than 39 days and for patients with non-cardiac symptoms almost 17 days.

Patients with 0 to 2 risk factors for CAD have an average waiting time more than 34 days, patients with 3 to 5 risk factors have an average waiting time of almost 38 days (table 21).

Table 21: Correlation waiting time and characteristics of the patients.

Waiting time (N=40)	Mean	Minimum	Maximum	St. deviation
Gender: - Men (N=29) - women (N=11)	 37,8 28,6	 2 9	 107 43	 27,2 12,6
Age: - 26 – 50 year (N=18) - 51 – 79 year (N=22)	 38,1 33	 2 7	 107 85	 29,2 19,8
Type of complaints: - Typical (N=10) - Atypical (N=27) - Non-cardiac (N=3)	 29,9 39,3 16,7	 2 9 9	 64 107 28	 21,1 25,6 10
Risk factors - 0 – 2 (N=29) - 3 – 5 (N=11) - 6 of meer (N=0)	 34,3 37,7 -	 2 7 -	 101 107 -	 23,1 28,1 -

5.6.1. CORRELATION COEFFICIENT

As explained in the methods are the variables waiting time, age and risk factors continuous variables, the correlation coefficient is therefore used to calculate the association between waiting time and these variables.

The correlation between waiting time and age is negative and has a coefficient of -0,02962. This means that the waiting time becomes shorter with increasing age. This is confirmed in table 21.

The correlation coefficient between the waiting time and the risk factors of the patients is 0,179946 (see table 22). This means that the more risk factors the patient has, the longer the waiting time. This is also confirmed in table 21.

It is debatable whether these coefficients reflects the truth because there are just 40 patients analyzed and there are only 11 women and 29 men included and there are 29 patients in the category 0 – 2 risk factors and only 11 patients in the category 3 – 5 risk factors and 0 patients in the category of 6 or more. The distributions in the groups are therefore rather uneven.

Table 22: Relation between waiting time and age and waiting time and risk factors

Waiting time	Correlation coefficient
Age	-0,02962
Risk factors	0,179946

5.6.2. THE CHI-SQUARED TESTS

Gender and type of complaints are binary variables. The chi-squared test is therefore used to calculate whether there is an association between the row and column variable. First the relation between waiting time within the Treek standards, the column variable and gender, the row variable is calculated (table 23). Thereafter the relation between waiting time within the Treek standard, the column variable and type of complaints, the row variable, is calculated (table 24).

Table 23: 2 x 2 table showing results of gender on treek standard

(a) Actual numbers

	Treek standard Yes	Treek standard No	totaal
Men	**13**	**16**	29
Women	**6**	**5**	11
total	19	21	40

(b) Expected numbers

	Treek standard Yes	Treek standard No
Men	13,775	15,225
Women	5,225	5,775

The Chi-square for gender and waiting time within in the Treek standard is 0,5826. The two-tailed *P*-value for 0,5826 with 1 degree of freedom equals 0,4453. This means that the probability that such an observed difference of waiting time within gender is arisen by chance is 44,54%. The smaller the *P*-value, the lower the chance of getting a difference as big as the one observed if the null hypothesis were true. In other words, the smaller the *P*-value, the stronger the evidence against the null hypothesis. If the *P*-value is large, more than 0,1, what is the case here, then the data do not provides evidence against the null hypothesis. Since there is a reasonable chance that the observed difference could simply be the result of sampling variation. This difference is considered to be not statistically significant. So it can be concluded that there is no evidence of a difference between waiting time within the Treek standard and gender. So there can no statement be made of the association between gender and waiting time within the Treek standards, but it is likely that this association is coincidence and there is no relation. In this case, it is not allowed to reject the null hypothesis.

The chi-square for type of complaints and waiting time within the Treek standard is 0,1469. The two-tailed *P*-value of 0,1469 with 2 degrees of freedom equals 0,9292. This means that the probability that such a observed difference between type of complaints and reaching the Treek standard could have arisen by chance is 92,92%. This difference is considered to be not statistically significant. So we can conclude that there is no evidence of a difference between waiting time within the Treek standard and gender.

Table 24: 3 x 2 table showing the results of type of complaints on Treek standard

(a) Actual numbers

	Treek standard Yes	Treek standard No	total
Typical complaints	**5**	**5**	10
Atypical complaints	**11**	**16**	27
Non-cardiac complaints	**3**	**0**	3
total	19	21	40

(b) Expected numbers

	Treek standard Yes	Treek standard No
Typical complaints	4,75	5,25
Atypical complaints	12,825	14,175
Non-cardiac complaints	1,425	1,575

5.6.4. RELATION TYPE OF SYMPTOMS AND RISK ON CAD

As mentioned in table 13 most patient with CAD have typical symptoms. If someone has typical complaints the risk to have CAD is significantly higher (45,5%) than the risk for patients with atypical symptoms (5,4%). The percentage of the non-cardiac patients (16,7%) is not representative because the total sample of this group is just 6 (table 18). The correlation coefficient between type of symptoms and risk on CAD is 0,022975. This value confirms that patients with typical symptoms have a higher risk of CAD than patients with atypical or non-cardiac complaints.

Table 25: type of symptoms and risk on CAD

	Typical	Atypical	Non-cardiac	Total
Patients with coronary artery disease	5	2	1	**8**
Total sample	11	37	6	**54**
% To have CAD with type of complaints.	**45,5%**	**5,4%**	**16,7%**	

5.7 POWER OF THE CORRELATIONS

Since the waiting is known for just 40 of the 54 patients, it is thus possible that these correlation coefficients are based on coincidence and there may be no relationship between the variables. It is likely that more patients are required to make reliable statements. In order to determine whether it is coincidence and to analyze the numbers of patients required to make reliable statements, the confidence intervals of the correlation coefficients have been calculated in this section. Also the confidence interval for the chi-squared test between waiting time within the Treek standard and gender has been calculated. The power of the analyses increases as the number of patients increase. The reliability of the analyses also has been analyzed.

