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Benchmarking the efficiency of the process of colorectal surgery in Dutch hospitals

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Samenvatting

Achtergrond

Kwaliteit van zorg is een belangrijk onderwerp van discussie geworden in de laatste decennia. Continue Kwaliteitsverbetering is een benadering die wordt gebruikt om het proces (efficiëntie, effectiviteit en tijdigheid van zorg) direct te verbeteren. Het proces is indirect van invloed op patiëntgerelateerde uitkomsten (patiëntgerichtheid en veiligheid van zorg). Eén van de mogelijkheden om Continue Kwaliteitsverbetering te stimuleren is benchmarking.

Onderzoeksvragen

De eerste onderzoeksvraag richt zich op het exploreren van de relatie tussen efficiëntie (doorlooptijden, aantal patiëntbezoeken en kosten) en patiëntgerelateerde uitkomsten (proces en uitkomst indicatoren) binnen de zorg voor patiënten met een colorectaal carcinoom. De tweede onderzoeksvraag zoekt een antwoord op de vraag 'hoe data in een benchmark rapportage gepresenteerd kunnen worden aan Nederlandse medisch specialisten betrokken bij de zorg voor patiënten met een colorectaal carcinoom.'

Methode

Acht ziekenhuizen werden ieder gedurende drie of vier dagen bezocht. Gegevens over efficiëntie en patiëntgerelateerde uitkomsten werden verzameld met betrekking tot de zorg voor patiënten met een colorectaal carcinoom. Chi-kwadraat testen en one-way ANOVA testen werden gebruikt om de data te analyseren. Op basis van de gevonden data werd een eerste voorstel gedaan voor het meest efficiënte zorgpad. Daarnaast werden de verzamelde data gebruikt om een voorstel voor een benchmarkrapportage te doen. Dit nadat een literatuuronderzoek was gedaan, een vergelijking van nationale en internationale benchmark rapportages en experts om advies was gevraagd.

Resultaten

Verschillende relaties werden gevonden. Een aantal gevonden relaties waren zeer relevant. Meest opmerkelijk was de positieve relatie tussen de wachttijd voor chirurgie en het aantal complicaties na chirurgie. Ook de negatieve relatie tussen de duur van de operatie en de voor de operatie verrichte beeldvormende onderzoeken sprong in het oog.

De meeste literatuur richt zich op de effecten van benchmarking en feedback op de uitkomsten van zorg, zodoende kon op basis van de literatuur geen antwoord worden gegeven op de tweede onderzoeksvraag. Met behulp van het advies van experts werd een benchmarkformat voorgesteld. Belangrijkste succesfactoren voor een goede benchmark zijn: continue informatie teruggeven, makkelijk te interpreteren data weergeven en heldere aanwijzingen geven om te komen tot verbetering. Om verbetering te stimuleren kan daarnaast gebruik worden gemaakt van een lijst van best presterende ziekenhuizen.

Conclusie

Een relatie tussen efficiëntie en patiëntgerelateerde uitkomsten werd gevonden, nader onderzoek is echter noodzakelijk om de data verder te analyseren en een verklaring te geven voor de gevonden relaties. In de toekomst is het mogelijk om doelen te stellen voor efficiëntie. Tevens kan verbetering worden gestimuleerd door de best presterende ziekenhuizen te identificeren en van deze ziekenhuizen te leren.

Summary

Background

Quality of health care has become an important issue in the last decades. Continuous Quality Improvement is an approach to improve the process (efficiency, effectiveness and timeliness of health care) directly, which is related to patient related outcomes (patient centeredness and safety of health care) indirectly. One of the tools to stimulate Continuous Quality Improvement is benchmarking.

Research questions

This first research question focuses on the exploration of the relation between efficiency (lead times, number of patient visits and costs) and patient related outcomes (process and outcome indicators) in colorectal cancer. The second research question searches an answer on the question 'how should data be presented in a benchmark report to Dutch medical specialists participating in the colorectal process?'.

Method

Eight hospitals were visited, during three or four days, and data about efficiency and patient related outcomes were collected, related to care for patients with colorectal carcinoma. Chi-square tests and one-way ANOVA tests were used to analyze the data. Combining the data, a first attempt was made to define the most efficient pathway. Besides, the data collected were also used to propose a benchmark format. This was done after answering the second research question performing a literature review, comparing national and international benchmark reports and asking expert advice.

Results

A lot of relations were found after the analysis. Some relations were very relevant, most notable are the positive relation found between the waiting time before surgery and the number of complication after surgery and the negative relation between the length of the operation and preoperative imaging.

No answer to the second research question could be given based on the literature, most literature focused on the effects of benchmarking and feedback on outcomes. Taking the advice of the experts in account a benchmark format was proposed. Important success factors for a good benchmark are that it is continuous, that the data are easy to interpret, and that clear suggestions are made for improvement, to stimulate improvement a list of best practices could be presented.

Conclusion

A relation between efficiency variables and patient related outcomes was found, further research is however needed to further analyze the data and to find an explanation for this relation. In the future it could be possible to settle efficiency goals and to stimulate improvement by identifying and learning from best practices.

Preface

Good healthcare is important to us all. There is evidence that much care falls short of excellence and costs are soaring making care no longer available for everyone. All troublesome developments for citizens, medical professionals and managers in health care.

As a medical doctor I have learned a lot about contact with patients however I have learned little about the economic and organizational aspects of healthcare. After receiving my medical degree I decided that I wanted to learn more about health care in this other perspective. This Master Thesis gave me that opportunity and is part of the fulfillment of the Master degree Health Sciences at the University of Twente.

Under the guidance of Professor Wim van Harten and Sabine Siesling I accomplished this Master Thesis. The research project is part of the PhD trajectory of Dorine Pluimers. I would like to thank my supervisors, all the medical specialists, nurses, experts in benchmarking and hospital managers that have helped me to accomplish this research project.

Above all I would like to thank my parents, Kamiel and Jeroen who stood by my side and supported me when I announced that after six years of medical school I was not becoming a doctor yet but once more a student.

Anne Niezink
February 2011

Chapter 1: Introduction

1.1. General

In the last two decades, attention to the quality of patient care has become an important health care issue. Not only for authorities and policymakers, but also among physicians and patients (Grol, 2001). The Dutch government for example has settled the goal that, in 2011, information on the quality of the 80 most common diseases should be available, using indicators to measure quality (Ministery of Health, Welfare and Sports, 2009). Another goal is to make information on quality of care available for patients, so that patient can choose their hospital based on differences in quality. For example the website kiesbeter.nl or the magazine 'dr. Yep, kies de beste zorg' (KiesBeter.nl, 2010 and dr. Yep, 2010).

Three reports, published around the end of the last century, were of major importance for the increased attention to quality:

- The Institute of Medicine's (IOM) National roundtable on Health Care Quality report, 'The urgent need to improve health care quality' (Chassin & Galvin, 1998).
- To err is human (Kohn et al, 2000).
- IOM's Crossing the quality chasm (IOM, 2001)

These reports made a tremendous statement and called for action on the state of health care, its gaps, and the opportunity to improve its quality in the United States (Ransom et al, 2008). For example in the introduction of 'To err is human' it was estimated that annually between 44,000 and 98,000 Americans die due to medical errors (van Everdingen et al, 2007).

In this first chapter an introduction will be given about the definition of quality, how quality can be measured and a model will be introduced for measuring quality in hospitals and how continuous improvement can influence the outcome of health care.

1.2. Quality of health care

Different definitions of quality of health care are known. Most commonly used and widespread nowadays is the definition introduced by the Institute of Medicine (IOM) in 1990: "Quality of care is the degree to which health services for individuals and populations increase the likelihood of desired outcomes and are consistent with current professional knowledge" (Donaldson, 1999).

To measure quality, information is needed from which inferences can be drawn about quality of care. Donabedian classified these information into three different categories: 'structure', 'process' and 'outcome' (Donabedian, 1966 and Donabedian, 1988). This is a classic formulation of the dimensions of quality of care, described more than 50 years ago (IOM, 1999). *Structure* denotes the attributes of the setting in which care occurs. This includes material resources (for example facilities and equipment), human resources (the number and qualification of personnel), and organizational

structures (medical staff organisation or methods of reimbursement). *Process* denotes what is actually done in giving and receiving care. It includes patient's and practitioner's activities in seeking care, diagnosing and treatment. *Outcome* denotes to the effects of care on the health status of patients and populations (for example patient satisfaction, survival and unintended effects of treatment) (Donabedian, 1988).

A relation between these three components seems logical, good structure increases the likelihood of a good process, and good process increases the likelihood of a good outcome. But there is little research known about these relations (Pluimers & van Harten, 2011). Donabedian argues that it is not possible to assess the outcome of care, only directly, because multiple factors influence outcome. Even correcting these outcomes for case-mix might not be enough. Conformation is needed by a direct assessment of the process itself (Donabedian 1988). The Institute of Medicine agrees with this opinion, for an outcome to be a valid measure of quality, it must be closely related to processes that can be manipulated to affect the outcome (IOM, 1999)[Figure 1].

Figure 1. *The three part approach to quality assessment of Donabedian (Donabedian, 1988)*

The definition of quality of the Institute of Medicine contains six aspects, which provide the best-known and most goal-oriented definition for quality (Ransom et al, 2008): safety, effectively, efficiently, timely, patient centeredness and equity. The definitions of these aspects are:

- **Safety**: Care should be as safe for patient in healthcare facilities as in their homes.
- **Effectively**: The science and evidence behind healthcare should be applied and serve as the standard in the delivery of care.
- **Efficiently**: Care and service should be cost effective, and waste should be removed from the system.
- **Timeliness**: Patients should experience no waits or delays in receiving care and service.
- **Patient centeredness**: The system of care should revolve around the patient, respect patient preferences, and put the patient in control.
- **Equity**: unequal treatment should be fact of the past; disparities in care should be eradicated.

These six aspects are closely related to the process and outcome classes Donabedian identified. For measuring the process three of these aspects could be used: *effectively, efficiently* and *timeliness*. For the outcome *safety* and *patient centeredness* could be used. Only *equity* is difficult to place in this approach, the reason for this is that equity is an aim that plays a role on a different level. The approach of Donabedian is made to assess quality on the level of the business (hospital level, meso level) and equity plays a role on the insurance companies and the government (macro level) [figure 2].

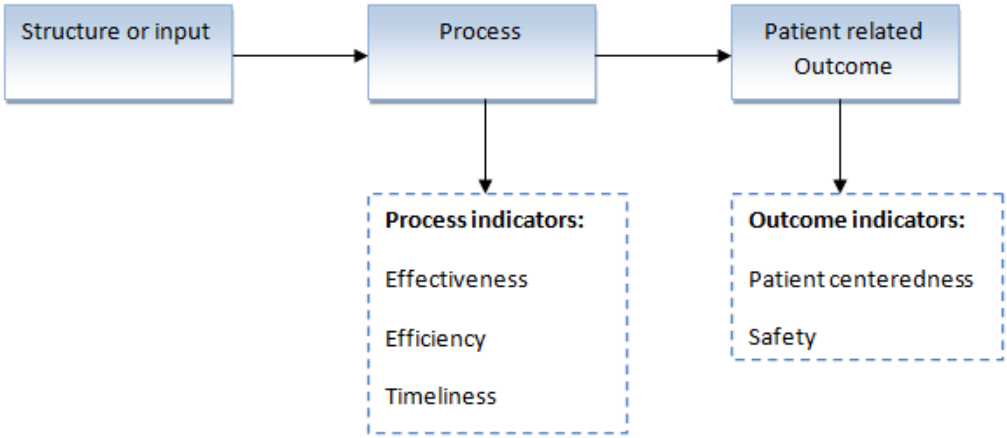

Figure 2. *The model of Donabedian combined with five of the six aspects of quality of the IOM.*

1.3. Quality of healthcare in The Netherlands

The three reports mentioned before were based on the situation in the United States a decade ago, but how is the current situation in The Netherlands? To get insight in the trends in quality, accessibility and costs of health care, 'the Rijksinstituut voor Volksgezondheid en Milieu' (RIVM), acting upon instructions from the Dutch Ministry of health, monitors quality, accessibility and costs every two years. In 2010 the third edition of the Health Care Performance Report was presented. The conclusions of the report of 2010 are mainly positive: *'the accessibility of the Dutch Health care is excellent'*. The rising costs are mainly due to the greater volume of services delivered; many parts of the system are delivering good-quality care, and demonstrable improvements have been made (Westert et al, 2010).

On the other hand there are still a lot of concerns and points that need improvement. Quality of care lacks transparency, suitable information about quality of care and about patient outcomes in particular should become available. Some more explicit examples to illustrate the variety of problems and the need for improvement are listed in table 1. The RIVM finally has concerns about the availability of data on health care and public health. Current information is mainly based on self-report and this might influence the continuity and reliability of some data registries.

Examples of problems that are still concerning and do need improvement
▪ The death rate within 30 days of hospital admission for an acute condition (heart attack, brain hemorrhage, stroke) was about twice as high in The Netherlands as in the European countries with the lowest rates.
▪ One out of six patients report having experienced minor or major medical errors during treatment.
▪ In Europe, the 5-year relative survival for colorectal cancer varies between 32% and 64%.
▪ 30 -50% of the patients do not receive care according to the latest standards.
▪ In The Netherlands annually 1734 patients die each year due to medical errors.

Table 1. *Examples of problems in current health care that need to be improved.*

1.4. Improving quality of health care

Knowing how to define and measure quality is one thing, knowing how to improve quality is another question. Berwick presented two approaches, he describes them by using two examples about two production lines [figure 3]. One is called *' the Theory of the Bad Apples'*. This theory relies on control and inspection to improve quality. This is a top-down approach. Those who rely on this theory will look for better tools of inspection and will publish data about mortality and invest heavily in systems of case-mix adjustment. An important disadvantage of using this theory is that it is about blaming. The second one is '*the Theory of Continuous Improvement'*, which compares quality aiming on improvement and is therefore based on a deepened understanding of the general sources of problems in quality. Studying problems gives opportunities to improve, and a constant effort should be put in reducing waste, rework and complexity (Berwick, 1989). Moreover best-practices could be revealed and learned from.

Example 1	**Example 2**
Foreman one walks the line, watching carefully, "I can see you all, "he warns. "I have the means to measure your work, and I will do so. I will find those among you who are unprepared or unwilling to do your jobs, and when I do there will be consequences. There are many workers available for these jobs, and you can be replaced."	Foreman two walks a different line and he too watches, "I am here to help you if I can, "he says. "We are in this together for the long haul. You and I have a common interest in a job well done. I know that most of you are trying very hard, but sometimes things can go wrong. My job is to notice opportunities for improvement – skills that could be shared, lessons from the past, or experiments to try together – and to give you the means to do your work even better than you do now. I want to help the average ones among you, not just the exceptional few at either end of the spectrum of competence. "

Figure 3. *The examples of Berwick.*

The Institute of Healthcare Improvement (IHI) presented a model for using continuous improvement in health care a decade ago. Important for the success of continuous improvement are the medical professionals and the organization of the business (hospital). The knowledge, the experience, the need to innovate and the need to improve of the professionals in both parts of the business are crucial to implement and use 'the Theory of Continuous Improvement' [Figure 4, arrow B and C]. Another important factor to succeed is a good cooperation between both professionals [Arrow A]. Continuous improvement will influence the hospital process directly [Arrow D] and structure and patient related outcomes indirectly.

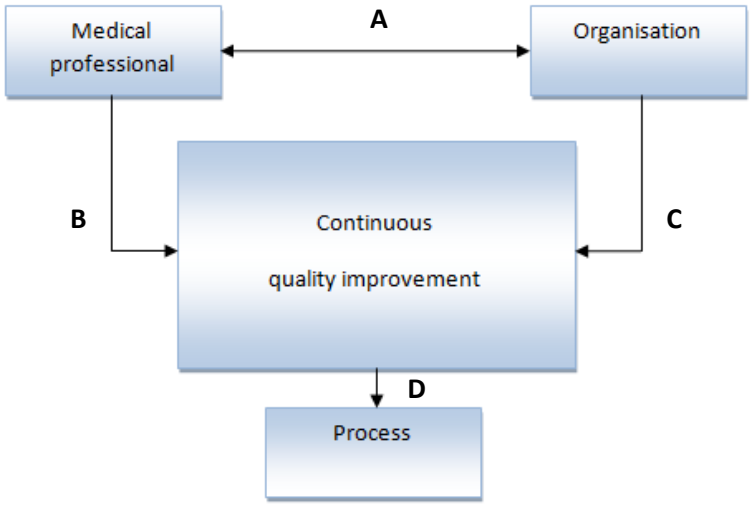

Figure 4. *The IHI model influencing the process.*

Combining the models and theories presented, gives a model that shows a relation between structure, process and outcome as Donabedian introduced. For measuring these relations five of the six aspects of quality are used. Continuous quality improvement has a direct influence on the process and both medical professionals and the organisation can be found in the model, influencing the improvement process and indirectly the outcome [figure 5].

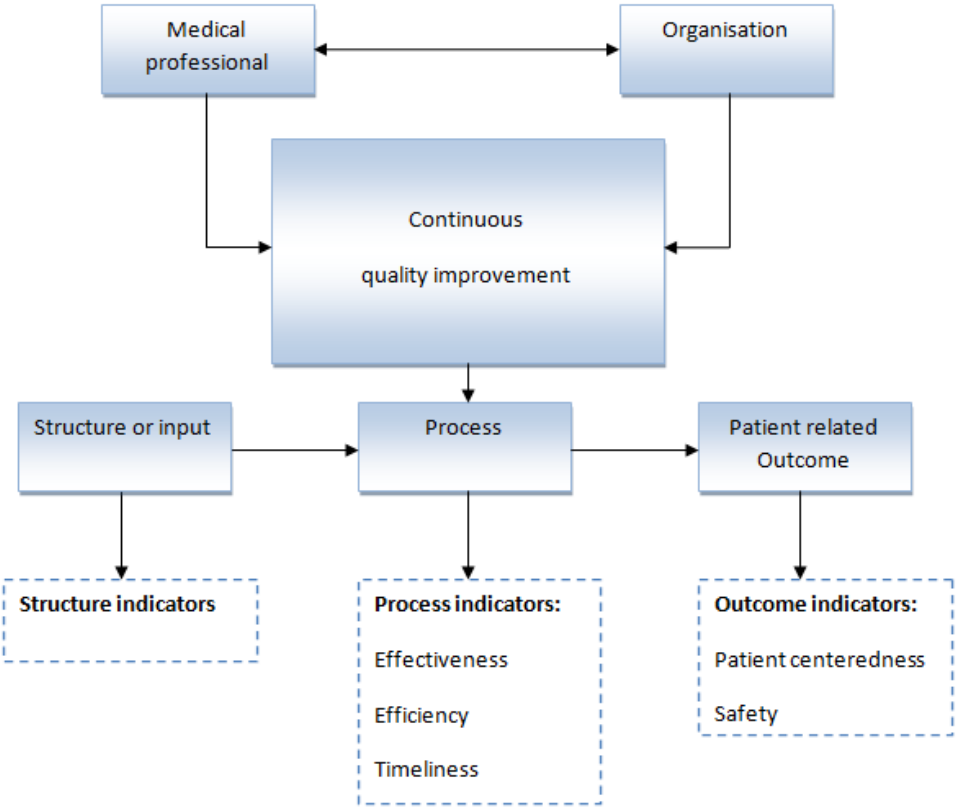

Figure 5. *A model combining the IHI model, the model of Donabedian and five of the six aspects of quality. Showing the possible relations between the different parts of the model*

Only a minority of the relations presented in this model [figure 5] have been part of published research. The relation between medical professionals and professionals working in the organisation has been part of research, using a culture gap questionnaire. The questionnaire was filled in by 166 medical professionals and 71 hospital managers of Dutch hospitals. It was found that below the surface the relation between both groups of professionals is tense, leading to suboptimal cooperation. This might decrease hospital performance, and could ultimately harm patients the authors state (Klopper-Kess et al, 2010).

Pluimers and van Harten found that there is some evidence that operations management interventions and related management theories (used to stimulate continuous quality improvement), applied in health care can contribute to patient-related outcomes. In a literature review they found 18 articles, all presenting positive effects of interventions on outcomes, however only 6 showed a significant effect. The authors of the reviewed articles used a wide range of study designs and tools, which made it difficult to compare the results. Pluimers and van Harten concluded that more research is needed using comparable study designs (Pluimers & van Harten, 2011).

As a first attempt to learn more about the relations in the presented model, a study was set up to explore the relations between the organisation of the process and the patient related outcomes. The University of Twente started this research project in close cooperation with the Dutch Surgical Colorectal Audit (DSCA). The DSCA aims to improve quality of care by auditing and collects therefore data about outcomes of health care, on national level (DSCA, 2010).

Chapter 2: Research questions

2.1. Quality in colorectal cancer care

The search for quality in colorectal cancer care is plausible, since there seem to be substantial differences in care between countries, hospitals and doctors. For example, in Europe, the 5-year relative survival for colorectal cancer varies between 32% and 64% (van Gijn & van de Velde, 2010). The complicated course after colorectal surgery in Dutch hospitals varies little, but there are some hospitals that perform better and some that perform worse (DSCA, 2010). It is also known that quality is related to the number of operations performed each year by a surgeon (Wouters et al, 2009). Quality assurance in surgical oncology is relative new compared to other medical fields such as chemotherapy and radiotherapy. For a long time surgery was thought to have too much unexpected variation to be feasible for standardization and quality control.

Surgical audit is a quality instrument which has been established in the last two decades in Europe. The first audit in this field was founded in 1993 in Norway 'the Norwegian Rectal Cancer Project'. In 2009, the Dutch Surgical Colorectal Audit was started. More than 16,500 patients were included until December 2010 and all Dutch hospitals are nowadays participating (DSCA, 2010 and van Gijn & van de Velde, 2010).

2.2. Colorectal cancer

Colorectal cancer is the third most common malignancy worldwide, after lung- and breast cancer, with 1.15 million new cases every year (van Gijn et al, 2010). In the Netherlands, cancer is the second cause of death (Kampman & Nagengast, 2006). Colorectal cancer is for women the second and for men the third most common cancer [figure 6].

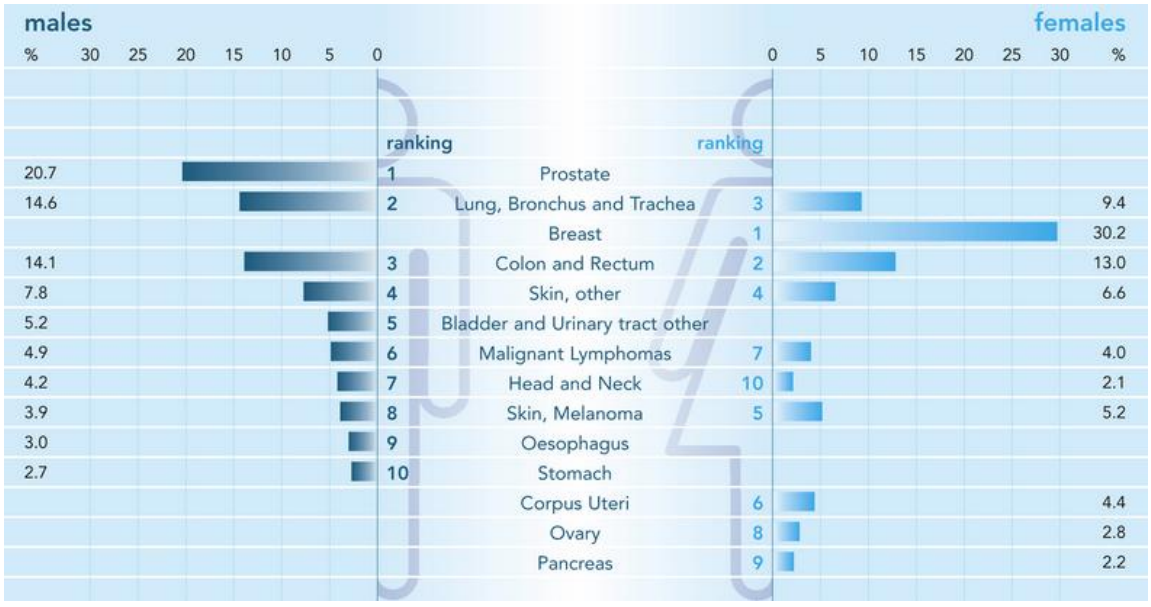

Figure 6. *The proportion and ranking of the ten most frequent cancers among males and females in 2008 (source: Netherlands Cancer Registry, 2010).*

> Incidence and prevalence

In January 2007 the 10-years prevalence of colorectal cancer was 48.900 persons (3.1 per 1000 men and 2.9 per 1000 women), the incidence in the same year was 11.500 persons. Between 1990 and 2003 there was an increase of the incidence of colorectal cancer. Corrected for population size and age distribution there was an increase of 16% among men and an increase of 11% among women.
The prevalence also increased, with 3% for colon cancer and 11% for rectum cancer. The increase of the prevalence is due to an increased incidence of colon and rectum cancer and an increase of survival rate of rectum cancer.

