

STAYING AHEAD BY LEARNING FROM THE BEST

A BENCHMARKING STUDY AMONG FOUR ACADEMIC RADIOTHERAPY CENTERS IN EUROPE

MASTER THESIS:

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MANAGEMENT

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Management summary

Context and aim of the study

Increasing demands from the Dutch government and individual patients are leading to an extended focus on the quality of care given at the Netherlands Cancer Institute – Antoni van Leeuwenhoek Hospital (NKI-AVL). Therefore, the NKI-AVL is exploring ways to improve their services. Good experiences of the NKI-AVL with benchmarking studies were the main motivation for starting this research.

The choice for benchmarking the radiotherapy department is based on a recommendation from prior research. This study claims that the radiotherapy department is a good candidate for benchmarking, as the process is stable and has relatively little variation. Furthermore, this research assumes that radiotherapy is a mostly separate department for which a reasonable amount of data is available.

This thesis describes a benchmarking study among four academic radiotherapy centers in Europe:

- NKI-AVL, Amsterdam, The Netherlands
- Karolinska Institutet, Stockholm, Sweden
- Medizinische Fakultät und Universitätsklinik Carl Gustav Carus, Dresden, Germany
- Institut Jules Bordet, Brussels, Belgium.

The aim of this study is developing a benchmarking framework with performance indicators that makes it possible to compare the different academic radiotherapy centers, and to eventually indicate improvement options for each of the partners involved. As the title explains, the main goal of this study is to learn from each other. To be able to reach this goal the following research questions were posed:

How can a benchmarking framework be constructed and which indicators can be used to benchmark the performance concerning quality and efficiency, on a MACRO and MESO level, of academic radiotherapy centers in Europe?

How do the different academic radiotherapy centers in Europe perform when benchmarked on quality and efficiency indicators on a MACRO and MESO level, and what improvement suggestions can be given to the individual academic radiotherapy centers and to academic radiotherapy centers in general?

Methodology

Literature reviews and desk research are performed for the identification of the contingency factors, the development of the framework and the performance indicators, and the execution of the stakeholder analysis. Interviews and visits of the benchmarking partners are used for retrieving the data necessary for comparing the partners.

Conclusions for the NKI-AVL

Based on the analysis of the performance indicators, the NKI-AVL has the best practices for the following indicators: risk analysis, shortness of the waiting times, measuring patient

satisfaction, number of publications and patients in a clinical trial, instrumentation and dosimetry, and the use of IMRT in breast cancer patients.

Recommendations for the NKI-AVL

- Register what improvement actions follow from the patient satisfaction questionnaires and from the risk analysis system, hence finishing the quality cycle.
- Upgrade the EPR, also of use in multidisciplinary meetings.
- Improve the appointment planning system by making appointments earlier available for patients.
- Register waiting times for all patients.
- Determine if planned downtime can be decreased.

Recommendations for future research

- Visit the benchmarking partners two times instead of once.
- Measure the indicators prospectively instead of retrospectively.
- Measure research data over a five-year time period.
- Use different tumor groups for analyses at MESO level.

For future radiotherapy benchmarking studies the renewed shortlist of indicators should be used, as this contains indicators that provide that most interesting outputs and can be measured reliable with the new definitions.

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List of abbreviations

ART	Adapted Radiotherapy
CCC	Comprehensive Cancer Center
CPZ	Cluster Patient Care
EFQM	European Foundation for Quality Management
EPR	Electronic Patient Record
EZIS	Electronic Hospital Information System
GP	General Practitioner
HIS	Hospital Information System
IGRT	Image Guided Radiotherapy
IMRT	Intensity Modulated Radiotherapy
IoM	Institute of Medicine in the United States
LineAcc	Linear Accelerator
MCRT	Reporting Committee Radiotherapy
MIP	Patient Incidents Reporting
MM	Multidisciplinary Meeting
NKI-AVL	Netherlands Cancer Institute - Antoni van Leeuwenhoek Hospital
NVRO	Dutch Society for Radiation Oncologists
TB	Tumor Board
TQM	Total Quality Management
QFD	Quality Function Deployment
VIM	Safety Incidents Reporting
VWS	Ministry of Health, Welfare and Sports in the Netherlands

Preface

After having had the opportunity to do my internship at the Netherlands Cancer Institute – Antoni van Leeuwenhoek Hospital, I am proud to present my master thesis titled: Staying ahead by learning from the best. This thesis marks the completion of my studies Healthcare Technology and Management at the University of Twente in Enschede, the Netherlands and presents a benchmark study among four academic radiotherapy centers in Europe.

However, I could not have done this thesis alone. Therefore I would like to take this chance to thank Professor van Harten and Professor Krabbendam for their time and input during our meetings and discussions. Also, I would like to say thanks to Luc and Bart for fitting me in their tight schedules. Special thanks goes to Professor Ringborg, Professor Baumann, Dr. Zips, Dr. Burrión, and Dr. van Houtte, for the time spent with me at their institutes, showing me around and answering my questions. I hope this thesis will prove that it was worth the input.

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I hope you will enjoy reading this thesis,

Relinde de Beer

Amsterdam, August 2008

1 Introduction

At the Netherlands Cancer Institute - Antoni van Leeuwenhoek Hospital (NKI-AVL), several (international) benchmarking studies have been performed in recent years. This Master thesis for the Healthcare Technology and Management track of the study Industrial Engineering and Management at the University of Twente in the Netherlands will continue to build on these studies and describes a benchmarking study for academic radiotherapy centers in Europe. This introduction chapter describes the motivation for this research (1.1) and explains why benchmarking and the radiotherapy department were chosen for this research. Further, the problem statement is described and the research questions formulated (1.2). Finally, the term quality of care is defined (1.3) and a reading guide for this thesis is provided (1.4).

1.1 Motivation for this research

Quality of care is one of the main issues addressed in the Policy Agenda for 2008, drawn up by the ministry of Health, Welfare and Sports (VWS) of the Dutch government. The agenda states that healthcare is of a good quality when the care itself is aimed at the individual wishes of patients, and when it is effective, safe and timely delivered (Klink, 2008). According to the Dutch minister of VWS, healthcare quality should continuously be evaluated and improved (Klink, 2008). At the same time, patients have become increasingly demanding over the years when it comes to the quality of the care they receive.

The NKI-AVL is aware of these increasing demands from both the government and the patients and is therefore looking for ways in which to improve the quality of care.

In healthcare the most common way to increase knowledge and therefore the quality of care is by evidence-based research, which focuses primarily on the effectiveness of the treatments, but primarily does not take into account other aspects of quality of care. Therefore much is to be gained by conducting research into the quality of care actually provided to the patient (Corrigan, 2001).

1.1.1 Why benchmarking

The NKI-AVL has performed different benchmarking studies into the area of quality of care and concluded that benchmarking is a valuable method for finding areas of improvement for the different aspects of quality of care.

The definition used for benchmarking in this research comes from Poerstamper (2007), who developed a definition for benchmarking in healthcare.

Benchmarking is a continuous and systematical process used for generating steering information by measuring and comparing efficiency and quality of performance, with the objective to get a lead for improvement of the own performance by implementing best practices (Poerstamper, Herk, & Veltman, 2007).

Why this definition for benchmarking was chosen is explained in chapter 2. From the definition of Poerstamper (2007) a number of key words for benchmarking can be extracted. First of all, benchmarking is a continuous and systematical process. This means that benchmarking is not a one-time event and therefore a methodology is needed in order to

perform a valuable research, which can be repeated over time. Second, benchmarking includes measuring and comparing information about performance for both efficiency and quality, as in improvement actions these two are often contradictory. The definition for quality and efficiency used in this study is given in paragraph (1.3). Finally, benchmarking gives leads for (organizational) improvement, which is the aim of this study.

1.1.2 Why the radiotherapy department

One of the first benchmarking exertions at the NKI-AVL was the research from Van Lent and Roijmans (2005), who explored the possibility of benchmarking complete comprehensive cancer centers (van Lent & Roijmans, 2005). They concluded that it was challenging to define indicators to benchmark entire comprehensive cancer centers and therefore recommended benchmarking separately identifiable parts of comprehensive cancer centers. The radiotherapy department was identified as a suitable candidate for benchmarking because of the assumption that the process within the radiotherapy department is stable and has relatively little variation, and the assumption that radiotherapy is a mostly separate department for which a reasonable amount of data is available (van Lent & Roijmans, 2005).

In 2004, such a benchmarking study of radiotherapy centers had already been performed for three radiotherapy departments, namely the NKI-AVL and two departments in Denmark. Although this study showed that the NKI-AVL has a significant higher productivity than the two Danish departments (Grau, 2004), critics of this study claim that the study had some methodological flaws and that important information was not taken into account when comparing the data.

Based on the recommendation of Van Lent et al. (2005) and the wish of the NKI-AVL to perform a more academic benchmarking study for the radiotherapy department, this research was started. For readers not familiar with the concept of radiotherapy, some background is provided in appendix A.

1.1.3 Levels of analysis: MACRO and MESO

Within the radiotherapy department, different processes can be distinguished. To guide the selection of these processes for this research, different levels of analysis are considered.

Because the subject of this research is the whole radiotherapy department, the departmental level is considered as the MACRO level. This level includes all overarching processes within the department of radiotherapy.

The MESO level of analysis is defined as a specific group of patients with the same cancer diagnosis, treated with radiotherapy. To be able to compare the different groups, a large amount of patients in the groups is favorable when looking at the statistical validity of the analysis. Therefore, for this study breast cancer patients and prostate cancer patients are chosen, as these are the largest groups of patients for the radiotherapy department.

The MICRO level is the individual patient level. As there are many patients treated each year in the cancer centre and for a number of them exceptions are made to the standard treatment protocols, there would be very many different processes on the MICRO level. Therefore we will not take this level into account for this research. Consequently, for this research, the analyses are executed on both MACRO and MESO level.

1.2 Problem statement and research questions

Based on the motivation for this study and the choices mentioned above, we state that there is a request for a benchmarking framework that will make it possible to compare academic, high-end radiotherapy departments, which aims at providing learning opportunities for the benchmarking partners involved.

It is determined that a benchmarking framework should be developed, which takes into account the different levels of analysis, both the MACRO and the MESO level. Furthermore, from the definition of benchmarking it can be concluded that the framework should contain both quality and efficiency indicators. The level of analysis and the distinction between quality and efficiency are introduced in the problem statement for this research, which has been formulated as follows:

The radiotherapy department of the NKI-AVL wishes to obtain quality and efficiency performance information on a MACRO and a MESO level by doing an international benchmark study of academic radiotherapy departments and getting leads for organizational improvement.

Research questions

Because of the twofold objective of the problem statement, this research has two research questions.

The first research question focuses on benchmarking as a continuous process. Therefore a benchmarking framework is needed, which makes it possible to benchmark academic radiotherapy centers in Europe, but can also be used on a continuous basis in the future. The first research question describes the methodological problem of developing such a benchmarking framework and is formulated as follows:

What benchmarking framework and which indicators can be used to benchmark the performance concerning quality and efficiency, on a MACRO and MESO level, of academic radiotherapy centers in Europe?

The second research question focuses on the use of the benchmarking framework, the collection of performance information and the actual learning from each other. This second research question is formulated as follows:

What are the benchmarking outputs of the different academic radiotherapy centers when compared on quality and efficiency indicators on a MACRO and MESO level, and what improvement suggestions can be given to the individual academic radiotherapy centers and to academic radiotherapy centers in general?

1.3 A definition for quality of care

Most people have a general idea of what the term quality of care means, though it is not always clear what exactly quality of care entails. As described in previous paragraphs, many different ideas of quality of care exist. For example, Poerstamper (2007) makes a distinction between quality and efficiency, while Corrigan (2001) sees efficiency as a part of quality. Klink (2008) however, defines quality of care as care that is aimed at the individual wishes

of patients and is effective, safe and timely delivered (Klink, 2008). Therefore, a definition for quality of care used primarily for this research is developed.

The Institute of Medicine (IoM) defines quality of care as “the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge” (Corrigan, 2001). This definition of quality is very broad and hard to use by itself. Therefore, for this study the more specific agenda for improvement, a list of six performance characteristics that aim for improving healthcare, will be used instead. These six aspects for improvement are: *safety, effectiveness, patient-centeredness, timeliness, efficiency and equity*, but not all six aspects of quality will get the same emphasis in this research.

First, the aspect efficiency will be discussed separately, such as Poerstamper (2007) and Van Hoorn (2006) suggest, as also the management of the radiotherapy department of the NKI-AVL has indicated that efficiency improvement is one of their main concerns. Second, as explained in paragraph 1.1, the effectiveness of the treatments is usually studied in evidence-based research. In these randomized studies, factors such as lifestyle and socio-economic status of the patients involved can be taken into account (Mant, 2001), which is not possible for this research. Therefore, the aspect effectiveness will only be used when other aspects cannot be measured. Finally, equity is not a big issue in the Netherlands at this moment and this aspect is hard to measure, therefore equity is not taken into account in this study. We can now give a definition for quality of care in this research:

Quality of care is reflected by the aspects safety, timeliness, patient-centeredness and efficiency, with emphasis on the latter.

1.4 Reading guide

In this chapter the motivation for this research is formulated and the research questions described. In chapter 2 the research design and methodology is explained. In chapter 3, the process at the radiotherapy department is outlined and the contingency factors formulated. In chapter 4 a benchmarking framework is constructed and a long-list of performance indicators is selected from literature to fit this framework. In chapter 5 a stakeholder analysis is performed to determine the stakeholders for this research. The defined stakeholders then transform the long-list into a shortlist of indicators that are used in this study. In chapter 6 the outcomes of the indicators are analyzed on both MACRO and MESO level. In chapter 7 based, on the outcomes of the analysis, conclusions are drawn and recommendations described for each of the benchmarking partners. Finally, in chapter 8 the used models are discussed and some adjustments are suggested.

2 Benchmark study design

This chapter describes the design of this benchmarking study. First, we describe benchmarking in theory (2.1). Second, we depict the research design for this research (2.2). Finally, we explain the methodology for this research is (2.4).

2.1 Benchmarking in theory

This paragraph discusses benchmarking in theory. First, the origin of benchmarking in Total Quality Management (TQM) is described (2.1.1). Second, a definition for benchmarking is formulated (2.1.2). Then a profile for this benchmarking study is described (2.1.3) and a benchmarking process model from literature is chosen for the structure of this research (2.1.4).

2.1.1 The origins of benchmarking

Benchmarking as a method to improve the performance of an organization, is described as a part of the Total Quality Management (TQM) philosophy (Finnigan, 1996; Freytag & Hollensen, 2001; Maleyeff, 2003). Gregory Watson (as cited in Finnigan, 1996) states that it is no longer the question *whether* TQM organizations should conduct benchmarking, but *how* they should do it (Watson, 1992). Finnigan (1996) explicitly states: "benchmarking is a key element of any total quality strategy" (Finnigan, 1996, p.4).

Richardson and Gurtner determined that in healthcare the TQM philosophy, and therefore also benchmarking, is one of the most prominent managerial strategies (1999) and Yasin and Alavi (1999) state that "even though there is no agreement as to how to make the healthcare industry more efficient, effective and customer oriented, it is believed that such goals can be achieved through the application of TQM in healthcare organizations" and they back this statement up with evidence that shows that TQM works in a healthcare setting.

2.1.2 A definition for benchmarking

The term benchmarking is derived from land surveying, where reference points (benchmarks) in the environment, such as rocks or walls, are used to establish a position in a topographical survey (Finnigan, 1996; Slack, Chambers, & Johnston, 2001). In the 1970's, the term benchmarking was used in business vocabulary to describe a measurement process by which organizations are compared. Xerox was the first company to use the term for organizational comparison with their competitors. Xerox is therefore seen as a pioneer in the benchmarking concept, with Robert Camp as the leading person (Finnigan, 1996).

Different definitions for benchmarking can be found in literature. We start with the definition from the benchmarking guru Robert Camp. He defines benchmarking as:

"The search for industry best practices that lead to superior performance" (Camp, 1989).

His definition is very general and does not mention how 'superior performance' is to be achieved by the organizations. A second definition comes from Murray *et al* (1997):

“Benchmarking is a process used by companies to target key areas for improvement within their operations so they can increase their productivity, competitiveness and quality” (Murray, Zimmermann, & Flaherty, 1997).

This definition is less general than the one from Camp as this definition also states that there is a process behind benchmarking and it describes areas in which improvement can be reached. A third definition for benchmarking comes from Spendolini (1992). He defines benchmarking as:

“A continuous systematic process for comparing the products, services and processes of institutions that are identified as representing best practices for the purpose of organizational improvement” (Spendolini, 1992, p. 11).

This definition is the least general and gives insight in how the results can be achieved. Spendolini even offers a benchmarking menu, which offers the opportunity to adjust the terms in the definition so it fits the organization best (Spendolini, 1992).

The final definition for benchmarking discussed is that of Poerstamper (2007). This definition developed mainly for use in the healthcare sector, but some of its components are similar to those used in the definition of Spendolini. Both authors see benchmarking as a continuous systematic process, feel the need for identification of best practices and claim that the goal of benchmarking is improvement of the performance of the own organization.

Benchmarking is a continuous and systematical process used for generating steering information by measuring and comparing efficiency and quality of performance, with the objective of a lead for improvement of the own performance by implementing best practices (Poenstamper et al., 2007).

The main difference between the definitions of Spendolini (1992) and Poerstamper (2007) is that the definition of Poerstamper (2007) has a multidimensional character, focusing on both quality and efficiency, which prevents that a problem is approached from only one side (Poenstamper et al., 2007).

Based on the comparisons of the benchmarking definitions discussed, we can now conclude that the definition of Poerstamper is the most elaborative, and therefore this definition is used in this research.

2.1.3 Different profiles for benchmarking studies

Although we have already determined this research to be a benchmarking study and defined a definition for benchmarking, we now have to decide on what type of study this particular benchmark is. In literature, different ways for classifying benchmarking studies are described. Poerstamper (2007) reports five criteria in literature that classify benchmarks, which are goal, subject, comparison group, level of analysis, and the use of norms or standards. Poerstamper (2007) adds to this list the criteria research process. Next, definitions for these criteria are given and we describe the benchmarking profile of this study.

Benchmark study criteria

Goal: Although researchers agree that the goal of benchmarking should be to learn from each other (Finnigan, 1996; Poerstamper et al., 2007; Spendolini, 1992), the term

benchmarking is sometimes confused with the term performance comparison. The goal of performance comparison can be to learn from each other (benchmarking), but can also be providing transparency or making a ranking between competitors based on performances (Werkgroep Benchmarken Openbare Sector, 2004).

Examples of performance comparison (ranking) studies presented as benchmarking studies are present in the healthcare sector. Each year ranking lists of the Dutch hospitals such as the "De Beste Ziekenhuizen (The Best Hospitals)" by Elsevier and the "Ziekenhuis Top 100 (Hospital Top 100)" by the Dutch newspaper Algemeen Dagblad, are presented. These ranking lists are based solely on outcomes of care and are primarily developed to inform (future) patients about the results of the hospitals and therefore do not provide leads for improvement for the benchmarking partners, which should be the objective of benchmarking. Furthermore, according to critics these lists do not take into account differences between general, academic and categorical hospitals and give very little information about the methods used to calculate the scores, which make the validity of these scores questionable. These kinds of comparisons can easily turn into 'naming and shaming' and this is not the aim of this study. We can therefore say that making these ranking lists by definition is not benchmarking and is probably not valuable for improving the quality of care.

Therefore, when developing this benchmarking study, the goal should be to learn from each other. Both Spendolini (1992) and Finnigan (1996) refer to the learning aspect of benchmarking by stating that organizations must learn from their environment to create their own successful future.

Subject: The subject of a benchmarking study describes *what* is benchmarked: processes or outcomes. Poerstamper (2007) describes that for benchmarking in healthcare, only comparing processes will not give a clear view of the actual performances of hospitals. However, processes can be used to explain differences in the outcomes. Then the problem of determining what outcomes of care actually are arises, because there is no consensus on this definition. In current benchmark studies, the focus is therefore more on (quality) outputs than on outcomes. For this research, we prevent using outcomes and define the indicators in such a way that they either describe processes or outputs.

Comparison group: The comparison group describes against whom we benchmark. A general division for comparison groups is internal, competitive, functional and generic benchmarking (Finnigan, 1996; Poerstamper et al., 2007; Spendolini, 1992).

- Internal benchmarking: comparing business practices internally
- Competitive benchmarking: compare with processes, products and services of direct competitors
- Functional benchmarking: compare with processes, products and services of organizations that are not direct competitors
- Generic benchmarking: compare against best practices, regardless the industry

This benchmark is a *functional benchmark*, as we compare with centers in the same industry (healthcare) and with the same processes, products and services (radiotherapy) that are not competitors due to the distance between the centers.

Level of analysis: The level of analysis entails the level of data collection. This can be the entire organization, but also a process within an organization. For this research, we define two levels of analysis: the MACRO level being the radiotherapy department, and the MESO level being the processes for breast cancer and prostate cancer patients.

Use of norms or standards: We also decide if we compare the outputs with objective norms or with the outputs of the other centers. For this research, we look for best practices and therefore compare the outcomes with each other and norms are not determined.

Research process: This criteria developed by Poerstamper (2007) describes if the benchmark is performed by the institution itself or by an external company. An internal developed benchmark will require more input from the organization. However, a benchmark performed by an external organization will likely lower the expectance from the organization. This benchmark is developed internally at the NKI-AVL, as it is part of a master thesis and therefore requires more input from the organizations themselves. This demand is increased by the fact that the research area is relatively new to the researcher.

Benchmarking profile

Based on the analysis above, a benchmarking profile for this study is constructed, which is described in Table 1.

The goal of a benchmarking study should be to learn from each other and therefore at the end of this study, improvement action should be formulated for each of the partners involved. As this study is a functional benchmark, there is little danger in window-dressing, as the partners are non-competitors. Furthermore, when developing the performance indicators, we have to make sure that indicators are developed on both MACRO and MESO level and measure quality and efficiency of the centers. Finally, we do not need to develop norms or standards, as we will compare each center to the best practice of this study for each indicator.

Criteria	Radiotherapy benchmark
Goal	Learning from each other
Subject	Quality and efficiency of processes and outputs
Comparison group	Functional benchmark
Level of analysis	MACRO: radiotherapy department
	MESO: Breast cancer and prostate cancer patients
Use of norms or standards	No, best practice comparisons
Research process	Internal

Table 1: Radiotherapy benchmarking profile (Based on Poerstamper, 2007)

2.1.4 Benchmarking process models

As described in the definition in paragraph 2.1.1, benchmarking is a structured process. This structure of the process is provided by the development of a benchmarking process model (Spendolini, 1992).

A benchmarking process model provides a basic structure for action, within which all types of variations can be made and it is therefore possible to make the model fit the requirement of the organization that uses it (Spendolini, 1992). Many different benchmarking process models are present in literature and according to Finnigan (1996) all of these are valid. Thus when constructing a benchmarking process model for this research, we predominantly look at the fit of the mentioned models for this research.

To determine which benchmarking process model fits this research best, we first evaluate what process models already exist in literature and determine what their strong and weak points are. We start with the benchmarking process model of Spendolini (1992), who has held a number of management positions at Xerox, the founder of the concept *competitive benchmarking*. Then we discuss the model of Finnigan (1996), which is more aimed at managing the benchmarking process. Finally the model of Van Hoorn (2007) is described, which focuses primarily on benchmarking in healthcare.