5.7.1. POWER ASSOCIATION WAITING TIME AND AGE

For studies which sample size is less than about 100, confidence intervals for the correlation coefficient can be derived using Fisher's transformation: $Zr = 0.5 \log_e(1+r/1-r)$. Than the confidence interval for Zr is: 95% CI = Zr – 1,96/ √(n – 3) to Zr + 1,96 / √(n – 3) To give the confidence interval for r this results have to be transformed back using the inverse of Fisher's transformation (Kirkwood & Sterne 2008). Applying the inverse of Fisher's transformation to the upper and lower confidence limits gives 95% CI's for the following number of patients:

Table 25: Confidence intervals of the correlation coefficient waiting time and age (-0,02962)

N	*54*	*100*	*200*	*500*	*1000*
Upper limit	*0,240048*	*0,167776*	*0,109573*	*0,058222*	*0,032432*
Lower limit	*-0,29505*	*-0,22474*	*-0,16768*	*-0,11701*	*-0,09145*

A confidence interval gives the range of values within which we are reasonable confident that the population difference lies. The difference between the upper and the lower limit by N=54 is 0,535098. This is by N=1000 0,059018. This is a major difference. The results of this analysis can be described as follows. The 95% CI of the correlation coefficient between waiting time and gender ranges from -0,29505 to 0,240048 in 54 patients and from -0,09145 to 0,032432 in 1000 patients. The null hypothesis states that this connection is 0,0. If 0 is within the CI, the null hypothesis is not rejected. If 0 is not within the CI, the null hypothesis can be rejected (Howitt & Cramer 2007). So If the confidence interval includes 0 we can say that the population is not significantly different from zero, at a given level of confidence (Shen & Lu 2010).

Each CI in the table contains the value 0 (table 25), concluding that there is no difference between waiting and men and women. The correlation coefficient of 0,02962 is coincidence. The correlation coefficient is very close to 0 and if the correlation coefficient equals 0, the variables are not associated. So this outcome was to be expected.

5.7.2. POWER ASSOCIATION WAITING TIME AND RISK FACTORS

The confidence interval for the correlation coefficient waiting time and risk factors has been derived at the same way as for waiting time and age.

Table 26: Confidence intervals of the correlation coefficient waiting time and risk factors 0,179946

N	54	100	200	500	1000
Upper limit	*0,427131*	*0,363519*	*0,310927*	*0,263481*	*0,239271*
Lower limit	*-0,09226*	*-0,01708*	*0,042258*	*0,093733*	*0,119283*

The difference between the upper and the lower limit by N=54 is 0,519391. By N=1000 this is 0,119988. The 95% CI of the correlation coefficient between waiting time and risk factors ranges from -0,09226 to 0,427131 by 54 patients and from 0,119283 to 0,239271 by 1000 patients. In this study 0 is located within the CI so that the null hypothesis of no significant difference in waiting time between the number of risk factors, is not rejected. However, from N=200 are upper and lower limits both positive so 0 not in the CI, so the null hypothesis rejected. The null hypothesis in this study is unjustified not rejected. The power increases from N=200. The values at higher numbers increases. From N=200 there is a significant relationship between waiting time and risk factors. This relationship is positive (0,179946). As the number of risk factors increases, also the waiting time increases.

5.7.3. POWER ASSOCIATION WAITING TIME AND GENDER

To analyze the power of the difference between waiting time within men and women, which is calculated using the chi-squared test, it will be examined whether the difference in the average waiting time between men and women is significant. The average waiting time for men (N=29) is 37,83 days. For women (N=11) the average waiting time is 28,55 days. The central question of this analysis is: what does the difference between the two group means in our sample tell us about the difference between the two group means in the population? This is addressed by calculating a confidence interval for the range of

likely values for the difference. Before a confidence interval for the difference between two means can be constructed, the sampling distribution of the difference have to be known. The difference between the mean outcomes in the men group and women group in our sample provides an estimate of the underlying difference between the mean outcomes in the men and women group in the population. Because both groups are smaller than 30, the method to derive the confidence intervals for two means is based on the *t* distribution rather than the normal distribution.

The difference between the means: ẋ1 - ẋ0

S = √[(N1-1)S1^2 + (N0-1)S0^2/ (N1+N0-2)]

S.E. = S√(1/N1+1/N0)

The confidence interval is calculated using *t'*, the appropriate percentage point of the *t* distribution with (N1 + N0 – 2) degrees of freedom:

CI = (ẋ1 - ẋ0) – (*t'* * S.E.) to (ẋ1 - ẋ0) + (*t'* * S.E.) d.f.= (N1 + N0 – 2)

difference between the means is: ẋ1 - ẋ0 = 37,83 – 28,55= 9,25 days

standard deviation, S= √[28 * 27,19^2 + 10 *12,6 ^2/ (29 + 11 – 2)]= 24,2182 days

standard error of the difference, S.E. = 24,2182√(1/29 + 1/11)= 8,5758 days

degrees of freedom, d.f.= 29 + 11 – 2 = 38

the 5% percentage point of the *t* distribution with 38 degrees of freedom is: 2,02.
So the 95% confidence interval for the difference between gender and waiting time is:

9,25 – (2,02 * 8,5758) to 9,25 + (2,02 * 8,5758) = -8,0731 to 26,5731.

With 95% confidence, mean waiting time is between -8,0731 and 26,5731 lower for men than for women. The waiting time for men can be 8 days shorter than for women but also 26 days longer, and 0 is within the interval. Therefore it can be concluded that there is in this study no link between gender and waiting time. This was expected because the P-value is 0,4453, which means a 44,53% probability that the relationship is coincidental.