Based on the expected demographic changes in the future, it is calculated that the incidence of colorectal cancer will increase with approximately 40% between 2005 and 2025. (Kampman & Nagengast, 2006). Further reading about colorectal cancer can be found in appendix A.

2.3. Efficiency

One of the six aspects of quality is efficiency. The objective of efficiency measures in health care is improving the use of health care resources (Romley et al, 2009). Measuring efficiency on hospital level plays an important role in the evaluation of health policy initiatives (macro level), but in the changing world of health care it can become more important for hospitals and professionals (organisational level).

In operations management, efficiency means *'being able to perform activities well at the lowest cost'*, or in other words how well resources are used in achieving a given result. Efficiency improves whenever the resources used to produce a given output are reduced. Although economists typically treat efficiency and quality as separate concepts, separating the two in healthcare may not be easy or meaningful. Because inefficient care uses more resources than necessary, it is wasteful care, and care that involves waste is deficient – and therefore of lower quality – no matter how good it may be in other respects. *'Wasteful care is either directly harmful to health or is harmful by displacing more useful care'* (Donabedian 1988). This sounds logical but only there is little systematic knowledge about the relation between efficiency and quality.

Efficiency should be measured as objective as possible. Different definitions have been used for efficiency in health care. The definition presented in the introduction *'In an efficient system, care and service should be cost effective, and waste should be removed from the system'* or the definition of Kop *'efficiency is the degree to which the process avoids waste and minimizes the amount of resources used in delivering care'*(Kop, 2008) are both very abstract. A more practical approach which can be used to measure efficiency was introduced by van Vliet et al. They defined efficiency in terms of lead times, number of hospital visits per patient and costs (van Vliet et al, 2010).

Lead times have been part of research recently, McConnell studied the relation between timely access and quality of care in colorectal cancer and found that those are not synonymous and both must be studied to improve colorectal cancer care (McConnell, 2010). Other research about efficiency focuses on efficient colon cancer screening. No other research is known about organisation efficiency for colorectal cancer, especially not comparable to the research about efficiency, as van Vliet et al did for cataract surgery (van Vliet et al, 2010).

Because data to calculate patient related outcomes are available on a national level and efficiency is one of the six quality aspects that can be measured objectively, the first research question formulated for this master thesis is:

Research question 1

What is the relation between efficiency of the colorectal process and patient related outcome of patients undergoing colorectal surgery in Dutch hospitals?

Sub-questions

- How to measure efficiency using the definition of van Vliet?
- How to measure patient related outcomes in colorectal cancer care?

2.4. Benchmarking

There is a growing interest in performance of health services and the practices leading to excellent performance. One of the operations management practices used to improve efficiency is benchmarking (van Lent et al, 2010 and Ransom et al, 2008). Benchmarking its origin lies in the manufacturing industry and it is therefore still uncertain whether it is suitable for application in hospitals.

Definitions used for benchmarking in industries are multiple, for example 'studying the business practices of other companies for purposes of comparison' (Ransom et al, 2008) or 'the search for- and implementation of best practices' (van Lent et al, 2010). Benchmarking can be more precisely defined for healthcare, *'… benchmarking is the continual and collaborative discipline of measuring and comparing the results of key work processes with those of the best performers. It is learning how to adapt these best practices to achieve breakthrough process improvements and build healthier communities'* (van Lent et al, 2010).

Poerstamper et al present in his book on benchmarking in health care, success factors for a benchmark. It should measure continuous or at least performed more than once, it should be broadly supported, the used research instrument should be of high quality, participation should be voluntary and the data should be handled accurate. A disadvantage of the work of Poerstamper is that it focuses on the professionals in the organisation of the business and not on the medical professionals. Cooperation between these professionals seems however essential for improvement (Poerstamper et al, 2007).

To answer the first research question, data of the process and outcome of different hospitals become available. These results can be used to make a benchmark and can, in that way, help hospitals to learn from each other and improve their own businesses (care for colorectal patients). To achieve that medical professionals can obtain an useful insight in their process organisation and can compare their own performance with other hospitals. The second research question of this master thesis is:

Research question 2:

How should the data of the DSCA and the efficiency data be presented in a benchmark to Dutch medical specialists participating in the colorectal process?

Chapter 3: Methodology

3.1. Introduction

In the first chapters, a model for research and two research questions about colorectal cancer care in The Netherlands were introduced. Colorectal cancer care is very broad concept, starting with a change on molecular level, presentation of symptoms, treatment and follow-up. In this chapter different definitions needed in this research project will be introduced and discussed, as will the different steps in the research project and the use of statistics.

As a start it is important to know that the research project is broader than the two research questions introduced in the first chapters. Main purpose of this broader research project was to get, in a structured manner, insight in the relations of the model presented in the first chapter. Structuring the colorectal process makes it possible to compare and measure organization and finally identify best practices.

3.2. General definitions

> Colorectal process

Only the intramural (in-hospital) part of the colorectal process will be measured, because the main goal was to focus on comparing processes and outcomes in hospitals. The DSCA measures outcomes of patients undergoing surgery, that is why the colorectal process will only include the surgery and not postoperative therapy or follow-up.

Definition colorectal process:

The first visit to the outpatient clinic of the patient until the day of discharge from the hospital after colorectal surgery.

In this part of the colorectal process, four different phases can be distinguished, based on medical decision making.

Phase	Definition
▪ Diagnostic phase	From first visit to the outpatient clinic until the day of the result of the pathology after colonoscopy or sigmoidoscopy.
▪ Staging of the disease	The investigations necessary to stage the disease after the diagnosis until the conference of the Multi Disciplinary Team (MDT)
▪ Preoperative phase	The time between the MDT and the day of operation, mostly a preoperative screening takes place during this phase
▪ Admission phase	The day of operation until the day of discharge

> Selection of hospitals

Hospitals participating in the DSCA in 2009 (n=75), having at least 50 patients included in the database of the DSCA and had more than 90% of the data fully completed, were selected to participate in this study (n=41). In total 22 hospitals were invited. The DSCA contact person of every hospital received an invitation letter, followed by an email with the same information send two days after the letter. After two weeks a reminder was send. A letter of recommendation from the DSCA was included by the first letter [See appendix B].

The hospitals who responded positively were contacted by the junior researcher (AN) and appointments were made for July and August 2010. The other hospitals received a letter by email that another round of visits would be planned at the end of 2010.

> Selection of patients

All patients undergoing surgery (a resection of a part of the colon, including the rectum via open or laparoscopic surgery) in 2009 (from January the first until December 31th) because of primary colon carcinoma or primary rectum carcinoma in an elective setting (the time the surgical procedure is subject to choice, opposite to urgent or acute setting). And registered in the DSCA on 1 July 2010.

> Data collection

All data were collected during a three or four days visit to the participating hospitals. The data were collected based on a semi-structured interview, observations (using a adapted version of the Rapid Plant Assessment (RPA) (Goodson, 2002)). To collect additional information of the patients in every hospital, the Electronic Health Record (EHR) was used. The semi-structured interview and the observation list are available on request.

3.3. First research question

'What is the relation between efficiency of the colorectal process and patient related outcome of patients undergoing colorectal surgery in Dutch hospitals?'

> Efficiency

Efficiency is defined as 'the degree to which the process avoids waste and minimizes the amount of resources used in delivering care' (Kop, 2008). More specific efficiency will be quantitative measured in terms of lead times (a), number of hospital visits per patient (b) and costs (c) (van Vliet et al, 2010).

a. Lead times

Definition lead times:

The lead times of the colorectal process from the first to the outpatient clinic until the last in hospital day, in days.

The following lead times were formulated:

- **GI – PA:** the number of workdays between the day of the first visit to the Gastro-intestinal and the day that the pathology is known.
- **Scopy – PA:** the number of workdays between the day of the colonoscopy an the day the result of pathology is known.
- **PA – MDT:** the number of workdays between the day that the result of the pathology is known and the day that the patient is discussed in the Multidisciplinary Team (MDT).
- **Waiting time**: the number of workdays between the day that the pathology is known and the day of the surgery.
- **The length of stay**: the number of days between the day of the surgery and the day the patient is discharged from the hospital.
- **The surgery time**: the time between the entry of the patient in the operation room and the patient leaving the operation room after surgery.

The day of the colonoscopy, the day the result of the pathology is known, the day of the MDT, the day of the first visit to the surgery department, the day of surgery and the day of discharge were collected in every hospital using the Electronic Health Record (EHR) for each patient operated for a primary colorectal carcinoma in an elective setting in 2009 individually. The surgery times were, in some hospitals, collected based on different systems used in the different hospitals and afterwards related to the patient numbers by hand, to collect the surgery time of the right patient group.

b. Hospital visits per patient

Definition of hospital visits per patient:

The number of visits per patients from the first visit to the outpatient clinic until the last in hospital day.

A patient visit was formulated as a visit to the hospital for an activity related to the colorectal pathway of the patient. Only the departments Radiology, Gastrointestinal Medicine, Surgery and Anaesthesiology were included. If a patient visits the hospital for two different activities (for example for an echo and a MRI scan) on the same day, this was counted as one patient visit. The in-hospital days because of the surgery were counted as one patient visit.

The number of patient visits were calculated for every patient independent, using the EHR of every hospital. All visits to the Gastrointestinal Medicine department, Surgery department, Radiology department and Anaesthesiology department from colonoscopy until admission for operation were counted. Visits to the Radiotherapy and Oncology department or visits to nurses or physician assistants were not included. Although they might play an important role in the number of hospital visits, these were excluded because not for every hospital data were available. This has two different reasons. First, not all hospitals have their own radiotherapy centre so patients go elsewhere to get radiotherapy and no data are known. Secondly the visits to nurses or physician assistants are mostly not registered in the EHR. Instructions for collecting the data in the EHR are described in more detail in appendix C.

c. Costs

Definition of costs:

Main direct costs of the colorectal process per patient.

Two options to calculate costs were used. The first by estimating the direct costs, using activity based costing. For calculating the direct costs the process for the patient with a colorectal malignancy should be split in different activities. For each activity, mean costs were calculated per patient, time for every activity was multiplied with the costs for personnel and that was multiplied with the mean number of times the patient underwent the activity. Only the main person facilitating the activity was included.

- **The diagnostic phase**
  - Diagnostic test: colonoscopy.
  - Visit to GI-department.
- **The staging**
  - MRI, CT and X-thorax.
- **The preoperative phase**
  - Visits to medical doctors.
- **The operative phase**
  - The operation time and the in-hospital days.

Because the main costs of the activities described above are made during the operative phase, the second approach was to calculate the main direct costs. The total number of in-hospital days multiplied with the costs of a hospital bed on a nursing department divided by the number of patients treated.

> Patient related outcomes

To relate efficiency to patient related outcomes, two case-mix corrected outcomes defined as the two main outcomes of the DSCA were used (a.). The first is 'postoperative mortality' and the second 'complicated course' (see the definitions of the DSCA in the blue box). Besides that, intermediate indicators (including outcome indicators and process indicators) were selected, to obtain insight in the quality of care (b.).

For the patient related outcomes and the selected indicators, the data of the Dutch Surgical Colorectal Audit were used. All hospitals gave permission on paper to the 'Stichting Informatievoorziening Zorg' (IVZ) to use the data of their hospital. For the additional data collection in the EHR a verbal agreement was given [Appendix B].

a. Case mix corrected outcomes

Differences in patient- and tumour characteristics between groups of patients are expected to influence the outcomes of care of the hospitals (DSCA, 2010). In the DSCA a wide range of data are collected of every patient, used to correct two main outcomes (postoperative mortality and complicated course) for patient- and tumour characteristics. To make the postoperative mortality and the complicated course comparable for different groups and different hospitals both were corrected for case-mix. The following data were used for case-mix correction of these two outcomes by the DSCA: Age, gender, co morbidity, abdominal operations, ASA classification, number of tumours, tumour size, location of the tumour, complications of the tumour and tumour stage.

Definition of postoperative mortality:

Death of a patient within 30 days of the resection or during the actual in-hospital stay.

Definition of complicated course:

' A patient with complications which lead to death OR for which re-intervention was necessary OR which lengthened the in-hospital stay by more than 21 days.'

b. Intermediate indicators

A review of the literature was performed in Medline, using the following search terms: Quality indicators, Health status indicators, Colorectal surgery. Out of the literature found a list of indicators was selected. This selection was discussed with several experts (WvH, SS, MW, NK en AN) and a final selection was made. The selection of the intermediate indicators will be discussed in detail in chapter 4.

3.4. Second research question

'How should the data of the DSCA and the efficiency data be presented in a benchmark to Dutch medical specialists participating in the colorectal process?'

> Literature review

The first step to answer this research question was to perform a literature search. For this literature review, Medline and Cochrane library were searched. Only abstracts written in English or Dutch were included. All the relevant studies were selected based on title and abstract. All not selected articles were sorted in categories to give insight in the literature found. The following research terms were used: quality of care, feedback, communication, physicians, medical specialist, performance measurement, educational measurement, information presentation, benchmarking, comparison and best practices.

> Comparison with other registrations

In Europe and America several different registries in health care are known. Especially the north European countries have registrations for colorectal cancer which are set up in the early 90's. To answer the research question, a comparison of registries was made to obtain insight in the way other countries present data to medical specialists.

Three national registries were selected: the perinatal registry (PRN), the intensive care registry (NICE) and the orthopaedic registry (LROI). In addition, five international registries were selected: Norway, Sweden, United Kingdom, Canada and the United States. These registries were represented during the presentation of the first result of the DSCA. The registries were contacted by email and asked to send their last registry report format to the researcher (AN). A comparison was made based on these registry reports and formats, using a method of van der Veer et al (van der Veer et al, 2010).

To get insight in the different variables collected in the colorectal registries, an overview of the European Registration of Cancer Care (EURECCA) was used. Eight colorectal audit registries committed to participate in this network. The selected intermediate indicators were used to make a comparison between the participating countries.

> Expert opinions

Three non-medical experts were asked to give their opinion about presenting data for medical specialists. Experts were interviewed in person or by telephone. They were selected based on their experience with benchmarking in health care in the recent past.

Medical specialist (surgeons in the field of colorectal surgery) participating in the pilot phase of the research project were asked to give their opinion on the way data were presented to them. A set of different possibilities were given to them and they were asked to select the best way the data were presented and why they likes this option best. They were free to give suggestions about the data presentation and were asked to give a selection of the possible data that could be presented, to make a benchmark report that was most relevant and understandable to them.

> General

Based on the three methods described above the most relevant data, important for a good benchmark were selected. And the best way to present these selected data were used to make a format for the benchmark that was given back to the medical specialists in the participating hospitals.

3.5. Analysis

To answer the first research question the data of the DSCA and the data collected in the EHR were combined, using hospital number, date of birth and gender. To complete the dataset, the data of the result of the pathology and the MDT were combined from both data bases. Descriptive statistics were used to analyse the efficiency and patient related outcomes on hospital level. To analyse if there were differences between the means of these data one-way ANOVA tests were used.

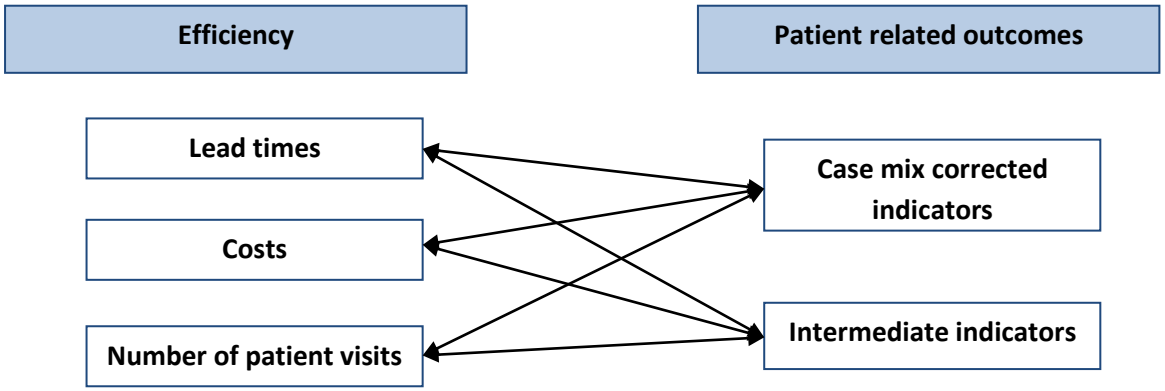

Figure 7. *Overview of the method for research question one, showing the possible relations between efficiency and patient related outcomes.*

On patient level the means, median and standard deviation was calculated and a chi-square test was used to show if relation are likely. The patients were classified in different groups: patients with colon carcinoma and patients with rectum carcinoma. The patients with rectum carcinoma were further classified in patient who underwent a short schedule of radiotherapy and patients who underwent a long schedule of radiotherapy (long radiotherapy, chemo radiotherapy or palliative radiotherapy). To use the chi-square test the efficiency measures were classified in two groups, with the mean as a cut off point. For the subgroups separate means were used (colon carcinoma, rectum carcinoma long schedule radiotherapy and rectum carcinoma short schedule radiotherapy), because especially for the lead times there were major differences, which might have otherwise influenced the results. See figure for an overview of the relations analysed [Figure 7].

Microsoft Office Excel 2007, PSAW statistics version 18.0 and MagnaView 4.2 were used for the analysis.

Chapter 4: Selecting patient related outcomes

Reports and articles concerning suboptimal and unsafe care are making a stronger and stronger call for accounting the quality of care. Methods to justify the level of care activities by quantification were first used two decades ago in the United States, followed by the United Kingdom and Denmark (Wollersheim et al, 2007). Indicators can give an indication of the quality of the patient care delivered. To measure quality of the colorectal cancer care process and outcome indicators will be selected. This was done by selecting indicators from articles found in a structured literature search.

The Dutch initiative 'Zichtbare Zorg' had a committee that evaluated in 2009 the possible indicators for the colorectal process (Zichtbare Zorg, 2009). Only three indicators were finally accepted, (1) participating in the DSCA ,(2) The number of lymph nodes examined after resection and (3) the percentage of patients with a rectum carcinoma discussed in a MDT preoperative. Besides these three indicators the committee considered a much longer list of indicators, this list was used to evaluate the indicators selected in the literature (Zichtbare Zorg, 2009).

4.1. Literature search

A literature search was performed in Medline, using the MeSH terms: quality indicators, health status indicators and colorectal surgery. These terms were combined using OR and AND, which gave 28 articles of which 5 were reviews [Table 2].

#	MeSH term	Number of articles	Number of reviews
1	Quality Indicators, Health Care	7.950	740
2	Health Status Indicators	141.495	14.454
3	#1 OR #2	149.081	14.671
4	Colorectal Surgery	1.439	148
5	#3 AND #4	28	5

Table 2. *Literature search in Medline on 14th September 2010.*

Based on the title and abstracts relevant articles were selected. Only papers about malign tumours and in which indicators or variables were main object of the article were selected. Excluded were papers about surgery for non-malignant diseases and predictors of outcomes. Of the 28 articles, 12 articles were included. Full text of these articles were read and all indicators mentioned were listed [Appendix D].

4.2. The selection of the indicators

Of the indicators found in the literature a selection was made. First all indicators that were no part of the colorectal process were excluded (from the first visit to the outpatient clinic of the patient until the day of discharge from the hospital after colorectal surgery). Second, the remaining indicators

were discussed with medical and non-medical experts ((WvH, SS, MW, NK and AN). Based on this discussion two indicators were added to the list: the percentage of radical resections for rectal cancer based on the Circumferential Resection Margin (CRM) and the percentage of patients with imaging of the lung and liver preoperative. Five indicators were excluded. Table 3 shows the complete list of indicators that were discussed.

Subject indicator	Type	Comment	Select	References
▪ Proportion of in-hospital mortality or mortality within 30 days of colon or rectal cancer surgery (for non-emergent surgery)	O	Used in the DSCA, also case mix corrected	Y	(Dimick, 2010/ Gagliardi, 2005 / ZZ (na)
▪ Proportion of patients undergoing surgery for rectal cancer who experience an anastomotic leak.	O	Instead of only anastomotic leak, the total number of complications was selected (nr. 8)	N	Mazeh, 2009 / Saliangas, 2004 / Gagliardi, 2005/ ZZ (na)
▪ Proportion of patients undergoing surgery for rectal cancer who have preoperative imaging of the pelvis with CT or MRI	P		Y	McCory, 2006 / Gagliardi, 2005 / ZZ (na)
▪ Proportion of patients undergoing surgery for colon or rectal cancer who have preoperative imaging of the liver with ultrasonography, CT or MRI	P	Possible difficulty is that there is a time that these data are not correctly registrated for rectal surgery in the DSCA in 2009	Y	Gagliardi, 2005 /ZZ (na)
▪ Proportion of patients undergoing surgery for colon or rectal cancer who have preoperative imaging of the lung and liver with ultrasonography, CT or MRI	P	See nr. 4	Y	experts
▪ Percentage of patients of who 10 or more lymph nodes are examined	P		Y	ZZ (a)
▪ Percentage of patients with a rectum carcinoma that are discussed in a preoperative multidisciplinary work group.	P		Y	ZZ (a)
▪ Number of days between the date of the result of pathology and date of surgery	P	The lead times will be part of the efficiency data	N	ZZ (na)
▪ Percentage of re-interventions because of complications, within the in-hospital stay or within 30 days after resection of the primary tumour.	O	Relevant, however it is influenced by case-mix	Y	
▪ Percentage of complications within the in-hospital stay or within 30 days after resection of the primary tumour	O	See nr.9	Y	experts
▪ Proportion of patients undergoing	O	Used in the DSCA, also case mix	Y	experts

surgery for colon or rectal cancer who have a of complicated course *'A patient with complications which lead to death OR for which re-intervention was necessary OR which lengthened the in-hospital stay by more than 21 days.'*		corrected		
▪ Proportion of patients undergoing surgery for a T1 –T3 colon or rectal cancer who have a radical resection (R0).	O	Relevant, but should be better to correct for case mix	Y	ZZ (na)
▪ the proportion of patients undergoing rectum surgery that had a radical resections based on the Circumferential Resection Margin (CRM)	O		Y	experts
▪ Specialized nurse (in oncology or stoma care)	P	Relevant, but not available on patient level	N	ZZ (na)
▪ If a patient is diagnosed with colorectal cancer, then treatment should be initiated within 10 weeks after biopsy or 6 weeks after seeing the surgeon for consultation or documented why performed later.	P	The six and ten weeks mentioned are arbitrary. And the number of days are part of efficiency.	N	McCory, 2006
▪ If a patient is undergoing colorectal cancer surgery, then in addition to the surgeon, a baseline preoperative risk assessment should be obtained by an anesthesiologist.	P	Not registered in the DSC A, but registered this during our research.	N	McCory, 2006

Table 3. *Overview of all discussed indicators. O=Outcome indicator, P= Process indicator, ZZ= Zichtbare Zorg. NA= not accepted by the Zichtbare Zorg Commission, A= Accepted by the Zichtbare Zorg Commission. The column* select *shows whether the indicators are included (Y=yes) or excluded (N=no).*

Chapter 5: Results first research question

5.1. Introduction

In total 22 hospitals were invited to participate in the study, after the second invitation 18 hospitals gave permission for a hospital visit and the use of the DSCA dataset (Response rate 82%). All hospitals were contacted by the junior researcher (AN) by telephone and / or email to make an appointment for the hospital visit. In total visits to eight hospital were planned and completed in July and August 2010. The other ten hospitals received an email with the information that at the end of 2010 another round of visits will be held.

5.2. Results on hospital level

Of the eight hospitals, three were academic hospitals, one was a teaching hospital and four were non-teaching hospitals. In all hospitals additional information was collected of in total 472 patients who underwent surgery in 2009 [table 4].