Benchmarking process model of Spendolini

In his Benchmarking Book, Spendolini (1992) develops a five-stage benchmarking model that can be applied to any benchmarking profile by any type of organization. As Spendolini bases his model on a research of twenty-four benchmarking process models developed by other organizations, this model has a high validity and is therefore taken into account in this comparison.

Spendolini compares these twenty-four models and determines which process steps they all have in common. This way Spendolini derived four characteristics that a benchmarking model should have, which are: 1) follow a simple, logical sequence of activity; 2) put a heavy emphasis on planning and organization; 3) use customer-focused benchmarking; and 4) make it a generic process. The five-stage benchmarking process model as depicted in Figure 1 is the result of this research.

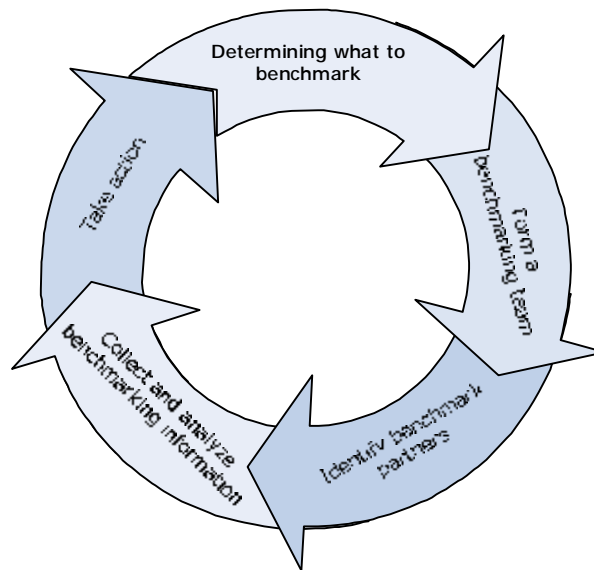


Figure 1: Five-stage benchmarking model (Spendolini, 1992, p.48)

The model of Spendolini (1996) focuses on the organization of the benchmarking project instead of focusing on the steps that need to be taken to execute an accurate benchmark study. For example, the subject for this benchmark is already determined, as can be seen in Table 1. Therefore the first step of the model does not need to be executed. Also there will be no benchmarking team, as this research is part of a graduation project and is therefore executed by one researcher. The same person therefore fills in the different roles (project management, data analysis, project support) described by Spendolini. This means that the second step as well does not need to be executed.

Benchmarking process model of Finnigan

J. Finnigan was also a manager at Xerox, where he was responsible for the implementation of the competitive benchmarking strategy. He bases the benchmarking process model in his book: '*a managers guide to benchmarking*' on the four-phase, ten-step benchmarking model developed by Xerox and defined by Robert Camp. Finnigan (1996) claims that all the different benchmarking models developed in the past are valid, but are always rooted in four basic phases. Finnigan's benchmarking process model is depicted in Figure 2.

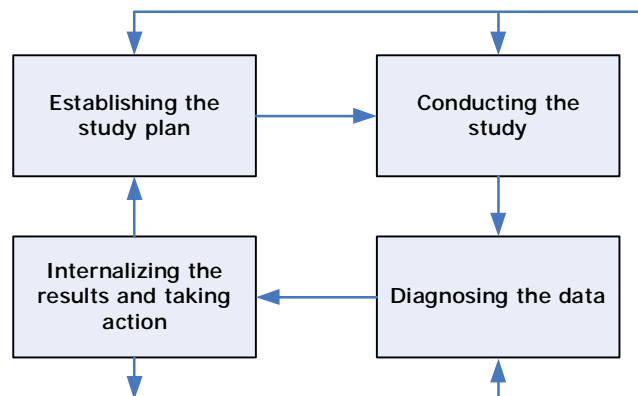


Figure 2: Benchmarking process (Finnigan, 1996, p. 40)

Finnigan (1996) mentions all the important steps for a benchmarking study in his model, but these steps are broadly defined and do not provide handles, which can be used to develop a benchmarking process model for this specific research. Therefore, his model contains the right steps that should be taken into account in a benchmarking process model for this research, but without providing a concrete action plan.

Benchmarking process model of van Hoorn

The benchmarking model of Van Hoorn (2006) focuses primarily on benchmarking in healthcare and is therefore also taken into account for this research (Hoorn, Houdenhoven, Wullink, Hans, & Kazemier, 2006). His process model is based on three principles: the first principle explains that performance comparison is only possible when there is a good insight in the similarities and differences between the partners; the second principle describes that accountability should never be the goal of benchmarking; and the third and final principle determines that a benchmark should strive towards finding specific improvement options for each partner. Van Hoorn believes that none of the existing models takes into account these three principles, and therefore he developed a new benchmarking process model.

The model of Van Hoorn *et al* (2006) consists of nine steps, which are:

1. *Make a choice for a comparable process*
2. *Make a choice for comparable benchmarking partners*
3. *Describe and analyze process and contingency variables*
4. *Develop comparable performance indicators*
5. *Stakeholders make a choice for performance indicators*
6. *Measure the performance indicators unambiguous and integral*
7. *Analyze differences in performance*
8. *Develop improvement plans*
9. *Implementation of improvement plans*

Van Hoorn claims that, with this adjusted model, he is able to get round two risks of existing benchmarking process models. First, he states that existing models ignore the internal and external circumstances that can influence the processes and results of the organizations involved, which leads to the suggestion that organizations are always and completely

comparable. This can lead to comparing apples and oranges. Second, a premature conclusion about the differences in performance can lead to naming and shaming, without exactly knowing where the measured differences come from. These two risks can undermine the trust relation between the partners, which prevents benchmarking from becoming a continues process (Hoor et al., 2006).

Other benchmarking process models that are evaluated contained steps comparable to those of Spendolini and Finnigan (Bagchi, 1996; Hanman, 1997; Murray et al., 1997). Therefore, these models are not described in detail in this paragraph.

Conclusion benchmarking process models

In the previous paragraphs, three benchmarking process models have been described in detail. Each of these models has advantages and disadvantages over the other models, which makes them more or less suitable for this research. When we compare the three discussed models by placing them in a scheme, it becomes clear that each of the models has a different place in the process of benchmarking.

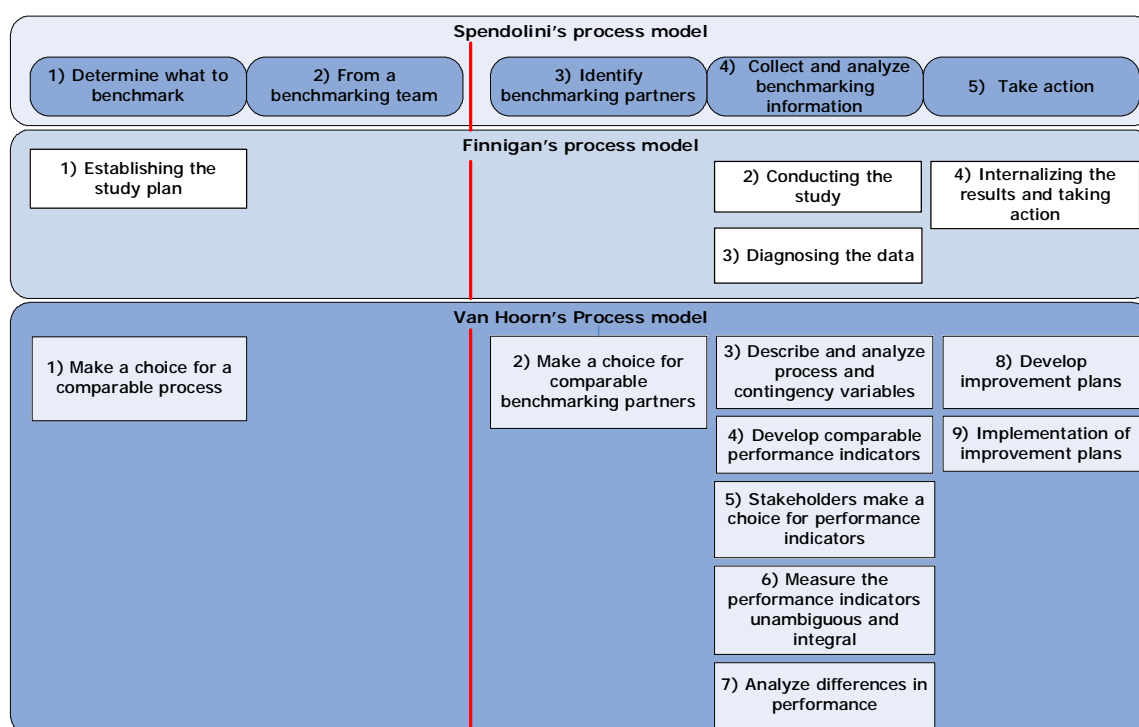


Figure 3: Comparison of the different benchmarking process models

Figure 3 shows that the model of Spendolini is focused mostly at the organization of the benchmarking process and is the only one that takes into account the forming of the benchmarking team. However, Spendolini uses just one step for the entire data collection

and analysis of the research, whereas Finnigan describes two and van Hoorn even five individual steps. As we have seen, the basic concept of the model of Spendolini aims at providing the right circumstances to execute a benchmarking study, while we are looking for a model that provides handles for developing a research design. Therefore, for this research, the model of Spendolini is not the best model to start with.

Figure 3 also shows that the model of Finnigan skips two of the steps by Spendolini, *forming of the benchmarking team* and *identifying the benchmarking partners*, but his first step *establishing the study plan* is so broadly defined that this could also entail these steps. However, Finnigan does not specify this first step, just like with step two: *conducting the study* and this is exactly what makes this model less useful for this research.

The red line in Figure 3 indicates steps that are already determined. Therefore a benchmarking process model is necessary for the steps behind the red line. The first step of each of the models is already determined in the research question, and is defined as *the radiotherapy departments of comprehensive cancer centers in Europe*. The second step of Spendolini does not need to be performed, as this is a graduation project.

When we look at the steps behind the red line, we see that the model of van Hoorn follows the process models of Spendolini and Finnigan, but the model of van Hoorn is able to determine more specific the course of action for conduction the benchmarking project. Therefore for this research the model of van Hoorn provides us with the best handles to perform a valuable benchmark and his benchmarking process model is used as a starting point for the research design of this study.

2.2 Research design

In the previous paragraph the choice for the benchmarking process model of Van Hoorn (2006) for use in this research was explained. In Figure 4 the research design for this research based on the model of Van Hoorn and the circumstances for this research as described in the first chapter is depicted.

As is shown, steps 2 to 4 describe the development of a benchmarking framework, which is mainly based on literature and gives an answer to the first research question: *how can a benchmarking framework be constructed and which indicators can be used to benchmark the performance concerning quality and efficiency, on a MACRO and MESO level, of academic radiotherapy centers in Europe?*

Steps 5 to 7 describe the use of the framework in a case study between the NKI-AVL and three benchmarking partners, who are selected in step one, and give an answer to the second research question: *how do the different academic radiotherapy centers perform when benchmarked on quality and efficiency indicators on a MACRO and MESO level, and what improvement suggestions can be given to the individual academic radiotherapy centers and to academic radiotherapy centers in general?*

Figure 4 also depicts when the feedback moments with the benchmarking partners are planned and which two decision moments are included in the research process. The first decision moment is when the concept shortlist with performance indicators is finished and the second decision moment is when the concept report is finished. When the complete research

design is completed, each of the partners receives recommendations pinpointed at their specific situation.

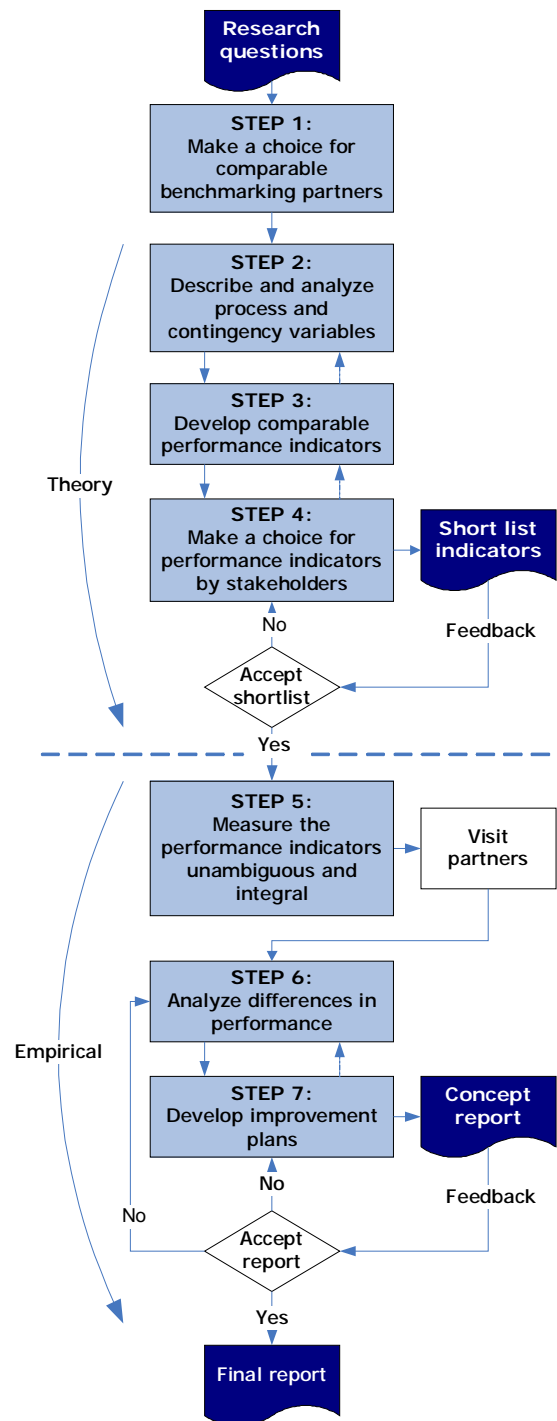


Figure 4: research design

2.3 Methodology

While the research design is determined, this paragraph describes the methodology and methods used in this study to find an answer to the research questions. As the research questions are split-up into different steps of the benchmarking process model, the methodology and methods are also described per step. For each of the benchmarking process model steps, sub-questions are formulated; and for each of the sub-questions a description of the used methods is given.

Step 1: Make a choice for comparable benchmarking partners.

Who are the benchmarking partners?

Five possible benchmarking partners are approached, based on the fact that they should be radiotherapy departments of academic, high-end comprehensive cancer centers in Europe willing to take part in this research. Four of these possible partners had participated in an international benchmarking study of the NKI-AVL before, and one was new. Of these five possible partners, three partners are selected for this research, which are:

- NKI-AVL, Amsterdam, the Netherlands
- Karolinska Institutet, Stockholm, Sweden
- Medizinische Fakultät und Universitätsklinik Carl Gustav Carus, Dresden, Germany
- Institut Jules Bordet, Brussels, Belgium.

Step 2: Describe and analyze process and contingency variables

What is the process of a radiotherapy department?

To be able to determine possible performance indicators, first the processes at a radiotherapy department are described. This description is based on a literature review on the process of radiotherapy, observation of the radiotherapy department, and interviews with the manager, head patient care, chief clinical physicists and chief of the radiation technologists of the radiotherapy department of the NKI-AVL.

What are the important contingency factors of the different partners?

Describing the contingency factors enables us to determine on beforehand differences between the partners that can explain differences in the outcomes of the indicators, which are not related to actual differences in performance. Therefore the contingency theory is described based on literature and the contingency factors that are used for this research are determined. Furthermore we analyze the determined contingency factors for each of the partners, so that we get a clear view of the differences between the partners.

Step 3: Develop comparable performance indicators

As determined in the research questions, the development of the comparable performance indicators is divided into two parts: the development of the benchmarking framework, and the development of the performance indicators within the framework.

What framework should be used to benchmark the performance concerning quality and efficiency, on a MESO and MACRO level, of academic radiotherapy centers in Europe?

For the comparison of the partners a framework is constructed, which is used to determine the areas in which performance indicators will be developed. The method used to develop this framework is a literature review of possible frameworks for benchmarking in healthcare. Search words that are used to find related articles are: *benchmarking, framework, benchmarking model, quality, efficiency, healthcare, hospital* and combinations of these search words. The reference lists of these articles are used to find complementary articles. Based on the found frameworks, a customized framework is developed which is used for determining the indicators for this research.

What are possible performance-indicators concerning quality and efficiency, on a MACRO and MESO level, for academic radiotherapy centers in Europe?

When the benchmarking framework is constructed, a long-list of possible performance indicators is developed. The methods used to develop the long list of comparable performance indicators are a literature review, an interview with a member of the Dutch Society for Radiotherapy Oncologists (NYRO) and interviews with the members of the Cluster Patient Care (CPZ) of the NKI-AVL. Search words that were used to find related articles are: *indicators, performance indicators, indicator development, quality, efficiency, healthcare, hospital* and combinations of these search words. The reference lists of the articles found are used to find complementary articles.

Step 4: Make a choice for performance indicators by stakeholders

Before we can ask the stakeholders for their opinion, we need to know who these stakeholders are. Therefore this step is divided into two parts: determining the stakeholders for this research, and make a choice for a short list of indicators based on the stakeholders opinions.

Who are the important stakeholders for this study on a MACRO and on a MESO level?

First a literature review is executed to determine how we can best identify the stakeholders for this research. Search words that were used to find related articles are: *stakeholder, stakeholder identification, stakeholder identification model, healthcare, hospital* and combinations of these search words. The reference lists of the articles found were used to find complementary articles. Then we used the found literature to determine the stakeholders for this research and we evaluate the outcome of the literature study by discussing the outcomes with stakeholders at the NKI-AVL.

According to the stakeholders which indicators should be chosen to benchmark the performance concerning quality and efficiency, on a MESO and MACRO level, of academic radiotherapy centers in Europe?

When the key stakeholders for this study are determined, the long-list of performance indicators is presented to these stakeholders. First this discussion is held at the NKI-AVL with the different stakeholders defined. After this first discussion an adapted long-list of performance indicators is sent for adjustment to the comprehensive cancer centre management of the different partners, which results in a definitive set of performance indicators.

Step 5: Unambiguously and integrally measure the performance indicators

What indicator results are found for the different academic radiotherapy centers?

For each of the performance indicators in the short-list, data will be collected from the benchmarking partners with the use of multiple methods. A questionnaire will be sent to the benchmarking partners to collect initial information. Then we visit the partners in order to conduct interviews with the key stakeholders for this research, collect data from their information systems and to observe the processes at their radiotherapy departments. The found results are provided to the partners for evaluation. This way we make sure that the right data is used for the analysis.

Step 6: Analyze differences in performance

What differences can be found between the academic radiotherapy centers?

The collected information is analyzed and results of the benchmarking partners are compared on both MACRO and MESO level.

Step 7: Develop improvement plans

What improvements suggestions can be given to the individual academic radiotherapy centers and academic radiotherapy centers in general?

In this last step recommendations are formulated. First, recommendations based on the differences found in the previous step are formulated, which leads to for performance improvement of the radiotherapy department of each of the benchmarking partners. Second, recommendations for future research are formulated. Finally, in the discussion section suggestions are made to improve the used benchmarking process model, the benchmarking framework, and the short list of indicators for future research.

3 Process and contingency variables

In this chapter the first step of the benchmarking process model depicted in Figure 4 is executed. This means that first a description of the process at a radiotherapy department is given (3.1) and then the contingency factors for the selected benchmarking partners are described (3.2).

3.1 *The process at a radiotherapy department*

Each individual radiotherapy treatment consists of four phases: initiation, preparation, treatment, and follow-up (Dolsma, Froma, Hegeman, Keus, & Ru, 2001). The phases are sequential interdependent, meaning that the output from one phase is the input for the next phase (Daft, 2001). The sequential interdependent phases can be seen in Figure 5. Sequential interdependence generally requires extensive planning and scheduling as the lack of output from one phase can prevent the next phase from starting, resulting in longer waiting times for patients. As can also be seen in Figure 5, two feedback loops have been taken into account. As sometimes treatments are not successful, patients can enter the whole process again. Or in the case of palliative treatments or other reasons to adjust the treatment plan, the process does not completely start again, but only the preparation phase is repeated.

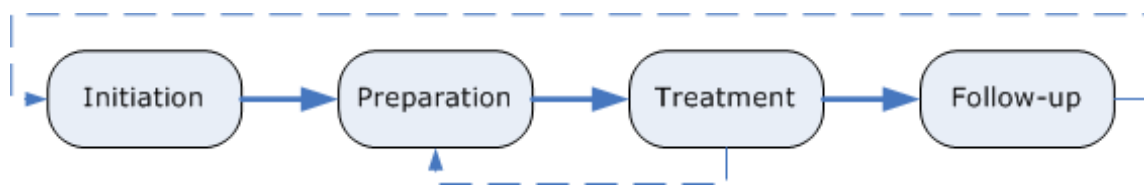


Figure 5: Radiotherapy treatment phases

Initiation

After the diagnosis cancer has become clear, a multi-disciplinary team of physicians develops a treatment plan. First the physicians decide whether the treatment will be curative, palliative or complementary. Curative treatments are aimed at curing the patient from cancer. Palliative treatments are aimed at relieving pain and soothing the symptoms for patients that cannot be cured from cancer. Complementary treatment is given before or after a curative treatment, in order to improve the chances of long-term survival. This decision is based on a number of factors such as the TNM-classification of the tumor, the size of the tumor, and the physical health of the patient (Dolsma et al., 2001). Then the way the tumor will be treated is discussed. There are five common methods for treating cancer: surgery, radiotherapy, chemotherapy, hormone therapy and biological therapy or a combination of these. The treatment plan is usually based on international standardized treatment protocols, but these can vary somewhat within the institutions (Dolsma et al., 2001). When radiotherapy is the chosen treatment, a choice will be made between teletherapy and brachytherapy. The decision tree can be seen in Figure 6. These decisions will then be discussed with the patient in a first appointment. During this appointment the provision of information to and education of the patient will have a central role.

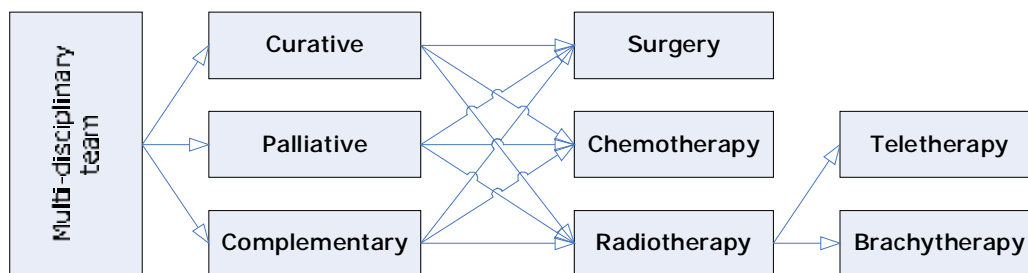


Figure 6: Initiation phase decisions

Preparation

The preparation phase consists of three or four sub-phases, depending on the type of radiotherapy. Because most of these phases are quite similar for both teletherapy as brachytherapy, the sub-phases of teletherapy will be described; a note will be made when there are differences for brachytherapy.