5.8. COST-CONSEQUENCES ANALYSIS

The costs of the current diagnostic process are based on the DOT, Diagnosis treatment combination on their way to transparency. This has been found on the site of the EMC. The declaration code is 15A001, and the health care product code is 99599005, part of ischemic heart disease, en is called 'outpatient treatment or research of patient with chest pain'.

Table 26: Cost-consequences table of the current diagnostic process and the new blood test (erasmc.nl; mauskopf et al 1998).

	A. Current diagnostic process	**B. New blood test**
Cost components:		
Medical costs - Costs honorarium - Costs hospital - Costs NFU* - Total	 € 181,- € 653,- € 936,- *€ 1.536 +*	 ? ? ? *€ 200 +*
Indirect resource use or costs - Time missed from work for patient - Time missed from other activities for patient	- Probably high opportunity costs	- No opportunity costs
Consequences:		
Symptoms impacts - Patient distress days - Patient disability days	- Long time of uncertainty - Disability days high because long time for diagnosis	- No uncertainty
Clinical process - Waiting time - Labor intensivity	- 19 of the 54 patients waiting time within Treek standard - Very labor intensive	- All 54 patients waiting time within the Treek standard. - Not labor intensive. Test performed by GP, only diagnosed patients referred - Limited inflow current process - Kind of screening
Clinical outcomes - Cost calculation 100 patients	100 * 1536= 153.600	All 100 patients get the new blood test. Thereafter the GP refers 20% (N=20) to the hospital for the current care process: 100 * 200= 20.000 20 * 1536= 30.720 + 50.720

		- Earlier stage of diagnosis - Probably longer life expectancy

*The Dutch Federation of University Medical Centra (NFU) in Dutch 'De Nederlandse Federatie van Universitair Medische Centra' is a partnership of eight university medical centers in the Netherlands and has the general objective to represent the common interests of the UMC (NFU.nl 2013)

In total, the standard process cost €1536,-. The hospital component is €653,- (table 26). The additional funding which the EMC receives for the cost components patient care and employees from the government is 8.540.000 and 111.700.000 (see annex 8). €936 of this amount of money is spent on each patient of the FTP AP. For the full additional funding which the EMC and other UMCs receives see annex 8. The remaining costs for employees is €181, -. Personnel costs are thus both funded by government and health insurer.

It is likely that the opportunity costs are higher for the current diagnostic process than for the new blood test. The intention is that the new blood test will be performed at the GP where the patient after a much shorter waiting time undergo the test than in hospital for the current diagnostic process. Therefore the waiting for the new intervention is for probably all patients within the Treek standard. Because people experience chest pain as the most frightening symptom, patients are less likely to go work or other activities in the waiting time before the diagnostic process. The time of uncertainty is probably longer for the patients in the current diagnostic process. The investigation time is also even longer of the current diagnostic process than of the blood test, which leads probably to higher opportunity costs.

The patients who have been diagnosed by the GP probably do not have to undergo the whole process in hospital. For these purposes, the accuracy of the test have to be known. This has to be determined in the future.

But the new blood test is certainly about one third cheaper. If 100 patients undergo the current diagnostic process the costs are €153.600. If 100 patients first undergo the blood test, and only actually diagnosed patients (probably around 20%) undergo thereafter the current process the total costs are €50.720. This is more than 1/3 cheaper. In the best case scenario, some of the current tests or even the entire diagnostic process will be replaced by the blood test, resulting in even lower costs.

The test is also less labor intensive, and if only actually diagnosed patients will be referred to the hospital the inflow decrease, making the waiting time of the patients within the Treek standard.

6. DISCUSSION

6.1 RESULTS

The main results of this study are that there is hardly any variation in the standard care program of chest pain patients visiting the FTP AP. Most of the patients completed all standard examinations. If a patient failed to complete the standard care process (in one day), this was associated with the characteristics of the patient, for example having an allergy for the contrast fluid of the MSCT scan, or the patient was not able to do the XECG. The organization of the hospital was not responsible for this.

However, it is a very labor-intensive process. There are a lot different specialists present during the tests. In total, all examinations together take more than two hours.

The average waiting period for the Fast Track clinic is more than 35 days. This is well above the norm of 28 days. Consequently, the waiting time was within the Treek norm for only 19 of the 40 patients (47,5%). There is a wide variability in the waiting period between patients referred by a GP and referred by an internal department of the EMC. The average waiting time of patients of an internal department is much longer than the waiting time of patients referred by a GP. The average waiting time for all Cardiology outpatient clinics was 20 days in 2008 and 15 days in 2012. The average waiting time of the Fast Track outpatient clinic of the EMC is far above national average.

There is only an association between waiting time and number of risk factors, concluded by the correlation coefficient and the confidence interval for this correlation coefficient. If the number of risk factors increases, the waiting time also increases. The other expected associations are coincidence.

The average processing time A was more than 3 days. 45 of the 54 patients (83,3%) completed all tests in one day. This is a high percentage. Processing time B was longer in contrast to processing time A; an average of 12 days. This is still far below the norm. Consequently, 50 of the 54 patients (92,6%) passed within the norm.

In conclusion the bottlenecks in the current diagnostic process are the long waiting times and the labor intensity. The new blood test can be performed by a GP and is considered to be able to exclusively refer CAD suspected patients (20%), in this study only 14,8% (8 of 54 patients), which will decrease the inflow and thus the waiting time. This is also time saving for the cardiologists, because the diagnosis has been made before the patient comes to the hospital instead of after the entire care process. For the patient there is also a period of uncertainty about the physical health, and considerable tension/ discomfort. With the new developed blood test, however, the diagnosis can be made rapidly.

The blood test shows whether the heart has oxygen deficiency, and indicates cardiac patients in a fast and efficient way. This leads most probably to a waiting time within the Treek standard of 28 days.