Hospital number	Total number of patients	Number of patients with colon carcinoma	Number of patients with rectum carcinoma
1	100	73	27
2	75	36	39
3	61	45	16
4	30	21	9
5	40	18	22
6	45	31	14
7	58	28	30
8	63	42	21
Total	**472**	**294 (62,3%)**	**178 (37,7%)**

Table 4. *Number of patients of the participating hospitals.*

> Patient related outcomes

On hospital level the patient related outcomes and the efficiency data are presented in table 5 up to 9. In table 5 and 6 the case mix corrected outcomes are presented. These are based on all patients registered in the DSCA in 2009 on 1 July 2010. This means that also acute and urgent patients are included. The Leiden University Medical Centre calculated the expected mortality using the patient and tumour characteristics. The case mix corrected mortality and complicated course are calculated dividing the observed mortality by the expected mortality (based on case-mix of the patient group), multiplied by the mean mortality of all patients. The same formula was used to calculate the case mix corrected complicated course. The mean mortality in 2009 was 3,7% and the mean complicated course in 2009 was 23,9%.

Hospital	Patients registered in the DSCA	Expected mortality	Observed mortality	Expected percentage	Case mix corrected mortality
1	111	3,14	0	2,83%	0,0%
2	93	3,29	4	3,54%	4,0%
3	85	3,28	1	3,86%	1,0%
4	67	4,21	2	6,28%	1,6%
5	52	1,42	0	2,73%	0,0%
6	56	1,89	0	3,38%	0,0%
7	65	1,11	0	1,71%	0,0%
8	77	3,43	4	4,45%	3,8%

Table 5. *Case mix corrected mortality per hospital. The case mix corrected mortality and complicated course are calculated dividing the observed mortality by the expected mortality, multiplied by the mean mortality of all patients.*

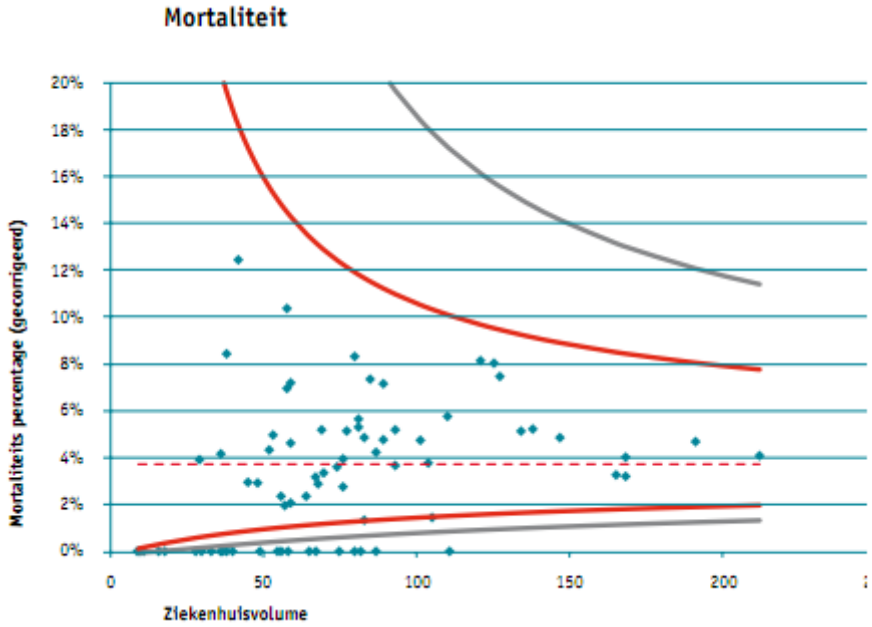

Figure 8. *The corrected mortality, The dots are the hospitals participating in the DSCA, the red line is the 95% confidence interval and the grey line the 99,8% confidence interval. Data 2009. (source DSCA, 2010).*

In figure 8 a funnel plot is presented, it shows all hospitals participating in the DSCA in 2009. All hospitals score between the 95% confidence interval. No outliers are found. So the differences between our four hospitals are in the range of coincidence. The mean corrected mortality for 2009 was 3,7%, seven of the eight hospitals score below this mean off all patients.

In Table 6 the case mix corrected complicated course of the eight hospitals are presented, figure 9 shows a funnel plot of the complicated course. Because of the higher percentage of cases in relation with mortality, the confidence intervals narrow. There are two hospitals which have a significant higher number of patients with a complicated course. There are also some hospitals that score better than the mean of 23,3%. The eight hospitals visited all perform within the 99,8% confidence interval, two hospitals perform better than the 95% confidence interval (hospitals 1 and 3).

Hospital	Patients registered in the DSCA	Expected complicated course	Observed complicated course	Expected percentage	Case mix corrected complicated course
1	111	25,06	15	23%	14,3%
2	93	23,12	25	25%	25,8%
3	85	18,90	11	22%	13,9%
4	67	18,93	17	28%	21,5%
5	52	12,11	10	23%	19,7%
6	56	13,03	10	23%	18,3%
7	65	13,21	19	20%	34,4%
8	77	20,33	22	26%	25,9%

Table 6. *Case mix corrected complicated course per hospital. The case mix corrected mortality and complicated course are calculated dividing the observed mortality by the expected mortality, multiplied by the mean mortality of all patients.*

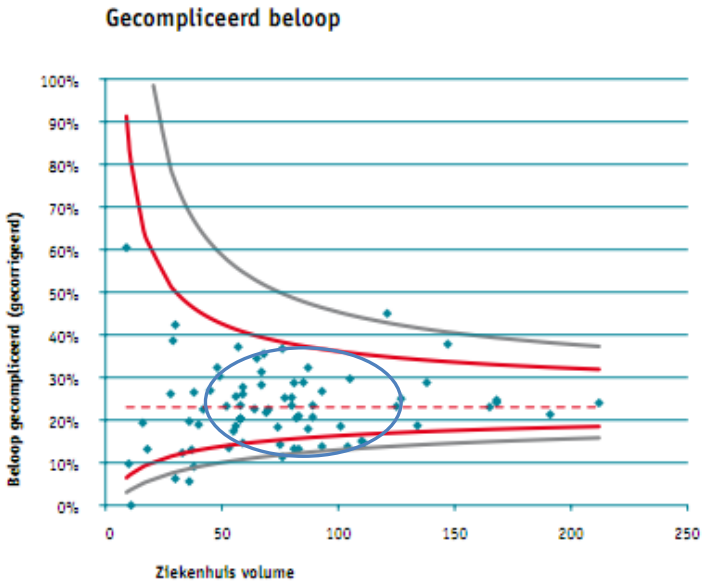

Figure 9.*The corrected complicated course, The dots are the hospitals participating in the DSCA, the red line is the 95% confidence interval and the grey line the 99,8% confidence interval, all eight visited hospitals fall within the blue oval. Data 2009. (source DSCA, 2010).*

> intermediate indicators

For the intermediate indicators the proportion in number of patients and in a percentage is presented in table 7 as is the total number of patients of which the indicator was known. This is presented for all eight hospitals, for the total of the hospitals the mean and median was calculated (last two columns). To obtain a more specific insight, these measures were also calculated for colon carcinoma and rectum carcinoma separate.

		1	2	3	4	5	6	7	8	Total
Preoperative imaging of the liver	Colon carcinoma	71 97,3% n=73	33 91,7% n=36	45 100% n=45	21 100% n=21	18 100% n=18	30 96,8% n=31	28 100% n=28	38 90,5% n=42	284 96,6% n=294
	Rectum carcinoma	0 0,0% n=27	3 7,7% n=39	0 0,0% n=16	0 0,0% n=9	1 4,5% n=22	0 0,0% n=14	1 3,3% n=30	1 4,8% n=21	6 3,4% n=178
	Total	71 71,0% n=100	36 48,0% n=75	45 73,8% n=61	21 70,0% n=30	19 47,5% n=40	30 66,7% n=45	29 50,0% n=58	39 61,9% n=63	290 61,4% n =472
Preoperative imaging of the lung and liver	Colon carcinoma	71 97,3% n=73	31 86,1% n=36	43 95,6% n=45	18 85,7% n=21	18 100% n=18	26 83,9% n=31	27 96,4% n=28	37 88,1% n=42	271 92,2% n=294
	Rectum carcinoma	0 0,0% n=27	2 5,1% n=38	0 0,0% n=16	0 0,0% n=9	1 4,5% n=22	0 0,0% n=14	1 3,3% n=30	1 4,8% n=21	5 2,8% n=178
	Total	71 71,0% n=100	33 44,0% n=75	43 70,5% n=61	18 60,0% n=30	19 47,5% n=40	26 57,8% n=45	28 48,3% n=58	38 60,3% n=63	276 58,5% n=472
Pre-op imaging of the pelvis	Rectum carcinoma	27 100% n=27	38 97,4% n=39	16 100% n=16	9 100% n=9	22 100% n=22	14 100% n=14	30 100% n=30	21 100% n=21	177 99,4% n=177
Preoperative discussed in a MDT	Colon carcinoma	65 89,0% n=73	20 57,1% n=35	22 68,8% n=32	4 19,0% n=21	17 100% n=17	22 88,0% n=25	13 50,0% n=26	40 97,6% n=41	203 75,2% n=270
	Rectum carcinoma	27 100,0% n=27	39 100% n=39	14 93,3% n=15	4 44,4% n=9	22 100% n=22	11 84,6% n=13	24 82,8% n=29	21 100% n=21	162 92,6% N=175
	Total	92 92,0% n=100	59 79,7% n=74	36 76,6% n=47	8 26,7% n=30	39 100,0% n=39	33 86,8% n=38	37 67,3% n=55	61 98,4% n=62	365 82,0% n=445
More than 10 lymph nodes examined	Colon carcinoma	49 68,1% n=72	31 88,6% n=35	36 83,7% n=43	16 76,2% n=21	17 94,4% n=18	26 86,7% n=30	24 85,7% n=28	31 75,6% n=41	230 79,9% n=288
	Rectum carcinoma	13 52,0% n=25	24 61,5% n=39	9 60,0% n=9	6 66,7% n=9	18 81,8% n=22	7 50,0% n=14	18 66,7% n=27	8 28,1% n=21	103 59,9% n=172
	Total	62 63,9% n=97	55 74,3% n=74	45 77,6% n=58	22 73,3% n=30	35 87,5% n=40	33 75,0% n=44	42 76,4% n=55	39 62,9% n=62	333 72,4% n=460
CRM (radical resection)	Rectum carcinoma	15 100% n=15	22 73,3% n=30	11 100% n=11	3 75,0% n=4	4 66,7% n=6	11 91,7% n=12	12 70,6% n=17	16 94,1% n=17	94 83,9% n=112

		1	2	3	4	5	6	7	8	Total
Percentage radical resections for patients with a T1 – T3 tumour	Colon carcinoma	53 98,1% n=54	25 92,6% n=27	38 90,5% n=42	16 100% n=16	13 92,6% n=14	19 82,6% n=23	16 94,1% n=17	34 97,1% n=35	214 93,9% n=228
	Rectum carcinoma	24 96,0% n=25	26 89,7% n=29	15 100% n=15	8 100% n=8	19 95,0% n=20	10 83,3% n=12	21 100% n=21	17 89,5% n=19	139 94,0% n=148
	Total	77 97,5% n=79	50 90,9% n=55	53 93,0% n=57	24 100,0% n=24	32 94,1% n=34	29 82,6% n=35	37 97,4% n=38	51 94,4% n=54	353 94,0% n=376
Re-interventions within 30 days	Colon carcinoma	3 4,1% n=73	4 11,1% n=36	3 6,8% n=44	5 23,8% n=21	2 11,1% n=18	6 19,4% n=31	7 25,0% n=28	7 17,1% n=41	37 12,7% n=292
	Rectum carcinoma	1 3,7% n=27	2 5,1% n=39	1 7,7% n=13	2 25,0% n=8	2 9,1% n=22	2 14,3% n=14	8 26,7% n=30	2 10,0% n=20	20 11,6% n=173
	Total	4 4,0% n=100	6 8,0% n=75	4 7,0% n=57	7 24,1% n=29	4 10,0% n=40	8 17,8% n=45	15 25,9% n=58	9 14,8% n=61	57 12,3% n=465
Complications	Colon carcinoma	14 19,2% n=73	14 41,2% n=34	10 22,2% n=45	5 23,8% n=21	2 11,1% n=18	10 34,5% n=29	10 35,7% n=28	14 34,1% n=41	79 27,3% n=289
	Rectum carcinoma	12 44,4% n=27	18 46,2% n=39	5 33,3% n=15	4 44,4% n=9	8 36,4% n=22	3 23,1% n=13	14 46,7% n=30	10 50,0% n=20	74 42,3% n=175
	Total	26 26,0% n=100	32 43,8% n=73	15 25,0% n=60	9 30,0% n=30	10 25,0% n=40	13 31,0% n=42	24 41,4% n=58	24 39,3% n=61	153 33,0% N=464
Complicated course	Colon carcinoma	7 9,6% n=73	5 15,2% n=33	6 14,0% n=43	5 23,8% n=21	2 11,1% n=18	8 25,8% n=31	8 28,6% n=28	9 21,4% n=42	50 17,3% N=289
	Rectum carcinoma	7 25,9% n=27	11 28,2% n=39	1 6,3% n=16	2 22,2% n=9	4 19,0% n=21	2 14,3% n=14	11 36,7% n=30	5 25,0% n=20	43 24,4% N=176
	Total	14 14,0% n=100	16 22,2% n=72	7 11,9% n=59	7 23,3% n=30	6 15,4% n=39	10 22,2% n=45	19 32,8% n=58	14 22,6% n=62	93 20,0% n=465
30 days in-hospital mortality	Colon carcinoma	0 0,0% n=73	1 2,8% n=36	0 0,0% n=45	0 0,0% n=21	0 0,0% n=18	0 0,0% n=31	0 0,0% n=28	1 2,4% n=42	2 0,7% n=294
	Rectum carcinoma	0 0,0% n=27	0 0,0% N=39	0 0,0% n=16	0 0,0% n=9	0 0,0% n=22	0 0,0% n=14	0 0,0% n=30	1 4,8% n=21	1 0,6% n=178
	Total	0 0,0% n=100	1 1,3% n=75	0 0,0% n=61	0 0,0% n=30	0 0,0% n=40	0 0,0% n=45	0 0,0% n=58	2 3,2% n=63	3 0,6% n=472

Table 7. *intermediate indicators. n=number of patients.*

For colon carcinoma the percentage of the performance of preoperative imaging of the liver varies from 90,5% (hospital 8) until 100% (hospitals 3,4,5 and 7) and for preoperative imaging of the lung and liver varies from 83,9% (hospital 6) until 100% (hospital 5). Due to a problem with the digital registration form of the DSCA it was not possible to fill in the imaging of the lung and the liver for rectum carcinoma. This explains the low percentages scored on this item for the total population for all hospitals. Some hospitals score lower on imaging for colon carcinoma, this might be due to the relative large number of secondary referrals, because 3 of the 8 hospitals are academic hospitals. Imaging of the pelvis was performed in almost all patients with rectum carcinoma, only hospital 2 scored slightly below 100%, with 97,4% missing imaging of one patient.

There is a wide variance between the hospitals discussing patients with a colon carcinoma preoperative, 19% (hospital 4) until 100% (hospital 5). For rectum carcinoma this range is smaller, 44% (hospital 4) until 100% (hospitals 1,2,5 and 8). A likely explanation is that this is a quality indicator for rectum carcinoma and not for colon carcinoma. It might also be due to a different organisation in the hospitals. Some hospitals decided to discuss all patients in a weekly MDT while others discuss the patient directly after the first visit with other specialists during the combined outpatient clinic.

Three indicators are related to pathology. The first is the examination of lymph nodes after resection, more than 10 lymph nodes examined is the norm. For colon carcinoma this varies from 75,6% (hospital 8) until 94,4% (hospital 5). For rectum carcinoma the variation is broader, 28,1% (hospital 8) until 81,8% (hospital 5). The Circumferential Resection Marge (CRM) is related to the prognosis for rectum carcinoma and is categorized in radical and irradical. The lowest number of radical marges was found in hospital 5 (66,7%) and the highest in hospitals 1 and 3 (100%). The size of a tumour is pointed out with a T, for T1 –T3 tumours a radical selection is an indicator. For colon carcinoma all hospitals scored high, from 82,6% (hospital 6) until 100% (hospital 4). For rectum carcinoma the lowest score was also for hospital 6 (83,3%) and the highest for hospital 3,4 and 7 (100%).

The number of re-interventions varies from 4,1% (hospital 1) until 25% (hospital 8) for colon carcinoma. The same tendency can be seen for rectum carcinoma, 3,7% (hospital 1) until 26,7 (hospital 8). The number of complications varies from 11,1% (hospital 5) until 41,2% (hospital 2) for colon carcinoma and for rectum carcinoma varies from 23.1% (hospital 6) until 46,7% (hospital 8). The complicated course, patients with complications which lead to death OR for which re-intervention was necessary OR which lengthened the in-hospital stay by more than 21 days varies for colon carcinoma from 9,6% (hospital 1) until 36,7% (hospital 8), for rectum carcinoma from 6,3% (hospital 3) until 36,7% (hospital 8). All these outcome indicators are influenced by the patient group (patient- and tumour characteristics). That is why, as explained earlier, complicated course and 30 days mortality are corrected for case-mix. Finally the 30-days mortality varies little, the mortality is very low and only three patient of the 472 died postoperative.

> Efficiency – number of patient visits

To measure efficiency, three different groups of variables were measured: number of patient visits, lead times and costs. The number of patient visits can be found in table 8. Apart from the total number of patient visits, also the number of days the patient visited the hospital because of activities related to staging and the number of days the patient visited the outpatient clinic were calculated. The total patient group was categorised in colon cancer and rectum cancer because of different pathways patients follow preoperative. Rectal cancer was further subdivided in patients undergoing short radiotherapy or long radiotherapy. Short therapy is a 5 days contiguous radiotherapy schedule (with a radiation dose of 5x5 Gray), this could give a delay of one workweek. And long radiotherapy is a schedule of 14 weeks combining radiotherapy (with a radiation dose of in total 45-50 Gray) and waiting time before surgery combined with chemotherapy for some patients (Landelijke Werkgroep Gasto Intestinale tumoren, 2008).

			1	2	3	4	5	6	7	8	Mean overall	Median overall
Number of patient visits related to staging	Colon		1,65 (0,858) n=72	1,03 (0,810) n=36	2,11 (3,128) n=45	1,05 (0,384) n=21	1,56 (0,856) n=18	1,45 (0,810) n=31	1,07 (0,874) n=27	1,48 (0,740) n=42	1,50 (1,458) N=292	1,00
	Rectum	RT Short	1,94 (0,827) n=17	1,92 (1,564) n=12	1,21 (0,426) n=14	1,00 (0,000) n=7	1,40 (0,548) n=5	2,33 (1,225) n=9	1,39 (1,037) n=18	2,47 (0,625) n=17	1,77 (1,018) n=99	2,00
		RT Long	3,00 (1,512) n=8	1,87 (1,191) n=24	2,50 (0,707) n=2	2,00 (1,414) n=2	2,47 (1,598) n=15	3,00 (1,826) n=4	1,18 (1,079) n=11	3,00 (0,816) n=4	2,17 (1,404) n=70	2,00
		total	2,11 (0,847) n=27	1,82 (1,275) n=39	1,38 (0,619) n=16	1,22 (0,667) n=9	2,14 (1,424) n=22	2,50 (1,345) n=14	1,30 (1,022) n=30	2,57 (0,676) n=21	1,89 (1,144) N=178	2,00
	Total		1,82 (0,968) n=100	1,44 (1,142) n=75	1,92 (2,716) n=61	1,10 (0,481) n=30	1,88 (1,223) n=40	1,78 (1,106) n=45	1,21 (0,951) n=58	1,84 (0,884) n=63	1,65 (1,372) N=472	1,00
Number of patient visits to the outpatient clinic	Colon		3,53 (1,256) n=72	2,39 (0,903) n=36	2,78 (0,927) n=45	2,95 (1,717) n=21	3,94 (1,259) n=18	2,52 (1,546) n=31	2,78 (2,025) n=27	3,83 (1,228) n=42	3,12 (1,423) N=292	3,00
	Rectum	RT Short	4,00 (2,121) n=17	2,92 (0,996) n=12	4,21 (0,975) n=14	3,43 (1,397) n=7	3,20 (0,837) n=5	4,33 (1,118) n=9	3,39 (2,033) n=18	4,53 (1,375) n=17	3,83 (1,597) n=99	3,00
		RT Long	5,25 (1,909) n=8	3,54 (1,414) n=24	6,00 (2,828) n=2	5,50 (2,121) n=2	4,00 (1,773) n=15	4,25 (3,304) n=4	5,64 (2,942) n=11	4,00 (1,155) n=4	4,36 (2,092) n=70	4,00
		Total	4,37 (2,022) n=27	3,26 (1,292) n=39	4,44 (1,315) n=16	3,89 (1,691) n=9	3,86 (1,552) n=22	4,29 (1,816) n=14	4,20 (2,565) n=30	4,43 (1,326) n=21	4,02 (1,799) n=178	4,00
	Total		3,76 (1,532) n=100	2,84 (1,197) n=75	3,21 (1,266) n=61	3,23 (1,736) n=30	3,90 (1,411) n=40	3,07 (1,181) n=45	3,48 (2,415) n=58	4,03 (1,282) n=63	3,46 (1,634) N=472	3,00

Total number of hospital visits	**Colon**		7,06 (1,861) n=72	5,06 (1,567) n=36	6,36 (1,048) n=45	4,95 (1,717) n=21	7,28 (1,602) n=18	5,48 (1,913) n=31	5,41 (2,832) n=27	7,26 (1,380) n=42	6,27 (1,55) N=292	6,00
	Rectum	**RT short**	7,88 (2,088) n=17	5,92 (1,564) n=12	7,57 (1,016) n=14	5,43 (1,397) n=7	6,60 (0,894) n=5	8,44 (1,130) n=9	5,89 (2,193) n=18	8,76 (1,640) n=17	7,20 (2,020) n=99	7,00
		RT Long	10,50 (2,726) n=8	6,50 (2,798) n=24	10,50 (2,121) n=2	8,00 (2,828) n=2	8,27 (3,262) n=15	8,75 (5,500) n=4	7,82 (3,341) n=11	9,25 (2,062) n=4	7,99 (3,264) n=70	8,00
		total	8,52 (2,392) n=27	6,10 (2,469) n=39	7,94 (1,482) n=16	6,00 (1,936) n=9	7,91 (2,793) n=22	8,43 (2,821) n=14	6,53 (2,788) n=30	8,86 (1,682) n=21	7,43 (2,606) N=178	7,00
	Total		7,50 (2,149) n=100	5,60 (2,137) n=75	6,77 (1,359) n=61	5,27 (1,182) n=30	7,62 (2,328) n=40	6,40 (2,597) n=45	5,97 (2,828) n=58	7,79 (1,657) n=63	6,72 (2,303) N=472	7,00

Table 8. *Number of patient visits. n=number of patients*

The mean number of total patient visits for all hospitals is 6,72. In other words patients visit the hospital on 7 different days before undergoing surgery. The patients with rectal cancer visit the hospital on more days than the patients with colon cancer (a mean of 7,43 visits and a mean of 6,29 visits respectively). There is also a differences between the number of visits to the outpatient clinic between patient with a colon- and a rectum carcinoma (a mean of 3,12 visits and a mean of 4,02 respectively). The standard deviations for all these results differ from less than one to more than three. So there is a broad variation between the hospitals for the number of visits per patient.
Hospital 4 has the lowest total number of patient visits (a mean of 5,27) and hospital 8 the most (a mean of 7,79). The standard deviation of the hospitals varies from 1,18 (hospital 4) to 2,60 (hospital 6), which shows that there is a variation between the number of visits per patient in one and the same hospital.

> Efficiency – lead times

Six different lead times during the colorectal process were calculated. Of these the mean, the standard deviation and the number of patients of which the indicator was known are presented in table 9. Besides these calculations for each hospital, two columns with the mean and median of the total patient population are presented. The total patient group was divided in patients with colon carcinoma and patients with rectum carcinoma. The patients with rectal cancer were further classified in a short schedule radiotherapy and long schedule radiotherapy, as explained above [table 9].