The first sub-phase is the development of support devices. Support devices are usually immobilization devices, but can also have other goals, therefore the broader term of support devices is used (Dolsma et al., 2001). Examples of immobilization devices are fixating head masks, polystyrene vacuum bags and other moulds. Other devices can be intra-oral devices, beam modifications, and moulds for brachytherapy (Dolsma et al., 2001). Devices that have to fit the patient precisely are made in the mould room of the radiotherapy department. Other devices are made in the instrument making room.

The second sub-phase is the localization phase. Localization establishes what the radiated area should be in relation to the internal and external anatomy of the patient (Dolsma et al., 2001). The localization reference points are applied to the skin with ink or tattoo-dots or they are applied on the immobilization devices. Localization can be carried out by palpation, but usually a simulator, MRI, CT-scan or a combination of these appliances is used to determine the exact location and size of the tumor (Dolsma et al., 2001).

The third sub-phase is the development of the radiation treatment plan. A choice must be made between high and low energy rays; or between different radioactive isotopes for brachytherapy (Dolsma et al., 2001). High-energy rays penetrate the body more deeply than low energy rays therefore the latter are used for more superficial tumors. For teletherapy a decision must be made on the number of fractions a treatment will be divided in and how many beams will be used (Dolsma et al., 2001). In this sub-phase the dose-time consideration is especially important; the tumor should receive a dose high enough to kill the cancer cells, but should be low enough to prevent complications from occurring (Mieszkalski, Brady, Yaeger, & Class, 2001).

Treatment

During a curative teletherapy treatment the patient usually visits the centre five days a week for the course of the treatment. Urgent teletherapy treatments usually exist of one

high dose of radiation and the number of teletherapy treatments for palliative treatments differ very much per diagnosis. For curative treatments it is very important that the patient is placed on the table in exact the same way each day as during the simulation, in order to make sure that the target volume is reached by the radiation and not the surrounding tissue (Dolsma et al., 2001). The immobilization devices are used for this purpose.

Follow-up

After the treatment, the effect of the treatment on the patient will be evaluated. First the management of the acute complications of the treatment is the most important issue to be dealt with. When these complications have been treated successfully and the treatment was successful, the patient will still visit his or her radiation oncologist for quite some time after the treatment (Dolsma et al., 2001). When the treatment was not successful, a new course of action is discussed within the multi-disciplinary team of physicians. A flow diagram of the complete radiotherapy process can be found in appendix B.

3.2 Contingency variables

A difference between the benchmarking frameworks of Spendolini (1992) and Finnigan (1996) and that of Van Hoorn *et al* (2006) is that the latter specifically mentions the contingency factors that give insight in the similarities and differences between the partners. By formulating these contingency factors it is possible to determine on beforehand differences between the benchmarking partners that can explain differences in the output of the indicators in a later stage of the benchmarking process (Hoorn et al., 2006).

To be able to determine the contingency factors for this research we first determine what contingency factors are based on a contingency theory literature review. Then these found contingency factors are described for each of the partners, and finally differences between the benchmarking partners are formulated.

3.2.1 Contingency theory

Contingency theory states that there is no single organization structure that is effective for all organizations and thus that the optimal structure for an organization is contingent upon certain factors, which are therefore called *contingency factors* (L. Donaldson, 1999). Originally the contingency theory was developed to be able to determine the fit between the structure of the organization and the conditions in their external environment (Daft, 2001; L. Donaldson, 1999). Therefore the task of contingency research is to identify the particular contingency factors to which each aspect of the organizational structure needs to fit (L. Donaldson, 1999).

In literature there is hardly consensus on what exactly the different contingency factors are, although it is agreed that there are two different kinds of contingency factors: external and internal contingency factors; the first describing the external factors that influence the performance of the organizations and the second describing the structure of the organizations and their core business (L. Donaldson, 1999; Hoorn et al., 2006).

Table 2 describes the contingency factors described by Daft (2001), L. Donaldson (1999), and Chukmaitov (2005). As Table 2 shows, there are six factors mentioned in their

contingency theories and each of the described authors chose a number of these factors in their contingency theory.

	Donaldson (1999)	Daft (2001)	Chukmaitov (2005)
Strategy	X	X	
Size	X	X	X
Environment	X	X	X
Task uncertainty	X		X
Task Interdependence			X
Technology	X	X	

Table 2: Sets of contingency factors mentioned in literature (Daft, 2001; L. Donaldson, 1999)

For this research contingency factors are used to compare the structure of the organizations of the partners with each other instead of with the structure of the organizations. We will describe the contingency factors discussed in table 2 and determine if they result in differences between the partners. The six contingency factors are described based on their definitions from the literature mentioned in Table 2.

Description of the contingency factors

Strategy:

Porter introduced a framework that describes three competitive strategies: low-cost leadership, differentiation and focus (Daft, 2001).

- The *low-cost leadership* strategy is concerned with offering products with comparable quality for a lower price than the competitor. With this strategy the organization seeks efficient facilities, and pursues cost reduction.
- With a *differentiation* strategy the organization tries to distinguish their products from others in the same industry. An organization that pursues a differentiation strategy needs to invest in marketing and creative employees.
- The *focus* strategy means that the organization concentrates on a specific market, region, or buyer group.

A comprehensive cancer centre has a focus strategy as they primarily focus on cancer patients and thus concentrate on a specific 'buyer' group. This is true for all partners, as they have selected based on being a comprehensive cancer centre. Therefore the contingency factor strategy does not create differences between the different partners.

Size:

The size contingency affects the bureaucratic structure of the organization (L. Donaldson, 2001). The size, measured in number of employees, affects the degree to which an organization is bureaucratic or decentralized, the first fitting large and the latter small organizations (Chukmaitov, 2005; L. Donaldson, 2001). The size of the partners can differ and therefore this contingency factor will be taken into account in this research.

Environment:

The organizational environment can be defined as all elements and components that exist outside the boundary of the organization and have the potential to affect the organization (Daft, 2001). Although the environment of the different partners will differ, it is not possible within the context of the research to define all environmental differences.

There is however one environmental factor that is of interest for the differences between the centers and that is the factor patient-mix. Patient mix is a contingency factors that is related to differences in outputs of hospitals (West, 2001). Therefore we choose to discuss this environmental contingency factor.

Task uncertainty:

Task uncertainty describes the predictability of the tasks of the employees. In a professional organization such as a hospital, task uncertainty is generally high, therefore asking for a decentralized organization (Chukmaitov, 2005; L. Donaldson, 1999). This means that each of the partners will have a high task uncertainty, based on the act that all academic hospitals are professional organizations. The task uncertainty will probably differ among the employees of a hospital, but will generally be the same between the partners and therefore will not be discussed further as a contingency factor for this research.

Task interdependence:

Thompson defined three types of interdependence: pooled, sequential and reciprocal (Chukmaitov, 2005; Daft, 2001).

- *Pooled interdependence:* in an organization with pooled interdependence work does not flow between the different units of the organization. This is the lowest form of interdependence.
- *Sequential interdependence* means that the output from one unit is the input for the next unit. The second unit can only perform correctly when the first unit has done its work.
- *Reciprocal interdependence:* here the output for unit A is the input for unit B and vice versa. Therefore this is the highest form of interdependence.

The four phases of a radiotherapy treatment are sequential interdependent, as can be seen in Figure 5. Sequential interdependence generally requires extensive planning and scheduling as the lack of output from one phase can prevent the next phase from starting, resulting in longer waiting times for patients. This is however true for all radiotherapy centers and therefore does not make a difference between our benchmarking partners.

Technology:

Daft (2001) defines technology as "the tools, techniques, machines, and actions used to transform organizational inputs [...] into outputs". Technology describes the organizations'

productions processes and includes work procedures as well as machinery (Daft, 2001) and is divided into two main types of organizations: manufacturing and service organizations. Service organizations accomplish their primary purpose through the production and provision of services, such as healthcare. Therefore, for this study the typology of service organizations is of interest.

Service technology has a number of characteristics that are specific for service organizations. These characteristics are (Daft, 2001):

- Intangible products
- Productions and consumption take place simultaneously
- Labor and knowledge intensive
- Customer interaction generally high
- Human element very important
- Quality is perceived and difficult to measure
- Rapid response time is usually necessary
- Site of facility is extremely important

All characteristics mentioned by Daft (2001) are true for the technology used in radiotherapy. Each of the partners uses approximately the same technology and where they do not, this a variable factor and therefore not a contingency factor as defined by van Hoorn (2006). Concluding, the contingency factor technology does not differ between the centers and is therefore not discussed any further.

Conclusion contingency factors

Table 3 shows in short the outcomes of the descriptions above. Based on Table 3 we can now say that the benchmarking partners are comparable on four of the six mentioned contingency factors. The other two, size and environment (patient-mix) are described in more detail in the next paragraph.

Contingency factor	Conclusion
Strategy	Focus, the same for all benchmarking partners
Size	Not the same for all benchmarking partners
Environment	Differences in the patient mix
Task uncertainty	High, the same for all benchmarking partners
Task Interdependence	Sequential, the same for all benchmarking partners
Technology	Service organization, the same for all benchmarking partners

Table 3: Conclusions for each of the discussed contingency factors

3.2.2 Contingency variables size and patient-mix

This paragraph discusses the two contingency factors that might differ between the partners: size and environment. The other four factors are not discussed in detail, as they are comparable for all the benchmarking partners.

Size of the radiotherapy departments

The size of the departments can be measured in several ways. L. Donaldson (1999) and Chukmaitov (2005) mention the number of employees, but we also analyze the number of LineAcc's to get a broader view of the size of the centers.

Table 4 describes the number of employees and the number of LineAcc's per center, and shows that there are in fact two large and two small centers. Jules Bordet and Carl Gustav Carus are small centers with both less than hundred employees and three LineAcc's. The NKI-AVL and Karolinska are large departments, with more than hundred employees and respectively nine and twelve LineAcc's.

	Total number of employees	Number of LineAcc's
NKI-AVL	229	9
Karolinska	153*	12
Carl Gustav Carus	78	3
Jules Bordet	29**	3

Table 4: Internal contingency variables for the size of the benchmarking partners (data from 2006)

* without medical-radiation oncologists, which are 100 in total. ** Data for 2007.

The exact data for the total number of employees for the radiotherapy department of Karolinska could not be determined. However, the number of LineAcc´s and the estimation of 153 employees, gives us enough reason to presume that they are a large department.

The difference between a large and a small department can have an influence on the processes within the departments. For example, large departments such as the NKI-AVL purchase a new LineAcc every year. Therefore, every year a LineAcc with the latest technologies is available at the NKI-AVL. At Carl Gustav Carus a new LineAcc arrives maybe once every three years. Therefore, in the years between, new technologies are not made available at Carl Gustav Carus. It is these differences that influence the outputs of the centers that they cannot influence.

Patient mix

The patient-mix describes the division between the different tumor groups within the radiotherapy department. Variance in the patient-mixes might explain differences in the outputs of the indicators. We were not able to gather the data needed to determine the actual patient mixes at the centers. Therefore, for this research we use the national data. Figure 7 shows these national differences.

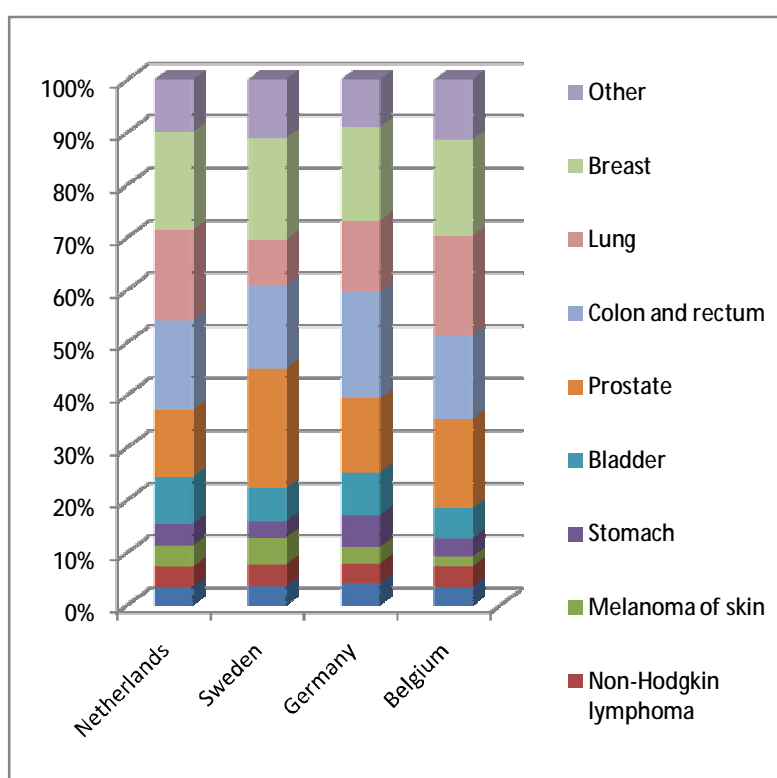


Figure 7: Patient mixes for The Netherlands, Sweden, Germany and Belgium in 2004; (Ferlay, Bray, Pisani, & Parkin., 2004)

Figure 7 shows that in general the division between the tumor groups are the same between the countries involved in this study. However, when we take a closer look, we see that in Sweden the number of prostate cancer patients is higher than in the other countries. Also, in Belgium high the number of lung cancer patients is high, when in Sweden this is low. These differences can influence the outputs of the centers, as some tumor groups put more pressure on the resources than other. For example, at the NKI-AVL the treatment plans for lung cancer patients are based on a PET-scan. Therefore, the more lung cancer patients there are, the higher the strain on the efficiency of the PET-scans.

However, the data available for this study describes the national cancer data and not the exact number of patients for each radiotherapy department. For the NKI-AVL this data was available and we see that there are large differences between the percentage of patients that are nationally diagnosed with a certain type of cancer and the actual data for the patients that received radiotherapy at the NKI-AVL. For example, the national data from figure 7 shows that 17% of all cancer patients diagnosed in 2004 were breast cancer patients. For the radiotherapy department of the NKI-AVL for 2006 the percentage of patients treated with breast cancer was 24%. Therefore, for this contingency factor in the future the data for the radiotherapy departments should be used and not the national cancer data.

3.2.3 Conclusion contingency factors

Although for most contingency factors there are no differences between the center, based on the contingency factors size and patient-mix, we conclude that for these factors the centers are not the same. For the contingency factor size we determined that the NKI-AVL and Karolinska are large and Carl Gustav Carus and Jules Bordet are small centers. For the factor patient-mix no clear difference was found, mainly because the available data was not reliable enough to base conclusion on for the radiotherapy department. For the latter contingency factor, the exact data for the radiotherapy department should be available in order to compare them.

4 Benchmarking framework

This chapter describes the *development of comparable performance indicators*, which is the third step of the benchmarking process model described in Figure 4. The development of comparable performance indicators is executed in two phases. First, a benchmarking framework is constructed (4.1). Second, within this framework, a long-list of comparable performance indicators is selected from existing literature (4.2)

4.1 Constructing a benchmarking framework

In this paragraph the development of a benchmarking framework for this research is described. Therefore we first formulate the preconditions for this framework (4.1.1). Second we describe three models from literature that live up to the preconditions defined and are therefore used to construct a framework for this research (4.1.2). Finally, we describe the framework and explain how it will be used for this research (4.1.3).

4.1.1 Preconditions for the framework

When constructing a benchmarking framework for this research, first the preconditions for this framework need to be formulated. As this framework should be able to benchmark the *quality*, defined as safety, timeliness and patient-centeredness, and the *efficiency* of the partners, a framework should be able to take both into account. The second precondition is that the framework can be used within a case study approach, as this research has only four benchmarking partners and no statistical comparison can be executed. Finally the framework should not only describe the differences between the partners, but also takes into account the processes behind the outcomes, as this is necessary in order to be able to learn from each other.

In existing literature, many articles on benchmarking frameworks have been written over the years. Therefore we first review these frameworks for their use in this study and determine which of the frameworks complies best with the preconditions mentioned. Based on our findings in literature, we determine if we can use the found framework without adjustment. When this is not possible, we construct a framework based on the found frameworks that can be used to benchmark the radiotherapy departments.

4.1.2 Frameworks from literature

European Foundation for Quality Management (EFQM) Excellence Model

When performing our literature search it appeared that the EFQM Excellence Model was used in many articles that described a *quality of care* framework. To determine the possible use of the EFQM Excellence framework for this research, first this framework is described, and then compared to the preconditions from paragraph 4.1.1.

The EFQM was founded in 1988 by fourteen representatives of European multi-national organizations and developed a model to structure and review the quality management of an organization (Nabitz, Klazinga, & Walburg, 2000). In 1999 an improved EFQM model was introduced and was called the EFQM Excellence Model (Nabitz et al., 2000).

In Europe the development of models to be able to assess the quality of care has a long tradition (Nabitz et al., 2000). The EFQM approach covers quality management as an integral part of all professional and management functions on all levels of organizations and is seen as a promising overall conceptual framework in healthcare quality management (Nabitz et al., 2000). Nowadays, health care improvements based on the EFQM Excellence Model can be seen in almost every European country (Moeller, 2001).

The EFQM Excellence Model is a non-prescriptive framework, which is based on nine criteria (EFQM, n.d.). In this definition non-prescriptive means that “there is no one-way of achieving excellence” (Stahr, 2001). Five of the nine criteria are enablers and four are result criteria.

The enablers cover the process, structure and means of an organization (Nabitz et al., 2000) and can also be described as “how things are done in the organization” (Jackson, 1999). The results cover the aspects of performance in a broad way (Nabitz et al., 2000) and can also be described as “what is achieved by the enablers” (Jackson, 1999). Figure 8 shows the EFQM model and the definitions for the nine criteria.

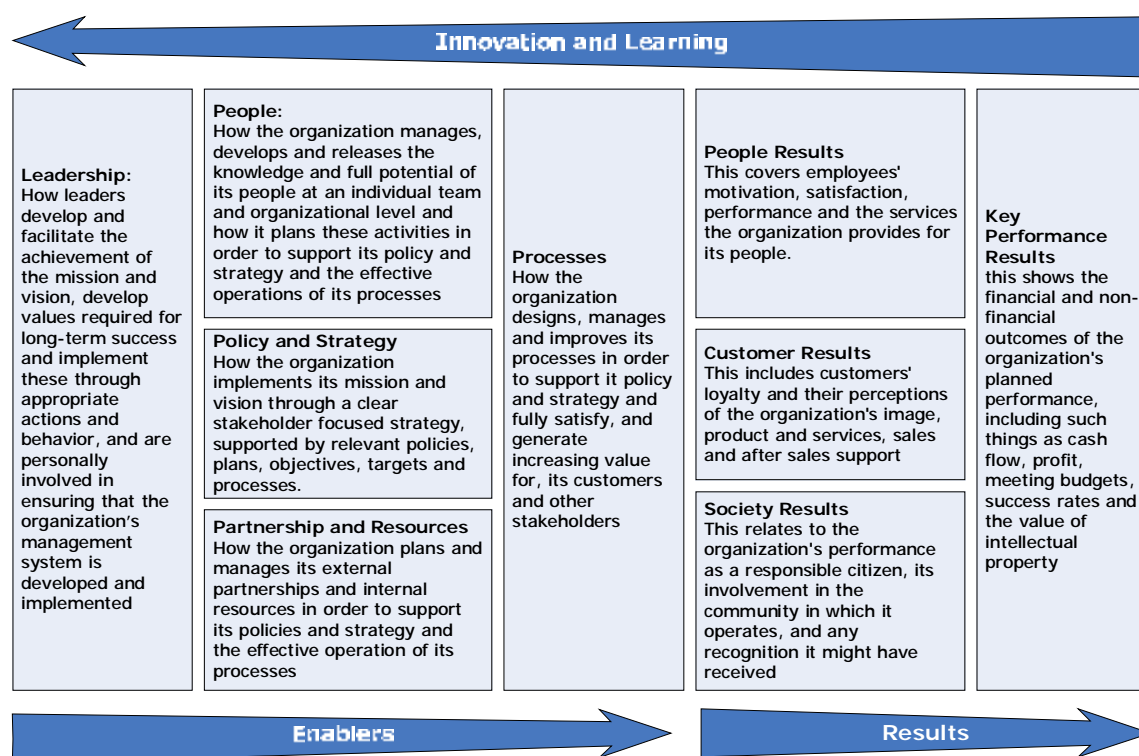


Figure 8: EFQM Excellence Model (EFQM, n.d.; Slack et al., 2001)

The EFQM Excellence Model can be used in three ways: 1) as a frame of reference for the quality management documentation and development of an organization, 2) as a self-

assessment tool and 3) to win a national or the European Quality Award (Moeller, 2001; Nabitz et al., 2000).

The fact that the EFQM Excellence Model can be used as a frame of reference for the quality management documentation and development of an organization makes it a suitable framework for this study, especially because of the fact that the EFQM Excellence Model can be customized when it is used for performance improvement (Conti, 2007). Next to this, according to Conti (2007) "the [benchmarking] model will be accepted more easily when managers are involved in the development of the model".

When we re-assess the preconditions described, we can say that this model is a suitable framework for benchmarking quality of care. However, it puts no extra emphasis on efficiency indicators other than financial results. The EFQM model can also be used in a case study approach as the model can be used as a frame of reference for the quality management documentation and development of an organization and is not prescriptive. Finally the processes of the organization are taken into account as the enabler criteria describe *how* things are done within the organization. Therefore we can conclude that the EFQM Excellence Model fits two of the preconditions and might have the opportunity to fit the last precondition, by adjusting this model for performance management objectives.

Transformation process model

An often-used model to show what input is needed to produce a certain output is the input-output model. A variation on the input-output model is the transformation process model, which divides the input in transformed and transforming resources (Slack et al., 2001). Transformed input being the resources that are treated, transformed or converted and transforming input being the resources that act upon the transformed resources (Slack et al., 2001). In the case of hospitals the most important transformed resources are patients and information, the most important transforming resources are the treatment facilities and staff. The transformation process model is depicted in Figure 9.

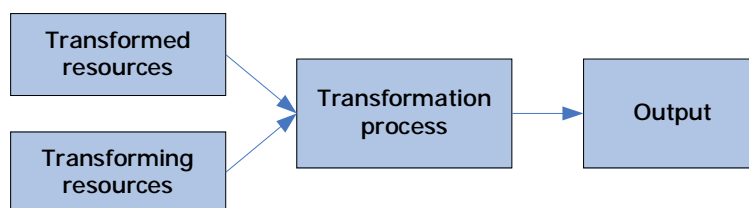


Figure 9: Transformation process model

This model can be used to determine the efficiency of an organization (Daft, 2001). Daft (2001) defines organizational efficiency as "the amount of resources used to produce a unit of output". When compared to the definition used by the IoM (2001), which is *avoiding waste*, this definition is more quantitative, where the definition of the IoM is more qualitative. When using the transformation process model, three approaches can be taken. When an organization wants to evaluate whether they effectively obtain resources for high performance, the focus will be on the resources side of the model (Daft, 2001). When an

organization wants to look at internal activities, the focus will be on the transformation processes (Daft, 2001) and when an organization wants to evaluate whether they achieve their goals in terms of the desired levels of output, the focus will be on the output side of the model (Daft, 2001). As the aim of this study is to find areas for improvement, the outputs of the benchmarking will be compared. Therefore the latter approach fits best. Poerstamper (2007) uses the transformation process model as the basis for his model for benchmarking in healthcare.