In addition to cost saving from less unnecessary referrals, the new diagnostic process will be less labor intensive and more convenient for the patient. Last, the new blood test is probably 1/3 cheaper than the current diagnostic process. This is also confirmed in the cost-consequences table. The goals of the blood test are probably the same. This test creates a possibility for the future to diagnose AP in an earlier stage, decreases the waiting time of the care process and enhances the efficiency of the diagnostic process.

The accuracy of the current tests in this study was sufficient in relation to the literature. Only two XECGs were false-negative and two false-positive. The MSCT scan demonstrated no false-positive or false-negative values. In total 9 of the 51 XECGs were inconclusive, due to patients who not reached the Target Heart Rate. There was 1 MSCT scan inconclusive. Moreover, 2 patients were wrongly diagnosed.

The accuracy of the new blood test is still unknown, but it is assumed that the aim of the new blood test is not to improve the accuracy of the current diagnostic tests by these data. It is particularly expected to generate lower costs by means of lower labor-intensive work, decrease of the inflow and thus the waiting time, and more rapid diagnostics.

6.2. CLINICAL IMPLICATION

In practice, much more has to be established about the blood test to make a statement of their contribution to the current process or even to replace the current process. But right now it is expected that the blood test is cost saving. The new blood test will be less labor-intensive, and is probably able to decrease the inflow of the patients and thus the waiting time. The new blood test is probably 1/3 cheaper than the current diagnostic process. The cost-consequences analysis showed that the direct medical costs of the current care process are much higher than for the new blood test.

The other two components of the cost-consequences analysis are not yet determined. Consequently this is not a full examination of costs, but using the results of the current diagnostic process, it is expected that the added value of the new blood test is high.

The new test will most probably not improve the accuracy of the current diagnostics, since this is quite sufficient, in the study even better than in the literature. But to be sure the accuracy of the new test has to be determined before statements can be made.

It is also unlikely that the test will be introduced to achieve health benefits. However this could be the case due to earlier stage of diagnosis of the patients, but this is not known yet. This needs to be further investigated.

6.3. STRENGHT AND LIMITATIONS

This study has several strengths and limitations. The first limitation is related to the number of analyzed patients; 54 patients. Consequently, no clear conclusions can be made, the results are possibly based on coincidence. The minimum number of analyzed patients was based on the confidence interval of a percentage. Nearly 93% of the patients in the sample had a processing time B within the Treek standards. To find out to what extent this is reliable for the general population the CI is used:

0,93 +/- 1,96 * √ (0,93*0,07/ number of patients)

In case of N=30 the CI ranges between 0,838697 and 1,021303. If the N increases to N=50, the difference between the lower and the upper limit decreased with 0,042. To decrease the lower and upper limit again with 0,042, the number of patients had to expanded to N=100. Therefore is chosen for 50 patients.

Another limitation is related to missing links. The date of referral was unknown for 14 patients, and only 54 patients were included in the study. Therefore only 40 patients were included in the analysis of the waiting time. Consequently, the calculated associations between waiting time and patient characteristics are possibly coincidence. Therefore, the power of these correlations has been calculated using CIs. These CIs showed that there is only an association between waiting time and risk factors, and not between the other three patient characteristics and waiting time (within the Treek standard).

The analyzed patient files dated from 2010. A trial was launched in 2011 which is still going on. This trial influences the current diagnostic process. The diagnostic process of 2010 is therefore chosen to analyze as current diagnostic process. The current diagnostic process in 2013 with exclusion of the trial is almost the same as the current process observed in this study. This is established using the participatory observations. The chest pain patients who underwent the diagnostic process in 2010 got a XECG and a MSCT. In the trail patients are randomized to either a XECG or MSCT scan. When patients choose not to participate in the trial or do not qualify for the trial, they only get a XECG and not a MSCT. Otherwise, the trial results will be negatively influenced if these patients would still undergo both tests.

The analyzed patient files dated from 2010, but in practice these are dated from a few months of 2010.

The data collection started with patient files of January 2010 for patients who visited the FTP-AP. This went on every month until 50 patients were selected who fulfilled the selection criteria. After the month of May there were enough patients selected to carry out the analyses. Therefore the analysis were based on just a few months, which made it also difficult to make statements.

The definitions of the risk factors is a further limitation of this study. All risk factors have a binomial distribution in this study. No gradations were included. As a result, for example, the number of cigarettes a person smoked was not defined, while this affects the risk of CAD. The same applied for other risk factors, the amount of overweight of the patient, the level of the high cholesterol, or the number of relatives with CAD. In further research this gradations have to be included.

Patients who were previously treated for CAD in the past 5 year were filtered out of the database. Cardiac history is an important confounder which affects the outcomes of the results. If the treatment for CAD was longer than 5 years ago the patient was not filtered out of the database and was seen as eligible to the sample. But a patient with cardiac history more than 5 years ago also has an increased risk of developing CAD. This is an important limitation of the study.

The research occurred in one hospital. These results only applied for the Erasmus MC and generalization to other hospitals is not possible. However, the research can simply be reproduced for the same audience in another hospital with the aid of the research design.

The external validity of the study was relatively low. This was particularly appropriated in the qualitative research methods. The three different qualitative research methods were used interchangeably and it was difficult to identify which information was derived from which method. If information was missing, it was determined which research method was most appropriate to conduct this information. The study design was therefore not really followed. This is also a limitation.

A final limitation of this study is that the cost-consequences table does not reflect full cost-effectiveness analysis. This was not possible because the accuracy of the new blood test is still unknown. The table presents limited information about the costs, only the DOT price is reflected. Therefore a full cost-consequences analysis is not accomplished.