			1	2	3	4	5	6	7	8	Mean overall	Median overall
GI - PA (workdays)	Colon		14,60 (10.51) n=48	18,00 (12,728) n=2	16,39 (15,90) n=36	11,23 (8,68) n=13	19,64 (11,43) n=11	19,50 (21,92) n=2	-	15,52 (16,00) n=29	15,45 (13,260) n=141	12,00
	Rectum	RT short	11,88 (3,64) n=8	12,00 n=1	5,00 (4,31) n=8	7,00 n=1	17,00 (17,71) n=5	6,67 (5,51) n=3	-	8,20 (7,98) n=10	9,47 (8,706) n=36	7,00
		RT long	7,83 (2,93) n=6	-	13,00 n=1	-	9,45 (4,86) n=11	-	-	7,00 n=1	9,00 (4,150) n=19	7,00
		Total	11,13 (5,55) n=16	12,00 n=1	5,89 (4,83) n=9	7,00 n=1	12,41 (10,56) n=17	6,67 (5,51) n=3	-	8,09 (7,58) n=11	9,83 (7,751) N=58	7,50
	Total		13,73 (9,60) n=64	16,00 (9,64) n=3	14,29 (14,95) n=45	10,93 (8,41) n=14	15,25 (11,29) n=28	11,80 (13,59) n=5	-	13,48 (14,48) n=40	13,81 (12,172) n=199	11,00
Scopy – PA (workdays)	Colon		3,79 (1,284) n=70	3,36 (1,367) n=28	4,47 (2,128) n=45	5,35 (5,815) n=20	3,22 (1,003) n=18	2,14 (2,624) n=22	3,79 (2,293) n=14	2,74 (0,627) n=42	3,63 (2,356) n=259	3,00
	Rectum	RT short	3,06 (0,748) n=17	2,67 (1,033) n=6	3,86 (2,476) n=14	4,00 (1,915) n=7	3,40 (2,074) n=5	2,38 (2,066) n=8	3,18 (1,168) n=11	2,88 (0,781) n=17	3,18 (1,567) n=85	3,00
		RT long	2,75 (0,463) n=8	3,33 (1,862) n=6	6,00 (1,414) n=2	4,00 (1,414) n=2	3,23 (1,092) n=13	1,00 n=1	4,00 n=1	3,00 (0,816) n=4	3,27 (1,326) n=37	3,00
		Total	3,11 (0,892) n=27	3,00 (1,477) n=12	4,13 (2,446) n=16	4,00 (1,732) n=9	3,25 (1,333) n=20	2,10 (1,912) n=10	3,25 (1,138) n=12	2,90 (0,768) n=21	3,21 (1,505) n=127	3,00
	Total		3,59 (1,217) n=98	3,25 (1,391) n=40	4,38 (2,200) n=61	4,93 (4,920) n=29	3,24 (1,173) n=38	2,13 (2,393) n=32	3,54 (1,838) n=26	2,79 (0,676) n=63	3,49 (2,119) n=387	3,00
PA – MDT (workdays)	Colon		7,39 (2,931) n=64	12,95 (15,03) n=19	6,05 (4,655) n=22	11,25 (10,720) n=4	34,00 (26,514) n=3	6,67 (2,895) n=15	10,67 (10,820) n=6	7,33 (7,613) n=39	8,42 (8,522) n=172	7,00
	Rectum	RT short	8,47 (3,676) n=17	19,20 (11,28) n=10	6,85 (4,318) n=13	2,67 (1,528) n=3	8,00 (4,637) n=5	16,67 (13,924) n=6	23,43 (30,149) n=7	9,12 (5,453) n=17	11,44 (12,035) n=78	8,50
		RT long	6,00 (2,777) n=8	37,43 (37,98) n=21	7,00 n=1	3,00 n=1	27,77 (38,75) n=13	59,75 (49,98) n=4	20,43 (10,52) n=7	5,50 (3,697) n=4	27,27 (34,329) n=59	12,00
		Total	8,63 (3,972) n=27	30,41 (31,56) n=34	6,86 (4,148) n=14	2,75 (1,258) n=4	26,10 (37,33) n=20	31.91 (36,54) n=11	21,07 (21,22) n=15	8,43 (5,287) n=21	18,77 (25,717) n=146	10,00
	Total		7,68 (3,358) n=92	24,15 (27,96) n=53	6,36 (4,422) n=36	7,00 (S8,40) n=8	27,13 (35,70) n=23	17,35 (26,47) n=26	18,10 (19,17) n=21	7,72 (6,862) n=60	13,13 (19,174) n=319	8,00

Waiting t time (workdays)	Colon		26,82 (9,857) n=71	38,60 (14,17) n=35	16,93 (9,516) n=45	14,70 (8,399) n=20	21,78 (13,50) n=18	30,92 (22,82) n=26	36,36 (46,48) n=25	32,05 (25,46) n=42	27,52 (21,496) n=282	23,00
	Rectum	RT short	39,24 (15,63) n=17	80,20 (74,97) n=10	24,86 (7,62) n=14	18,29 (4,192) n=7	27,60 (6,804) n=5	33,75 (9,316) n=8	51,89 (54,63) n=18	38,76 (20,22) n=17	41,10 (38,339) n=96	30,50
		RT long	79,25 (24,67) n=8	100,73 (29,45) n=22	138,00 (53,74) n=2	83,50 (7,778) n=2	94,69 (15,15) n=13	105,25 (6,898) n=4	108,25 (17,77) n=8	83,50 (17,46) n=4	97,54 (25,420) n=63	96,00
		Total	49,00 (24,43) n=27	91,26 (47,21) n=35	39,00 (41,67) n=16	32,78 (29,12) n=9	76,55 (34,61) n=20	54,31 (36,58) n=13	65,39 (53,15) n=28	47,29 (26,40) n=21	62,11 (43,211) n=169	43,00
	Total		33,55 (19,07) n=99	64,93 (43,59) n=70	22,72 (24,42) n=61	20,31 (19,04) n=29	50,61 (38,30) n=38	38,72 (29,83) n=39	51,70 (51,75) n=53	37,13 (26,57) n=63	40,60 (35,638) n=452	28,00
Length of stay (days)	Colon		10,51 (15,49) n=72	11,78 (10,20) n=36	10,07 (9,98) n=44	8,14 (6,102) n=21	6,67 (4,982) n=18	10,52 (8,820) n=31	13,33 (16,64) n=27	11,63 (13,04) n=41	10,61 (12,224) n=290	7,00
	Rectum	RT short	13,94 (11,34) n=17	12,45 (7,789) n=11	8,50 (4,310) n=14	10,71 (11,17) n=7	25,20 (32,72) n=5	13,56 (15,70) n=9	15,50 (14,04) n=18	15,24 (12,92) n=17	13,82 (13,299) n=98	10,00
		RT long	15,25 (13,13) n=8	13,83 (7,396) n=23	11,00 (4,243) n=2	18,00 (15,55) n=2	13,93 (21,02) n=15	9,00 (2,828) n=4	24,27 (34,29) n=11	20,25 (14,33) n=4	15,81 (18,195) n=69	12,00
		Total	13,15 (9,789) n=27	13,68 (7,296) n=37	8,81 (4,246) n =16	12,33 (11,58) n=9	15,64 (23,12) n=22	12,21 (12,57) n=14	18,37 (23,33) n=30	16,19 (12,97) n=21	14,31 (15,011) n=176	10,00
	Total		11,54 (14,42) n=100	12,74 (8,83) n=73	9,73 (8,803) n=60	9,40 (8,156) n=30	11,60 (17,86) n=40	11,04 (10,02) n=45	15,93 (20,24) n=58	13,18 (13,09) n=62	12,08 (13,492) n=468	8,00
Surgery time (hours: minutes)	Colon		2:59 (0:48) n=72	4:26 (2:23) n=36	1:58 (1:12) n=41	-	-	-	-	-	3:03 (1:41) n=149	2:43
	Rectum	RT short	4:26 (0:59) n=17	5:12 (1:09) n=12	3:27 (1:13) n=12	-	-	-	-	-	4:22 (1:16) n=41	4:17
		RT long	4:13 (0:49) n=8	6:54 (2:25) n=24	4:00 n=1	-	-	-	-	-	6:10 (2:25) n=33	5:43
		Total	4:24 (0:55) n=27	6:24 (2:12) n=39	3:29 (1:10) n=13	-	-	-	-	-	5:14 (2:04) N=79	4:46
	Total		3:23 (1:03) n=100	5:27 (2:29) n=75	2:20 (1:21) n=54	-	-	-	-	-	3:49 (2:05) (n=229)	3:25

Table 9. *Lead times. The mean of the lead times in days or working days of the colorectal process. Colon= all patients with a colon carcinoma, rectum= all patients with a rectum carcinoma, RT short= all patients with preoperative radiotherapy short schedule, RT long= all patients with preoperative radiotherapy long schedule, Rectum Total=all patient with rectum carcinoma combined, Total=all patients with a colorectal carcinoma. n=number of patients.- = no data available.*

The time between the visit to the Gastro-Intestinal department and the pathology result was longer for patients with a colon carcinoma (mean 15,45 workdays, SD 13,260 and n=141) compared to patients with a rectum carcinoma (mean 9,83 workdays, SD7,751 and n=58). There is only a small difference between the hospitals, the median is 11 workdays. The number of workdays between the colonoscopy and the day of the result of the pathology, varies from a mean of 2,13 workdays (hospital 6) until 4,93 workdays (hospital 4). The total mean of all patients is 3,49 (SD 2,119 and n=387). The number of workdays between the day the result of the pathology is known and the day that the patient is discussed in a multidisciplinary team varies from a mean of 6,36 workdays (hospital 3) until 27,13 workdays (hospital 5). Overall is the mean 13,13 workday (SD 19,174 and n=319). The difference between all patients with a colon carcinoma and with a rectum carcinoma is more than 10 days (8,38 workdays and 18,77 workdays respectively).

The waiting time for surgery (the day of the result of the pathology until the day of the surgery) varies for patients with a colon carcinoma from 14,70 workdays (hospital 4) until 38,60 workdays (hospital 2). For rectum carcinoma a big difference can be seen between patients with preoperative radiotherapy short schedule (41,21 workdays) and preoperative radiotherapy long schedule (96,27 workdays). The lowest number of in-hospital days (the days between surgery and discharge) was found in hospital 4 (mean of 9,40 days) and the longest in hospital 7 (mean of 15,93 days), a difference of 7 days. For colon carcinoma it varies from a mean of 6,67 days (hospital 5) until 13,33 days (hospital 7), for rectum carcinoma with preoperative radiotherapy short schedule from a mean of 8,50 days (hospital 3) until 25,20 days (hospital 5) and for rectum carcinoma with preoperative radiotherapy long schedule from a mean of 9,00 days (hospital 6) until 24,27 days (hospital 7). The time between the patient entered the operation room and the patient leaving the operation room could be calculated for four hospitals. The mean time for all patients was 3:49 (SD 2:05, n=229), the mean operation time for colon carcinoma was 3:04 (SD 1:41, n=150) and for rectum carcinoma 5:14 (SD 2:04, n=79).

> efficiency –costs

In all hospitals the times scheduled for every activity were collected. These times were almost alike in all eight hospitals. No difference in costs could therefore be calculated. Only three hospitals gave insight in the cost of one in-hospital day for a patient treated for colorectal cancer. With these results both approaches presented in the methodology chapter are unfortunately impossible to use.

> Comparing means

To determine whether the differences found in the tables above are not based on coincidence the means of the eight hospitals were compared, using one-way ANOVA tests. This test was performed for the lead times and the number of patients visits (nine variables). The means of the total patient population were compared for the eight hospitals. The 0-hypothesis: ‘all the means of the eight hospitals are equal, the differences found are based on coincidence’. The results of the one-way ANOVA tests can be found in table 10.

Dependent variable	F-ratio	p
▪ Total Number of patient visits	11,216	0,000
▪ Number of visits related to diagnosis	2,813	0,007
▪ Number of visits to the outpatient clinic	4,410	0,000
▪ Lead time Colonoscopy until Pathology	7,233	0,000
▪ Lead time Pathology until MDT	8,278	0,000
▪ Lead time Pathology until Surgery	11,672	0,000
▪ Lad time Length of Stay	1,260	0,269
▪ Lead time GI and pathology	0,246	0,960
▪ Lead time surgery	57,260	0,000

Table 10. *One-way ANOVA tests.*

The total number of patient visits was significant different in the eight hospitals overall (F = 11,216, p= 0,000). For the number of visits to the outpatient clinic and visits related to staging also a significant difference between the hospitals was found. The number of workdays between colonoscopy and the result of pathology was significant different between the hospital (F=7,233, p=0,000) as was a significant difference found between the hospitals for the waiting time for surgery (F= 11,672, p=0,000) and the time for surgery (F= 57,260, p=0,000).

There was no significant difference between the means of the hospitals for the length of stay and the number of workdays between the day of the visit to the Gastro Intestinal department and the day the result of the pathology is known.

> Best practice

An optimal, most efficient, number of patient visits and lead times can be suggested based on the observations in the hospitals and the results presented above. For a standard patient, referred by the general practitioner a minimum of four patient visits is needed. One to perform the colonoscopy, one for additional imaging for staging of the disease, one visit to the outpatient clinic to the surgeon and anesthesiologist and finally the day of the admission to the hospital because of the surgery. The median of the total number of patients visits found is 7, hospital 4 scores best with 5,27 patient visits. To do a proposal for the optimal lead time an overview of the best practices of the different lead times is given in table 11. Combing the lead times of the best practices give a total lead time for colon carcinoma of 32,3 days. And for rectum carcinoma with short schedule preoperative radiotherapy 37,7 days and 99,2 days for patient with long schedule radiotherapy. Remarkable is that again hospital 4 scores high on different lead times.

Lead-time		Median	Best practice	Hospital number
First visit GI-dep. – Pathology (workdays)	Total all patients	11	10,93	4
Colonoscopy – pathology result (workdays)	Total all patients	3	2,13	6
Pathology – MDT (workdays)	Total colon	7	6,05	3
	Total rectum	10	2,75	4
	Total all patients	8	6,36	3
Pathology – Surgery (workdays)	Total colon	23	14,70	4
	Total rectum RT short	30,5	18,29	4
	Total rectum RT long	96	79,25	1
	Total all patients	28	20,31	4
Surgery – Discharge (days)	Total colon	7	6,67	5
	Total rectum RT short	10	8,50	3
	Total rectum RT long	12	9,00	6
	Total all patients	8	9,40	4

Table 11. *Overview of the best practices of the different lead times, showing the median, the mean of the best practice and the number of the best practice hospital.*

5.3. Results on patient level

> Demographics

There were 472 patients included in the database undergoing colorectal cancer surgery in an elective setting for a primary tumour in 2009 in one of the eight hospitals. Demographic characteristics of the patients are summarized in table 12. 41% of the patients were over 70 years of age, 12,5% were obese (BMI ≥ 30 kg/m^2) and 32% scored one or higher on the Charlson Comorbidity Index. Of all patients 58,3% had a colon carcinoma and 37,5% a rectum carcinoma, most common stage was T3 with 56,4%.

		Group	n	%
Patient characteristics	Age	≤40	8	1.7
		41 – 50	33	7.0
		51 – 60	83	17.6
		61 – 70	154	32.6
		71 – 80	137	29.0
		81 – 90	56	11.9
		> 90	1	0.2
	Gender	Male	257	55.4
		Female	215	45.6
	BMI (kg/m^2)	Normal / underweight (≤25,00)	180	38.1
		Overweight (25,01 – 30,00)	157	33.3
		Obese (> 30,01)	59	12.5
		missing	76	16.1
	Charlson Comorbidity Index	0	321	68.0
		1	85	18.0
		> 1	66	14.0
Colorectal cancer	Tumour location	Right colon	122	25.8
		Left colon	22	4.7
		Sigmoid	131	27.8
		Rectum	177	37.5
		Missing	20	4.2
	TNM stage Pathological T score	I	22	4.7
		II	91	19.3
		III	266	56.4
		IV	70	14.8
		x	18	3.8
		Missing or unknown	5	

Table 12. *Demographics (n=472.*

> Relation between efficiency and patient related outcome

Total patient population

To explore the relation between efficiency and patient related outcomes, crosstabs were made and chi-square tests were performed. The efficiency data were classified in two categories using the mean as a cut-off point. In total 99 cross tables were made [appendix E]. The cross tables with a p-value less than 0,05 are presented in table 13.

Nr.	Row	Colum	N	Chi -square	P	Direction
1	Total number of pat. Visits	Pre operative imaging of the liver	461	6.168	0.013	Positive relation
2	Total number of pat. Visits	Pre operative imaging of the lung and liver	461	8.227	0.004	Positive relation
3	Total number of pat visits	Pre operative MDT	434	33.262	0.000	Positive relation
4	Number of visits outpatient clinic	Pre operative imaging of the liver	461	4.801	0.028	Positive relation
5	Number of visits outpatient clinic	Pre operative imaging of the lung and liver	461	7.998	0.005	Positive relation
6	Number of visits outpatient clinic	Pre operative MDT	434	10.102	0.001	Positive relation
7	Number of visits related to staging	Pre operative imaging of the liver	461	77.084	0.000	Positive relation
8	Number of visits related to staging	Pre operative imaging of the lung and liver	461	67.757	0.000	Positive relation
9	Number of visits related to staging	Complications	453	8.711	0.003	Negative relation
10	Lead time Colonoscopy – Pathology result	Pre operative imaging pelvis	381	36.569	0.000	Negative relation
11	Lead time Colonoscopy – Pathology result	Pre operative imaging of the liver	381	32.638	0.000	Positive relation
12	Lead time Colonoscopy – Pathology result	Pre operative imaging of the lung and liver	381	22.163	0.000	Positive relation
13	Lead time Colonoscopy – Pathology result	10 or more lymph nodes	372	6.649	0.010	Negative relation
14	Lead time Pathology result- Surgery	Pre operative MDT	417	7.559	0.006	Positive relation
15	Lead time Pathology result – Surgery	Complications	433	7.254	0.007	Positive relation
16	Lead time Pathology result – Surgery	Complicated course	434	4.150	0.042	Negative relation
17	Lead time in hospital stay	Re-interventions	449	93.474	0.000	Positive relation
18	Lead time in hospital stay	Complications	448	137.237	0.000	Positive relation
19	Lead time in hospital stay	Complicated course	449	203.563	0.000	Positive relation
20	Lead time in hospital stay	CRM	103	6.184	0.013	Negative relation
21	Lead time during surgery	Complications	220	10.138	0.001	Positive relation
22	Lead time during surgery	Complicated course	218	4.683	0.030	Positive relation

Table 13. *Cross tables combining the patient related outcomes and the efficiency variables for patients with colon carcinoma and rectum carcinoma as one group. N is the number of patients.*

In table 13 all relations for which a significant relations was found are shown. Most of these relations seem logical. For example number 1, a higher number of patient visits gives a higher chance that preoperative imaging of the liver was performed (χ^2 = 6.168, p=0.013). These two variables are dependent and therefore a relation can be expected. Other relations are dependent in the same way (number 2,4,5,7 and 8). No unexpected results were found in these Chi-square analyses.

Interesting is that the total number of patient visits and the number of visits to the outpatient clinic were positive related to the chance a patient was discussed in a MDT (χ^2 = 33.262, p=0.000 and χ^2 = 10.102, p=0.001). Also is the chance that a patient was discussed in a MDT higher if the waiting time (workdays between pathology result and day of surgery) is longer (χ^2 = 7.559, p=0.006). If a negative relation was found, it could be concluded that discussing a patient during a MDT has a positive influence on the efficiency. Because the relation is positive it can be said that a minimal number of patient visits and time is needed to perform good quality of care.

More complications are seen in patients that visited the hospital less times for staging related activities (χ^2 = 8.711, p=0.003). This can be explained by the information staging (the performance of MRI and CT) can give preoperative and which can influence the decision to operate. The surgeon has a better knowledge about the location of the tumour and of the tumour invasion in the surrounding tissue and is therefore better prepared.

The number of workdays between the day of the colonoscopy and the day the pathology is known was found to influence the imaging of the pelvis (negative relation, χ^2 = 36.569, p=0.000) and the imaging of the liver and of the lung and liver (positive relation, χ^2 = 32.638, p=0.000 and χ^2 = 22.163, p=0.000). Based on current knowledge no explanation can be given why more imaging of the lung and liver would be made if the number of workdays between colonoscopy and pathology result are higher. Or that it is less likely that imaging of the pelvis is performed if the number of workdays is higher.

A shorter duration of the time between the day of the colonoscopy and the day of the result of the pathology of that biopsy gives a higher chance that more than 10 lymph nodes were examined during pathology examination after surgery (χ^2 = 6.649, p=0.010). This might be due to a better organisation of the pathology department. A better organisation makes the department more efficient and delivering higher quality.

A longer waiting time for surgery (workdays between the day the pathology result is known and the day of surgery) gives a higher chance for complications after surgery (χ^2 = 7.254, p=0.007) and gives less chance of a complicated course for the patient after surgery (χ^2 = 4.150, p=0.042). This shows that waiting time influences outcomes of care and is very relevant because waiting time is a factor that can be influenced by the organisation.

Complications, re-interventions and a complicated course all give a higher chance of a longer length of in hospital stay. Which is as expected. Especially for complicated course, because an in-hospital stay of more than 21 days is part of the definition of complicated course. Also there is less chance of a radical resection based on the CRM for patients with a rectum carcinoma if the in-hospital time is longer. This could be due to the more complex patients that are less likely to be operated radical and more likely to stay longer.

A longer operation time gives a higher chance of complications after surgery and a complicated course for the patient. An explanation is that a longer operation can be due to a complex problem during the operation, which gives more change of complications and therefore more chance of a complicated course.

Subpopulations colon carcinoma and rectum carcinoma

In table 14 the results are shown for the crosstables of rectum carcinoma and colon carcinoma separate. For the subpopulations colon carcinoma and rectum carcinoma three intermediate indicators were analyzed: The preoperative MDT, Preoperative imaging for liver and for preoperative imaging of the liver & lung. Performing a preoperative MDT is one of the national quality indicators for rectum carcinoma, so it is likely that a difference can be found in the chi-square analysis between colon carcinoma and rectum carcinoma. The preoperative imaging of the liver and liver & lung could not be filled in for rectum carcinoma on the digital DSCA form in 2009, that is why these were also part of the separate analysis for colon carcinoma.

Nr.	Patient group	Row	Column	N	Chi-square	P	Relation
1	Rectum carcinoma	Lead time Pathology result – Surgery	Pre operative MDT	178	6,314	0,012	Positive relation
2	Colon carcinoma	Number of visits related to staging	Pre operative imaging of the liver	294	25,537	0,000	Positive relation
3	Colon carcinoma	Number of visits related to staging	Pre operative imaging of the lung and liver	294	11,542	0,001	Positive relation
4	Colon carcinoma	Number of visits related to staging	Pre operative MDT	270	15,083	0,000	Positive relation
5	Colon carcinoma	Number of visits outpatient clinic	Pre operative MDT	270	13,441	0,000	Positive relation
6	Colon carcinoma	Total number of pat. Visits	Pre operative imaging of the lung and liver	294	4,868	0,027	Positive relation
7	Colon carcinoma	Total number of pat. Visits	Pre operative MDT	270	39,033	0,000	Positive relation
8	Colon carcinoma	Lead time Colonoscopy - Pathology	Pre operative imaging of the lung and liver	260	5,832	0,016	Positive relation
9	Colon carcinoma	Lead time Pathology result – Surgery	Pre operative imaging of the liver	283	6,732	0,009	Negative relation
10	Colon carcinoma	Lead time Pathology result – Surgery	Pre operative MDT	261	4,492	0,034	Positive relation
11	Colon carcinoma	Lead time during surgery	Pre operative imaging of the liver	150	8,439	0,004	Negative relation
12	Colon carcinoma	Lead time during surgery	Pre operative imaging of the lung and liver	150	6,430	0,011	Negative relation

Table 14. *Cross tables combining the patient related outcomes and the efficiency variables for patients with colon carcinoma and rectum carcinoma separate. N is the number of patients.*

As table 14 shows, some relations are still found, others disappear and new ones are found when analyzing the data for colon carcinoma and rectum carcinoma separately. The relations that disappear are the numbers 1,4,5,10 and 11 of table 13. These are all related to preoperative imaging of the pelvis, liver and lung & liver. The relations number 4,5,9,11 and 12 in table 14 are new. Most notable is that the chance that preoperative imaging of the liver is performed is lower if the waiting time (the number of workdays between the result of the pathology is known and the day of the surgery) is longer (χ^2 = 6,732, p=0.009). Also preoperative imaging of the liver and of the lung & liver gives a higher chance that the surgery time is longer (χ^2 = 8,439, p=0.004 and χ^2 = 6.430, p=0.011 respectively). This might be due to a better preparation for surgery if staging of the disease is known.