It is clear that the transformation process model can be used for benchmarking efficiency, but is not developed for measuring and comparing quality. The transformation process model does take into account the processes, as the second part of the model described the transformation processes. Because of the simplicity of the model it can be customized to fit the purpose of this study, which is a case study approach. Concluding we can say that the transformation process model offers a basis for a framework to benchmark efficiency.

Structure-process-outcome framework

Donabedian developed the structure-process-outcome framework for quality assessment in healthcare (Sunol, 2000). Many authors have used this framework for the development of indicators (Campbell, Braspenning, Hutchinson, & Marshall, 2002; Cionini et al., 2007; Mainz, 2003; Mant, 2001; Tawfik-Shukor, Klazinga, & Arah, 2007); (Beersen, Kallewaard, Croonenborg, Everdingen, & Barneveld, 2007). As these categories of indicators are so widely used, we evaluate if this framework can be used to determine the indicators for this research.

Structure indicators measure a health systems' characteristics that affect an organizations ability to meet patients healthcare needs (Mainz, 2003). Health systems' characteristics can be seen as personnel, finances and availability of appointments (Campbell et al., 2002).

According to Mainz (2003) *process indicators* "assess what the provider did for the patient and how it was done", therefore a process indicator describes actual medical care such as diagnoses, treatment referral and prescribing (Campbell et al., 2002). Process indicators directly measure the quality of health care, given that there is a demonstrated link between the process and the outcome (Mant, 2001).

According to Mainz (2003) *outcome indicators* are "states of health that follow care and that may be affected by healthcare". The Dutch Quality institute for Healthcare (CBO) states about outcome indicators that they are dependant of many factors, and therefore it is hard to relate them directly to the care for patients (Beersen et al., 2007). Mant (2001) describes four causes for variation between outcome indicators, which are: differences in the type of patients, differences in the way that data is collected, differences that may be due to chance and differences may reflect a real difference in the quality of care (Mant, 2001). When it is not possible to make sure that data retrieved can be interpreted reliable, which means that this differences cannot be explained by the differences in types of patients, data collection methods or due to chance, outcome indicators should not be used (Mant, 2001).

According to Mant (2001) process indicators are preferred to outcome indicators as "they are much easier to interpret and are much more sensitive to differences in the quality of care", which is exactly why it is so important to describe the processes within the different benchmarking partners. Mant (2001) also states that in general, when the scope narrows,

the use of process indicators becomes more useful and the use of outcome indicators becomes less useful. As for this research the scope is narrow, the radiotherapy department of four centers, this is a second reason not to take into account outcome indicators for this research. Therefore, for this research only structure and process indicators should be used.

When we re-assess the preconditions described, we see that this model is suitable as a basis for developing performance indicators. The framework does not distinguish between quality and efficiency, since structure indicators as well as process indicators can measure either quality or efficiency. Also, this model can be used for process description, because of the inclusion of process indicators. Furthermore there are no reasons to presume that this model cannot be used in a case study approach. Although this model fits the precondition, it should be mentioned that this model alone would probably not give enough handles to base the performance indicators for this research upon.

Conclusion frameworks from literature

The feasibility of the three general frameworks discussed in the previous paragraph depends on the three preconditions mention in paragraph 4.1: benchmarking quality and efficiency, the framework can be used in a case study approach, and it takes into account he processes. The comparison of the mentioned models is depicted in Table 5.

Preconditions	Does the model distinguish between quality and efficiency?	Can this model be used in a case study approach?	Can the model be used for process description?
EFQM	No, only quality	Yes	Yes
Input-Output	No, only efficiency	Yes	Yes
Structure-process-outcome	Yes, both	Yes	Yes

Table 5: Comparison of frameworks from literature

From Table 5 it can be concluded that only the structure-process-outcome of the described frameworks complies with all the preconditions mentioned. However, this model alone will probably not give enough handles to base upon the performance indicators for this research. Therefore a customized framework is build, which is based on all three models described, as they all have something to add to the development of the best performance indicators. This customized framework will be able to provide a framework that can be used for benchmarking both quality and efficiency and take into account structure and process indicators.

4.1.3 A customized benchmarking framework

In the previous paragraph three models have been described that can be used to develop performance indicators for this research.

When the structure of the EFQM excellence model is compared with that of the transformation process model, and the processes boxes are lined-up, it shows that the EFQM Excellence Model can be viewed as an extended version of the transformation process model. The leadership, people, policy & strategy and partnership & resources line-up with the input boxes from the transformation process model and the people results, customer results, society results and key performance results line-up with the output box. In Figure 10 the connection between the two models is shown.

Figure 10 shows the arrow for innovation and learning, which is the purpose of this study. For innovation and learning we read this model from left to right, meaning that we start with determining which people, customer, society and key performance results should be benchmarked, which forms the indicators for this research. In developing these indicators we take into account the structure-process-outcome framework, as we need to develop both structure and process indicators, but we need to be careful with the use of outcome indicators, as was described by Mant (2001). The development of the performance indicators is described in paragraph 4.2 and finished in paragraph 5.2.

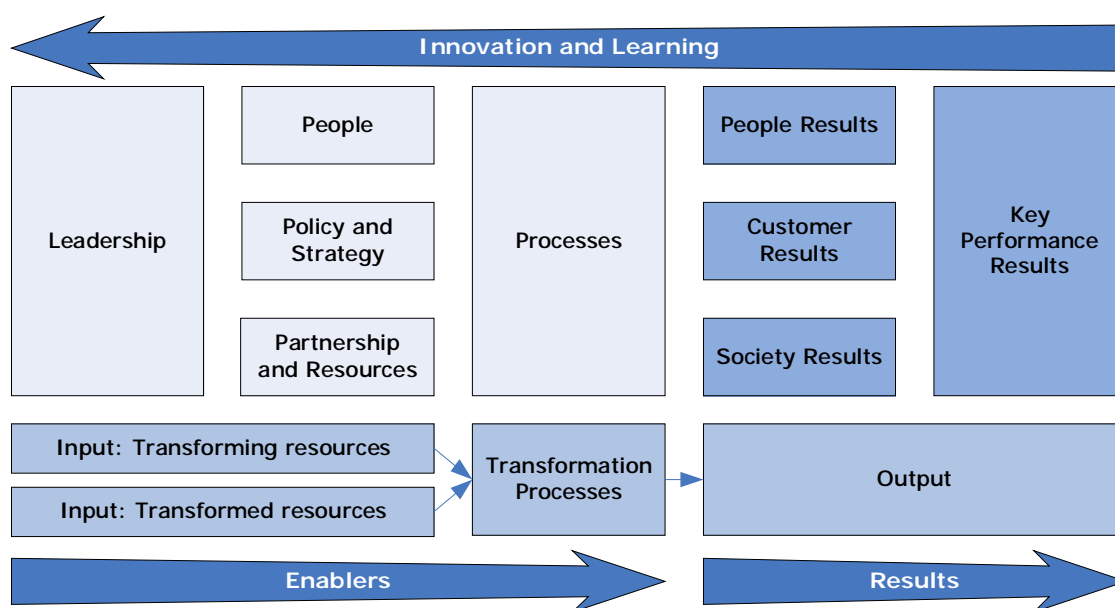


Figure 10: EFQM Excellence Model combined with Input-Output model

After the performance indicators are determined on the output side of the model, the processes on the basis of these results need to be assessed and then the transformed and transforming inputs necessary for these processes and outputs need to be determined. These inputs are determined based on the data necessary for calculating the performance indicators on the output side of the model and are divided in the four categories, leadership, people, policy and strategy and resources on the input side of the model in Figure 10.

For determining the performance indicators we read the model from right to left. However, when measuring the outputs from the indicator, we use this model from left to right. We

measure the determined enabler criteria, which make it possible to calculate the result criteria. Finally, we look at the outputs of the indicators and determine which differences in the enablers are the causes of these differences. The recommendations for the benchmarking partners are then determined based on the differences in the enablers, as these are the transformed and transforming resources and the processes at the different departments that can be changed by the partners. Figure 11 shows how this model is used for this study.

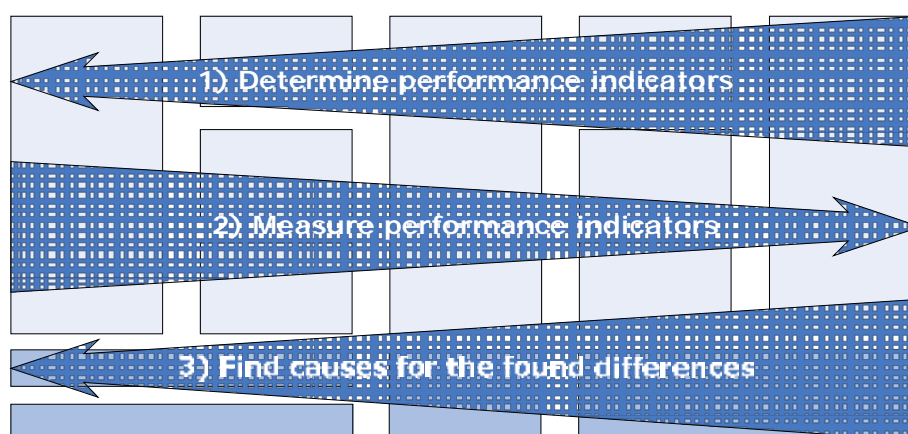


Figure 11: Use of the model in three steps during the study

4.2 Development of a long-list of performance indicators

To determine the performance indicators for this study, we use the output side of the framework for benchmarking radiotherapy centers constructed in the previous paragraph. The development of these indicators starts with the formulation of a long-list of performance indicators, which is described in this paragraph. For this research a number of sources were used to construct this long list of indicators. First a literature source from Cionini et al (2007) is described (4.2.1). Then we discuss the indicators developed by the NVRO (4.2.2). Finally, previous benchmarking research at the NKI-AVL is reviewed for indicators that can be of value in this study (4.2.3).

4.2.1 Cionini et al. (2007)

One of the sources for the long-list of performance indicators is the article from Cionini named *Quality Indicators in Radiotherapy* (Cionini et al., 2007). In this article Cionini defines thirteen quality indicators for radiotherapy department performance monitoring, which are depicted in Table 6. The exact definitions, numerator and denominators of this long-list of indicators can be found in appendix C.

Indicators from Cionini	
G1	Workload
G2	Use Linear accelerators
G3	Waiting times
G4	Clinical record quality
G5	Survey of patients' opinions
G6	Multidisciplinary approach
P1	Linear accelerator downtime for non-planned maintenance
P2	Instrumentation for dosimetry and quality control
P3	Equipment quality control programs
AC1	Treatment planning with CT
AC2	Number of fields per planned treatment volume
AC3	Shaped fields
AC4	Portal verification

Table 6: Indicators from Cionini (2007); G: general features, P: health physics activities, AC: accuracy and technical complexity

Table 6 shows that Cionini divides these indicators in three categories, which are: general features (G), health physics activities (P) and accuracy and technical complexity (AC). We use this list of performance indicators by Cionini (2007), as it is developed for benchmarking radiotherapy centers. However, the list of Cionini was not developed principally for international benchmarking, but based on the elaborate definitions determined by Cionini. There is no reason to suspect that these indicators cannot be used for benchmarking on an international level. Therefore, all indicators from Cionini are introduced in the long-list of performance indicators for this research.

4.2.2 Dutch Society of Radiotherapy Oncologists (NVRO)

The second source of radiotherapy indicators is developed by the NVRO. Table 7 shows eleven performance indicators developed by the NVRO. Their goal is to improve the quality of radiotherapy treatments in the Netherlands, but currently they are not yet used for benchmarking radiotherapy centers in the Netherlands.

NVRO indicators	
1	Pain management
2	Risk analysis
3	Brachytherapy
4	Follow-up policy
5	Waiting times
6	Quality control of radiation planning
7	Quality Control of the LineAcc's
8	Positioning control for prostate cancer patients
9	Complications with prostate cancer patients
10	Multidisciplinary approach
11	Patient satisfaction

Table 7: indicators for the NVRO (NVRO, 2007)

The list of indicators from the NVRO has some resemblance with the list of Cionini. Both take into account waiting times, multidisciplinary approach, and patients' opinions/satisfaction. Also both mention indicators aimed at quality control of the radiation plans and the LineAcc's. Initially the double indicators are both placed in the long list and when developing the shortlist a choice is made for the indicators with the clearest definition.

Therefore, all indicators from the NVRO are introduced in the long-list of performance indicators for this research. The exact definitions, numerator and denominators of this long-list of indicators can be found in appendix C.

4.2.3 Past benchmarking studies at the NKI-AVL

Finally, three theses on benchmarking in comprehensive cancer centers were used for the development of the long list of indicators. There are two qualitative studies reviewed, these theses are from van Lent and Roijmans (2004), and van Lent (2005). Also the more quantitative research from van Bokhorst (2007) was discussed.

Indicators Van Lent and Roijmans (2004)
Work pressure

Table 8: Indicators from van Lent and Roijmans (2004)

Table 9: Indicators from van Lent (2005)

Sick leave
Turnover rate
Electronic Patient Record
Use of CT-scans and LineAcc's

Table 10: Indicators from van Lent

The thesis of van Bokhorst (2007) describes indicators for the international benchmarking of the research centers. From this thesis the indicators that compare the bibliographic performance of the radiotherapy research departments are selected for use in this study. As these indicators are not related to patient care and van Bokhorst shows that these indicators are good predictors for efficiency of the research department, in this case we decided to use outcome indicators. The exact definitions, numerator and denominators for these indicators can be found in appendix C.

Indicators van Bokhorst (2007)

Number of peer reviewed articles published
Number of impact points

Table 11: Indicators from van Bokhorst (2007)

4.2.4 Conclusion indicators

To determine whether or not the long-list of performance indicators describes the radiotherapy department in a broad sense, we revisit the criteria for this research. In the introduction of this research it was determined that the indicators should be on both MACRO and MESO level and should measure both quality and efficiency. In paragraph 4.1.2 we defined that process as well as structure indicators should be developed. Table 12 shows how many of the indicators from the long list fit the mentioned criteria. Based on these numbers we presume that there is indeed a mix of different indicators that describe the radiotherapy department. However, there are more MACRO indicators than MESO indicators. This can be explained by the fact the MACRO indicators also influence processes on MESO level, but the other way around this is not always the case. This makes up for the lesser amount of MESO indicators.

		Quality	Efficiency
MACRO	Structure	11	5
	Process	6	7
MESO	Structure	2	1
	Process	4	5

Table 12: Number of indicators in the long-list that measures the defined criteria

5 Indicator development with stakeholders

In the previous chapter a long-list of performance indicators was composed based on existing literature and previous benchmarking research. By presenting the long-list to the key stakeholders a short-list of indicators is determined with the most interesting performance indicators.

To determine who the key-stakeholders are, first a literature review of stakeholder theory is executed and this theory is used to determine whom the key-stakeholders for this research are (5.1). Second, the long-list of performance indicators is presented to these stakeholders and the short-list of indicators is defined (5.2).

5.1 Stakeholder analysis

In step four of the benchmarking model, stakeholders are introduced to determine the performance indicators for this research. Van Houdenhoven (2005) states that it can be assumed that within a professional bureaucracy organization structure there is more resistance to performance measurement projects than this would be the case in more hierarchical organizations, which can be explained by the fact that the responsibility for the process lies with the professionals themselves (Houdenhoven et al., 2005). Therefore it is important to involve the professionals in determining the short-list of performance indicators. This way only performances that are *of interest to* and *changeable by* the different professionals are taken into account, which improves the value of the outcomes for the centers.

Furthermore, involving the professionals and other stakeholders does not only help us determining the right performance indicators, but it also keeps them involved with the project. This is important for the acceptance of the recommendations at the end of the project (Houdenhoven et al., 2005). To be able to involve the stakeholders, we need to determine who these stakeholders are, which the aim of this paragraph is. Therefore we first define the term stakeholder and evaluate which stakeholder identification models are available in literature and determine which one best fits the purpose of this study (5.1.1.). Then this model is used to determine the stakeholders for this research (5.1.2). Finally the key stakeholders for this research are defined and their impact for this study is described (5.1.3.).

5.1.1 Theory on stakeholder analysis

The term *stakeholder* was introduced in the 1960s, but it was not until the 1980s that the concept gained widespread acceptance (Preble, 2005). Nowadays the concept of stakeholders has become embedded in managerial thinking, both in academic and professional literature (T. Donaldson & Preston, 1995; Mitchell, Agle, & Wood, 1997). Also in the healthcare sector stakeholder management has become an important issue. According to Carignani "hospital managers achieve success satisfying their stakeholders' interest" (Carignani, 2000), this idea is shared by Van Hoorn (2006) who introduced stakeholder interests in the benchmarking process model.

Defining the term stakeholder

Multiple definitions for the term stakeholder can be found in literature. One of the most cited definitions is the definition from Freeman (Brugha & Varvasovszky, 2000; Mitchell et al., 1997; Preble, 2005):

"A stakeholder in an organization is any group or individual who can affect or is affected by the achievement of the organizations objectives (Freeman, 1984, p.46)"

This definition is also one of the broadest definitions in literature (Mitchell et al., 1997). Both Mitchell (1997) and Preble (2005) compare this definition of Freeman to the narrower definition of Clarkson (1995) who defines stakeholders as:

"Persons or groups that have, or claim, ownership rights, or interests in a corporation and its activities, be they past, present, or future" (Clarkson, 1995)

According to Mitchell (1997) the broader definition takes into account the reality that companies can be affected by almost anyone, but is also much harder to apply than a more narrow definition. For this research ownership rights are not an important issue, which according to the definition of Clarkson (1995) leaves the following definition:

Persons or groups, that have interests in the benchmarking of the radiotherapy departments, be they past, present, or future

When we redefine the definition of Freeman according to our research objective, the following definition of stakeholders arises:

A stakeholder for the benchmarking of the radiotherapy departments is any group or individual who can affect or is affected by the achievement of the research objectives

The two redefined definitions of stakeholders are much more useful for this research, as they guide the direction in which to look for potential stakeholders. We will use a combination of these definitions for this research, being:

A stakeholder for the benchmarking of radiotherapy departments is a group or individual who is interested in, can affect or is affected by the achievement of the research objectives, now or in the future

Stakeholder prioritization

Mitchell et al. (1997) developed a framework for stakeholder identification that prioritizes identified stakeholders (Parent & Deephouse, 2007). The framework of Mitchell categorizes stakeholders in terms of power, legitimacy and urgency (Parent & Deephouse, 2007). With these attributes the salience of the different stakeholders can be determined, with salience meaning "the degree to which managers give priority to competing stakeholder claims" (Mitchell et al., 1997, p.854). *Power* is the ability of stakeholders to bring about the outcome they desire, even despite resistance (Mitchell et al., 1997) through coercive, utilitarian, or normative means (Parent & Deephouse, 2007). Suchmann (1995) describes a *legitimate* stakeholder as "one whose actions and claims are seen as appropriate, proper, and desirable in the context of the social system" (as defined in Parent & Deephouse, 2007). *Urgency* is the degree to which stakeholder claims are time sensitive or critical (Parent & Deephouse, 2007). The central relationship in the theory of Mitchell (1997) is that the more attributes a

stakeholder has, the greater his salience is (Parent & Deephouse, 2007; Preble, 2005). With these three attributes, Mitchell (1997) developed eight stakeholder types in four categories: 1) non-stakeholders who possess none of the attributes, 2) *Latent stakeholders* who have only one attribute, 3) *Expectant stakeholders* who possess two attributes and 4) *Definitive stakeholders* who possess all three attributes. In the category latent stakeholders there are *dormant stakeholders* who only have the attribute power, *discretionary stakeholders* who only have the attribute legitimacy and *demanding stakeholders* who only have the attribute urgency. In the category expectant stakeholders there are *dominant stakeholders* who possess the attributes power and legitimacy, *dependant stakeholders* who possess the attributes legitimacy and urgency, and *dangerous stakeholders* who possess the attributes power and urgency. As already mentioned, the definitive stakeholders possess all the attribute, power, legitimacy and urgency, which then have the highest degree of salience (Preble, 2005). In Figure 12 the different stakeholder categories are shown.

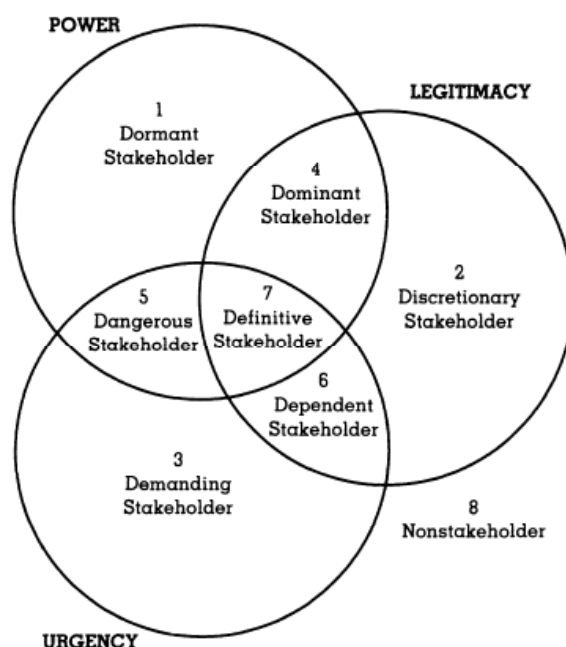


Figure 12: Stakeholder typology (Mitchell, Agle and Wood, 1997, p. 874)

Stakeholder management models

Preble (2005) uses the stakeholder prioritization theory described above in his Comprehensive Stakeholder Management Process Model. His model consists of six steps that facilitate the actual practice of stakeholder management. The steps of his model are displayed in Table 13.

Step 1	Stakeholder identification (primary, secondary and public stakeholders)
Step 2	General nature of stakeholder claims and power implications
Step 3	Determine performance gaps
Step 4	Prioritize stakeholder demands (prioritizing stakeholders)
Step 5	Develop organizational responses
Step 6	Monitoring and control

Table 13: Comprehensive stakeholder Management Process Model (Preble, 2005, p.415)

Prebles' process model is very extensive and takes into account all steps necessary to facilitate stakeholder management. However, this is not the aim of this study.

Brugha and Varvasovszky (2000) also describe a stakeholder management model, which contains four steps and is shown in Table 14. Brugha and Varvasovszky (2000) describe a model that is more aimed at stakeholder identification. The first step of their model is to identify the potential stakeholders, which is comparable to step one of Preble's model. Second, a stakeholder map has to be constructed in order to get a visual picture of the stakeholders involved, which is not the same as step two in Preble's model (Brugha & Varvasovszky, 2000). The third step of Brugha and Varvasovszky's model is to diagnose the stakeholders and see which stakeholder deserve a priority status. This step is comparable to the fourth step of Prebles' model that uses the framework of Mitchell to prioritize the stakeholders, which is a widely accepted model for stakeholder prioritizing. The last step of the model is called strategy formulation. In this step we will determine how the identified key-stakeholders will be involved in the rest of this research.