6.4. FUTURE DIRECTIONS

This study was done as prior research to a future economic evaluation for the blood test compared with the current diagnostic process for patients with AP. It is a recommendation to use a cost-effectiveness analysis including a decision-analytic model for future economic evaluation. The decision-analytic model evaluated costs and morbidity of patients undergoing the new blood test versus the current diagnostic process. In this case a Markov model can be applied, in which a hypothetical cohort will be studied through several health states particular to the new blood test or current process. The model estimated costs and quality-adjusted life-years (QALY), assessing cost-effectiveness of the blood test, relative to the standard therapy. It is a recommendation to do the economic evaluation with a CEA including a Markov model and calculation of the QALY, because CAD has a major impact on mortality and morbidity. The QALY as health output simultaneously capture gains from reduced morbidity (quality gains) and reduced mortality (quantity gains), and integrate these into a single measure. Therefore this is for this disease an appropriate way to calculate the cost-effectiveness of the new blood test. Before it is possible to set this cost-effectiveness study a lot of research should be done. The results of the new blood test of the 1000 patients were the test is currently tried out are important before a large cohort study can be conducted. If the outcomes and the accuracy of the test are determined it is possible to derive the transitions between the health states. This also makes it possible to determine the success rate of the blood test. Through these weighted averages the mortality and complication rates can be derived. Then a Markov model, which takes part of the CEA, can be established. This makes it also possible to establish if it is practically possible to perform the test at the GP and if the test is able to exclusively refer CAD suspected patients. This depends on the accuracy of the test. Consequently, it becomes clear if the test is provided to supplement or replace the current process.

To do this for the current diagnostic process more literature research is needed and the current diagnostic process have to be established in more hospitals. Next it is necessary to collect information on the costs and utility of the interventions, obtained from health-related preferences associated with quality of life. It is a recommendation to do this from the perspective of the health care provider because these costs have already been analysed in this study, the diagnostic-related groups.

This process has to be done in more hospitals because if the waiting time in other hospitals is below the standard the added value of the blood test is smaller.
This is possible, because the average waiting time for all outpatient clinics Cardiology is 15 days in 2012, so below the Treek standard.

So it is possible that the waiting time of the EMC is an outlier, this has to be find out. The added value of the test can also be smaller if the process in other hospitals is not so labor intensive. This also has to be found out.

The follow-up costs have to be derived from of the study of 1000 patients. A threshold has to be determined by the willingness to pay per QALY. The most commonly used is $50.000/QALY. Also the utility values have to be determined. This is possible using the EQ-5D. This utility weighs have to be multiplied by the duration in each health state to calculate QALYs. All costs en utilities have to be obtained for each health state and complication.

Finally, a sensitivity analysis will be performed to evaluate critical sources of variation in the input data, such as utilities of the major health states.

This demonstrates that more research needs to be done before an economic evaluation can be conducted. This study has contributed to future economic evaluation to provide an insight in the current diagnostic process and the costs associated with this. This study also gives an indication of the costs of the blood test. As a result, this study already contribute to future research. But as implicated above, there is still much that needs to be examined to establish the added value of the new blood test.

7. CONCLUSION

There is a possibility for the new blood test to improve the current process. One way to accomplish this is by means of reduction of the waiting time. The current waiting time is far above the Treek standard. For only 47,5% of the patients the waiting time is within the Treek standards. The blood test responds to that because is considered to be able to exclusively refer CAD suspected patients (20%). This will decrease the inflow and thus the waiting time. Therefore the blood test can result in a tremendous cost saving for health care expenditures. In addition to cost saving from less unnecessary referrals, the new diagnostic process will be less labor intensive and more convenient for the patient. Last, the new blood test is probably 1/3 cheaper than the current diagnostic process.

Although the first results are promising, much more has to be investigated about the blood test to determine its possible contribution to the current process or to even replace the current process in the future.

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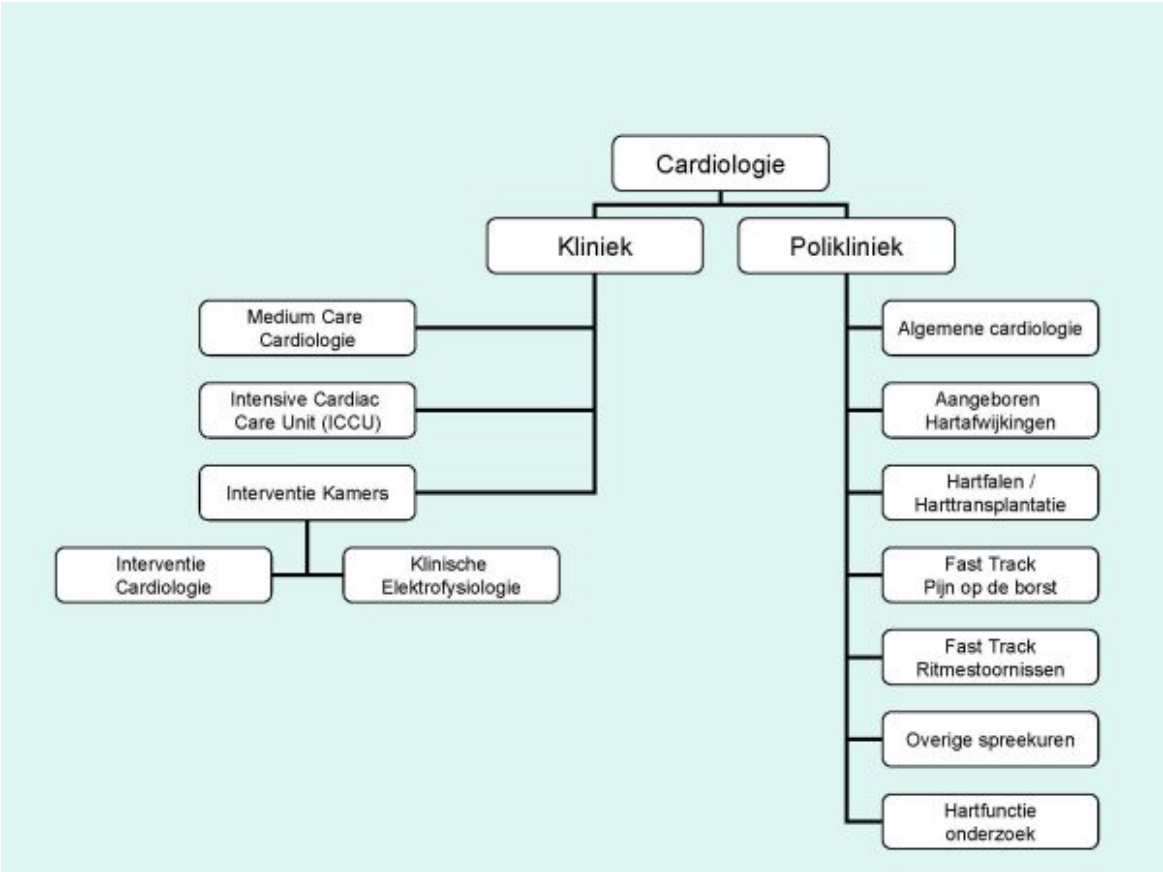
APPENDIX