Chapter 6: Results second research question

As described in the method, three different approaches were used to answer the second research question. The first approach was a literature search, the second a comparison between national and international registries and finally the expert opinions of medical and non-medical experts. The results will be presented in the same order.

6.1. Literature review

To answer the question how to present benchmark data to medical specialist, a literature search was performed in Medline and Cochrane Library. The following research question was formulated: 'How should benchmark data be presented to medical specialists'. In table 15 the used MesH terms are presented as are the number of articles found in Medline.

#	Search	Number of articles (MesH terms)	Number of articles (general terms)	Total number of articles
1	'Quality of health care'	3.825.523	47.231	3.826.008
2	Physicians	71.028	206.603	209.110
3	'Medical specialists'	-	1.184	1.184
4	Total of 2 OR total of 3	-	-	209.977
5	Total of 1 AND total of 4	-	-	89.837
6	'Educational measurement'	85.557	22.490	85.580
7	'Performance measurement'	-	669	669
8	Comparisons	-	89.563	89.563
9	'Best practice'	-	3.618	3.618
10	Benchmarking	7.830	9.180	9.180
11	Total 6 OR total 7 OR total 8 OR total 9 OR total 10	-	-	186.312
12	Total 1 AND total 11	-	-	110.044
13	Total 5 AND total 11	-	-	8.831
14	'Information presentation'	-	74	74
15	Communication	301.120	416.088	416.088
16	Feedback	-	78.495	78.495
17	(total 14 OR total 15) AND total 16	-	-	36.833
18	Total 1 AND total 17	-	-	9.069
19	Total 5 AND total 17	-	-	519
20	Total 11 AND total 17	-	-	1.514
21	Total 13 AND total 17	-	-	137

Table 15. *Medline search on 30th September 2010.*

Combining the research terms with AND and OR gave 137 articles. Using the same combination of search terms 4 articles were found in the Cochrane library. Based on title and abstract the relevant articles were selected. To give insight in the different articles found, the articles were categorized. No appropriate classification was found in the literature, that is why an own classification was made [table 16].

Groups		Number of articles Medline	Number of articles Cochrane Library
Feedback or competence measuring tools	Development	15	0
	Evaluation	26	0
	Effect	23	0
Training and education tools	Development	8	0
	Evaluation	16	1
	Effect	6	0
Tools for communication	Development	7	0
	Evaluation	20	2
	Effect	0	0
Presenting data	Development	0	0
	Evaluation	1	0
	Effect	2	1
Other and no abstract		13	0
Total		**137**	**4**

Table 16. *Classification of the articles.*

Only four articles were relevant, one of these articles is an update of one of the other relevant articles. And one was found both in the Cochrane library and in Medline, which leaves two relevant articles (Jamdtvedt et al, 2006). One of the two is a Cochrane review and the other a study about preferred feedback styles and therefore classified as 'evaluation of presenting data' (Prins et al, 2006).

The main objective of the Cochrane review was to assess the effects of audit and feedback on the practice of healthcare professionals and patient outcomes. Only randomised trials that reported objectively measured professional practice in healthcare settings or healthcare outcomes were included, in total 118 studied. The authors' conclusion was that audit and feedback can be effective in improving professional practice. However the effects are generally small to moderate. The relative effectiveness of audit and feedback is likely to be greater when baseline adherence to recommended practice is low and when feedback is delivered more intensively (Jamdtvedt et al, 2006). The recipients of feedback in the studies included, were likely to be passive recipients of feedback. The authors suggest that the effects might be larger when health professionals are actively involved and have specific and formal responsibilities for implementing change. The review was edited in 2010, which gave no change to the conclusions.

The aim of the second study of Prins et al was to get insight in the style and quality of feedback reports consultation skills written by general practitioners (GP's). It focuses on feedback for GP's by GP's (peer feedback). General practitioners were asked to write a qualitative feedback report for a video recording of a physician/ patient encounter. They were also asked to rank four feedback reports based upon their own personal preferences. The authors found that GP's prefer feedback reports that are descriptive, using first person and contains many reflective remarks (examples and suggestions for improvement). In this study no comparison was made between consultation skills or

presenting data. No useful literature was found to answer the formulated research question. Most literature focuses on tools for giving feedback, measuring competence and training of medical specialists. Tools for communication present data about tools for the communication between medical doctors and patients. If articles present data about audit, benchmarking or feedback they evaluate mostly the effect of these kind of tools.

6.2. Comparison with other registries

Nine registries were asked to send an example of the report they send to participating hospitals. Eight registries answered, one registry made no report. Of the remaining seven, three national and four international registries [Table 7].

	Name registry	Country
1	Dutch Surgical Colorectal Audit (DSCA)	The Netherlands
2	Stichting Perinatale Registratie Nederland(SPRN)	The Netherlands
3	National Intensive Care Evaluation (NICE)	The Netherlands
4	National Bowel Cancer Audit Program	United Kingdom
5	Swedish ColoRectal Cancer Registry	Sweden
6	Norwegian ColoRectal Cancer Project	Norway
7	National surgery Quality Improvement Program (NSQIP)	United States

Table 17. *Overview of the respondents.*

To obtain insight in the 7 different registries a summary of their characteristics was made, using the method which was prescribed in the review of van der Veer et al (van der Veer et al, 2010). All international registrations include colorectal cancer. The registration of the United States is broader, all general and vascular surgery are included. The three national registration have colorectal cancer, perinatal care an intensive care as their subjects. All reports are available on paper, and most reports are available online. The frequency of reporting varies from one to four times a year, one registration gives users the opportunity to make their own outputs on request. Some of the reports are anonymous available online, other registries send their reports to the head of the surgery department, the director of the hospital or the ministry of health. All registries report information about national means, national variation and hospital results. Mostly using number of patients and percentages, combined with a confidence interval and case mix correction for some data. Except the United States all registrations report about process and outcomes of care. The United States only gives information on complications and mortality. All reports are anonymous except for the report of the Norwegian registration [table 18].

	1	2	3	4	5	6	7
Registration unit	Colorectal cancer	Perinatal Care	Intensive care	All bowel cancers including Colorectal	Colorectal cancer	Colorectal cancer	General and vascular surgery
Since	2009	2001	1996	1999	1995	1993	1991
Medium	Paper and digital online	Paper and digital online	Paper	Paper and digital	Paper	paper	Digital
Frequency	Yearly with online update	Yearly	Quarterly and yearly	Yearly	Yearly	Yearly	On request and twice a year
Specificity	National, Facility, patient groups	National, facility, groups of patients	Facility	National, Facility	National, Facility	National, Facility	National, Facility
Recipient	Free available online	Free available online	Head of department	Free available online	Free available online	Head of department, Director hospital, ministry of health	Head of the department
Benchmark **	1,2,3,4,5	1,2	1,2,3,4,5	1,2,3,4,5	1,2,3	1,2,4	1,2,3
QI inf *	P / O	P /O	P /O	P /O	P /O	P /O	O
Timeliness	4 months	1 year and 8 months	NF	NF	1 year and 6 months	2 years	NF
Anonymous	Y	Y	Y	Y	N	Y	Y

Table 18. *Summary of the national and international registrations. *Quality Improvement Information in Feedback (S = Structure, P= Process, O=Outcome). ** 1= national means, 2=national variation, 3=hospital results, 4= using confidence intervals, 5= using case mix corrected outcomes. NF = no information found.*

To obtain a better insight in the differences in indicators used in the different countries in their colorectal registrations, an overview of van Gijn of the Leiden University Medical Centre was used to present the differences in outcomes measures. The intermediate indicators selected in chapter 5 and the data needed to calculate the efficiency data (both needed for answering the first research question) were used to make this overview [table 19].

Two of the eight countries only include patients with a rectum carcinoma (Spain and Belgium). All countries present data of the number of lymph nodes examined during pathology and all registrations collect the date of surgery. Almost all registries collect data of preoperative staging of the pelvis, the radical resections and the CRM (7 of 8 registries) and preoperative imaging of the liver and lung (5 of 8 registries). Half of countries collect data to calculate the 30 days mortality and if the patient was discussed in a MDT and only 3 of the 8 countries register re-interventions and complications.

	Spain	Norway	Sweden	Germany	NL	Belgium	UK	Denmark
Colon or rectal cancer	Rectal	Colorectal	Colorectal	Colorectal	Colorectal	Rectum	Colorectal	Colorectal
30 days mortality	Y	N	Y	N	Y	Y	N	N
Pre-operative CT / MRI of the pelvis	Y	N	Y	Y	Y	Y	Y	Y
Pre operative CT MRI liver and long	N	N	Y	Y	Y	Y	N	Y
10 or more lymph nodes	Y	Y	Y	Y	Y	Y	Y	Y
MDT	N	N	Y	N	Y	N	Y	Y
Re-interventions	Y	Y	Y	Y	Y	N	N	N
Radical resection of T1 - T3 tumours	Y	Y	N	Y	Y	Y	Y	Y
CRM	Y	Y	Y	Y	Y	Y	Y	N
Postoperative complications	Y	Y	Y	Y	Y	N	N	N
Radiotherapy long or short	Y	N	Y	Y	Y	Y	Y	N
Date of discharge	N	N	Y	Y	Y	Y	Y	N
Datum of operation	Y	Y	Y	Y	Y	Y	Y	Y
Elective or acute setting	Y	Y	Y	N	Y	Y	Y	Y
Total number of positive answers	10	7	12	10	13	10	9	7

Table 19. *Data collected in the different registries participating in the EURECA project (Source, personnel data of W. van Gijn, 2010). NL= The Netherlands, UK=United Kingdom.*

6.3. Expert opinions

To use the advice of experts in the field of benchmarking, three different companies were consulted during this research project: Mediquest, MagnaView and Integraal Kankercentrum West (IKW). Of the first and second in total three experts were interviewed, the expert of the IKW was interviewed by telephone.

	Name	Goal	Expert
1	Mediquest	Collects and analyses data of health care institutions with the purpose to improve quality	Dhr. Schaefer Mw. van de Donk
2	IKW	Comprehensive cancer care centre West	Mw. van der Geest
3	MagnaView	Develops applications to analyze data using visual analytics	Dhr. Riemers

Table 20. *Overview of the companies consulted.*

> Mediquest

Mediquest collects and analyses data to measure quality of health care. They give feedback to different parties in health care, not only medical specialists but also patients. Besides using quality indicators also experienced quality (using the Consumer Quality Index and advices of focus groups) are used. In their experience medical specialists want a quick overview of the total assessment of the quality. So it should be clear in a glance if there are concerns about the quality. Afterwards is should be possible to see the results in more details. All results should be very simple and clearly presented (see an example of Mediquest in figure 10). The standards (indicators) used should be based on consensus.

In general, to really improve quality, it is essential to create a transparency culture, to use peer pressure and measure continuous. To stimulate learning from each other it is helpful to publish a top five of the best scoring institutions.

	Heelkunde			↑		21 %	★★☆☆
	Borstkanker			↔		26 %	★★½☆
	Algemene chirurgie systeem complicatieregistratie borstkanker	eigen	landelijk	↔		beschikbaar	
	Beoordeling mammapoli	goed	voldoende	↔		beschikbaar	
	Diagnose mamma binnen 5 dagen geregistreerd opgeschoond	ja	ja	↑		beschikbaar	
	Mamma ervaring per chirurg	redelijk	redelijk	↓		beschikbaar	
	Mamma ervaring ziekenhuis	zeer goed	redelijk	↑		beschikbaar	
	Mamma informatievoorziening	redelijk	goed	↔		beschikbaar	
	Mamma ondersteuning	redelijk	goed	↔		beschikbaar	
	Mamma onderzoeken op 1 dag	goed	goed	↔		beschikbaar	
	Mamma samenstelling team	goed	goed	↑		beschikbaar	
	Mamma snelheid uitslag	matig	goed	↓		beschikbaar	
	Mamma voorzieningen	zeer goed	goed	↔		beschikbaar	
	Percentage patienten met diagnose binnen 5 dagen opgeschoond	65,21 %	88,92 %	↔		beschikbaar	

Figure 10. *Example of the Mediquest (source: website Mediquest).*

> Comprehensive cancer centre West

In a 3 years project of the IKW, hospitals were given feedback information about their own hospital performances compared to the highest and lowest scoring hospital in their region for colorectal carcinoma and mamma carcinoma. In the first year an oral presentation was given to clarify the results, because a lot of comments were made on the validity of the results and the used definitions the collected data were verified. The conclusion was that the results were reliable and complete and in the second and third year of the project the results were compared for the preceding year. They recommended to use figures and tables instead of numbers and data. To make it easy to interpret the tables should be simple and clear. Finally in their experience presenting the data in the hospitals was more effective than presenting data in a workgroup or commission because a broader public was present during the presentation.

> Magnaview

Magnaview is a company that uses visual analytics to analyze a lot of different data from different industries. Most important for presenting data is to communicate important information effectively. 'Less is more' states Few, an important author of books about theories of presenting data (Few, 2004). No more data than necessary should be presented and the use of colour should be used to improve clarity of the data. In the experience of MagnaView medical professionals have difficulty interpreting flow charts. They prefer to get an overview of the outcomes, whether for example advocated prefer to see all data available.

6.4. Recommendations

Data about the effect of benchmarking are subject of medical literature, but no literature was found about the best way to present benchmark data to medical specialists. Compared with other registries, the DSCA collects and presents a broad range of data. The use of case-mix adjusted data is also an advantage of this registration.

Based on the advice and comments of the experts a benchmark report was made. A good benchmark report should first give an overview of the main outcome with the possibility to obtain more detailed insight in the own performance. The data should be presented in a way easy to interpret, no more data than necessary should be presented, using colour to improve clarity. Good benchmarking should be continuous without long delays in given back the report. Only indicators based on consensus should be used. The benchmark should be relevant for medical professionals and professionals in the organisation of the hospital. An interactive digital benchmark could make it possible to select and view only the results of your interest. Publishing a top 5 of the best practices could stimulate improving.

The benchmark report was made using the program of MagnaView, see the anonymous example in Appendix F.

Chapter 7: Discussion

7.1. General

> Selection of hospitals

To invite the hospitals for this research project, a selection was made based on the number of patients included in the DSCA of every hospital, this is likely to give a selection bias. Mainly because these hospitals are probably more interested or organized to participate in the DSCA and therefore more active in the organisation of the care for patients with a colorectal carcinoma. This could have influenced the data, scoring overall higher on efficiency and probably also better on outcomes. That the hospitals were visited in 2010 was possibly a disadvantage, because some change may have occurred in the organisation in 2010 compared to 2009. To obtain insight in this difference, one of the questions in the interview was whether any changes were made in the care for patient with a colorectal carcinoma in 2010. The hospitals responded that no changes were made but in several hospitals plans to improve the pathway for patients were scheduled in the end of 2010 or 2011.

Eight Dutch hospitals were visited, 3 academic, 1 teaching hospital, and 4 non-teaching hospitals. This is not a representative reflection of all Dutch hospitals. There are 9 academic hospitals in the Netherlands and of the remaining 81 hospitals 44 teaching and 37 non-teaching hospitals. This influences the patient population. For example, the patient group of academic hospitals consists of a higher number of secondary referrals. These patients usually have had imaging in another hospital, which might influence the number of patient visits positive (lower number of patient visits) and the percentage of imaging of the pelvis, liver and lung negative (lower percentage of preoperative imaging).

> Selection of the patient population

All patients who underwent elective surgery in 2009 for a primary tumour of the colon or rectum were selected. No further selection (probability sampling) was done which prevents the occurrence of selection bias on population level. In 2009, 5.997 patients were included in the DCSA of which 472 were part of our study (7,9%). In this study 62,3% of the patient had a colon carcinoma and 37,7% a rectum carcinoma, which is comparable with the common distribution of all patients in the DSCA (67% colon carcinoma, 29% rectum carcinoma). The somewhat higher percentage rectum carcinoma may be explained by the relative high number of academic hospitals participating. The distribution of gender, BMI and Charlson Co morbidity Score are also similar. Which makes the selected group comparable to the total population included in 2009.

7.2. First research question

> Used efficiency data and patient related outcomes

Van Vliet et al published a model that intends to measures efficiency an objective way. The authors used the model to measure the efficiency for cataract pathway in three international eye hospitals. They recommended to conduct a larger study using the same methodology. The colorectal pathway is however much more complex. More professionals and departments are involved and more than one treatment is given. The method to calculate lead times and patient visits were possible to use

but calculating the direct costs was not possible because of the higher number of activities involved and reluctance of hospitals to provide cost-data.

Patient visits were collected using the data from the EHR, collecting the data accurate was sometimes difficult because some patient visited the hospital also for other diseases than colorectal cancer. Only visits to medical specialists were counted, some hospitals made use of specialised nurses in their organisation of the colorectal pathway, this could have resulted in a unjust lower number of patients visits.

The data needed for the lead times were also collected in the EHR, not all EHR databases contained data on the day that the result of pathology was known, the date of the MDT and the operation time. For the first two the information of the DSCA was used to complete the dataset as much as possible, but still some of the data are missing (waiting time 4% missing, workdays between colonoscopy and pathology 18% missing). This might have influenced the outcomes, because if no date of MDT was found it was assumed that the patient was not discussed during a MDT. Most data needed to calculate the patient related outcomes were complete, only for the imaging of the liver and lung a lot of data were missing for rectum carcinoma (For example only 3,4% of the patients had preoperative imaging of the liver, probably missing 96,6%). This was due to an error in the DSCA database in 2009. Although no significant differences in the lead time 'length of stay' were found, it should be noted that no information was known about the readmission percentage. Discharging patients early tend to lead to a lower mean length of stay but can result in a higher readmission rate.

To analyse whether the means between the efficiency data were significant different a one-way ANOVA tests were used. Significant differences between the hospitals were found in seven of the nine tests. However this does not necessarily imply that all the means of the eight hospitals are significantly different from each other. The Bonferroni test could help to show between which hospitals there were significant differences and help to identify best practices.

> relation between efficiency and patient related outcomes

One study about the relation between access time and quality of care in colorectal surgery was published in 2010 (McConnell et al, 2010). This study was performed among 392 North American Adults. They found a mean lead time of 28 days between diagnosis and surgery. Which is identical to the mean we found in our study. However the cohort of patients differed from the patient studied in this research, more co morbidity (scoring more than 1 on the Charlson Co morbidity Score in all patients, compared to 32% in this study) and a higher BMI (more than 70% overweight, compared to 41% in this study) and McConnell corrected the lead time for patients with rectal cancer (lead time minus ten weeks for preoperative radiotherapy). The authors used a multivariate regression analysis to analyse the relation between efficiency and patient related outcomes, they found that a shorter waiting time was related with a lack of preoperative staging imaging. Which we also found using the chi-square test. So it can be assumed that a minimal waiting time is necessary to perform all tests. Further analyzing our data could give a better insight in this question.

Analyzing the relation between efficiency and patient related outcomes obtained expected and unexpected relations. A lot of relations found could be easy explained, like the relations between the number of patient visits and preoperative imaging. To perform imaging the patient has to visit the hospital. The positive relation between the waiting time for surgery and the complications after surgery, as well as the negative relation between preoperative imaging and the surgery time and negative relation between could not be explained in such a direct way. The reasons for finding these relations could be explained by organisation differences. For example the negative relation found between the lead time data of colonoscopy until data of pathology result and the number of lymph nodes examined, could be explained by the organisation characteristics, if the pathology department is less organised or communication between departments is not optimal.

A first attempt was made to define the most efficient pathway. It was found that hospital 4 scored high. This hospital performs staging, visits to anaesthesiologist and surgeon at one (one stop staging) which indicates that a relation between efficiency and organisational characteristics is expected if further analyzing the data combined with the organisational characteristics collected.

Based on the relations found between efficiency and patient related outcomes, more analyses (for example a multi regression analysis) are needed to further establish the relations. In this study the relation was analysed on patient level, because data of only eight hospitals data were available. If sufficient hospitals are included the analysis could also be done on hospital level and a better insight in the relation between efficiency and patient related outcomes could be obtained.

As explained earlier, this study is part of a larger research project. Besides efficiency aspects also organisational aspects were collected in the hospitals. Further research between organisational characteristics, efficiency and patient related outcomes is therefore possible and can give points of support for the relation found in this study. This research can further underpin the model presented in the introduction. To accomplish this, the second important step to take would be to study the collected data of the organisation characteristics and make these data usable in a quantitative way.

7.3. Second research question

Answering the second research question performing a literature review appeared to be impossible. Some problems occurred because medical terms are used for terms we first selected for the search. For example, mirror information (as a term related to benchmarking) gave results about imaging in radiology. Besides the term feedback is often used related to a feedback mechanisms for example for hormone levels. In medical literature ‘presentation’ refers mostly to a patient presenting (going to a medical specialist) with symptoms related to a disease. As shown in the results a lot of literature focuses on the influence of feedback and benchmarking.

Compared with other registries, the DSCA collects and presents a broad range of data. The use of case-mix adjusted data and online available up to date results are also advantages of this registration.

Based on the advice and comments of the experts a format for a benchmark report was proposed. The data are presented in a way easy to interpret, no more data than necessary are presented and colour was used to improve clarity. Only indicators based on consensus were used. All important factors for a good benchmark. However a good benchmark should also be relevant for both medical professionals and professionals in the organisation of the hospital. Should stimulate improvement by formulating clear points for improvement and publishing for example a top 5 of the best practices. These advices could not be taken into account, but are very important for further improvement of benchmarking. No goals or standards were set, others like McConnell and colleagues used benchmark intervals (for example four weeks from diagnosis to surgery). If a sufficient number of hospitals are visited, the results could be used to improve the benchmark report, define best practices, set standards and stimulate learning from each other.

Chapter 8: Conclusion

8.1. First research question

It is possible to research the relation between efficiency and patient related outcomes using the model of van Vliet et al. It is clear that it is not necessary true that shorter lead times and less patient visits improve the outcomes. A minimum number of days and patients visits seems needed to give the best results. A relation between efficiency, patient related outcomes and organisation characteristics is likely after this study but further research is needed to interpret the reasons for the relations found.

8.2. Second research question

Literature about benchmarking focuses on the effect of feedback on the outcomes of care. No literature was found about the most effective way to present data to medical specialists. The effectiveness of the feedback might be influenced by the trust in the quality of the data, organisation factors and outcome expectance of the recipients. Important for a good interpretation of the results are clear presentation of the data. And finally to stimulate improvement continuous benchmarking without long delays in giving feedback and formulating clear points for improvement are important. Further research should be done to improve benchmark reports and improve the identification of best practices.

8.3. General

Improving the quality of health care is a tremendous challenge we face in the 21th century. Using Continuous Quality Improvement as a solution to this problem is not new as the literature shows, the first articles are published in the late ’80. These were theories about improvement of health care using the organisation as a tool for change. If relations between organisation characteristics, efficiency and patient related outcomes are found, this could stimulate to improve quality of health care by combining best of both worlds. Looking at hospitals (health care) as businesses and giving the patient the best quality of care possible.

8.4. Recommendation

Different organisations in the Netherlands collect data used to obtain insight in the quality of care. To prevent that medical professionals need to spend a substantial part of their time filling in these kind data, these organisations should work closely together. This could improve the quality of the data and stimulate excellent research.

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Chapter 10: Appendix

Content

A: Colorectal cancer
B: Invitation Letter and Recommendation letter of the DSCA
C: Instructions data collection Electronic Health Record
D: Complete list of considered indicators
E: Complete list of cross tables
F: Anonymous example of the Benchmark report

A: Colorectal cancer

> A medical overview

Cancer is, in general, an overgrowth of human cells. Normally cells have a life cycle, they die and new ones are made. Due to several causes on molecular level in the cell, cells can grow much faster, do not die and become more aggressive. Because of the fast growth and not dying of the cells, a tumor develops. Sometimes these cells are very aggressive and grow into blood vessels and nerves. Small parts of the tumor can become separated and spread through the body in the blood or lymph. They can give new tumors in other parts of the body, for example in the liver or the lung, called metastasis.

Colon and rectal cancer present in the lowest part of the digestive system, the large intestine and the rectum. Colorectal cancer can give different symptoms, changes in bowel habits (constipation or diarrhea) blood in the stool, feeling weak or tired, low iron level (due to the blood loss), black or dark-colored stool (also due to the blood loss, mostly in a higher part of the intestine).