Step 1	Identification of the important stakeholders
Step 2	Stakeholder mapping or assessment
Step 3	Stakeholder diagnosis
Step 4	Strategy formulation

Table 14: Stakeholder management model (Brugha and Varvasovszky, 2000, p. 242-243)

As the model of Brugha and Varvasovszky (2000) fits the objective for stakeholder identification of this study, this model will be used to determine the key-stakeholders for this research. The steps two, three, five and six of Preble's model focus too much on how to satisfy each stakeholder and not on how we can determine the key-stakeholders. Therefore we do not use his model for this research. However, the model of Preble might be reconsidered when implementing the recommendations that are derived from this research. For the implementation of changes in the organization, understanding the stakeholders wished and demand can only help in reaching success.

5.1.2 Stakeholder analysis

The first step in the stakeholder management model of Brugha and Varvasovszky (2000) is the identification of the important stakeholders. As defined in paragraph 5.1.1, *a stakeholder for the benchmarking of radiotherapy departments is a group or individual who is interested in, can affect or is affected by the achievement of the research objectives, now or in the future.*

According to Preble “in the case of hospitals, key stakeholders can often readily be identified [...] and expectations can then directly be discerned via open communication” (2005, p. 419), with which he states that by discussing the issue internally, the most important stakeholders can be identified. Preble (2005) already identifies the medical staff, patients, hospital management, professional staff and the board of trustees as the primary stakeholders of hospitals, which is the same list as presented by Fottler (Fottler, Blair, Whitehead, Laus, & Savage, 1989). When we then translate these stakeholders to fit the research objective, the following potential stakeholders can be defined:

Medical staff	→ Radiation technologists
Patients	→ Patients receiving radiotherapy
Hospital management	→ Comprehensive Cancer Centre management
Professional staff	→ Radiation oncologists
Board of trustees	→ Board of trustees

Carignani (2000) also determines the key stakeholders of a health care unit, which are depicted in Figure 13. Carignani has taken a broader view on the potential stakeholders than Preble (2005) and Fottler (1989) as she also takes into account the operating environment and the broad environment (primary, secondary and public stakeholders).

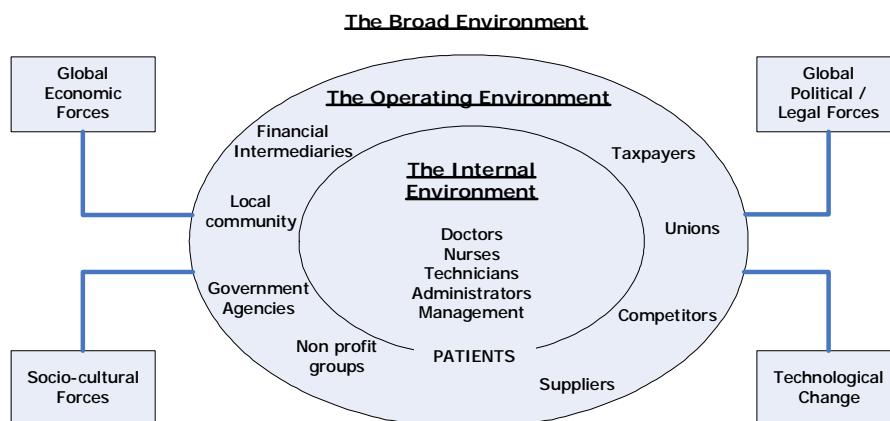


Figure 13: the health care unit environment (Carignani, 2000, p.9)

To be able to use the stakeholders mentioned by Carignani (2000) we translate the mentioned potential stakeholders in order to better fit this research.

Doctors	→ Radiation oncologists
Nurses	→ Radiation technicians
Technicians	→ Clinical Physicists
Administrators	→ Radiotherapy department administrative staff
Management	→ Radiotherapy department management
Patients	→ Patients receiving radiotherapy
Government agencies	→ Ministry of Health
Non-profit groups	→ National Cancer Society

Competitors, suppliers, taxpayers, unions, financial intermediaries and local community are not redefined, as they do not change by translating them to fit the research objective.

We will not take into account the Broad environment for this research, as this requires us to describe all national differences in economical, political, legal, socio-cultural and technological areas. However, we do mention influences from the Broad Environment in the analysis of the indicators, when these can explain differences in the outcomes.

As discussed in paragraph 5.1.1 a too broad definition is hard to implement and we should try to narrow down the field of stakeholders to keep a manageable amount of possible stakeholders. Also, as this is an international study, Prebles' view on key stakeholders is too tight as it leaves out all external stakeholders that can affect this research. The external stakeholders for the different centers involved can be different, due to national differences in the healthcare sector.

We now have the potential stakeholders mentioned by Preble (2005), and Carignani (2000). However, as one of the lists is too tight and one is too broad, we need to redefine the potential stakeholders based on these two maps. We can construct a specific stakeholder map for this research, which is step two of the stakeholder management model of Brugha and Varvasovszky (2000), by using the potential stakeholders mentioned by Preble and adding the potential external stakeholders mentioned by Carignani, which might also have an influence on the outcomes of this research, but leaving out the broad environment. The specific stakeholder map for this research is depicted in Figure 14.

As we now have determined a map for identified potential stakeholders, we prioritize these stakeholders to determine the key stakeholders for this research. Consequently, for all potential stakeholders their salience is determined, based on the three criteria power, legitimacy and urgency described by Mitchell (1997). Whether or not these stakeholders meet the criteria power and urgency is not solely based on literature, but is also discussed with different members of the CPZ of the NKI-AVL in order to take into account the actual environment in which these stakeholders operate.

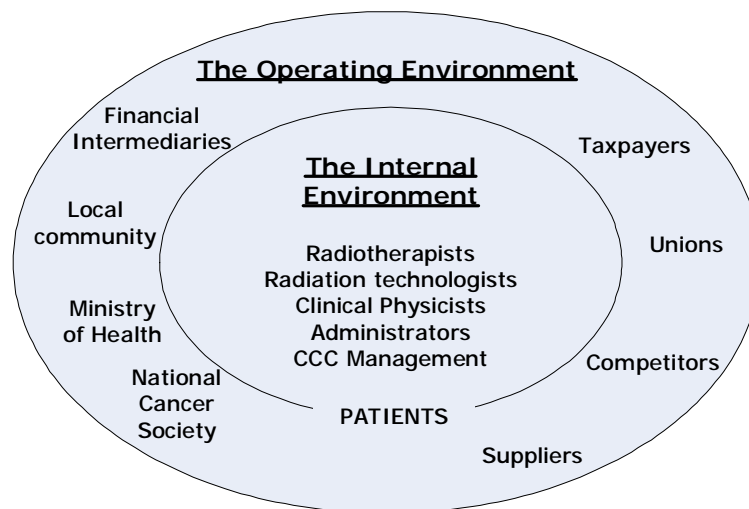


Figure 14: Adapted potential stakeholder model

Comprehensive cancer centre management

Power: The comprehensive cancer centre management (CCC management) has utilitarian power, meaning that they can exert power over the radiotherapy department as they control (at least partially) the financial resources of the department and are therefore critically important when it comes to the implementation of certain recommendations. However, this power can only be exerted when large amounts of money are involved, as the radiotherapy department has its own budget, and therefore manages its own finances until a certain level.

Urgency: As the urgency to take part in this research does not come from the members of the CPZ or the radiotherapy department management in general, we assume that the CCC management of the NKI-AVL is the stakeholder that experiences the most urgency. For the partners we assume that they also perceive some urgency, as otherwise they would not have committed to this research.

Legitimacy: The hospital management is a legitimate stakeholder, as it is hierarchical responsible for the choice made by the radiotherapy department and shares the responsibility for the actions taken.

Radiotherapy department management

Power: The radiotherapy department management also has utilitarian power, as it controls the financial resources allocated to the radiotherapy department. Depending on the organization structure the power will be more, equal or less than the power of the hospital management. At the NKI-AVL this power is conceived as equal, as they have the power to spend their budget according to their ideas, but this should be in accordance with the mission and vision of the entire hospital.

Urgency: As it was the hospital management of the NKI-AVL that induced this research, and not the radiotherapy department, it can be assumed that the urgency for the department is less than the urgency for the hospital management. For the partners we can assume the

same, as it was the hospital management of all the partners that decided to join this research, and not the radiotherapy department managers.

Legitimacy: this is a legitimate stakeholder, as eventually most changes suggested in this research will be within the radiotherapy department and therefore the radiotherapy department managers will partially be responsible for the implementation of these changes.

Radiation oncologists

Power: In a professional bureaucracy organization structure, traditionally the professionals possess normative power, which is power based on symbolic resources such as status and knowledge. Consequently based on theory radiation oncologists do have the attribute power. When we pose his statement to the members of the CPZ, they agree based on the normative power definition, but emphasize the idea that everyone in the organization has its contribution to the process and the process cannot run when one of the groups are taken away. This statement is obviously true for the process of the radiotherapy treatment, but when we look only at the stakeholders for this research, we can say that the radiation oncologists have somewhat more power, as they are involved in the decision making process around the implementation of the recommendations that follow from this research.

Urgency: The radiation oncologists are not the first to feel the urgency for an international benchmark of the department. This stems mainly from the fact that these professionals mainly function at a MICRO level, namely the individual patient, which is in their opinion impossible to compare to colleagues, let alone internationally.

Legitimacy: Yes, they are the ones that will be affected by possible changes induced by the results of the benchmark and they are also involved in deciding whether or not to implement the recommended changes.

Radiation technologists

Power: Based on theory the radiation technologists have little power, as they also work on MICRO level and are not directly involved in deciding which recommendations should be executed. Depending on the organization structure the radiation technologists are represented by the chief radiation technologists or by a head nurse, which has somewhat more power, as they are usually part of the department management. This is however already discussed for the stakeholder radiotherapy department management. But, when one of the changes that stem from this research results in resistance among the radiation technicians, they could exert coercive power, by going on a strike.

Urgency: The radiation technicians are mainly concerned with the day-to-day treatment process and therefore concentrate on the MICRO level of individual patient care. They are therefore not the stakeholders that are requesting a comparison on a MACRO/MESO level.

Legitimacy: They are legitimate stakeholder, as they can be affected by recommended changes induced by the results of this benchmark study.

Clinical physicists

Power: As the process of radiotherapy is highly technical, the clinical physicists are very important to keep the quality of the treatments at a high level. As they are usually the only

ones that know the different machines and the processes inside-out, they have normative power based on their knowledge and their skills. When we pose this statement to the members of the CPZ, they agree based on the normative power definition, but here also emphasize the idea that everyone in the organization has its own contribution to the process. This statement is obviously true for the process of the radiotherapy treatment, but when we look only at the stakeholders for this research, we can say that the clinical physicists have somewhat more power, as they are involved in the decision making process around the implementation of the recommendations that follow from this research.

Urgency: The clinical physicists probably do not feel the urgency for an international benchmark of the radiotherapy department, as this does not cohere with the nature of their work. They focus mainly on the day-to-day activities of keeping everything working and implementing new techniques. However, when checking this statement with a clinical physicist, it becomes clear that they are also involved in comparing outcomes within a national benchmark, which increases their urgency, as they are now more interested in the outcomes of this study. However, at the start of this research they did not yet have urgency, as they did not consider the idea of international benchmarking.

Legitimacy: As the clinical physicists are very important in the radiotherapy process, they also have legitimacy as they too can be affected by the outcomes of the study.

Patients

Patients are a special group of stakeholders everywhere in healthcare related subjects and also in this research. As can be seen in the stakeholder map, the patients have a central role as the radiotherapy departments exist only because there are patients who need their service, which makes the patients the customers of the hospitals. However, when we look at this from a different angle, we can also say that patients are the 'products' of the radiotherapy department and that not the patients themselves, but the radiation oncologists are the ones that determine what treatment a patient should receive. When determining the salience of patients, it is important to keep both viewpoints in mind.

Power: The patient as a customer has some utilitarian power as in most cases they can choose at which hospital they want to be treated and the hospital needs to treat patients in order to be efficient. But when we look at patients as 'products' they do not have very much power, as there is a knowledge gap between the radiation oncologist and the patients getting the treatment and the patient is not able to judge whether he or she is getting the right treatment. Together this means that patients have some utilitarian power based on their freedom of choice, the problem is that they do not have the right information to base this choice upon. Furthermore, the analysis above focuses at the MIRCO level treatment at the radiotherapy department. As this research considers only the MESO and MACRO level processes and the individual patient is not considered at this level, we can say that the individual patients have little power. However, when we discuss patients in a group, based on their diagnosis (MESO level) or the total group of patients (MACRO) they become more interesting for this research. Based on the discussion with members of the CPZ, it was decided that when we talk about groups of patients the radiation oncologists are the spokesperson and when we talk about the total group of patients the CPZ in total is the spokesperson. The spokespersons also have the accumulated power of the individual patients. However, these spokespersons have already been discussed as separate

stakeholders. This means that although groups of patients have more power through their spokespersons, the individual patient does not have much power.

Urgency: The urgency for treatment with the stakeholder patients is very high, but as we look at the salience for the benchmark project, the patients have less urgency. Patients want to receive the best treatment and as quickly as possible, therefore the outcomes of the benchmark could improve the treatment they get. The problem is that the patients themselves cannot determine whether their treatment was of a high standard and if it was timely delivered, in other words, they are not asking for immediate attention. Consequently, we can say that patients do not have much urgency.

Legitimacy: In all the involved countries patients have the right to receive the best treatment available. Therefore patients are legitimate stakeholders as the results of the benchmark could mean improvements (or deteriorations) in their treatment process.

External stakeholders

The external stakeholders are not discussed in the same way the internal stakeholders were. As external stakeholders are secondary stakeholders, they are not directly engaged in the organizations economic activities (Savage, 1991). However, the external stakeholders should be mentioned, as they might explain difference between stakeholders in the analysis phase of the study. Therefore we describe the secondary stakeholders defined and explain what their influence on this research might be and if we suspect this influence to be low or high.

Financial intermediaries: Although financial resources are extremely important for the different departments to be able to fulfill their tasks, there are no intermediaries found that might have an influence on the outcomes of this research. Therefore, the influence of the financial intermediaries is low.

Local community: The local community has little influence in this research, as this research only focuses on internal processes.

Ministry of Health: Each of the countries involved in the research has its own healthcare system, which is regulated by the Ministry of Health. As these laws and regulations are binding for the benchmarking partners, these might be of influence for the outcomes of this study. For example, some of the countries have strict regulations with regard to dosimetry levels, while others have not. We can therefore say that the influence of the Ministry of Health is high.

National cancer society: Each of the countries involved in the research has its own national cancer society. Although the national cancer society is usually a large source for income of the different centers, this money does not flow through the radiotherapy department. Therefore the influence of the national cancer society is low.

Taxpayers: The individual taxpayer is important to keep the national healthcare system working, but does not directly influence this research. Therefore, the influence of the individual taxpayer is low.

Unions: Unions are important for the wellbeing of the personnel, as they negotiate the workweeks and loans of the employees. For this research the employment conditions are

taken into account, and therefore the power of the unions might have an influence on the outcomes of these indicators. We therefore define the influence of the unions as moderate.

Competitors: Whether or not a radiotherapy center has competitors might be of influence on their internal processes. For example, when a center has no competitors, the drive to become the best might be less when compared to centers that do have competitors. We therefore define the influence of the competitors as high.

Suppliers: Which supplier was chosen for e.g. the LineAcc's, might have an influence on the processes at the different centers. However, the consequences of this diversity will probably not result in large differences. Therefore we suppose that the suppliers' influence is moderate.

5.1.3 Conclusion key stakeholders

When we translate the analysis of the internal stakeholders into Mitchell's stakeholder typology, we find the typologies as depicted in Figure 15.

A definitive stakeholder has all the attributes and is therefore the most important stakeholders. For this research that means that without the support of the definitive stakeholder, the research cannot be performed. Not only because information from the definitive stakeholders is necessary, but also because this stakeholder can exert influence on lower ranked stakeholders. For this research the comprehensive cancer center management is the definitive stakeholder, who we approached for joining this research. In two cases the cancer centre management was not interested, and therefore they could not be included in this research. In the case of the three benchmarking partners, the hospital management helped in retrieving the data from the dominant stakeholders.

According to Mitchell (1997) the influence of a dominant stakeholder is assured, and therefore they "matter". For this research the input from these stakeholders is needed to retrieve the information necessary to determine the outcomes of the indicators. Therefore interviews with these stakeholders are planned during the visits of the centers.

According to Mitchell (1997) discretionary stakeholders are important for corporate social responsibility and performance. This is especially true for the patients, because although individual patients have little power, the whole process is planned around them and they have a spokesperson. However, for determining the shortlist of indicators, discretionary stakeholders are not taken into account.

	POWER	LEGITIMACY	URGENCY	TOTAL
Comprehensive cancer center management	++	++	+	Definitive stakeholder
Radiotherapy department management	+	++	-	Dominant stakeholder
Radiation oncologists	++	++	-	Dominant stakeholder
Radiation technologists / nurses	-	++	-	Discretionary stakeholder
Clinical physicists	+	++	-	Dominant stakeholder
Patients	-	++	-	Discretionary stakeholder

Table 15: Key stakeholders for this research and their typology

The analysis of the external stakeholders resulted in two high rated stakeholders; the ministry of health and competitors, and two moderate stakeholders; unions and suppliers. Although we cannot interview these stakeholders in order to develop the short list of indicators, we can take them into account when analyzing the outputs.

Based on the analysis above, we can now conclude that the key stakeholders for this research are the comprehensive cancer centre management and to a lesser extent the radiotherapy department management, the radiation oncologists and the clinical physicists. The external stakeholders: ministry of health, competitors, unions, and suppliers might have an influence on the outcomes of this research and will therefore be taken into account in the analysis of the research. Figure 15 shows this analysis, the bold stakeholders are most important; the small stakeholders are least important.

Furthermore, it should be mentioned that stakeholder theory is dynamic (Mitchell et al., 1997) and that the analysis above is made for the current state only. In the future, based on changes in health systems and other factors, the stakeholder identification might result in different key-stakeholders. It is therefore important to reconsider this analysis, when using it again in the future.

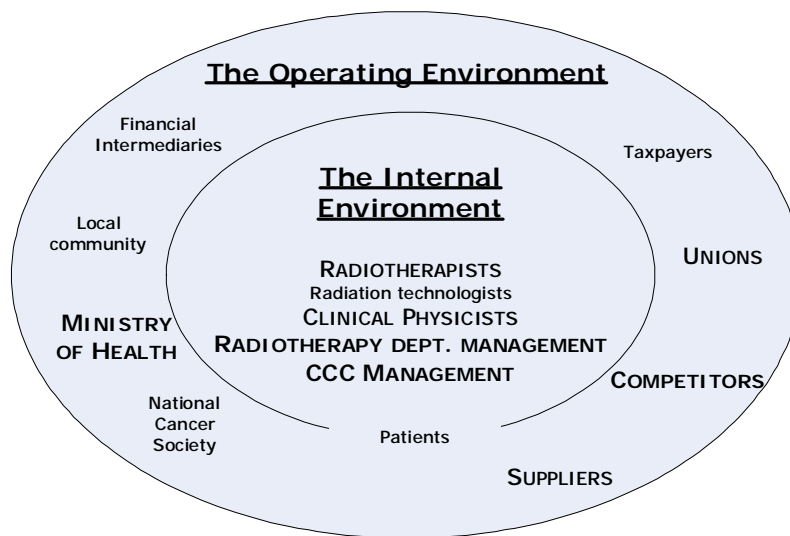


Figure 15: Adapted potential stakeholder model with priorities

5.2 Definitive set of performance indicators

Based on the stakeholder analysis the long-list of performance indicators was discussed with the different stakeholders. This paragraph discusses the adjustments based on these interviews (5.2.1) and presents a definitive set of performance indicators (5.2.2.).

5.2.1 Presenting the long list to the key-stakeholders

For each of the key-stakeholders, a spokesman is interviewed, which are the manager of the cancer centre who represents the CCC management, the manager of the radiotherapy department who represents the radiotherapy department management, the chief of the radiation oncologists who represents the radiation oncologists and two clinical physicists. This paragraph describes for each of the key-stakeholders, which adjustments for the long-list of performance indicators are suggested.

Manager radiotherapy department

In a discussion with the manager of the radiotherapy department the current set of indicators is discussed. He suggests taking into account more indicators that measure the efficiency of the department, as in the long-list the efficiency indicators are underrepresented. There were no indicators removed from the long-list by the manager of the radiotherapy department.

The first two indicators that are suggested by the manager of the radiotherapy department aim at measuring the efficiency of the use of the LineAcc's. The first of which are the *no shows*, which are empty slots in the planning of the LineAcc due to patients that, without warning, did not show up for their treatment and another patient could not fill their slot. This means that the LineAcc is not used for this amount of time, which is not good for the overall efficiency of the LineAcc and should therefore be kept as low as possible.

The second indicator for LineAcc efficiency is the overall *idle time* of the resources. This indicator measures the time LineAcc's are not used during treatment hours, due to planned and non-planned maintenance. The less maintenance is done during treatment hours, the more efficient the LineAcc can be used.

The third indicator does not only focus on the efficiency of the LineAcc but also at the efficiency of the other resources at the radiotherapy department, as in order for the whole department to be efficient, also the use of other resources needs to be efficient. The other resources added to the indicator of Cionini (2007) are the simulator, *CT-scans*, *MRI's*, and *PET- scans*.

The last indicator that is suggested is the *overhead of the radiotherapy department*. This indicator shows the percentage of the budget that is not used for direct patient care related subjects. The higher this percentage, the less efficient the use of the budget is. The added indicators are depicted in Table 16.

Indicators from NKI-AVL radiotherapy department manager
Added
No shows
Idle time resources
Use of CT scans / MRI scans / PET scans / simulators
Overhead radiotherapy department

Table 16: Indicators from NKI-AVL radiotherapy department manager

Chief radiation oncologists

The radiation oncologist suggests including the research indicator: *patients in a trial*, as clinical trials are an important research activity that can also be a strain on the efficiency of the LineAcc's. This indicator is measured at MACRO as well as on MESO level.

The chief of the radiation oncologists also mentions two indicators from the long-list that are not very suitable for use in this research. From the list of Cionini (2007) the indicator *clinical record quality* was removed, as it would be very labor intensive to gather the data and the chances of finding large differences would probably be very low. It was therefore decided to use the list with clinical record criteria for the indicator EPR introduced, as we can then decide how far the different partners are with implementing an EPR. The second indicator that is removed is *pain management*, as this is not measured at the NKI-AVL and therefore no information would be available to compare the outcomes with.

Table 17 sums up the indicators added and removed based on a discussion with the stakeholder chief of the radiation oncologists.

Indicators from NKI-AVL chief of the radiation oncologists	
Added	Removed
Number of patients in a trial	Clinical record quality
Appointment planning system	Pain management
	Follow-up policy breast cancer

Table 17: Indicators from NKI-AVL chief of radiation oncologists

Clinical physicists

The clinical physicists do not want to add extra indicators, but they suggest redefining part of the indicators from the long-list. For this reason the indicators: *health physics activities* and *accuracy and technical complexity* from Cionini (2007) and from the list of the NVRO: *the quality control of radiation planning*, *quality of the linear accelerators*, and *positioning control for prostate cancer patients* are evaluated.