APPENDIX 1: OVERVIEW OF THE MAIN CAUSES OF CHEST PAIN

Lung pathology	***Orthopedic pathology***
- infections: tracheitis, bronchitis, pneumonia, pleurisy	- Muscle or skeletal disorders
- trauma	- Radicular pathology
- pneumothorax, pneumomediastinum	- thorax disorders
- Pulmonary embolism	
- Pleural: post traumatic pneumothorax	***Dermatological pathology***
- tumor: lung cancer, mediastinal tumor, pleural metastases	- herpes zoster
Cardiovascular pathology	***Gastro-intestinal pathology***
- angina pectoris	- Gastric and esophageal pathology
- myocardial infarction	- Liver and biliary pathology
- Dissecting aneurysm of the aorta	- abdominal pathology, which gives rise to diaphragm stimulation
- pericarditis	
- Cardiac arrhythmias	***Psychological problems***
	- Psychological and social tensions

APPENDIX 2: ORGANISATIONAL CHART CARDIOLOGY SECTION EMC



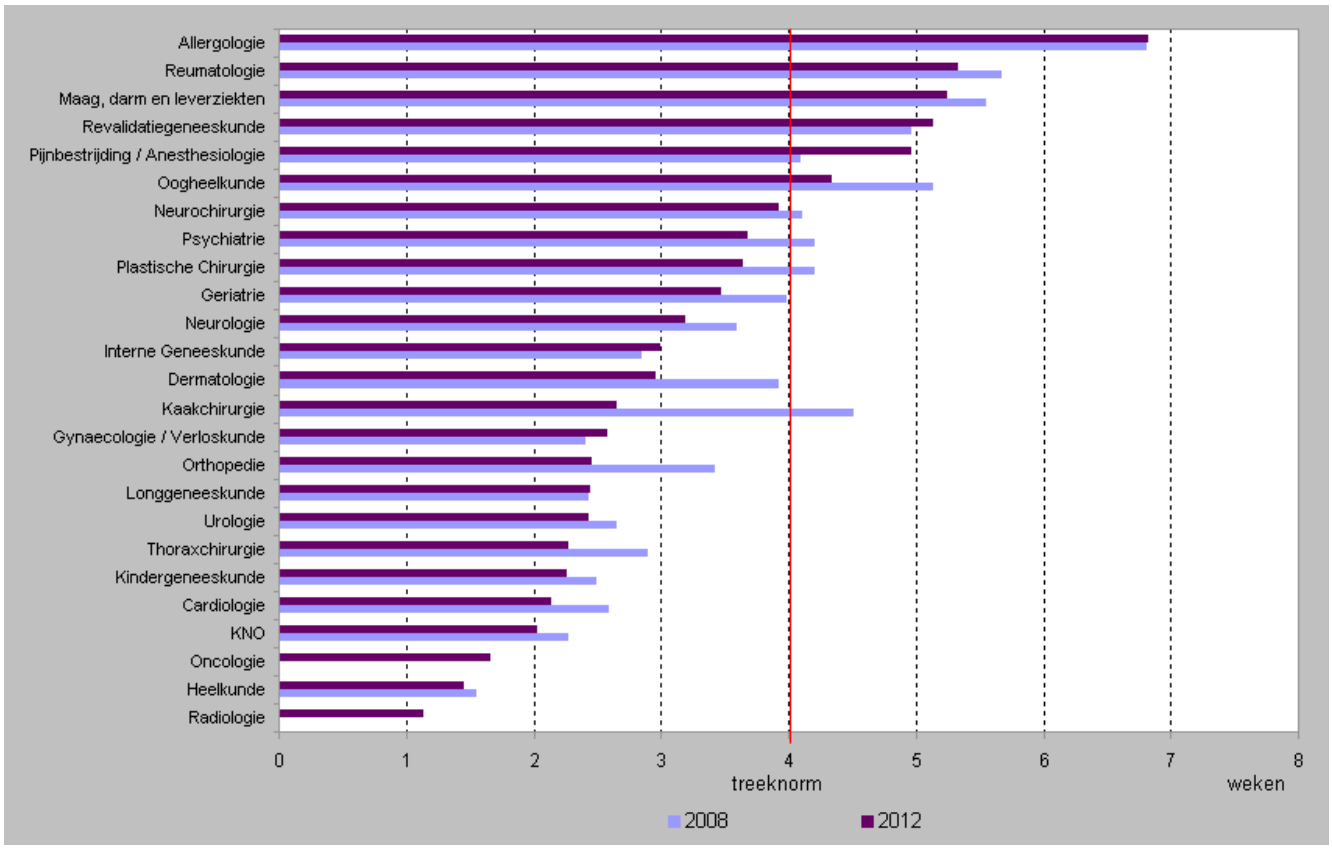
APPENDIX 3: MAXIMUM ACCEPTING WAITING TIMES (TREEK STANDARDS) PER HEALTH CARE SECTOR