A colonoscopy can be used to look inside the rectum and the large intestine. A colonoscopy is performed by inserting a device called a colonoscopy into the anus and can be advanced through the entire colon. A patient mostly gets a medicine to help to relax (sedative) during the colonoscopy. During the procedure small pieces of tissue are removed (biopsy). These pieces will be studied under a microscope by a pathologist. If cancer is seen during the colonoscopy and examined by the pathologist, more diagnostic tests needs to be done.

Staging is a system used to describe the aggressiveness and spread of a cancer, a TNM categorization is used. The T stands for the stage of the tumour, the N stands for the lymph nodes affected by the cancer and M stands for metastases. For colorectal cancer signs of cancer spread is examined by a physical exam, CT scan, or MRI of the abdomen and pelvis, chest X-ray. The treatment of colon and rectum carcinoma consists of a combination of surgery, radiotherapy and chemotherapy.

B: Invitation Letter and Recommendation letter of the DSCA

Datum 25-06-2010
Ons kenmerk CR-DP
Onderwerp Uitnodiging voor deelname aan het project 'process characteristics and the efficiency of colorectal surgery'

Geachte heer, mevrouw,

Van ziekenhuizen wordt in toenemende mate verwacht dat zij de zorg voor hun patienten niet alleen kwalitatief op een hoog niveau, maar ook op doelmatige wijze verlenen. De Universiteit Twente is daarom een onderzoek gestart naar de organisatorische doelmatigheid binnen de colorectale chirurgie. Het doel hier van is het identificeren van de organisatiestructuren en -processen die leiden tot doelmatige zorg enerzijds en het aanreiken van spiegelinformatie aan de individuele ziekenhuizen anderzijds. Graag zouden wij hier voor organisatorische kenmerken van ziekenhuizen relateren aan de kenmerken van de patientengroep (casemix), het zorgproces en de getoonde uitkomsten van zorg.

Het afgelopen jaar zijn er gedetailleerde gegevens over het chirurgische deel van het colorectale zorgproces verzamelt in de Dutch Surgical Colorectal Audit (DSCA). Uit de gegevens op de website van de DSCA blijkt dat uw ziekenhuis in 2009 deelnemer was aan de audit. Graag zouden wij u daarom willen vragen als deelnemer aan het project 'Process characteristics and the efficiency of colorectal cancer'. Participatie betekent dat uw ziekenhuis bezocht zal worden door onderzoekers van de Universiteit Twente om uw zorgproces in kaart te brengen en dat u gevraagd zal worden de gegevens die over uw ziekenhuis verzameld zijn door de DSCA aan de onderzoekers aan te leveren. Wij verwachten een week voor het verzamelen van gegevens nodig te hebben. Het betreft het bestuderen van interne gegevens zoals uw behandelprotocol, interviews en observatie van het proces. Voor u en uw team levert dit uiteindelijk een benchmark op waarmee u de mate van doelmatigheid waarmee er in uw ziekenhuis gewerkt wordt, kunt spiegelen.

Alle onderzoeksgegevens worden anoniem en strikt vertrouwelijk behandeld. Om u zo weinig mogelijk te belasten, maken wij waar mogelijk gebruik van de onderzoekgegevens uit het DSCA register. Wij vragen hierbij uw toestemming voor gebruik van dit register indien u besluit deel te nemen. Indien u akkoord gaat en dat nodig is, benaderen wij uw Raad van Bestuur voor toestemming voor het gebruik van administratieve data.

Hoe kan ik deelnemen?
U kunt meedoen door een bevestiging per email met uw naam en telefoonnummer te sturen naar d.j.pluimers@utwente.nl. U wordt vervolgens door ons gebeld voor een afspraak.

Terugkoppeling
In najaar 2010/voorjaar 2011 ontvangt u een benchmark rapport, waarin de uitkomsten van uw ziekenhuis en het bij u in kaart gebrachte zorgproces worden vergeleken met de geanonimiseerde resultaten van de overige participanten. Dit rapport kunt u gebruiken voor interne kwaliteitsverbetering.

In afwachting van uw reactie en
met vriendelijke groet, mede namens Prof. dr. R.A.E.M. Tollenaar

Prof. dr. W.H. van Harten,
Universiteit Twente, Health Care Technology & Services Research
Nederlands Kanker Instituut, PsychoOncologie en Epidemiologisch Onderzoek

Betreft: Verzoek tot deelname aan project TU Twente

Utrecht, 18 juli 2010

Geachte collega,

Bij deze brief ingesloten ontvangt u een verzoek van onderzoekers van de Technische Universiteit Twente om deelname aan het project: 'Process characteristics and the efficiency of colorectal cancer treatment'. Het project heeft tot doel beter zicht te krijgen op de manier waarop ziekenhuizen het zorgproces voor de patiënt met een colorectaal carcinoom hebben georganiseerd. Hierbij ligt het focus op de doelmatigheid waarmee de zorg wordt verleend. Aangezien het aantal patiënten met kanker in de komende jaren alleen maar toe zal nemen, met een achterblijvende groei van de hoeveelheid middelen en mensen om de zorg te verlenen, is het naar onze mening van grote waarde dat we streven naar het verbeteren van de efficiency van de zorg, met op zijn minst een gelijkblijvende kwaliteit. Naast een wetenschappelijk doel streven de onderzoekers dan ook een verbetering van de doelmatigheid na, waarbij u als tegenprestatie een rapport krijgt overhandigd over de organisatie van uw zorgproces en eventuele punten die voor verbetering vatbaar zijn.

Het bestuur van de Dutch Surgical Colorectal Audit heeft kennisgenomen van het onderzoeksprotocol dat werd samengesteld onder de supervisie van Prof W. van Harten , hoogleraar aan de Universiteit Twente. Om de organisatorische aspecten van de zorg te kunnen koppelen aan de uitkomsten hebben de onderzoekers de DSCA gevraagd van de deelnemende ziekenhuizen enkele gegevens te leveren die geregistreerd staan in de DSCA database. Deze gegevens zijn uiteraard eigendom

Dutch Surgical Colorectal Audit

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KvK 30214400
ABN AMRO 61.34.98.283

van de participerende ziekenhuizen zelf en daarom zijn wij bereid de benodigde gegevens aan de onderzoekers te leveren via de stichting Informatie Voorziening Zorg (IVZ), wanneer de ziekenhuizen hier schriftelijk toestemming voor verlenen. Verder is overeengekomen dat de informatie geanonimiseerd en niet naar de desbetreffende ziekenhuizen herleidbaar worden gebruikt in de rapportage van het onderzoeksproject.

Wij zijn van mening dat het project van de TU Twente goed aansluit bij de doelstellingen van de DSCA en dat hiermee een nieuwe stap kan worden gezet in het verbeteren van de kwaliteit en de doelmatigheid van de door ons geleverde zorg.

Hoogachtend,

Namens het bestuur van de DSCA,

Dr. EH Eddes
Voorzitter DSCA

Prof. dr. RAEM Tollenaar
Voorzitter wetenschappelijke commissie DSCA

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Toestemmingsverklaring

Mede namens de betrokken collegae verklaart ondergetekende in te stemmen met de verzameling van gegevens uit de Dutch Surgical Colorectal Audit (DSCA) bij patiënten die in onderstaande kliniek geopereerd zijn vanwege een colorectale maligniteit ten behoeve van het onderzoek in samenwerking met de Universiteit van Twente.

Naam: .....

Ziekenhuis: .....

Adres: .....

Postcode/plaats: .....

E-mailadres: .....

Datum: .....

Handtekening: .....

Het ingevulde formulier verzenden naar:
DSCA Databeheer
p/a Stichting Informatievoorziening Zorg
Postbus 504
3990 GH HOUTEN

C: Instructions data collection Electronic Health Record

Algemeen:

- Voor alle data en bezoeken geldt dat ze een relatie moeten hebben met het colorectaal carcinoom. Soms heeft iemand nog een tweede probleem en deze data en bezoeken worden niet meegenomen.
- De contacten met de verpleegkundigen worden niet meegenomen

Datum colonoscopie:

- De 1^{e} datum colonosopie met betrekking op de diagnose en behandeling van het colorectaal carcinoom
- Let op bij patiënten bekend met erfelijke darmkanker waarvoor ze screening kregen, eerder een keer waren geanalyseerd ivm een anemie of eerder een primair colorectaal carcinoom hadden gehad. Op dat moment kunnen er meerdere colonoscopien zijn gedaan.
- Soms is een extra scopie gedaan, omdat de eerste niet volledig was of de PA negatief, dan is de eerste als datum genomen en het bezoek voor de tweede wel geteld bij het aantal patiëntenbezoeken.
- Indien eerst een sigmoidoscopie waar de pathologie uitslag de eerste positieve uitslag is deze als scopy tellen.

PA-uitslag:

- De datum waarop de PA bekend is van het biopt bij de scopie.
- Vaak staat onderaan het PA-verslag de datum van ontvangst van het biopt en de datum waarop de uitslag bekend was.
- Let op: er is ook een datum van PA na de operatie van het operatie preparaat. De juiste datum is de datum van de PA uitslag van het biopt bij scopie.

MDO –datum:

- Indien bekend, de datum waarop de patiënt voor het eerst werd besproken, nadat de pathologie uitslag bekend is.

Operatie datum:

- De dag van de operatie, niet de dag waarop patiënten worden opgenomen voor de operatie, dit is vaak een dag eerder.

Ontslag datum:

- Datum van ontslag

Datum CT-abdomen of MRI abdomen:

- De datum waarop de eerste CT of MRI abdomen wordt gemaakt, in relatie tot het colorectaal carcinoom, ten behoeve van de stadiering.
- Soms wordt geen CT of MRI gedaan maar een echo, dan wordt deze datum opgenomen.

Aantal overige diagnostiek:

- De volgende dingen komen veel voor: echo- buik, CT-thorax, X-thorax, extra CT of MRI (ivm herstadiering na chemo of RT of onduidelijkheid eerder gemaakte echo).

- Buikoverzicht: X-abdomen: deze wordt vaak gemaakt vanwege verdenking op een ileus, let erop dat deze mensen soms acuut of met spoed worden geopereerd (en we ze dus moeten excluderen) of dat deze mensen werden opgenomen op de SEH.

Datum eerste polikliniek bezoek MDL:

- Soms voor en soms na scopie

Datum eerste bezoek polikliniek chirurgie

Datum bezoek aan anesthesiologie

- Ivm preoperatieve consult.

Extra aantal polikliniek bezoeken

- Van zowel MDL, Chirurgie als anesthesiologie

Aantal patiëntenbezoeken:

- Het totale aantal patiëntenbezoeken dat de patiënt brengt aan het ziekenhuis voor operatie
- Meegenomen: bezoeken aan chirurgie, MDL, anesthesiologie, radiologie, het bezoek in verband met de opname voor operatie.
- Wanneer meer dingen op een dag plaatsvinden, wordt maar één bezoek geteld.
- De contacten met de verpleegkundigen werden niet meegenomen.
- Gastroscopieen werden niet meegenomen.

D: Complete list of considered indicators

Subject indicator	T	Comment	References
Surgical site infections	O		Pastor, 2010 / Mazeh, 2009 / DaSilva, 2008 / Platell, 1997
Proportion of in-hospital mortality or mortality within 30 days of colon or rectal cancer surgery (for non-emergent surgery)	O	Used in the DSCA, also case mix corrected	Dimick, 2010 / Gagliardi, 2005 / ZZ (na)
Morbidity (≥ 1 complication)	O		Dimick, 2010
Intra abdominal abces	O	Only possible to calculate is: 'proportion of patients undergoing surgery because of intra abdominal abces	Mazeh, 2009
Pseudomembranous colitis	O		Mazeh, 2009
Atelectasis	O		Mazeh, 2009
Pneumonia	O		Mazeh, 2009 / DaSilva, 2008 / Saliangas, 2004
Proportion of patients undergoing surgery for rectal cancer who experience an anastomotic leak.	O	Only possible to calculate proportion of patients undergoing surgery because of anastomatic leak'.	Mazeh, 2009 / Saliangas, 2004 / Gagliardi, 2008 / ZZ (na)
Arrhytmia	O		Mazeh, 2009
Prolonged or postoperative ileus	O	See number 4	Mazeh, 2009 / DaSilva, 2008 /Saliangas, 2004
Anastomotic bleeding	O	See number 4	Saliangas, 2004
Rupture abdominal aneurysma	O	See number 4	Saliangas, 2004
Suppurations of perineal trauma	O		Saliangas, 2004
Deep vein thrombosis	O		Saliangas, 2004
Pulmonary embolis	O		Saliangas, 2004
Myocard infarct	O		Mazeh, 2009 / Saliangas, 2004
Sexual function	O		DaSilva, 2004
Body image	O		DaSilva, 2004
Self esteem	O		DaSilva, 2004

General Health / quality of life	O		DaSilva,2004
Delirium	O		DaSilva, 2004
Urinary retention	O		DaSilva, 2004
Fatique	O		Paddison,2009 ,Paddison, 2008
Overall 5 –year survival / adjusted 5-year overall survival rate	O		Saliangas, 2004 / Gagliardi, 2008 / ZZ (na)
Number of day on ICU	P		Saliangas, 2004
Estimated blood loss	O		Kiran, 2004
Drop in hemoglobin levels	O		Kiran, 2004
Blood Transfusion required after surgery	O	Used to find a difference in outcome between laparoscopic and open surgery. Not relevant for our study	Mazeh, 2009 / Kiran, 2004
Proportion of colon and rectal carcinomas detected by screening	P		Gagliardi, 2008 / ZZ (na)
Rate of local recurrence for patients who have had colon or rectal surgery	O	Part of the follow-up	Gagliardi, 2008 / ZZ (na)
Proportion of patients undergoing surgery for colon or rectal cancer who have preoperative complete large-bowel imaging, 3 months before surgery of within 6 months after surgery	P	Using the DSCA only a percentage of complete colonoscopy can be given.	Gagliardi, 2008 / ZZ (na)
Proportion of patients undergoing surgery for rectal cancer who have preoperative imaging of the pelvis with CT or MRI	P		Gagliardi, 2008 / ZZ (na)
Proportion of patients undergoing surgery for colon or rectal cancer who have preoperative imaging of the liver with ultrasonography, CT or MRI	P		Gagliardi, 2008 / ZZ (na)
Proportion of patients with rectal cancer undergoing surgery with a distal tumour-free margin (microscopic and 1 cm)	P	In our study we do not focus on the pathology, so this is not a relevant indicator. And this is an indicator of which the validity and reliability is not known.	Gagliardi, 2008 / ZZ (na)
Proportion of patients who have undergone rectal cancer surgery whose operative report includes mention of total mesorectal type dissection, location of tumour, extent of resection, degree of nerve preservation, extent of lymphadenectomy.	P	See above	Gagliardi, 2008
Proportion of patients with rectal cancer who see a radiation oncologist preoperatively, or whose cancer is stage II or III who see a radiation oncologist within 8 weeks after surgery	P		Gagliardi, 2008
Proportion of patients with rectal cancer who see a	P		Gagliardi,

medical oncologist preoperatively, or whose cancer is stage II or III who see a medical oncologist within 8 weeks after surgery			2008
Proportion of patients who have undergone colon or rectal surgery whose pathology report includes details on margin status (distal, radial)	P		Gagliardi, 2008
Proportion of patients who have undergone colon or rectal cancer surgery whose pathology report indicates number of lymph nodes examined and the number of positive lymph nodes	P	More precise is to calculate the number of lymph nodes.	Gagliardi, 2008
Percentage of patients of who 10 or more lymphe nodes are examined	P		ZZ (a)
Proportion of patients with colon cancer who undergo surveillance colonoscopy within 1 year after surgery.			Gagliardi, 2008
Participation DSCA	P	Not useful, is a selection criteria for participation in our study	ZZ (a)
Percentage of patients with a rectum carcinoma that are discussed in a preoperative multidisciplinary work group.	P		ZZ (a)
Time between first consultation, diagnosis and treatment	P	Because of difficulties with accuracy not part of the ZZ. In our study we do not include the first consultation to the GP. But the others we use for the lead times	ZZ (na)
Percentage of re-interventions because of complications, within the in-hospital stay or within 30 days after resection of the primary tumour.	O	Combines all the complications and can be calculated using the DCSA data, however it is influences by case-mix	DSCA
Number of laparoscopic procedures in every hospital	P	Not relevant in relation to quality	ZZ (na)
Percentage of laparoscopic procedures in relation with open procedures	P	Relation with quality unknown	ZZ (na)
Percentage R0 resection for patients with a T1 – T3 tumour	O	See number 34	ZZ (na)
Specialized nurse (in oncology or stoma care)	P	Is part of the lean characteristics but can also be used as process indicator.	ZZ (na)
Percentage of patients with diagnosed mammacarcinoma that had preoperative a consult at the specialized nurse	P		ZZ (na)

Table 21. *Overview of all discussed indicators. T=Type of indicator, O=Outcome indicator, P= Process indicator, ZZ= Zichtbare Zorg. NA= not accepted by the Zichtbare Zorg Commission, A= Accepted by the Zichtbare Zorg Commission. The column* select *shows whether the indicators are included (Y=yes) or excluded (N=no).*

E: Complete list of cross tables

Nr.	Row	Colum	N	Chi - square	p	Direction
1	Total number of pat. visits	30 days mortality	461	0,03	0,954	No relation
2	Total number of pat visits	Pre operative imaging pelvis	461	3,313	0,069	No relation
3	Total number of pat. Visits	Pre operative imaging of the liver	461	6,168	0,013	Positive relation
4	Total number of pat. Visits	Pre operative imaging of the lung and liver	461	8,227	0,004	Positive relation
5	Total number of pat visits	10 or more lymph nodes	449	1,551	0,213	No relation
6	Total number of pat visits	Pre operative MDT	434	33,262	0,000	Positive relation
7	Total number of pat visits	Re-interventions	454	2,237	0,135	No relation
8	Total number of pat visits	Complications	453	2,604	0,107	No relation
9	Total number of pat visits	Complicated course	454	1,620	0,203	No relation
10	Total number of pat visits	CRM	105	0,082	0,775	No relation
11	Total number of pat visits	Radical resection	368	0,204	0,651	No relation
12	Number of visits outpatient clinic	30 days mortality	461	0,51	0,821	No relation
13	Number of visits outpatient clinic	Pre operative imaging pelvis	461	6,507	0,011	Negative relation
14	Number of visits outpatient clinic	Pre operative imaging of the liver	461	4,801	0,028	Positive relation
15	Number of visits outpatient clinic	Pre operative imaging of the lung and liver	461	7,998	0,005	Positive relation
16	Number of visits outpatient clinic	10 or more lymph nodes	449	0,009	0,925	No relation
17	Number of visits outpatient clinic	Pre operative MDT	434	10,102	0,001	Positive relation
18	Number of visits outpatient clinic	Re-interventions	454	0,621	0,431	No relation
19	Number of visits outpatient clinic	Complications	453	0,253	0,615	No relation
20	Number of visits outpatient clinic	Complicated course	454	0,612	0,434	No relation
21	Number of visits outpatient clinic	CRM	105	0,444	0,505	No relation
22	Number of visits outpatient clinic	Radical resection	368	0,171	0,679	No relation
23	Number of visits related to staging	30 days mortality	461	0,743	0,389	No relation
24	Number of visits related to staging	Pre operative imaging pelvis	461	70,753	0,000	Should be calculated for rectum only
25	Number of visits related to staging	Pre operative imaging of the liver	461	77,084	0,000	Positive relation
26	Number of visits related to	Pre operative imaging of the	461	67,757	0,000	Positive relation

	staging	lung and liver				
27	Number of visits related to staging	10 or more lymph nodes	449	0,411	0,522	No relation
28	Number of visits related to staging	Pre operative MDT	434	2,376	0,123	No relation
29	Number of visits related to staging	Re-interventions	454	0,559	0,455	No relation
30	Number of visits related to staging	Complications	453	8,711	0,003	Negative relation
31	Number of visits related to staging	Complicated course	454	1,360	0,244	No relation
32	Number of visits related to staging	CRM	105	0,691	0,406	No relation
33	Number of visits related to staging	Radical resection	368	0,663	0,415	No relation
34	Lead time Colonoscopy - Pathology	30 days mortality	381	2,651	0,103	No relation
35	Lead time Colonoscopy - Pathology	Pre operative imaging pelvis	381	36,569	0,000	Negative relation
36	Lead time Colonoscopy - Pathology	Pre operative imaging of the liver	381	32,638	0,000	Positive relation
37	Lead time Colonoscopy - Pathology	Pre operative imaging of the lung and liver	381	22,163	0,000	Positive relation
38	Lead time Colonoscopy - Pathology	10 or more lymph nodes	372	6,649	0,010	Negative relation
39	Lead time Colonoscopy - Pathology	Pre operative MDT	360	1,061	0,303	No relation
40	Lead time Colonoscopy - Pathology	Re-interventions	374	0,425	0,515	No relation
41	Lead time Colonoscopy - Pathology	Complications	374	0,035	0,853	No relation
42	Lead time Colonoscopy - Pathology	Complicated course	374	0,687	0,407	No relation
43	Lead time Colonoscopy - Pathology	CRM	72	1,978	0,160	No relation
44	Lead time Colonoscopy - Pathology	Radical resection	313	0,433	0,511	No relation
45	Lead time Pathology -MDT	30 days mortality	309	0,157	0,692	No relation
46	Lead time Pathology -MDT	Pre operative imaging pelvis	309	1,862	0,172	No relation
47	Lead time Pathology -MDT	Pre operative imaging of the liver	309	2,568	0,109	No relation
48	Lead time Pathology -MDT	Pre operative imaging of the lung and liver	309	2,697	0,101	No relation
49	Lead time Pathology -MDT	10 or more lymph nodes	302	0,109	0,742	No relation
50	Lead time Pathology -MDT	Pre operative MDT	307	1,222	0,269	No relation
51	Lead time Pathology -MDT	Re-interventions	303	3,146	0,076	No relation
52	Lead time Pathology -MDT	Complications	303	0,867	0,352	No relation
53	Lead time Pathology -MDT	Complicated course	304	3,116	0,078	No relation

54	Lead time Pathology -MDT	CRM	89	0,676	0,411	No relation
55	Lead time Pathology -MDT	Radical resection	247	1,025	0,311	No relation
56	Lead time Pathology - Surgery	30 days mortality	441	1,271	0,259	No relation
57	Lead time Pathology - Surgery	Pre operative imaging pelvis	441	0,375	0,540	No relation
58	Lead time Pathology - Surgery	Pre operative imaging of the liver	441	0,004	0,948	No relation
59	Lead time Pathology - Surgery	Pre operative imaging of the lung and liver	441	0,037	0,847	No relation
60	Lead time Pathology - Surgery	10 or more lymph nodes	430	3,511	0,061	No relation
61	Lead time Pathology - Surgery	Pre operative MDT	417	7,559	0,006	Positive relation
62	Lead time Pathology - Surgery	Re-interventions	434	0,015	0,901	No relation
63	Lead time Pathology - Surgery	Complications	433	7,254	0,007	Positive relation
64	Lead time Pathology - Surgery	Complicated course	434	4,150	0,042	Negative relation
65	Lead time Pathology - Surgery	CRM	102	0,342	0,558	No relation
66	Lead time Pathology - Surgery	Radical resection	355	2,258	0,133	No relation
67	Lead time in hospital stay	30 days mortality	456	0,595	0,440	No relation
68	Lead time in hospital stay	Pre operative imaging pelvis	456	0,665	0,415	No relation
69	Lead time in hospital stay	Pre operative imaging of the liver	456	0,287	0,592	No relation
70	Lead time in hospital stay	Pre operative imaging of the lung and liver	456	0,028	0,868	No relation
71	Lead time in hospital stay	10 or more lymph nodes	444	0,479	0,489	No relation
72	Lead time in hospital stay	Pre operative MDT	430	0,000	0,987	No relation
73	Lead time in hospital stay	Re-interventions	449	93,474	0,000	Positive relation
74	Lead time in hospital stay	Complications	448	137,237	0,000	Positive relation
75	Lead time in hospital stay	Complicated course	449	203,563	0,000	Positive relation
76	Lead time in hospital stay	CRM	103	6,184	0,013	Negative relation
77	Lead time in hospital stay	Radical resection	363	3,530	0,060	No relation
78	Lead time GI - Pathology	30 days mortality	196	0,708	0,400	No relation
79	Lead time GI - Pathology	Pre operative imaging pelvis	196	0,842	0,359	No relation
80	Lead time GI - Pathology	Pre operative imaging of the liver	196	0,262	0,609	No relation
81	Lead time GI - Pathology	Pre operative imaging of the lung and liver	196	0,230	0,631	No relation
82	Lead time GI - Pathology	10 or more lymph nodes	191	0,052	0,820	No relation
83	Lead time GI - Pathology	Pre operative MDT	184	0,263	0,608	No relation
84	Lead time GI - Pathology	Re-interventions	192	1,920	0,166	No relation
85	Lead time GI - Pathology	Complications	193	0,076	0,783	No relation
86	Lead time GI - Pathology	Complicated course	193	0,345	0,557	No relation
87	Lead time GI - Pathology	CRM	32	0,008	0,927	No relation
88	Lead time GI - Pathology	Radical resection	168	0,10	0,921	No relation
89	Lead time during surgery	30 days mortality	223	0,667	0,414	No relation
90	Lead time during surgery	Pre operative imaging pelvis	223	0,296	0,587	No relation

91	Lead time during surgery	Pre operative imaging of the liver	223	1,386	0,239	No relation
92	Lead time during surgery	Pre operative imaging of the lung and liver	223	2,091	0,148	No relation
93	Lead time during surgery	10 or more lymph nodes	217	0,123	0,726	No relation
94	Lead time during surgery	Pre operative MDT	212	0,607	0,436	No relation
95	Lead time during surgery	Re-interventions	220	1,831	0,176	No relation
96	Lead time during surgery	Complications	220	10,138	0,001	Positive relation
97	Lead time during surgery	Complicated course	218	4,683	0,030	Positive relation
98	Lead time during surgery	CRM	50	0,32	0,857	No relation
99	Lead time during surgery	Radical resection	180	0,251	0,616	No relation

Table 22. *Cross tables combining the patient related outcomes and the efficiency variables for patients with colon carcinoma and rectum carcinoma as one group. N is the number of patients.*

F: Anonymous example of the Benchmark report

Geachte dr. …,

Voor u ligt de benchmarkrapportage over het jaar 2009. In deze rapportage vindt u gegevens van uw ziekenhuis terug, vergeleken met zeven andere Nederlandse ziekenhuizen. Deze ziekenhuizen werden allen in 2009 bezocht in kader van het project 'Analyzing the process of colorectal surgery from organizational perspective' van de Universiteit Twente.