Based on this discussion some of the definitions of the mentioned indicators are slightly changed, as the clinical physicists assume that the definitions of Cionini (2007) and the NVRO (2007) are not discriminating enough.

First, Cionini (2007) takes into account *treatment planning with CT*, but in 2006 also MRI and PET scans are used for making treatment plans. These techniques provide better images and therefore we can assume that treatment plans based on these images are of a higher quality than those based on solely a CT-scan.

Second, in radiotherapy the rate of technological development is high. Therefore the *use of new technologies* within the departments can be seen as an indicator for quality, when we assume that the new techniques have a higher quality than older techniques. The new technologies mentioned are IMRT, IGRT and ART.

Finally, the indicators *fields per planned treatment volume* and *shaped fields* were discussed, which led to the conclusion that due to the high innovation rate in radiotherapy treatments, these indicators are not longer leading when measuring quality of the treatment. Therefore these indicators were removed from the indicator list and it was suggested to determine the *number of segments per IMRT treatment planning* instead, as IMRT is a more recent innovation, which will probably result in more differences between the partners. According to the clinical physicists this is an indicator for treatment quality, because the more segments a treatment plan has, the better the tumor tissue can be treated without over-radiating the surrounding tissue.

The indicator portal verification was removed from the long-list as the NVRO also has an indicator that measures tolerance levels, but measure more than one criterion. Therefore the NVRO indicator *quality control of the LineAcc's* was chosen over the indicator of Cionini.

Indicators from NKI -AVL clinical physicists	
Added	Removed
Treatment planning with the MRI and the PET-scan	Fields per planned treatment volume
Number of IMRT treatments done	Shaped fields
Number of IGRT treatments done	Portal verification
Number of ART treatments done	
Number of segments per IMRT treatment	

Table 18: Indicators from NKI -AVL clinical physicists

Indicators by the researcher

During the observation of the radiotherapy department the appointment planning for patients is described. Based on these observations the indicator *appointment planning system* is added to the long-list. This indicator determines how the appointment planning at the different centers is organized and should be able to determine the best practice in this area. Therefore the process of patient planning needs to be described for each of the centers.

A removed indicator is *follow-up policy* from the NVRO. This is an indicator that measures effectiveness of the treatments, which is not measured in this study, as defined in paragraph 1.3.

Conclusion

The final definitions of the short-list of indicators can be found in appendix D. According to the framework description in paragraph 4.1.3 the numerators and denominators that are needed to get the outputs for the indicators are classified in the enablers: leadership, people, policy & strategy, partnerships & resources and processes. Figure 16 and Figure 17 show the shortlist on a MACRO and MESO level, with the enablers filled in at the output side of the model and the results filled in at the input and processes side of the model. With these inputs and processes descriptions from the short-list, the questionnaires and interviews for the partners are developed. The interview questions can be found in appendix E and the results of these questionnaires and the interviews can be found in appendix F.

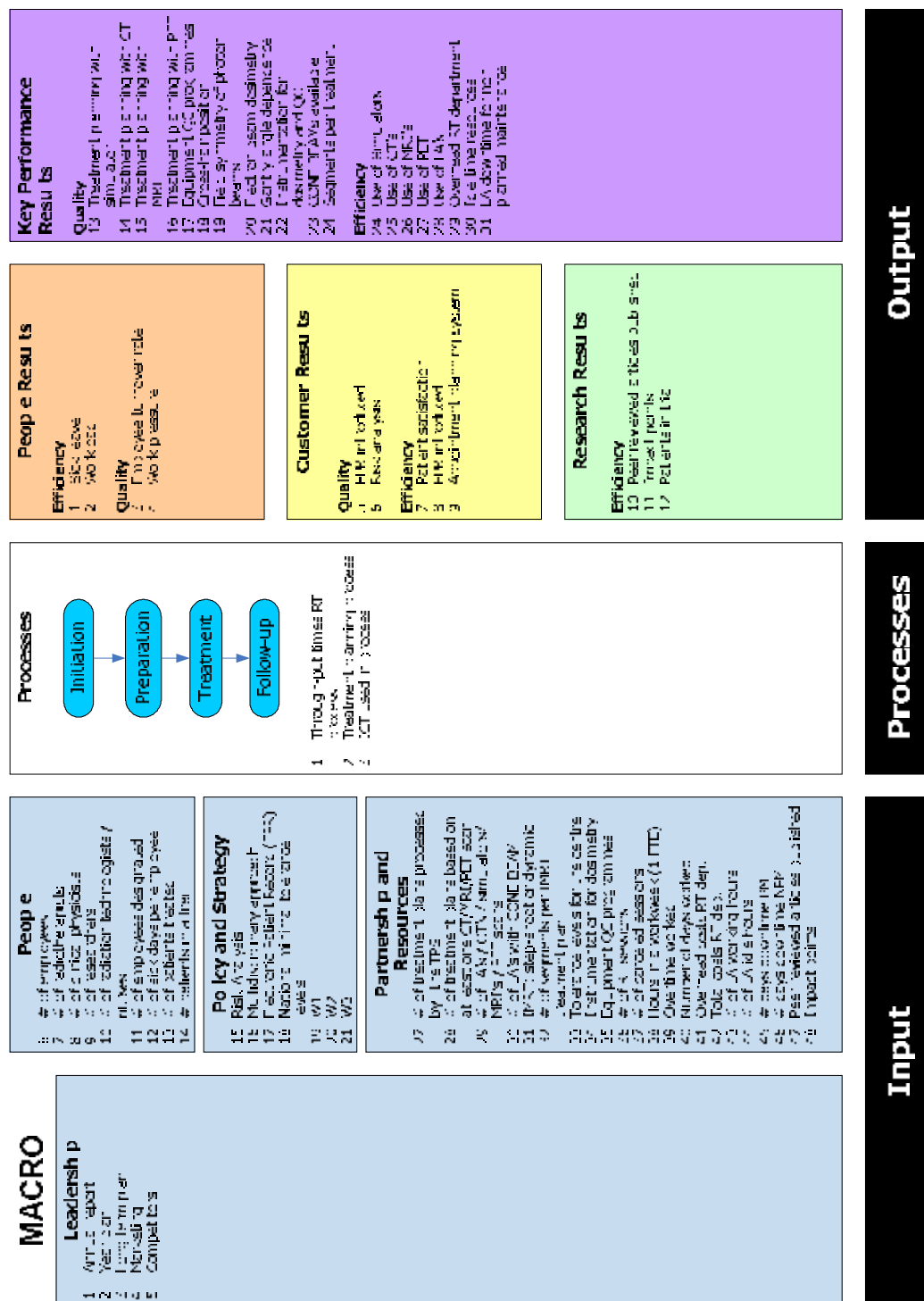


Figure 16: MACRO level indicators in framework

6 Analysis

This chapter describes step 7 of the benchmarking process model described in paragraph 2.2; *analyze differences in performance*, and as defined in paragraph 4.1.3 the analysis will be done for the employee results (6.1), the customer results (6.2), society results (6.3) and the key performance results (6.4) on both MACRO and MESO level of the radiotherapy centers. The definitions and sources for the indicators mentioned can be found in appendix D.

6.1 Employee results

In this paragraph the employee results workload (6.1.1), work pressure (6.1.2), and turnover and sick leave (6.1.3) are analyzed. All three indicators are analyzed on a MACRO level, as there were no MESO level indicators determined for employee results.

6.1.1 Workload

The number of patients treated per employee defines the workload for employees, for which we distinguish between radiation oncologists, clinical physicists and radiation technologists. Cionini (2007) assumes that the higher the patients per employee ratio, the higher the workload per employee is.

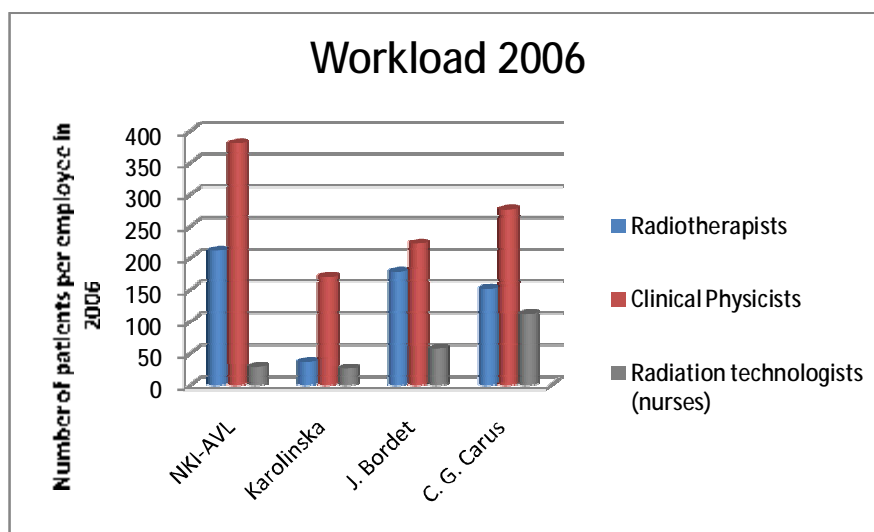


Figure 18: Workload on the employees defined by the number of patients treated per employee in 2006.

Figure 18 shows that the workload for the radiation oncologists and the clinical physicists is highest at the NKI-AVL, while the workload for the radiation technologists is the lowest at the NKI-AVL. For Carl Gustav Carus it is almost the other way around, as the workload for the radiation oncologists is lowest, and the workload for the radiation technologists is highest, compared to the other centers. Furthermore, we observe that the differences in

workload between the centers are the highest among the radiation technologists. These differences can be partially explained by the differences in responsibilities for the employees at the centers involved in this study.

For example, at the NKI-AVL radiation technologists (nurses) are responsible for making the somewhat more simple treatment plans, which takes away work from the clinical physicists. At the other centers the radiation technologists (nurses) are not responsible for these simple plans, which means that they have more time for their other responsibilities and can therefore have a higher workload in terms of patients per employee, without having an actual higher workload. This also explains the higher workload on the clinical physicists at the NKI-AVL as they plan fewer patients, but have a respectively higher workload per patient.

Another difference in responsibilities is observed with the medical / radiation oncologists at Karolinska. In Sweden radiation oncology is not a separate specialization, as it is in the Netherlands, Germany and Belgium. This difference accounts for the low workload on the medical / radiation oncologists. There is however at this moment not a reliable indicator to determine the number of hours spent by the medical / radiation oncologists on radiotherapy related tasks.

6.1.2 Work Pressure

The second employee-related performance indicator is work pressure, defined by van Lent and Roijmans (2004) as *the percentage of time employees work in overtime*. This indicator is measured by determining the average number of hours worked in overtime by the different employees in 2006 and dividing this number by the number of hours a fulltime contract entails for each employee.

Unfortunately, the number of hours overtime worked by employees is only recorded at the NKI-AVL for radiation technologists but not for the other employees and not at the other centers. Therefore, the output of this performance indicator could not be determined. We were however able to retrieve the data regarding the number of hours a fulltime contract entails for each employee, which was the nominator for this indicator.

Figure 19 shows that, except for Karolinska, the radiation oncologists have a higher number of hours in a workweek than the other employees. For the NKI-AVL, the differences are largest as the radiation technologists' work thirty-six and the radiation oncologist forty-five hours, a difference of nine hours.

At Karolinska, a staffing project has been running for one and a half year in which nurses at the LineAcc's work in two shifts. One shift is from 07.00 to 13.30 and one from 12.30 to 19.00. This project was introduced for two reasons, 1) to have more treatment time, and 2) to make the job of radiotherapy nurse financially more interesting, as they get paid for a forty-hour workweek and actually work 31,26 hours in a week. Other employees work a normal workweek of 40 hours.

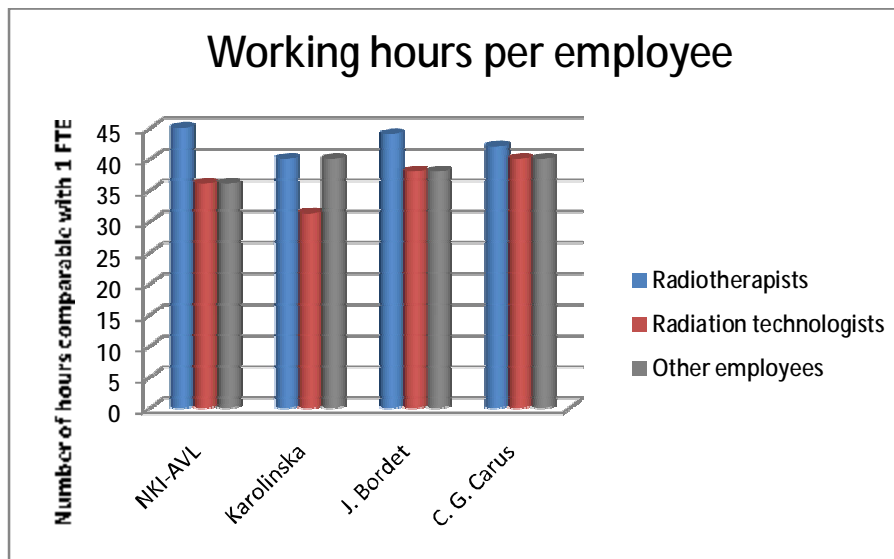


Figure 19: Contract hours per week per employee in 2006

6.1.3 Turnover and sick leave

Van Lent (2005) defines the indicator turnover as the percentage of employees that has left the centre in 2006. The indicator sick leave is based on the percentage of days a year employees did not work due to sickness, employees on maternity leave excluded. Figure 20 shows the data retrieved from the different centers.

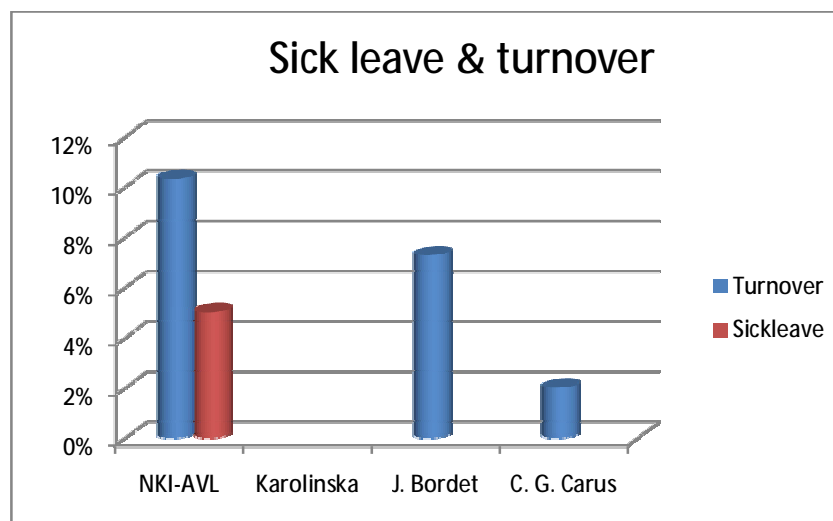


Figure 20: Turnover and sick leave for the centers based on percentage of employees that left the centre respectively the percentage of days employee were on sick leave (based on annual data for 2006)

As shown by Figure 20 data on sick leave could only be retrieved from the NKI-AVL and therefore no comparison on this indicator can be made. For the indicator turnover, no data was available from Karolinska, so the comparison is based on the other three centers.

In 2006 the turnover was highest at the NKI-AVL and lowest at Carl Gustav Carus. At Carl Gustav Carus the external factor labor market can partially explain the low turnover, as the unemployment rate is very high in Eastern Germany and therefore employees might not have the opportunity to change jobs as often as they would like to. However, the difference between Carl Gustav Carus and the other two centers is large enough to assume that the high unemployment rate is not the only contributing factor. No indication for what these other factors could be was found during this research.

6.2 Customer results

In this paragraph the customer results: patient satisfaction (6.2.1), risks analysis (6.2.2), electronic patient record (6.2.3), multidisciplinary approach (6.2.4), appointment planning system (6.2.5), and waiting times (6.2.6) are analyzed. As there are indicators on both MACRO and MESO level, first analyzed are the MACRO level indicators and then the MESO level indicators.

6.2.1 Patient satisfaction

Patient satisfaction is a quality indicator on a MACRO level that measures the quality aspect patient- centeredness. As already explained, this research does not describe outcome indicators and therefore we only discuss the *methods used* for collecting patient satisfaction information and not at the patient satisfaction outcomes measured by the different centers.

To be able to determine how well the partners are doing in the area of measuring patient satisfaction, a cycle based on the plan-do-check-act cycle from W. Edwards Deming for continuous improvement is used.

- Plan: develop a questionnaire or other measuring tool and data collection methods for measuring patient satisfaction.
- Do: Collect and analyze the outcomes of the questionnaires or other measuring tool and determine what improvement actions follow from the analyzed outcomes and implement these.
- Check: determine if the improvement actions led to an improvement of the patient satisfaction.
- Act: if necessary, change the questionnaire or other measuring tool so that it leads to improved patient satisfaction. Start the cycle over again.

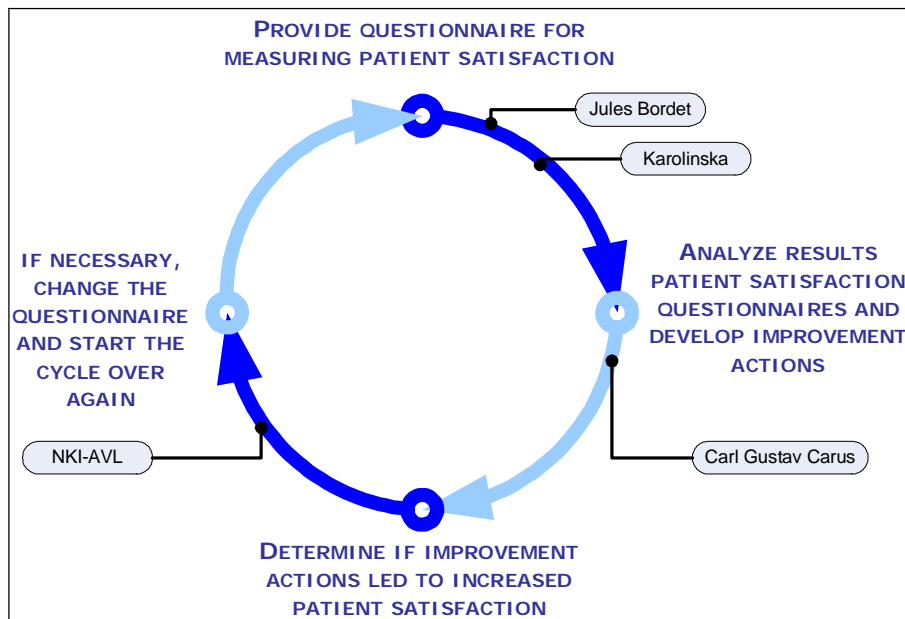


Figure 21: Patient satisfaction continuous quality management cycle

Figure 21 shows how far the different centers are in the continuous quality cycle for patient satisfaction described above.

Two of the centers, the NKI-AVL and Carl Gustav Carus, provide a patient satisfaction questionnaire to all patients receiving radiotherapy. Karolinska and Jules Bordet do not use patient satisfaction questionnaires in a systematic way to measure patient satisfaction. At Jules Bordet complaints letters from patients discussed at the radiotherapy department on an individual basis. At Karolinska, a box is available in which patient can put positive and negative feedback on their treatment. We observe that both centers have reactive, rather than a proactive method for measuring patient satisfaction.

We also observe that the attitude towards patients' satisfaction at NKI-AVL and Carl Gustav Carus is much more proactive. Both have a patient satisfaction questionnaire that is structurally provided to all patients treated at the center.

The response rate at Carl Gustav Carus is estimated at 50%, but this number can be questioned, as this is estimated by one of the radiation oncologists of the center, and could not be checked due to lack of reporting. At the NKI-AVL approximately sixty questionnaires are returned every month. This number is based on the two monthly analyses provided by the chief patient care of the NKI-AVL. When we compare this number to the total number of patients treated a year, this would mean that at the NKI-AVL there is a questionnaire return rate of approximately 20%.

At Carl Gustav Carus the results from the questionnaires are not analyzed in a structural way. Therefore, they are not able to determine improvement options based on the outcomes of these questionnaires.

At the NKI-AVL the results are analyzed and improvement options are formulated, which are reported to all radiotherapy employees on a two monthly basis. Whether or not the questionnaire needs to be adjusted is not analyzed. This means that the cycle does start over, but with exactly the same questionnaire, which also counts for Carl Gustav Carus.

6.2.2 Risk analysis

The definition for the performance indicator: *risk analysis* is defined by the NVRO (2007) as *the number of misses and near-misses that led to improvement actions within the centers*. This MACRO level indicator focuses on the quality-aspects safety, and patient-centeredness.

As well as for the indicator patient satisfaction, also for this indicator a quality cycle based on the plan-do-check-act cycle from W. Edwards Deming is determined.

- Plan: develop a method for reporting misses and near-misses.
- Do: analyze the number of misses, near-misses and their cause. Then develop and implement improvement actions.
- Check: determine if the improvement actions led to a decrease in the number of misses, and near-misses.
- Act: if necessary, change the method for reporting misses and near-misses. Start the cycle over again.

Figure 22 shows how far the different centers are in the continuous quality cycle for risk analysis described above.

We found that none of the partners finishes the cycle, which means that they are not adjusting their methods for risk analysis based on the outcomes of the analysis. In addition, none of the centers reports on a structural basis the decrease or increase in misses and near-misses. Because of this lack of reporting none of the four centers were able to provide the asked data for this indicator. However, we did observe differences between the centers with regard to how far along they are in the continuous quality cycle for risk analysis.

Of the four centers, Carl Gustav Carus has the least structure or methodology for analyzing risks. We observed that there is little request for a risk management system, as it is believed that a miss never happens twice and therefore it is not useful to implement a risk management system to try to prevent these onetime events from happening.

At Jules Bordet the misses are reported in the different systems available, but near-misses are not reported. Jules Bordet is however planning to improve the quality management system and has already started with the first step, collecting information on the systems already available.

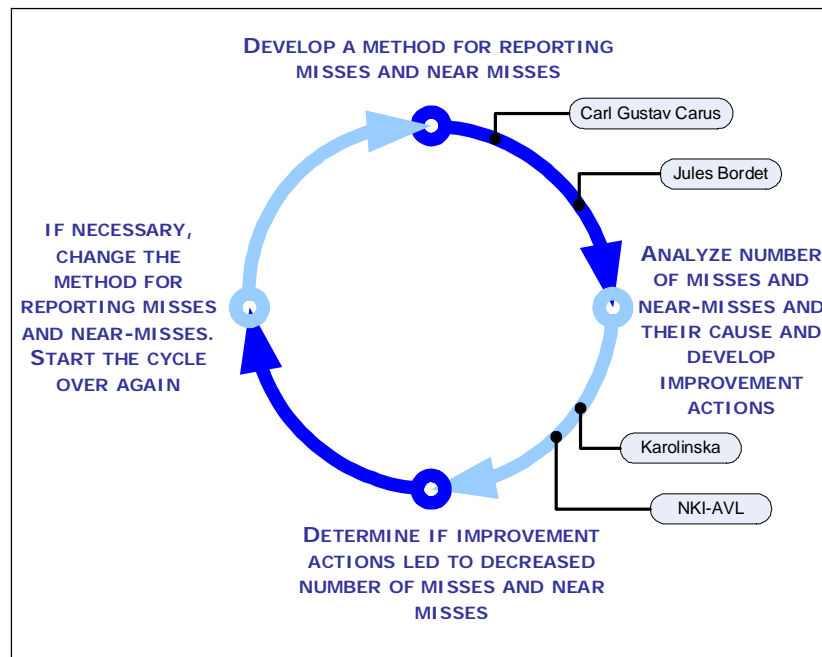


Figure 22: Risk management continuous quality cycle

At Karolinska there is a good methodology for collecting information regarding misses and near-misses and this data is used within the entire cancer centre to make monthly reports. Unfortunately, the radiotherapy department does not report the use of these reports for the development of improvement actions.