Hospital care	**Maximum acceptable**
Access time for outpatient clinic	4 weeks
Waiting time for diagnosis and assesment	4 weeks
Waiting time until actual treatment (day care)	6 weeks
Waiting time until actual treatment (clinic)	7 weeks
Nursing and care	
Nursing	6 weeks
Care	13 weeks
Home care	6 weeks
Care of the disbled	
Intellectually disabled	
Support day care	6 weeks
Support housing	13 weeks
Physically disabled	
Support day care	6 weeks
Support housing	13 weeks
Sensory disabled	
Support day care	6 weeks
Support housing	8 weeks
Mental health care	
waiting period registration	4 weeks
Rating waiting time	4 weeks
Waiting time for outpatient treatment	6 weeks
Waiting time for semimurale treatment	6 weeks
Waiting time for inpatient treatment	7 weeks
Waiting time for protected housing	13 weeks

APPENDIX 4: ADDITION INFORMATION ABOUT RISK FACTOR OF AP: CHOLESTEROL

LDL is known as the ‘bad cholesterol’. LDL complexes transport cholesterol from the liver to the body. The problem with LDL cholesterol is that it enters the vessel wall relatively easy and it is not possible to remove it from the vessel wall. This is the primary cause of plaque in the vessel wall, which can cause stenoses.
High HDL levels decrease the risk of CAD, because HDL cholesterol removes the ‘bad cholesterol’ from the blood. Therefore: high HDL cholesterol values are positive. The higher the HDL cholesterol levels, the more favorable the cholesterol ratio. The cholesterol ratio largely determines the risk of heart disease. A favorable cholesterol ratio means low LDL cholesterol and high HDL cholesterol. An increase in the total cholesterol level by 10% increases the risk of CAD by 20% (ConsuMed 2013).

APPENDIX 5: DEVELOPMENT WAITING TIMES FOR OUTPATIENT CLINICS IN 2008 AND 2012



(Source: *NZa, 2012b*)

APPENDIX 6: DATA EXTRACTION FORM FOR CHEST PAIN PATIENTS

a) Gender patient: 1) men 2) women
b) Age patiënt in 2010:
c) Length patient in metres:
d) Weight patient in kilograms:
e) Blood pressure patient:
f) Complaints:
   1= typical anginal complaints
   2= atypical anginal complaints
   3= non-cardiac complaints

g) Risk factors:
   1= smoking
   2= overweight
   3= Obesitas
   4= Hypertension
   5= family history
   6= Dyslipidemi
   7= Hyperlipidemia
   8= Diabetes mellitus
   9= Hypercholesteromie

h) Patiënt referred by: 1) GP 2) Intern
i) Date of referral GP/intern to cardiologist:
j) Date first consult cardiologist:
k) Date last consult cardiologist:
l) Date of final result (date letter with result to GP or intern):
m) Date catheterization:
n) Date final result catheterization (date letter to GP or intern):
o) Processing time A in days (j-k):
p) Processing time B in days (j-l):
q) Waiting time in days (i-j):

1) Processing time B within the Treek standard of 4 weeks:
   - o Yes
   - o No

2) Waiting time within the Treek standard of 4 weeks:
   - o Yes
   - o No

The tests:

3) Patiënt give blood sample in the hospital: (if applicable date: …….)
    - o Yes
    - o No

4) Patiënt has undergo an ECG:
    - o Yes
    - o No

5) Patient has undergo a echography:
    - o Yes
    - o No

6) Patient has been on consultation with the nurse specialist where the anamnesis and physical examination has taken place:
    - o Yes
    - o No

7) Patiënt has undergo a XECG:
    - o Yes
    - o No, reason:

8) Reported Watts during the XECG:

9) Reported Watts in percentage relative to the standard:

10) Maximum heart rate during the XECG per minute:

11) Target Heart Rate of the patiënt relative to the standard (%):

12) Calciumscore of the patient:

13) Patient has undergo a MSCT:
    - o Yes
    - o No

14) Patiënt receives diagnosis from cardiologist during the second consultation:
    - o Yes
    - o No

Results of the tests:

15) The result of the XECG is positive:
    - o Yes
    - o No

16) The result of the XECG is inconclusive:
    - o Yes
    - o No

17) The result of the MSCT scan is positive:
    - o Yes
    - o No

18) Patiënt has been prescribed medication after the standard process:
    - o Yes
    - o No

19) After the standard care process has been determined CAD:
    - o Yes. Go further to question 20.
    - o No

20) There is:
    - o 1-vessel CAD
    - o 2-vessel CAD
    - o 3-vessel CAD

21) Patiënt has been catheterized after the standard care process:
    - o Yes. Go further to question 22
    - o No

22) Date catheterization:

23) Date letter with result catheterization to GP or intern:

24) Patient is sent home after catheterization without further intervention because no heart defects are found:
    - o Yes
    - o No. Go further to question 25

25) Patient has undergo a PCI after catheterization:
    - o Yes
    - o No

26) Patient has undergo a CABG after catheterization:
    - o Yes
    - o No

Present specialists per test

	Laboratory technician	Cardiologist	Physician assistant	nurse	Other, namely:
Bloed test					
ECG					
Anamnesis					
Consultation/ physical examination					
Exercise test					
MSCT					
Other, namely:					

APPENDIX 7: CODE BOOK DATA EXTRACTION FORM

Gender:

1= Man

2= Woman

Age: age of the patient in years in 2010.