De cijfers in deze rapportage zijn gebaseerd op de gegevens uit de DSCA en de cijfers die wij in uw ziekenhuis hebben verzameld in het elektronisch patiënten dossier. De in dit rapport opgenomen gegevens zijn door de samenstellers met uiterste zorgvuldigheid verwerkt. Voor gegevens die desondanks onvolledig of onjuist mochten zijn, kan de samensteller in geen enkel opzicht aansprakelijk worden gesteld.

Deze benchmarkrapportage zal in 2011 een vervolg krijgen. Meer ziekenhuizen worden op dit moment bezocht en in samenwerking met de DSCA zal verder worden gekeken hoe ook gegevens over efficiency in 'mijn DCSA' kunnen worden teruggegeven.

Met hartelijke groet,

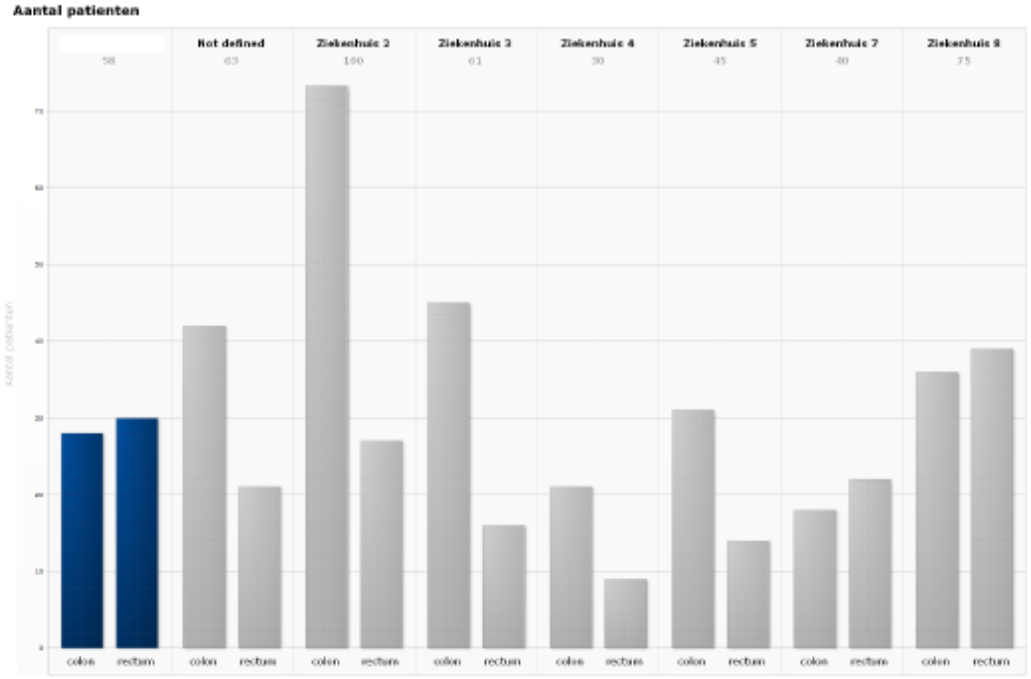
Anne G. H. Niezink, MD

Dorine J. Pluimers, Pt MSC

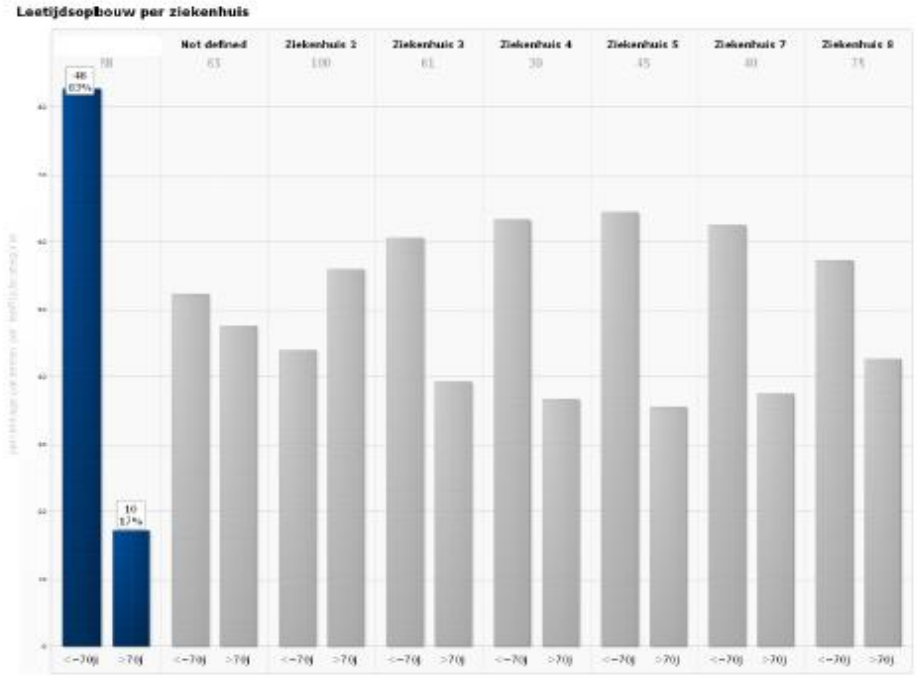
Wim H. van Harten, MD PhD

Patiëntengroep

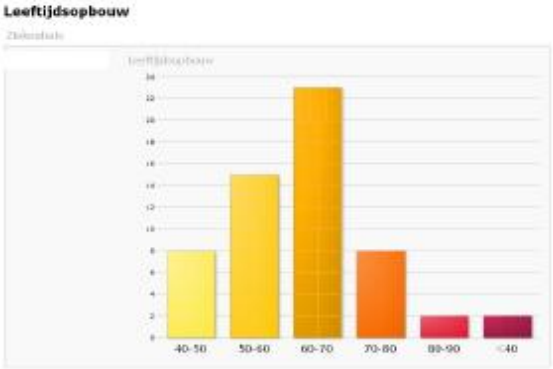
Van de acht ziekenhuizen die deelnamen waren er 3 academische ziekenhuizen, 1 opleidingsziekenhuis en 4 niet opleidingsziekenhuizen. In totaal ondergingen 472 patiënten electieve chirurgie vanwege een primair colorectaal carcinoom. Alle overige patiënten werden geëxcludeerd.



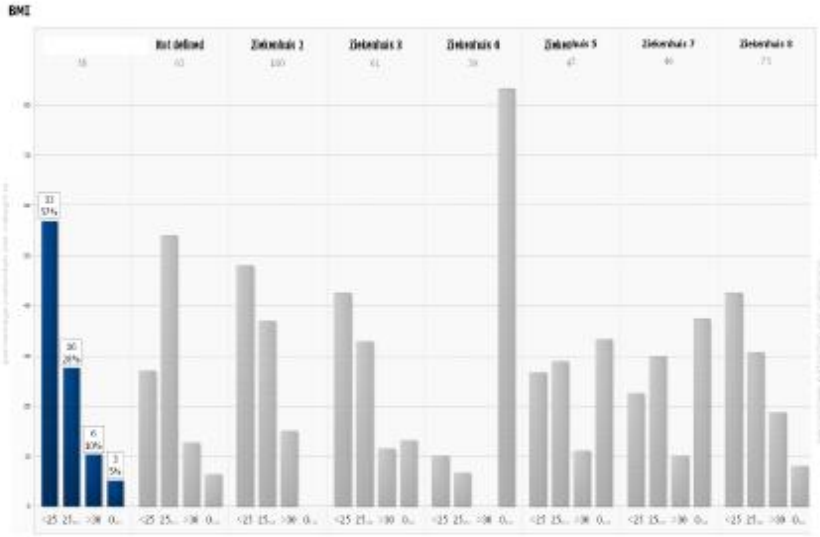
Tabel 1. *Het aantal electieve patiënten geïncludeerd per ziekenhuis. Colon = colon carcinoom, Rectum = rectum carcinoom.*



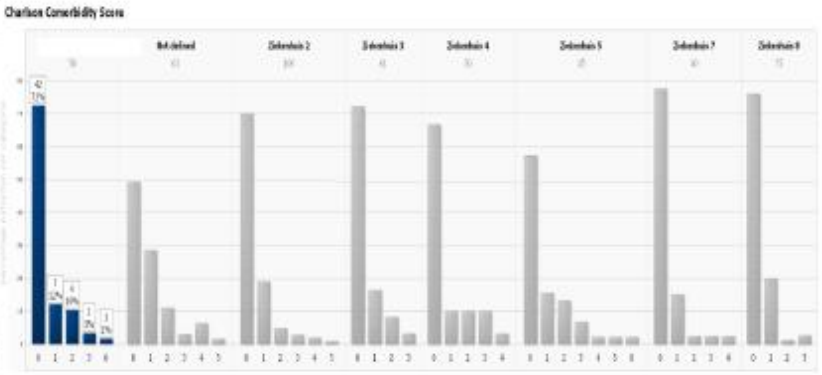
Tabel 2. *Leeftijdsopbouw per ziekenhuis. Verdeling onder of gelijk aan 70 jaar ten tijde van de operatie (= <= 70j) of ouder dan 70 jaar ten tijde van de operatie (= >70j).*



Tabel 3. *Leeftijdsopbouw van de patienten geopereerd in uw eigen ziekenhuis.*



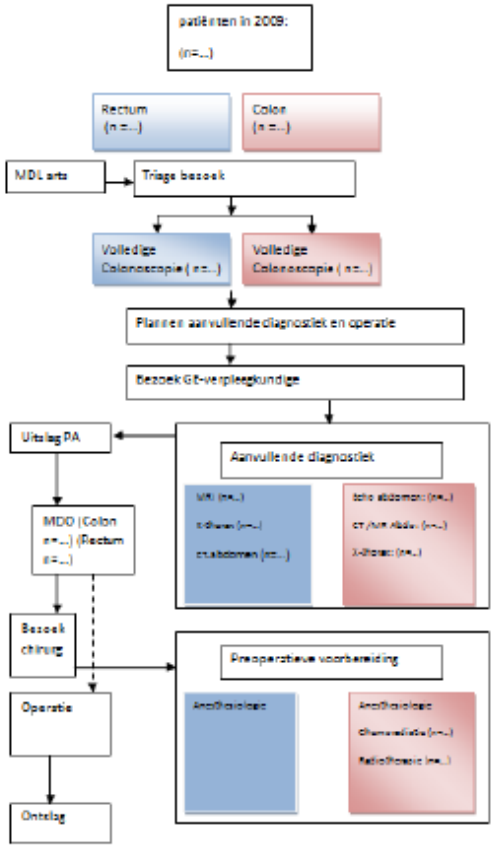
Tabel 4. *De Body Mass Index voor de patienten, indeling in kleiner of gelijk aan 25, Tussen 25 en 30 of groter of gelijk aan 30.*



Tabel 5. *Charlson Comorbidty Score.*

Flow chart

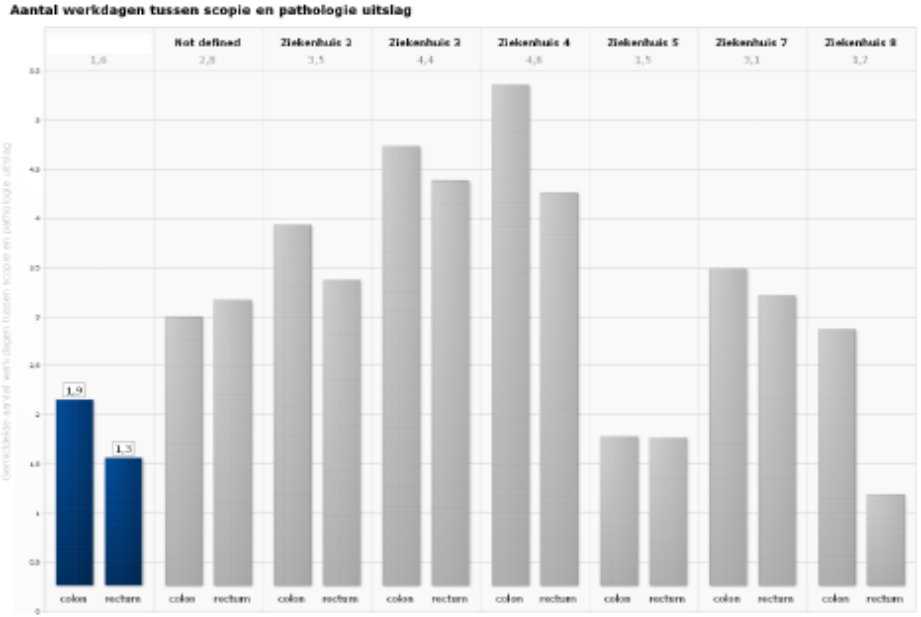
Op basis van het bezoek aan uw ziekenhuis werd een flow chart gemaakt waarin de patiënten stromen zijn weergegeven. Hiermee krijgt u inzicht in het pad dat de patiënten belopen.



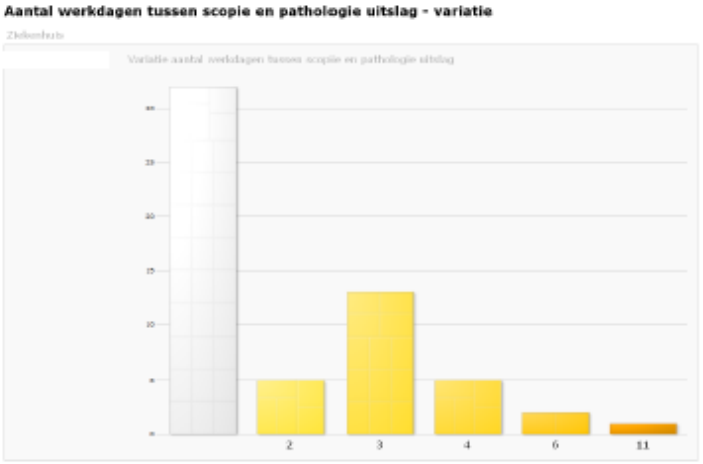
Tabel 6. *Flow chart van uw eigen ziekenhuis. Hier ziet u de verschillende patiënten stromen voor patiënten met een colon carcinoom en een rectum carcinoom.*

Doorlooptijden

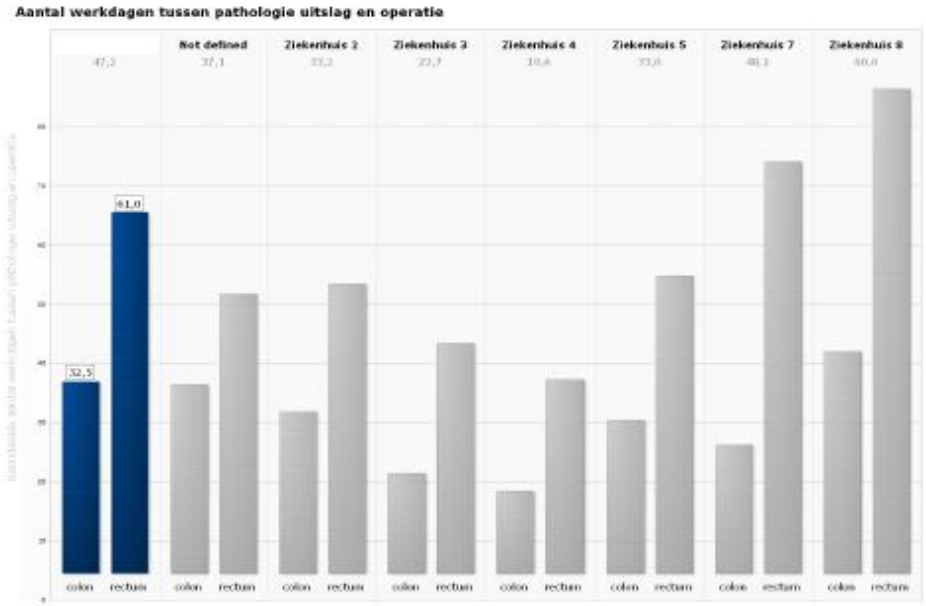
Met behulp van de gegevens uit de DSCA en het elektronisch patiënten dossier werden doorlooptijden berekend. Weergegeven zijn het aantal dagen tussen het gemiddelde van de ziekenhuizen voor patiënten met een colon carcinoom en een rectum carcinoom. Daarnaast vindt u een tabel met de variatie in uw eigen ziekenhuis.



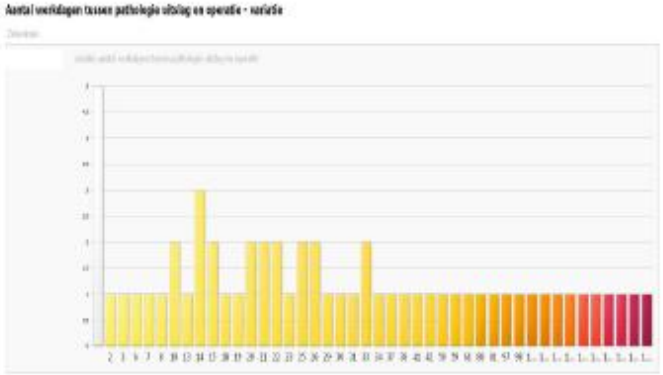
Tabel 7. *Het aantal werkdagen tussen de scopie (colonoscopie en in sommige gevallen de sigmoïdoscopie) en de dag dat de uitslag van de pathologie bekend is.*



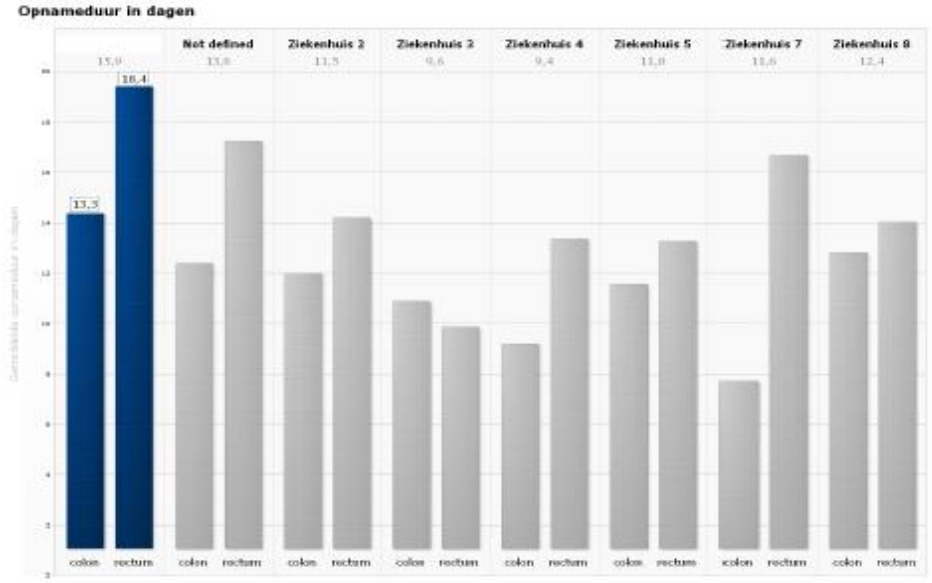
Tabel 8. *De variatie van het aantal werkdagen tussen de scopie en pathologie in uw eigen ziekenhuis.*



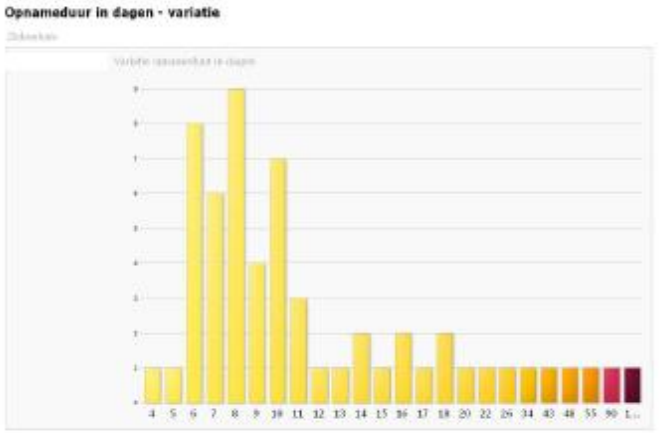
Tabel 9. *Aantal werkdagen tussen de pathologie uitslag en de dag van de operatie.*
Colon = colon carcinoom, Rectum =rectum carcinoom



Tabel 10. *Aantal werkdagen tussen de pathologie uitslag en de dag van de operatie in uw eigen ziekenhuis.*



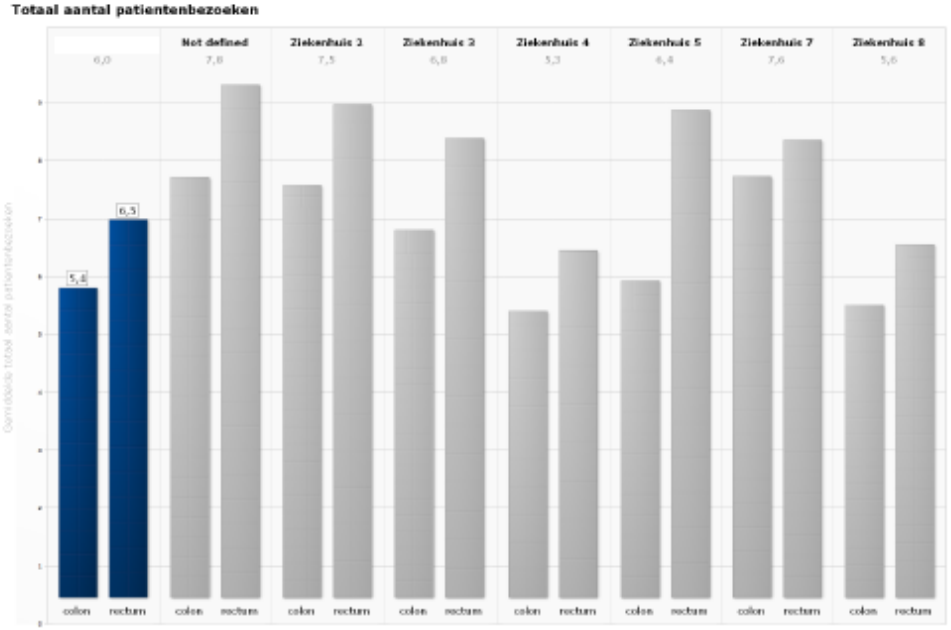
Tabel 11. *Opnameduur in dagen. Colon = colon carcinoom, Rectum = rectum carcinoom.*



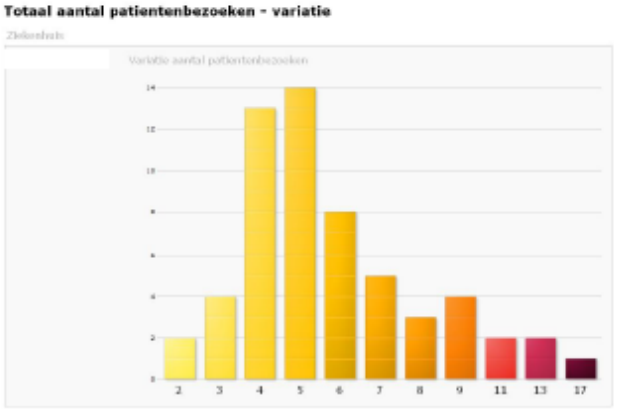
Tabel 12. *Opnameduur in dagen, de variatie in uw ziekenhuis.*

Aantal bezoeken per patiënt

In het elektronisch patiëntendossier werden het aantal bezoeken dat de patiënt bracht aan het ziekenhuis handmatig geteld. Daarbij werden de bezoeken aan de chirurg op de polikliniek, aan de MDL arts (of internist, afhankelijk door wie de colonoscopie werd uitgevoerd in het ziekenhuis), aan de anesthesioloog, de bezoeken aan de radiologie in verband met stadiering en de dag van opname, als bezoeken aan het ziekenhuis geteld.