At the NKI-AVL a structure similar to that of Karolinska was observed, with an online reporting system and structural analysis of these reports. The improvement actions based on these reports are discussed in the radiotherapy department meetings, but are not structurally reported.

6.2.3 Electronic patient record introduced

The indicator electronic patient record (EPR) is based on the indicator *clinical record quality* from Cionini (2007). Cionini defines a list of criteria a patients record should posses, which can be found in appendix C.1. We used this list in order to determine how many of these criteria are available electronically. For this research we want to know if the centers have a complete EPR. We define a *complete EPR* as an EPR that makes the paper patient record redundant, meaning that all criteria mentioned in appendix C.1 should be incorporated in the EPR. This is a MACRO level indicator, measuring both the quality (timeliness) and efficiency of collecting and distributing patient data.

An EPR is introduced at each of the benchmarked centers, but the development of these systems is not at the same level for each of the centers.

At the NKI-AVL the EPR is at this moment primarily an information system, meaning that much of the information on a patient is available in the system, but cannot be changed by

the physicians / radiation oncologists. Therefore, the paper patient record is still the most important record and we presume that the NKI-AVL does not have a complete EPR.

At Karolinska the EPR has taken over the paper patient record, but the current system is not very user friendly. There are many pop-up screens and therefore filling in the EPR sometimes takes longer than it would have when the paper patient records were still in use. Although there are some problems with the user friendliness of the system, the EPR replaces the paper record and therefore we can presume that Karolinska has a complete EPR according to our definition.

At Carl Gustav Carus the EPR has almost completely replaced the paper patient record. It is because of some legal issues, and some older machines that cannot be integrated with the system, that the paper record is still in use. The same counts for Jules Bordet. We can therefore presume that besides some legal issues, Carl Gustav Carus and Jules Bordet have a complete EPR.

6.2.4 Appointment planning system

This indicator focuses on how the appointments for the patients are distributed to the patients and is a quality indicator that measures patient-centeredness. The indicator is measured on a MACRO level.

At The NKI-AVL patients receive their appointments schedule each Thursday the week before the appointments are. At Karolinska and Carl Gustav Carus there is a similar system, although the day that patients receive their appointments is not always the same (could be Wednesday, Thursday or Friday).

At Jules Bordet there is a different appointment planning system, as patients receive all their appointments at the beginning of the treatment. With this system, patients know their planning for the remaining of the treatment period.

At the NKI-AVL a system such as used by Jules Bordet is said to increase the number of patients that want to reschedule their appointments, but at Jules Bordet this was not observed. We can presume that when patients know their appointments ahead of time, they are able to plan their other daily activities around these appointments. When they only know their appointments a couple of days ahead, they cannot take them into account when planning day to day activities, which can also induce rescheduling of appointments.

Concluding, we assume that the system at Jules Bordet is the most patient centered approach to planning. A pilot study should be able to provide answers to the questions of the NKI-AVL regarding the higher rate of rescheduling. The NKI-AVL is introducing a service desk for patients, which can be a good opportunity to do this pilot.

6.2.5 Multidisciplinary approach

The indicator multidisciplinary meeting describes the *percentage of patients discussed at least once in a multidisciplinary setting*. This indicator is measured at MESO level and focuses on the quality-aspects patient-centeredness, and timeliness.

At each of the centers multidisciplinary meeting are held for all tumor groups and besides exceptions all new patients are discussed in at least one multidisciplinary meeting.

Therefore, we can say that the indicator developed by the NVRO is not discriminating enough for use within these centers as all centers score 100% on this indicator.

However, we did find differences in the organization of the multidisciplinary meetings. We describe the differences found in the presence of the different professionals, and the use of the EPR for the distribution of the outcomes.

Professionals

Table 19 presents the professionals for whom presence at the multidisciplinary meetings is compulsory. For each centre, the following professionals' presence is compulsory for both prostate cancer and breast cancer multidisciplinary meetings:

- Radiation oncologist
- Medical oncologist
- Surgeon
- Radiologist
- Pathologist

	NKI-AVL *	Karolinska *	Carl Gustav Carus *	Jules Bordet *
Radiation oncologist	P,B	P,B [†]	P,B	P,B
Medical oncologist	P,B	P,B [†]	P,B	P,B
Surgeon	P,B	P,B	P,B	P,B
Radiologist	P,B	P,B	P,B	P,B
Pathologist	P,B	P,B	P,B	P,B
Cytologist		B		
Physiotherapists				B
Psychologist / Psycho-oncologist			B	B
Head nurse of surgery department				B
Secretary / data manager				B
Cosmetic surgeon	B			

Table 19: Professionals present at multidisciplinary meetings

* B = for breast cancer patients, P = for prostate cancer patients; † In Sweden radiotherapy and medical oncology are not separate professions, they only have medical / radiation oncologist's.

- Radiation oncologist
- Medical oncologist
- Surgeon
- Radiologist
- Pathologist

For the breast cancer meetings more differences occur. We can see that at Jules Bordet the most different professionals are present at the multidisciplinary meeting for breast cancer patients.

Use of the EPR

At each of the centers the EPR is used as input for the multidisciplinary meetings. At Karolinska and Jules Bordet, the outcomes of the meeting are directly and online imported in the EPR of the patient. This way everyone present can see if what is entered in the EPR is conform to what was discussed in the meeting. At Carl Gustav Carus a specially designed tool is used for presenting the patients and in this tool the outcomes are directly and online inserted. The output of the tool is emailed to the attending physicians. At the NKI-AVL the EPR is only used as an information tool, which means that the outcomes of the meetings are not online reported, but directly entered into the hard-copy patient record.

6.2.6 Waiting times

The indicator waiting times determines the waiting time for patients between the day they are referred to the radiotherapy department and the day they receive the first radiation fraction. The indicator is measured on a MESO level and measures the quality aspect timeliness.

Cionini (2007) divides the total waiting time into three sections (W's), for which four points in time (T's) are determined. We use these four T's to determine the waiting times at the different centers. Figure 23 shows the connection between the W's and the T's mentioned. Cionini (2007) defines the T's as follows:

- T1 is the day of referral to the radiotherapy department
- T2 is the day of the initial prescription
- T3 is the day of the final prescription, also defined as the day the treatment plan is finished
- T4 is the day the patient receives the first radiation fraction

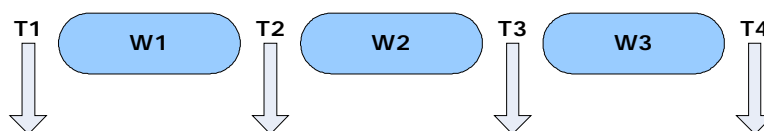


Figure 23: Points in time for measuring waiting times

None of the institutes structurally measures the waiting times of their individual patients. Therefore, a random sample of fifteen breast- and fifteen prostate cancer patients is taken

to be able to find a value for this indicator. For these patients T1, T2, T3 and T4 are looked up in their patient record.

The random sample of 15 was based on the workload the gathering of the data would take. A statistical analysis of the confidence intervals for these random samples is given in appendix G.

It was not always possible to find the exact data mentioned by Cionini (2007) in the patients' records. In some cases a point in time has been defined that is assumed to be approximately the same, but can be measured more reliable. To be able to compare these small differences in the data, the T's used at each of the centers are displayed in Table 20.

Table 20 shows that the variance occurs in the definitions of T1 and T2, which is induced mainly by the differences in the preparation process between the centers and the differences in the registration of these steps.

Another problem with defining the waiting times comes from the different times the multidisciplinary meetings are held. Especially for prostate cancer patients there can be a long waiting time between the patient being discussed in the multidisciplinary meeting and the time when the patient first visits the radiotherapy department. This waiting time is usually caused by the hormonal treatment patients receive for a couple of months before starting their treatment.

Figure 24 shows the waiting times at the centers for breast cancer patients and Figure 25 shows waiting times for prostate cancer patients based on the random sample taken at each center. Based on Figure 24 and Figure 25 it can be presumed that for the time between the day of referral to the radiotherapy department (T1) and the day of the initial prescription (T2) and for the time between the day of the initial prescription (T2) and the day of the final prescription (T3), differences can be seen for both breast and prostate cancer patients. For breast cancer the NKI-AVL and Jules Bordet have shorter waiting times than Carl Gustav Carus and Karolinska. For prostate cancer the NKI-AVL has a long waiting time between T1 and T2, but a short waiting time between T2 and T3.

There are large differences in waiting times between the day that the treatment plan is finished (T3) and the day that the patient receives the first radiation fraction (T4) for both breast and prostate cancer patients (W3).

	T1
NKI -AVL	Radiotherapy decision
Karolinska	Day of referral to the radiotherapy department
C. G. Carus	Date previous treatment is finished
Jules Bordet	Date multidisciplinary meeting (or end chemotherapy)

	T2
NKI -AVL	First radiotherapy consult
Karolinska	Day of the initial prescription
C. G. Carus	Date of first appointment at RT department
Jules Bordet	First radiotherapy consult

	T3
NKI -AVL	Day the treatment plan is finished
Karolinska	Day the treatment plan is finished
C. G. Carus	Day the treatment plan is finished
Jules Bordet	Day the treatment plan is finished

	T4
NKI -AVL	Day the patient receives the first radiation faction
Karolinska	Day the patient receives the first radiation faction
C. G. Carus	Day the patient receives the first radiation faction
Jules Bordet	Day the patient receives the first radiation faction

Table 20: Definitions of waiting times used for the different centers

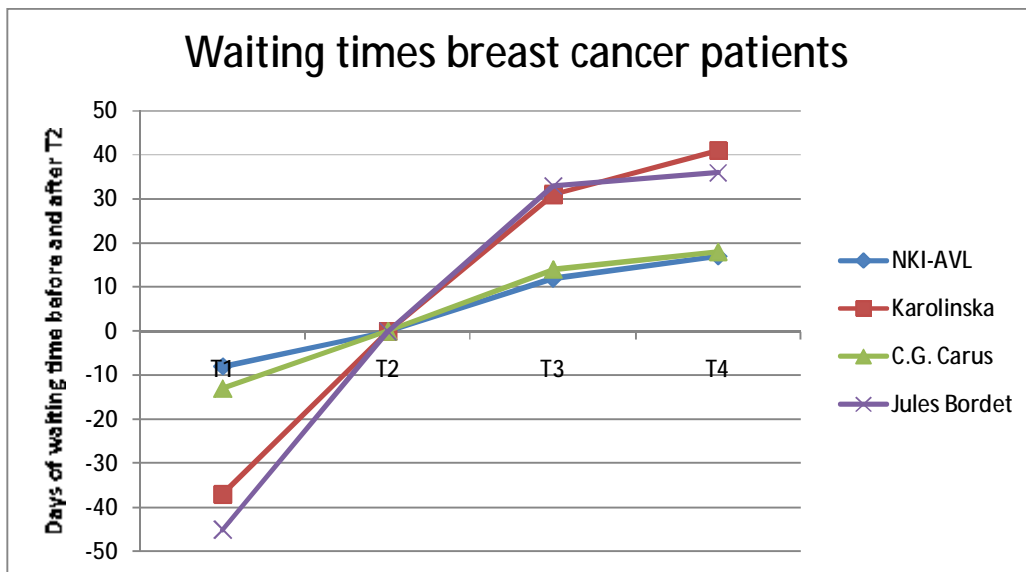


Figure 24: Waiting times in days for breast cancer patients at the radiotherapy departments in 2006.

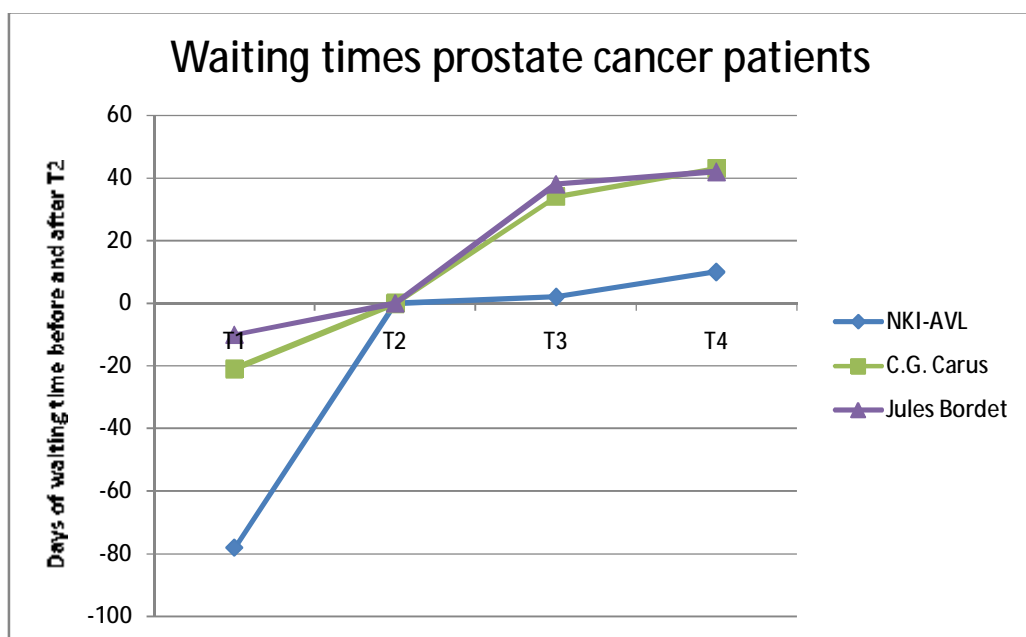


Figure 25: Waiting times for prostate cancer patients in days at the radiotherapy departments in 2006.

For prostate cancer patients there was a fault in the data from Karolinska, as the mean waiting time from W1 to W2 was over a year. As we do not have the data from which W1 – W4 are derived, we cannot determine where this fault stems from. Therefore Karolinska is not taken into account in this analysis.

The NKI-AVL seems to have a much longer waiting time prior to the first appointment at the radiotherapy department, but this can be explained by the fact that for the NKI-AVL the end date of the previous treatment was not determined.

6.3 Society results

For this research, *society results* focuses on two research-related issues, namely publications and clinical trials.

6.3.1 Publications

The indicator *number of publications* measures the output of the (radiotherapy) research departments of the centers. This indicator is measured on MACRO and MESO level and describes the quality aspect efficiency. We presume that the higher the output in terms number of publications, the higher the efficiency of the (radiotherapy) research department is.

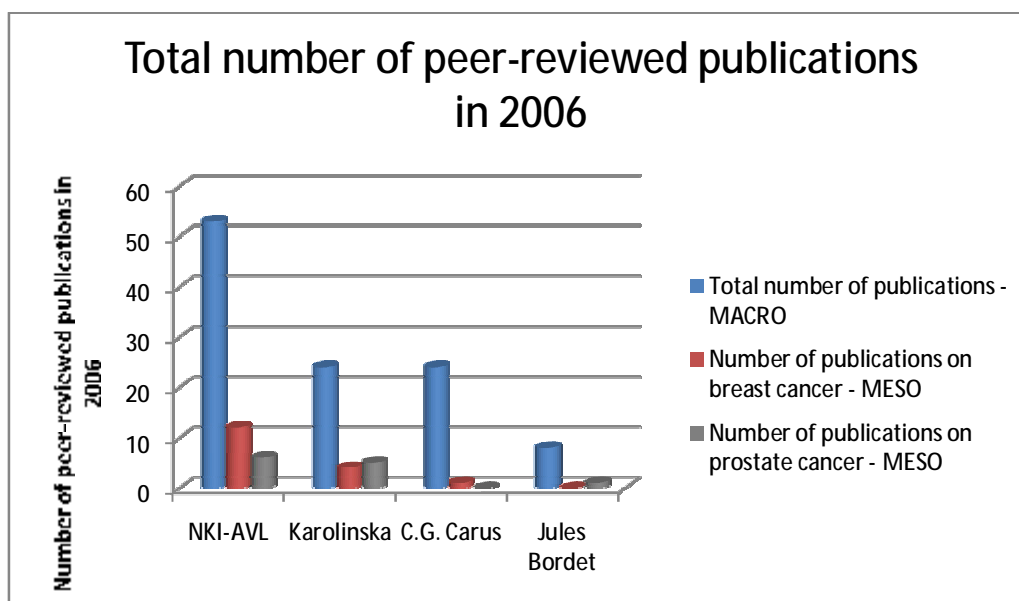


Figure 26: Absolute number of radiotherapy related publications published in 2006.

Figure 26 shows that the NKI-AVL published most publications. Although Karolinska is actually larger than the NKI-AVL in terms of LineAcc's and patients treated, they published approximately five times less articles than the NKI-AVL. The output of Carl Gustav Carus is somewhat comparable to that of Karolinska, but it should be taken into account that Carl Gustav Carus is much smaller than Karolinska. Jules Bordet has the lowest output in term of number of articles, and this does not change when taken into account the fact that Jules Bordet is a rather small center.

The analysis above only describes the actual output, but does not take into account the quality of the publications. To be able to compare the centers on quality of the publications, we define the impact points of the journals the publications were placed in and determined the average number of impact point per publication. This indicator is also measured on MACRO and MESO level.

We presume that the higher the average number of impact points per publication, the higher the quality of the articles published by the research department on radiotherapy related subjects.

Figure 27 shows the mean number of impact points per publication in 2006. Based on this figure we can presume that the publications from the NKI-AVL have the highest quality in terms of impact points. For Jules Bordet, data on the number of impact points per publications is not available.

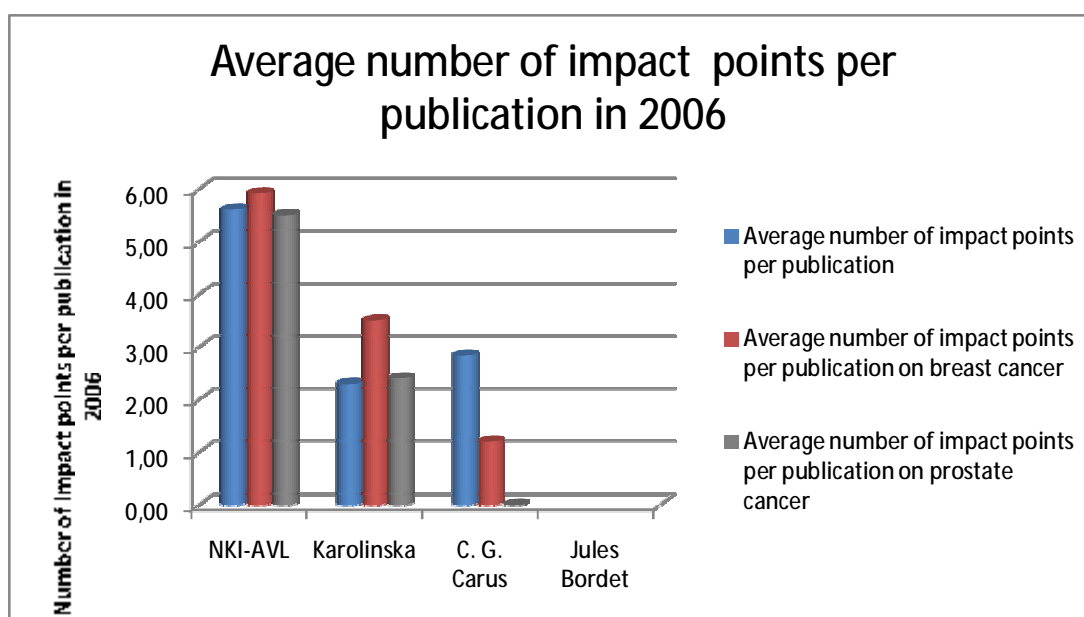


Figure 27: Quality of publications in terms of impact points per publication in 2006 on MACRO and MESO level.

An explanation for the high scores of the NKI-AVL can be the fact that it has a separate research department for radiotherapy, whereas Karolinska and Jules Bordet have not. This

could mean that for general research departments, radiotherapy is not an interesting research area.

Furthermore, at Carl Gustav Carus there is a separate research institute for radiotherapy research, OncoRay, of which the numbers are not included in this study. We should take into account the possibility that when these publications are taken into account (31 publications extra), Carl Gustav Carus has approximately the same output as the NKI-AVL. Given that Carl Gustav Carus is smaller than the NKI-AVL; this would make Carl Gustav Carus the best center.

6.3.2 Patients in trials

The indicator *patients in a clinical trial* determines what percentage of the patients were included in a radiotherapy clinical trial in 2006. This indicator is measured on MACRO and MESO level and measures the efficiency of the research department. We presume that the higher the percentage of patients in a trial, the better the centre scores at research, but that patients in a trial translate in less efficiency at the radiotherapy department, as patients that are treated according to a clinical trial protocol take more time per treatment.

Figure 28 shows the percentage of patients that were included in a clinical trial in 2006. Therefore, patients that received radiotherapy in 2006, but were included in a clinical trial in 2005, are not taken into account. Based on Figure 28 we can presume that at Carl Gustav Carus most patients are included in a clinical trial, followed by the NKI-AVL and at Karolinska the least patients are included in a radiotherapy trial. No data was available for Jules Bordet. A note must be made at the data from Carl Gustav Carus, as these numbers are based on an estimation from the chief of the radiotherapy department and therefore this data is less reliable than the data from the other two centers.

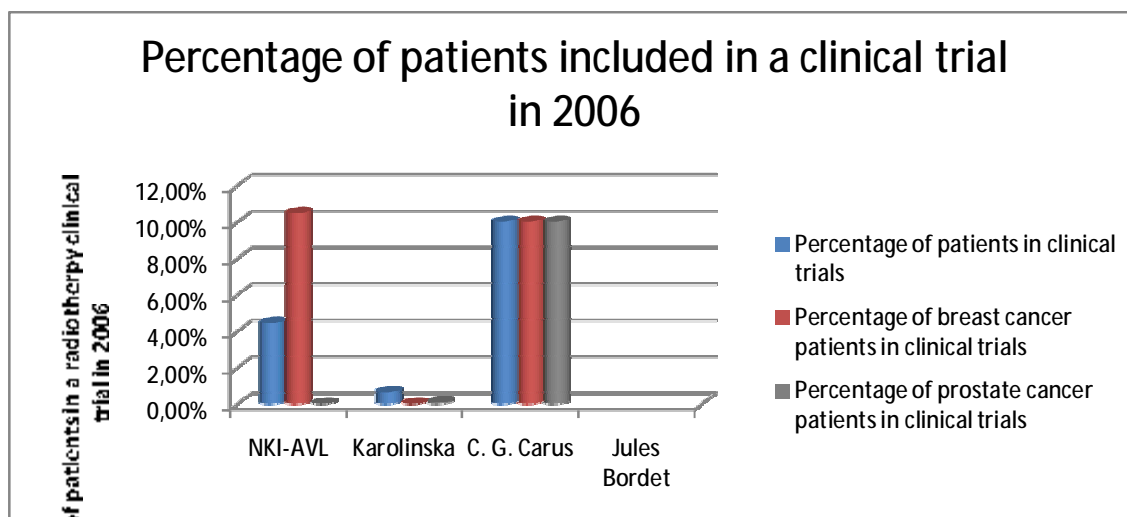


Figure 28: Percentage of patients included in a clinical trial for radiotherapy in 2006.