Length: length of the patient in meters

Weight: Weight of the patient in kilograms.

BMI of the patient: Body Mass Index. The value of the body mass index is equal to the mass of the body (in kilograms) divided by the square of the length (in meters).

BMI

< 18,5:	Patient is too light. Less risk of high cholesterol and heart disease.
18,5 – 24,9 :	Good on weight. Patient has an average risk of high cholesterol and heart disease.
25 – 29,9:	patient is overweight, and has an increased risk of high cholesterol and heart disease.
> 30:	Patient is obese, and has a greatly increased risk and high cholesterol and heart disease.

Patient's blood pressure: blood pressure of the patient in mmHg.

Complaints:

1= typical anginal complaints

2= atypical anginal complaints

3= non-cardiac complaints

Risk Factors:

0)	Non:	1= Yes	0= No
1)	Smoking:	1= Yes	0= No
2)	Overweight:	1= Yes	0= No
3)	Obese	1= Yes	0= No

4) Hypertension 1= Yes 0= No
5) Family history 1= Yes 0= No
6) Dyslipidemia 1= Yes 0= No
7) Hyperlipidemia 1= Yes 0= No
8) Diabetes mellitus 1= Yes 0= No
9) Hypercholesteromie 1= Yes 0= No

Way of referring: way patients were referred to the cardiology clinic.
1= General practitioner
2= internal department EMC

Date of referral: Date of referral letter by GP or consultation request with the cardiologists by internal department.

Dat first consult: Date of first consult with the cardiologist.

Date last consult Date of last consult with the cardiologist and verbal result of the standard care process.

Date result standard care process: Date of final result letter to GP or internal department of the EMC.

Date catheterization: Date of the catheterization.

Date result catheterization: date on which the letter containing the results of catheterization is sent to the GP or internal department.

Processing time A: time in days that elapses from the first visit to the outpatient cardiology to the last appointment with the Cardiologist

Processing time B: time in days that elapses from the first visit to the outpatient cardiology to the date of the letter with the final diagnosis to the doctor or the Department of Internal.

Waiting time: time in days which proceeds from the date of referral from your GP or Internal department to Cardiologist until the day of the first consultation with the cardiologist.

Processing time within the Treek standard of 4 weeks:

1= Yes

0= No

Waiting time within the Treek standards of 4 weeks:

1= Yes

0= No

The tests

lab: a blood sample has been obtained
1=Yes
0=No

ECG: Patient has undergo a ECG
1=Yes
0= No

Echo: Patient has undergo an echo
1= Yes
0= Nee

Consult: Patient has been on consultation with the nurse specialist where the anamnesis and physical examination has taken place

1= Yes

0= No

XECG: Patient has undergo an XECG.

1= Yes

0= N0

Reported Watts during the XECG:

Reported Watts in percentage relative to the standard:

Maximum heart rate during the XECG per minute:

Target Heart Rate of the patiënt relative to the standard (%):

Calciumscore of the patient:
Calciumscore van de patiënt: The calcium score is an investigation into the level of calcium in the coronary arteries with a CT scan. Calcium in the coronary arteries indicates the presence of coronary artery occlusion which is the major cause of heart disease

MSCT: Patient has undergo a MSCT.
1= Yes date if applicable:
0= No

Second consult: Patiënt receives diagnosis from cardiologist during the second consultation:
1= Yes
0= No

Results of the tests

XECG positief: The result of the XECG is positive. This means that coronary artery disease was found during the investigation. Coronary artery disease was defined as coronary artery stenosis
1= Yes
0= No

XECG inconclusive: the result of the XECG is inconclusive.
1= Yes
0= No

MSCT positive: the result of the MSCT scan is positive. This means that the scan has shown coronary disease.
1= Yes
0= No

Medication after the process: Patient prescribed medication after the standard care process

1= Yes

0= No

Established coronary artery disease after standard care process: the result of the standard care process is positive.

1= Yes

0= No

Type of coronary artery disease:

1= 1-vessel CAD

2= 2-vessel CAD

3= 3-vessel CAD

Patient catheterized: patient has been catheterized after the standard care process.

1= Yes

0= No

unjustified catheterized: means that the patient after catheterization is not further treated by PCI or CABG, so an invasive treatment. Drug treatment is not included.

1= Yes

0= No

PCI: patient has undergo a PCI after catheterization.

1= Yes

0= No

CABG: Patient has undergo a CABG after catheterisation

1= Ja

0= Nee

Kerngegevens umc's

	Totaal	MUMC+	UMCU	UMCG	LUMC	Erasmus MC	St Radboud MC	AMC	VUmc
Budget totaal	6.871	536	952	980	665	1.188	901	841	808
- Patiëntenzorg	4.671	412	691	649	388	854	554	568	555
- Onderwijs	467	21	53	97	61	48	58	73	56
- Onderzoek	1.232	63	156	156	148	233	154	177	145
- Opleidingen	371	40	52	46	40	50	49	53	41
- Overig	123	-	-	25	28	3	86	-30	11
2e, 3e en 4e geldstroom en subsidies tbv onderzoek	682	33	85	78	72	137	74	112	91

	MUMC+	UMCU	UMCG	LUMC	Erasmus MC	St Radboud MC	AMC	VUmc
Studenten geneeskunde	4.343*	2.152	2.869	2.160	2.318	2.220	2.446	2.453
Promoties	133	192	149	117	211	140	170	114
Promovendi	563	1037	884	550	1100	800	1251	582
Medewerkers	5.212	11.135	10.881	6.763	11.170	8.967	7.990	6.805
Medewerkers (per FTE)	4.306	8.002	8.561	5.676	9.715	7.651	6.068	5.753

* studenten geneeskunde MUMC+; getal is inclusief gezondheidswetenschappen