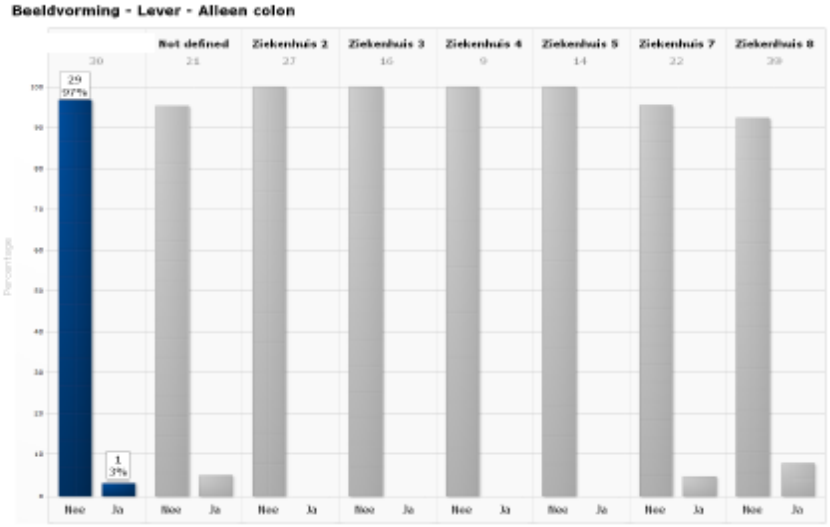
Tabel 12. *Het aantal bezoeken dat de patiënt bracht aan uw ziekenhuis voor de operatie. Dit aantal bezoeken is gebaseerd op het aantal bezoeken aan de polikliniek (waarbij bezoeken aan de chirurg, anesthesioloog en mdl-arts (of in sommige ziekenhuizen de internist) werden gerekend) en de bezoeken aan de radiologie (MRI, CT, PET en ander aanvullend onderzoek) en de dag van opname. Colon = colon carcinoom, Rectum = rectum carcinoom*



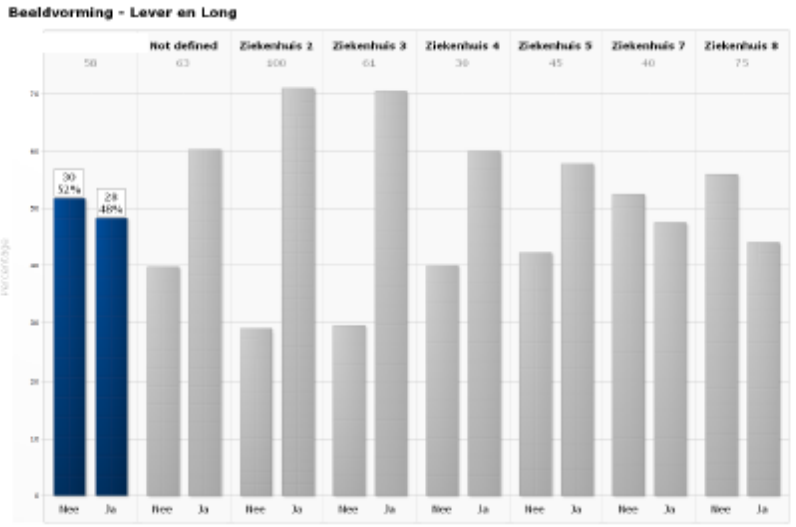
Tabel 13. *De variatie van het aantal bezoeken van de patiënt aan uw eigen ziekenhuis.*

De patiënt gerelateerde uitkomsten

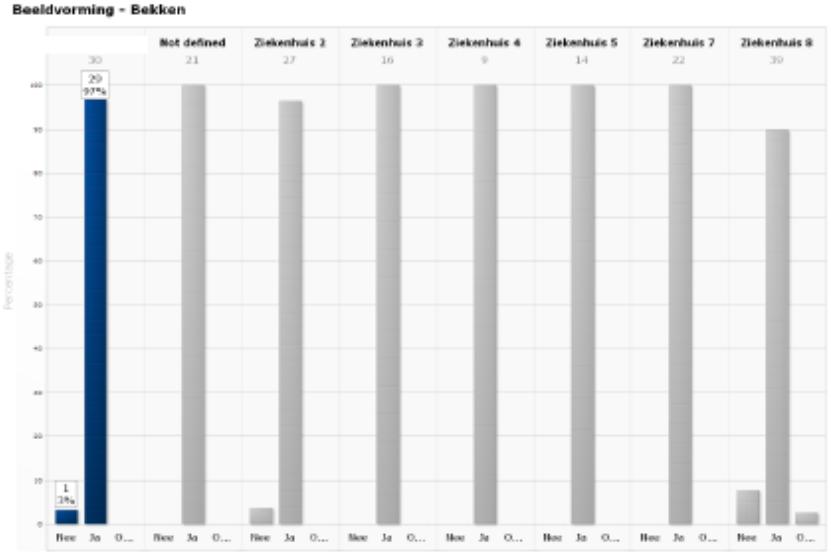
Op basis van literatuuronderzoek werden een aantal proces- en uitkomstindicatoren geselecteerd. Deze zijn hieronder en op de volgende pagina's weergegeven. De gegevens zijn gebaseerd op data uit de DSCA.



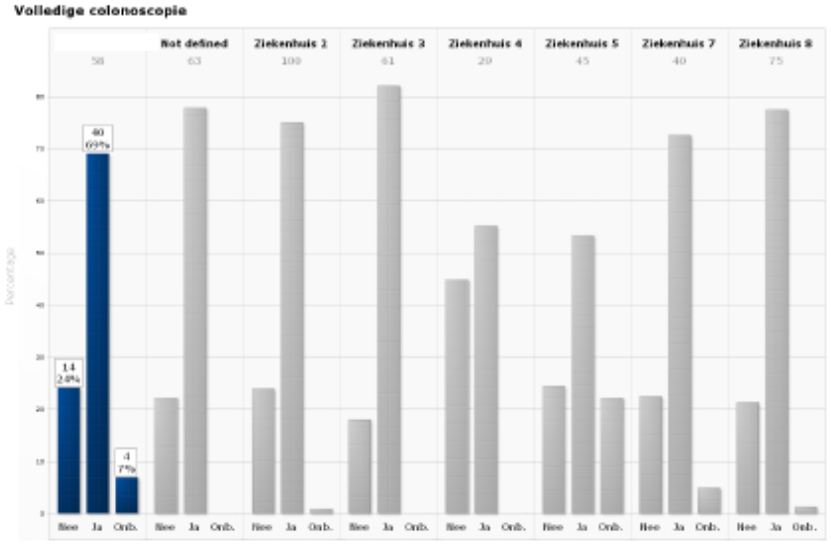
Tabel 14. *Beeldvorming van de lever preoperatief voor patiënten met een colon carcinoom.*



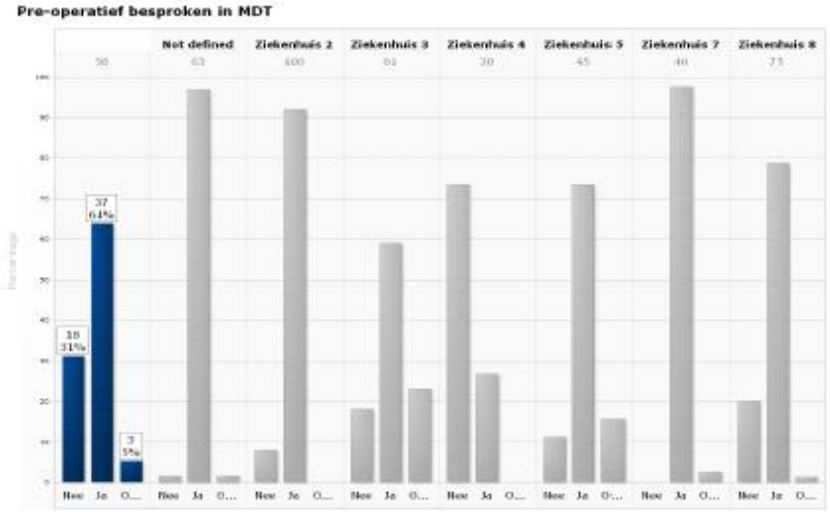
Tabel 15. *Beeldvorming voor de long en de lever voor zowel rectum carcinoom als colon carcinoom.*



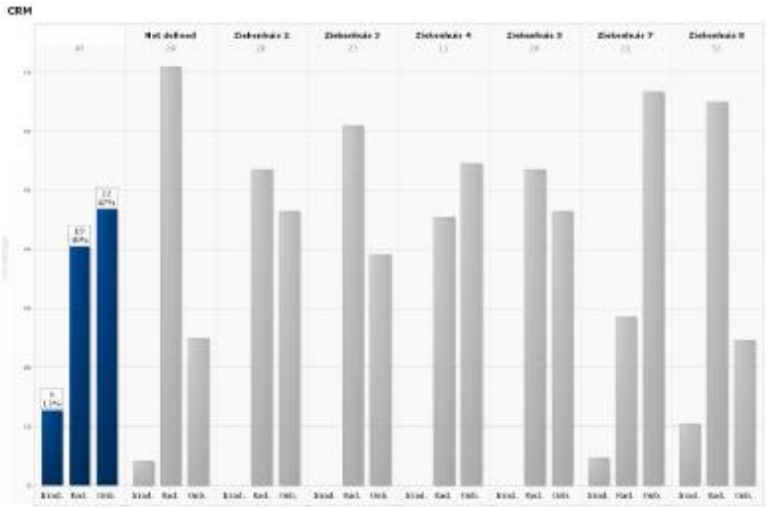
Tabel 16. *De beeldvorming van het bekken voor rectumcarcinoom. O. = Onbekend.*



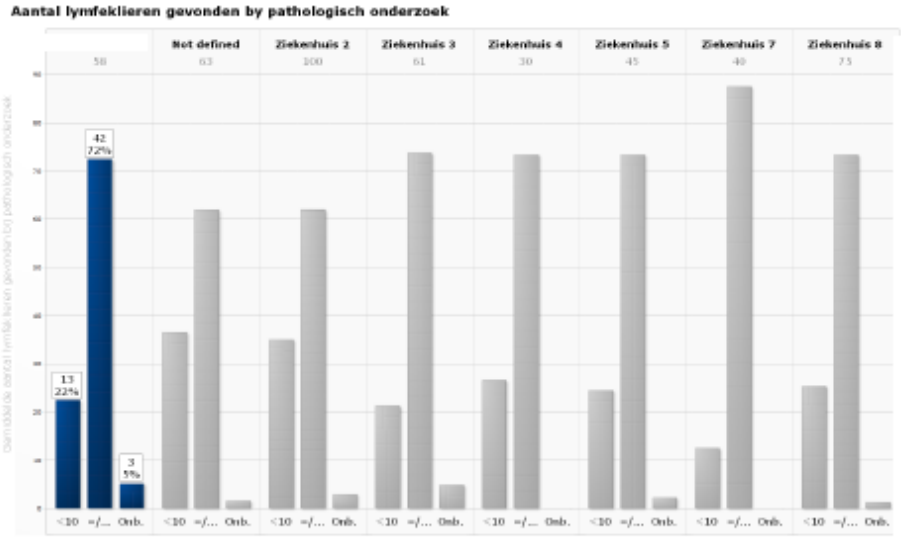
Tabel 17. *Het aantal verrichte volledige colonoscopieën. Onb. = Onbekend.*



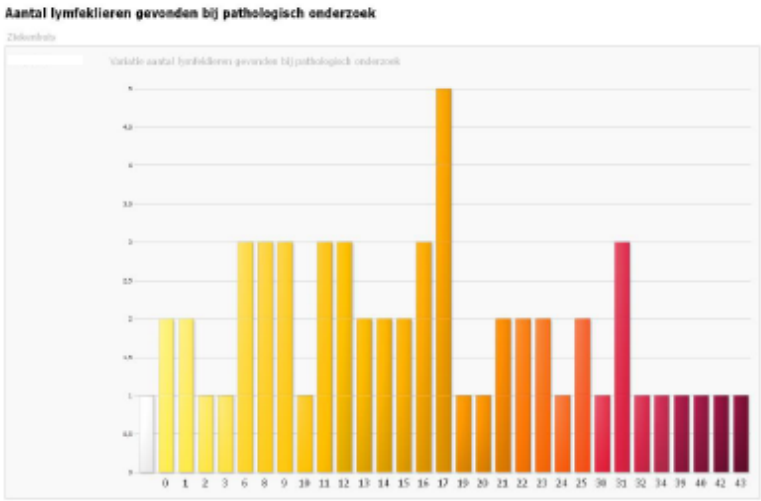
Tabel 18. *Het aantal en percentage patiënten dat werd besproken in een Multidisciplinair team preoperatief. 0. = Onbekend.*



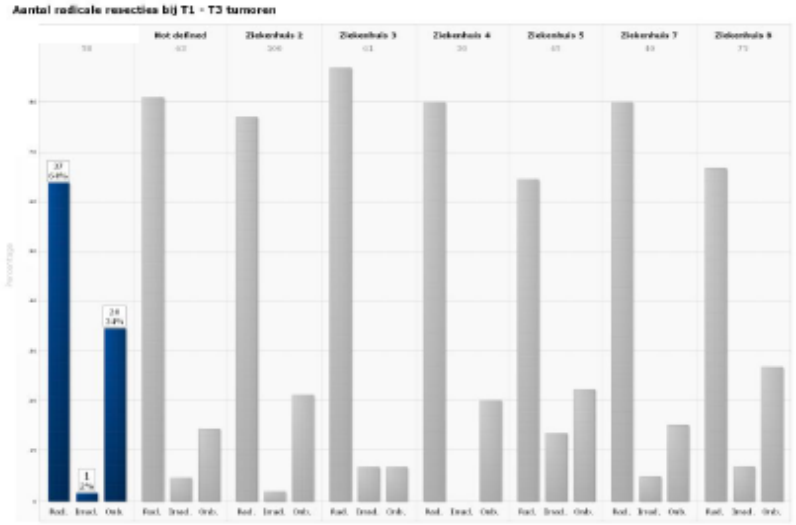
Tabel 19. *Het aantal en percentage patiënten met rectumcarcinoom waarbij de Circumferentiële marge radicaal was. Irr. = Irradicaal, Rad. = Radicaal, Onb. = onbekend.*



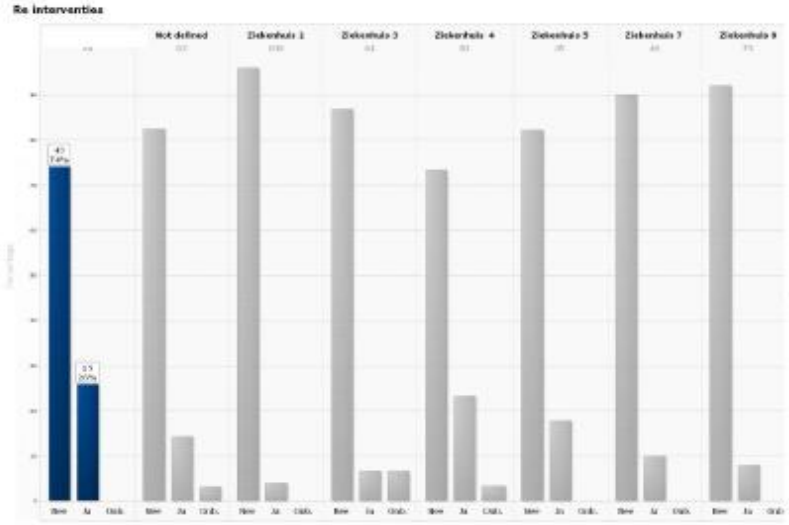
Tabel 20. *Het aantal en percentage gevonden lymfeklieren bij pathologisch onderzoek. =/ .. = gelijk aan of meer dan 10 lymfeklieren gevonden bij pathologisch onderzoek, Onb. = Onbekend.*



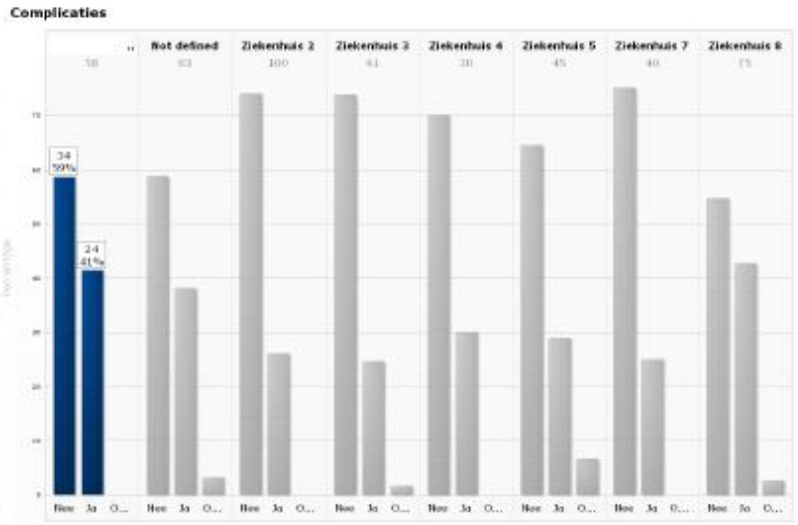
Tabel 21. *De variatie van het aantal gevonden aantal lymfeklieren in uw ziekenhuis.*



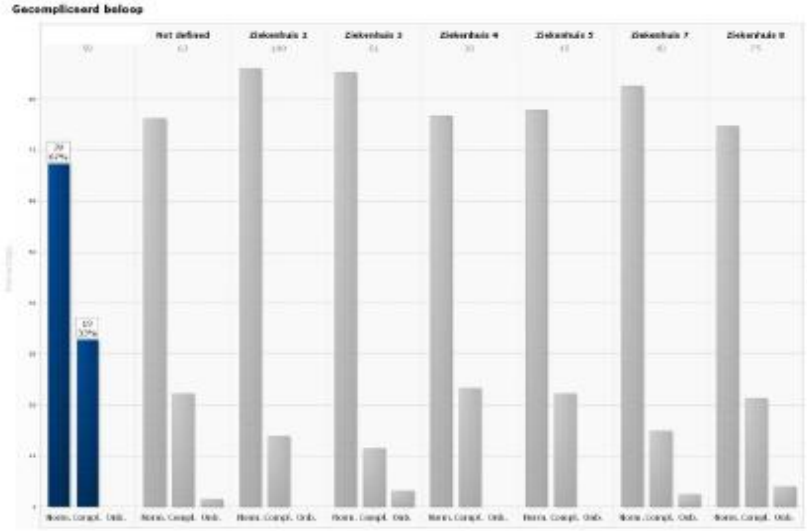
Tabel 22. *Het aantal en percentage patiënten met een T1 –T3 tumor waarbij een radicale resectie werd verricht. Rad.= Radicaal, Irrad. = Irradicaal, Onb. = Onbekend.*



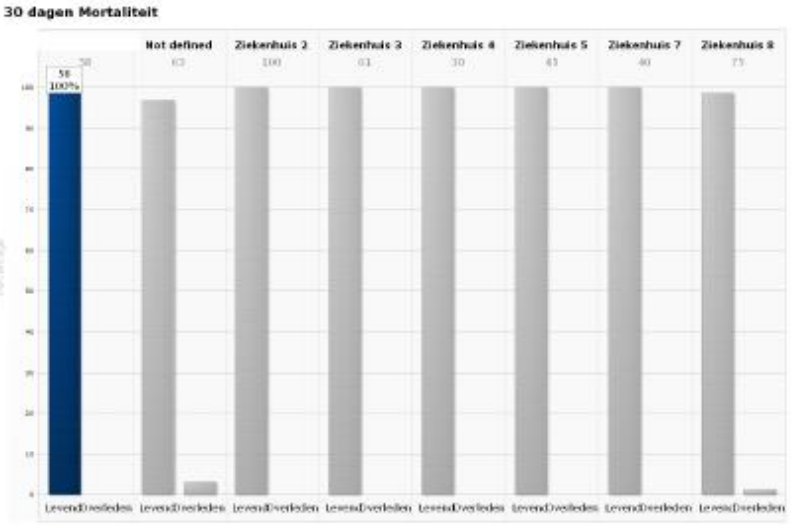
Tabel 23. *Het aantal en percentage re-interventies. Onb. = Onbekend*



Tabel 24. *Het aantal en percentage complicaties. O. = Onbekend.*



Tabel 25. *Het aantal en percentage gecompliceerd beloop. Een patiënt met gecompliceerd beloop is gedefinieerd als een patiënt met complicaties waaraan hij/zij overleden is of waar reïnterventie voor heeft plaatsgevonden of waarbij de opnameduur is verlengd tot meer dan 21 dagen. Norm. = Normaal beloop, Compl. = Gecompliceerd beloop, Onb. =onbekend.*



Tabel 26. *Het aantal en percentage 30 dagen mortaliteit.*

Organisatorische kenmerken

Tijdens het bezoek aan uw ziekenhuis zijn verschillende kenmerken van uw organisatie in kaart gebracht. In de tabel hieronder vindt u de voor u relevante bevindingen, opnieuw vergeleken met de andere bezochte ziekenhuizen. Op dit moment worden de gegevens geanalyseerd en zijn daarom nog niet in onderstaande tabel weergegeven.

	Ziekenhuis 1	Ziekenhuis 2	Ziekenhuis 3	Ziekenhuis 4	Ziekenhuis 5	Ziekenhuis 6	Ziekenhuis 7	Ziekenhuis 8	Mean
Focus									
One- stop diagnosis									
One- stop pre-assessment									
Gebruik maken van slots voor beeldvorming									
MDT voor patienten met coloncarcinoom									
Tijdstip van plannen operatie									
Gebruik sneller herstel programma									

Tabel 27. *Organisatorische kenmerken.*

Best practice

In de onderstaande tabel is een overzicht gegeven van de ziekenhuizen die het beste scoren op de verschillende efficientie variabelen.

Variable		Mediaan	Best practice	Ziekenhuis nummer
Het aantal werkdagen tussen het eerste bezoek MDL arts en uitslag van de pathologie	Total all patients	11	10,93	4
Het aantal werkdagen tussen de colonoscopie en de uitslag van de pathologie	Total all patients	3	2,13	6
Het aantal werkdagen tussen de uitslag van de pathologie en de dag dat de patiënt wordt besproken in een MDT	Total colon	7	6,05	3
	Total rectum	10	2,75	4
	Total all patients	8	6,36	3
Het aantal werkdagen tussen de dag van de pathologie uitslag en de dag van de operatie	Total colon	23	14,70	4
	Total rectum RT short s	30,5	18,29	4
	Total rectum RT long	96	79,25	1
	Total all patients	28	20,31	4
Het aantal dagen tussen de operatie en het ontslag	Total colon	7	6,67	5
	Total rectum RT short	10	8,50	3
	Total rectum RT long	12	9,00	6
	Total all patients	8	9,40	4
Het totale aantal ziekenhuisbezoeken per patiënt voor de operatie	Total all patients	7	5,25	4

Tabel 28. *De ziekenhuizen die het beste scoren op de verschillende efficiëntie variabelen.*