The low amount of prostate cancer patients included in a clinical trial at the NKI-AVL can be explained by the fact that a large prostate cancer study ended in 2004 and a new study started in 2007. Consequently, the NKI-AVL had 41 prostate cancer patients in a clinical trial in 2007. Based on this finding we can assume that a data collection time of one year is too short to determine an accurate outcome of this indicator.

We determined that *the number of patients included in a clinical trial* is an efficiency indicator, as we can assume that patients that are treated according to a clinical trial protocol take more time than patients who are not. Paragraph 6.5 describes this link with LineAcc efficiency.

6.4 Key performance results

In this paragraph the key performance results are analyzed. The efficient use of the resources in 6.4.1, the downtime of the LineAcc's in 6.4.2, treatment planning in 6.4.3, quality control and dosimetry in 6.4.4, tolerance levels in 6.4.5, new technologies in 6.4.6 and overhead of the radiotherapy department in 6.4.7. As there are indicators on both MACRO and MESO level, first analyzed are the MACRO level indicators and then the MESO level indicators.

6.4.1 Efficient use of the resources

For the efficient use of the resources, we look at the machines used at the radiotherapy department: LineAcc's, simulators, CT-scans, MRI-scans, and PET-scans, as these are present at each of the centers.

LineAcc's

The indicator *use of the LineAcc's* is defined by Cionini (2007) as the *number of patients treated per LineAcc in 2006*. This indicator is measured on MACRO level and measures efficiency.

During this research, we observed that the opening hours of the LineAcc's differ per centre. We therefore decided to introduce a second LineAcc efficiency indicator, which is *the number of patients treated per LineAcc working hour in 2006*. This indicator is also measured on MACRO level and measures the efficiency as well.

Figure 29 shows that the two indicators give different results for efficiency, which is an example of how important it is to describe exactly what an indicator measures. When we want to determine what centre has the highest efficiency of the LineAcc's, we can use both indicators; defining *the number of patients per LineAcc* concludes to Carl Gustav Carus being the most efficient, while defining *the number of patients treated per LineAcc working hour* concludes to Jules Bordet being the most efficient centre.

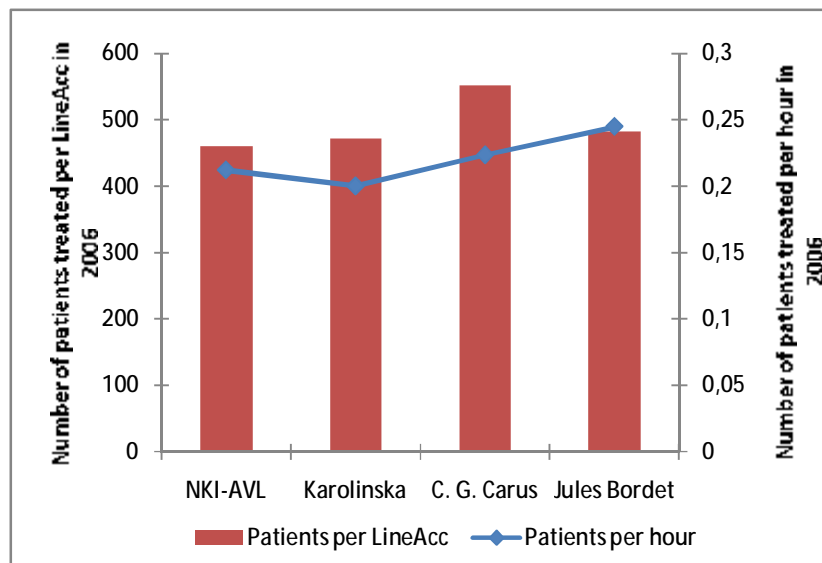


Figure 29: Efficiency of LineAcc use measured in *number of patients per LineAcc* versus *number of patients per LineAcc working hour* in 2006.

When one of the centers scored the highest on both the number of patients per hour and also had the longest opening hours of the LineAcc, this center would have been named the best practice. As this is not the case for this research, it depends on what is believed to be more important for the efficient use of the LineAcc, more opening hours or more patients per hour. We presume that the number of patients treated per hour is more important, as this can be changed by improvement strategies within the center. For the LineAcc's to have longer opening hours, external stakeholders, such as the unions, can become involved as personnel needs to be available to operate the LineAcc's outside normal working hours.

Although a second indicator is developed, which is believed to improve the reliability of this indicator, another possible problem for the reliability of this indicator could not be overcome. This other problem is related to the complexity of the treatments performed. In general we can say that the higher the complexity of the treatment, the more time it takes on the LineAcc. As there is no international standard available to compare treatment complexity, it is not possible to take this factor into account for the analysis of this data. However, differences in treatment complexity could give an explanation for the differences in LineAcc efficiency as depicted in Figure 29. This factor makes the output of this indicator less reliable.

Simulators and CT's

The indicator Simulator efficiency is defined as the *number of patients that used the simulators in 2006*. The indicator CT efficiency is defined as the *number of patients that used the CT's in 2006*. These are indicators on MACRO level and measure the quality aspect efficiency.

Figure 30 shows the use of the simulators and the CT's. The higher the number of patients treated per simulator or CT, the more efficient this machine is used, according to the

definition of Cionini (2007). Figure 30 depicts large differences in the efficiency of these resources.

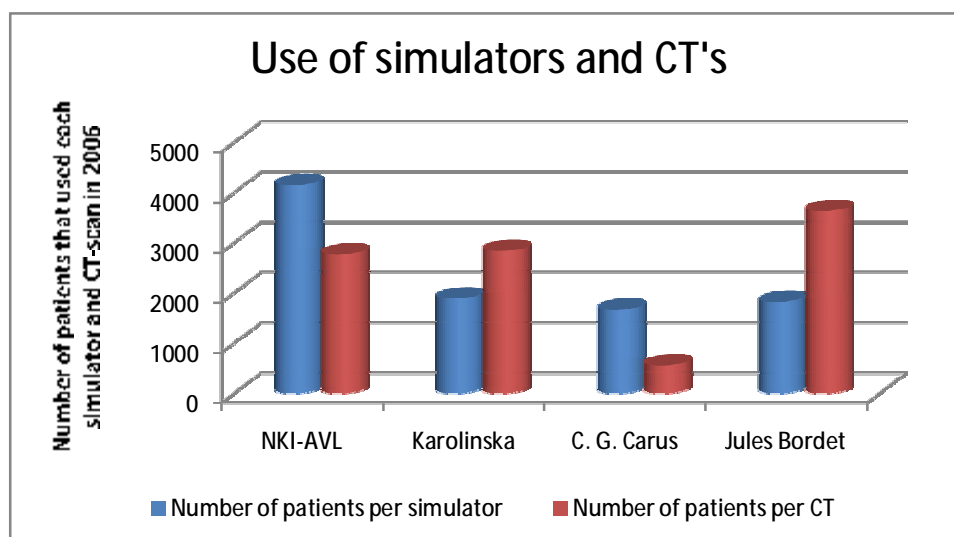


Figure 30: Number of patients that used the simulators and the CT in 2006.

As the use of the simulator is increasingly replaced by the use of the CT or even the PET-CT and the MRI, this indicator does not offer a correct image of the actual efficiency of the simulator. To be able to determine the efficiency of the simulator another indicator should be developed.

However the use of the CT-scans has become more important, due to the fact that the simulators are used less and less. As Figure 30 shows, the number of patients treated per CT-Scan is highest at Jules Bordet. This can be explained by the fact that Jules Bordet has a problem with space and therefore has only 0,5 CT-scan as they share the CT-scan with other disciplines. At Carl Gustav Carus the use of the CT-scan seems very inefficient, which can be explained by the fact that they have three CT-scans, which is a large amount for a rather small center as Carl Gustav Carus is?

MRI-scans and PET-scans

As the MRI-scan and PET-scan are more and more used for treatment planning in radiotherapy, we are also interested in the efficiency of these machines. Table 21 shows that only Carl Gustav Carus has a PET-scan at their department and that all the MRI-scans and the rest of the PET-scans are shared with the radiology department. At Karolinska a rough estimation is done of the percentage of time the radiotherapy is using the machines; the other centers are not able or willing to make such estimation. Yet, there was no research done in the amount of time the radiotherapy department uses from the radiology department, as this would broaden the scope of this research.

	MRI-scans	PET-Scans
NKI-AVL	0	0
Karolinska	0.1	0.15
Carl Gustav Carus	0	1
Jules Bordet	0	0

Table 21: Number of MRI -scans and PET-scans available for the radiotherapy department only

6.4.2 Downtime

The indicator downtime is defined as the *number of hours the LineAcc's were not in use due to planned and non-planned maintenance in 2006*. This is an indicator on MACRO level and measures the quality aspects efficiency and safety.

Figure 31 shows that the numbers of hours for planned and non-planned maintenance per LineAcc vary among the centers. A possible explanation for the deviation in non-planned maintenance is the difference in how the data is measured. At Karolinska and Carl Gustav Carus, the indicator was measured in days of downtime; a day of downtime being defined as a day for which less than one-third of the normal number of patients can be treated (Cionini, 2007). For the NKI-AVL we were able to define the exact number of hours of non-planned downtime, due to a very carefully kept diary of LineAcc maintenance. For Jules Bordet we were able to make an educated guess of the actual number of hours of non-planned maintenance. This means that for Karolinska and Carl Gustav Carus the number of hours for non-planned maintenance can be higher than displayed in Figure 31.

Another explanation for the large differences between the centers might be the interpretation of the term downtime. For example, this definition does not describe whether or not quality control and research activities should be seen as downtime or not. Because the possibility exists that downtime was interpreted differently by the various centers, the outcomes of this indicator has become less reliable.

As this data is not available, we base our conclusions on the data that is available. We can see that the NKI-AVL has the highest amount of planned maintenance, but also a reasonable amount of non-planned maintenance. At Carl Gustav Carus the amount of planned maintenance is the lowest of the partners. However, they also have the highest number of non-planned maintenance. When we look at the percentage of non-planned downtime from the total amount of downtime, we observe that the NKI-AVL, Karolinska and Jules Bordet are in the same range, respectively 14%, 12% and 18%. However Carl Gustav Carus has a much higher percentage, namely 45%. This makes us believe that Carl Gustav Carus is an outsider, which might be explained by the reasons mentioned above.

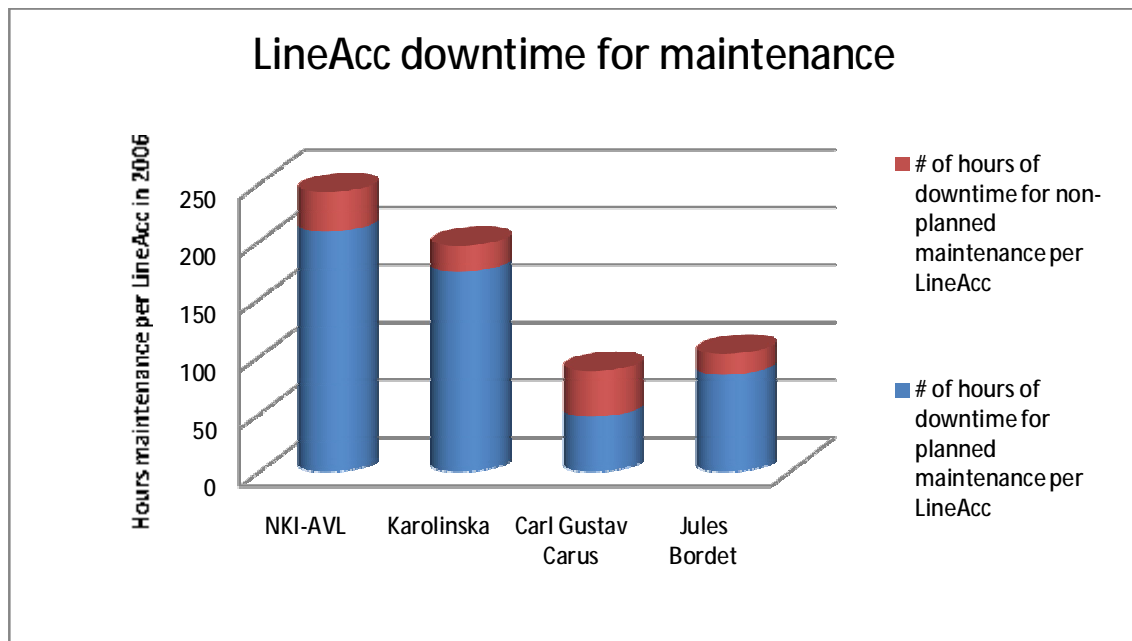


Figure 31: Downtime of the LineAcc measured in planned and non-planned maintenance for 2006.

6.4.3 Quality Control and dosimetry

The indicators *equipment quality control programs* and *instrumentation for dosimetry and quality control* from Cionini (2007) are measured by scoring the centers on a checklist, which can be found in appendices C.2 and C.3. These indicators are measured on a MACRO level and focus on the quality aspect safety. The scores of the different centers on this indicator are depicted in Figure 32.

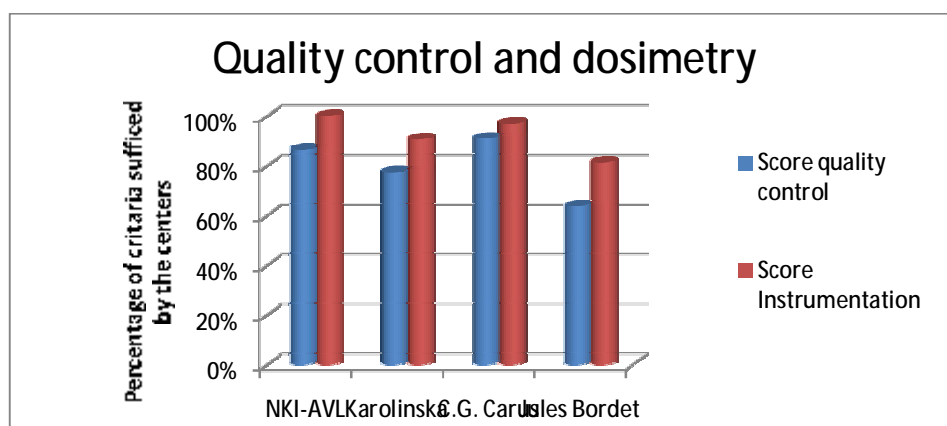


Figure 32: score on equipment quality control programs and instrumentation for dosimetry and quality control, based on Cionini (2007); Data shown is for 2008

Figure 32 shows that Jules Bordet scores somewhat lower than the other institutes, but this is mainly caused by the fact that Jules Bordet does not provide IMRT and IGRT treatments and therefore also does not have the according equipment.

Furthermore, we observe that the centers score higher on the instrumentation needed for dosimetry and quality control, than on the equipment for quality control programs.

6.4.4 Tolerance levels

The indicator *tolerance levels* describes three quality control points for the LineAcc's that should be checked on a regular basis by the clinical physicists of the centers. The maximum deviation of these points can never be more than the tolerance levels from the calibration norm. The points measured for this research are proposed by the NVRO (2007). This indicator is measured on MACRO level and focuses on the quality aspect safety.

Figure 33 shows that at the NKI-AVL the tolerance levels are lowest, and therefore we assume that at the NKI-AVL this might give a strain on the efficiency of the LineAcc's, as the lower the tolerance levels are, the more often the LineAcc's need to be adjusted, resulting in more downtime. At Jules Bordet the tolerance levels are highest, which could result in a lower quality of the treatments given. This relationship can however only be proven by studying the effectiveness of the treatments at the centers, which is not the aim of this study.

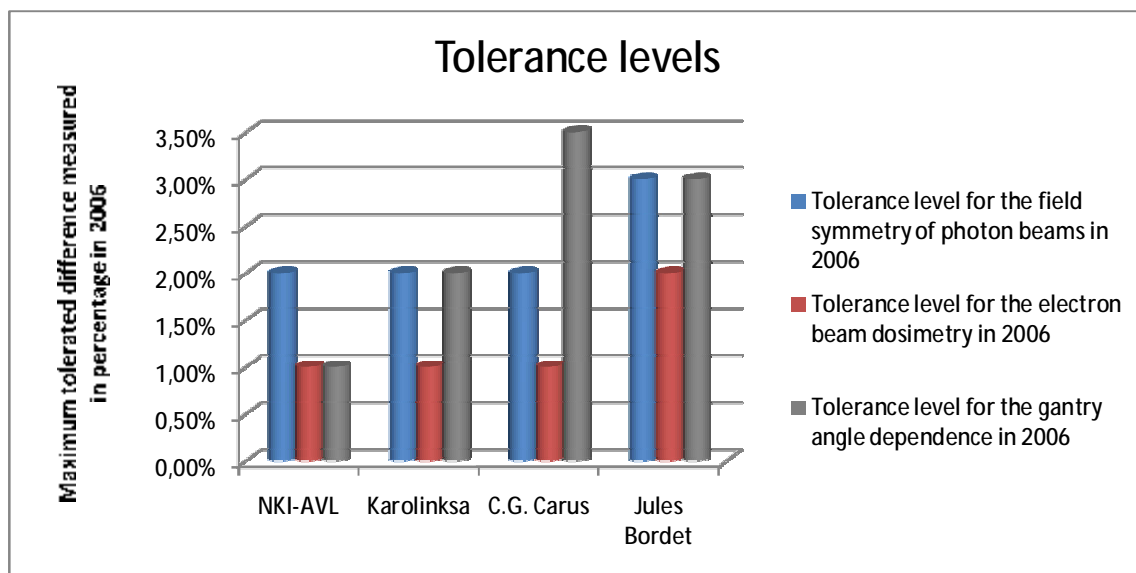


Figure 33: Tolerance levels for three quality control subjects; data for 2008.

6.4.5 Overhead radiotherapy department

The indicator *overhead of the radiotherapy department* measures the percentage of the total expenses from the radiotherapy department spent on issues not related to direct patient care. This indicator is measured on a MARCO level and describes the quality aspect efficiency.

When exploring the data, we discovered that it was quite a challenge to determine what exactly overhead costs are, as the definition: *expenses made for non patient care related issues*, seems to be too general. However, even when such a definition is defined more clearly, there is still the problem of the different ways the centers are keeping track of their expenses. For example, Jules Bordet does not distinct between depreciation of the machines and depreciation of the buildings, the first being directly related to patient care, while the second is not. Another example for Jules Bordet is that the expenses for the clinical physicist are not included in the radiotherapy costs, as they are actually hired from the physics department of the hospital. Furthermore, the data for Carl Gustav Carus is based on estimation from the head of the cancer center and therefore cannot be verified.

Based on the differences described above, we decided not to calculate the overhead percentage for the different centers, as we also cannot make any assumptions based on the found data.

6.4.6 Treatment planning

This paragraph describes the outcomes of the indicators *treatment planning with CT*, *treatment planning with MRI*, and *treatment planning with PET*. Each indicator is measured on MARCO as well as MESO level and describes the quality aspect safety, as the better the treatment plan fits the tumor, the less chance there is on over radiating the surrounding area.

MACRO level analysis

A radiation treatment plan can be based either on a simulator image or a CT-scan. An MRI or PET scan can also be used to retrieve more and better information about the localization of the tumor. The simulator and the CT are the more traditional bases for making treatment plans; MRI and PET are used to get additional information about the location of the tumor and are always used in combination with a CT-scan.

Figure 34 shows that solely a CT-scan is still the most often used imaging technique for making treatment plans. At the NKI-AVL, MRI and PET are used to retrieve extra information in respectively 8% and 1 % of the treatment plans. At Karolinska for 2% of the treatment plans an MRI was used and for less than 1% a PET scan was used. At Carl Gustav Carus 9% of the plans are based on a MRI and 16% are based on a PET-CT. At Jules Bordet 3% of the plans were based on combined PET-CT in 2006.

When we would determine the number of plans for 2008, they will probably be higher, as the use of new imaging techniques is a fairly recent development and therefore was not used very often in 2006.

The high number of PET-CT's at Carl Gustav Carus can be explained by the fact that the radiotherapy department owns the PET-CT, and therefore also controls the planning of the

machine. At Jules Bordet 40% of the plans are made on the traditional simulator, where none of the other centers uses this machine for the actual planning of the treatments.

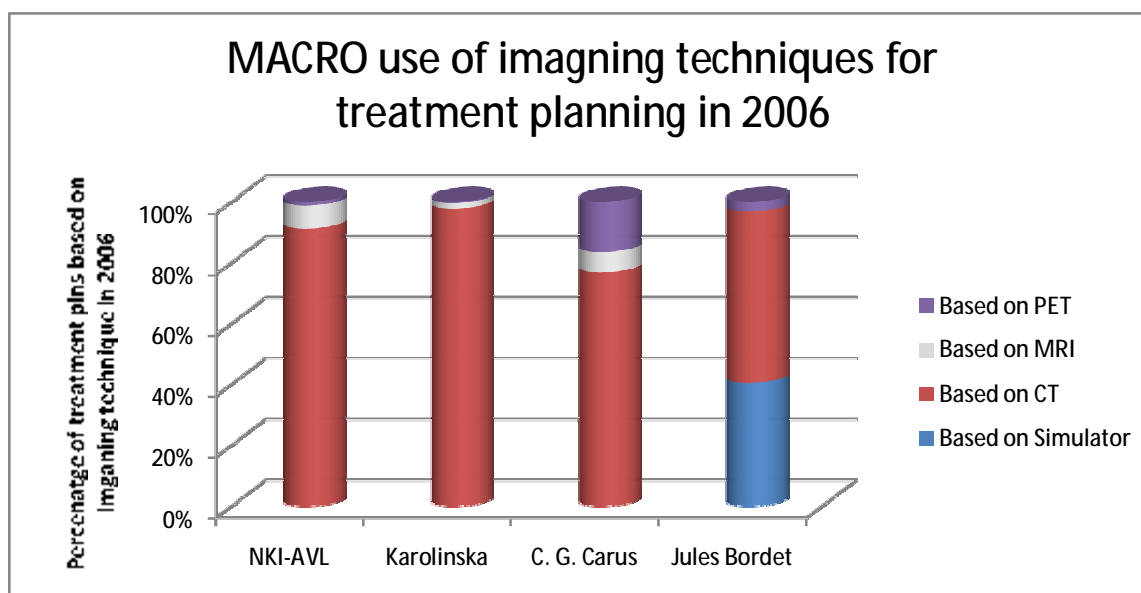


Figure 34: MACRO treatment plans based on the different imaging techniques in 2006.

MESO level analysis

Figure 35 shows the treatment planning used on MESO level. We observe that also on a MESO level, the CT is used most for treatment planning, except for the breast cancer treatment planning at Jules Bordet and Prostate cancer planning at the NKI-AVL.

Determining the exact amount of plans based on an MRI for prostate cancer in the NKI-AVL was difficult, as this is not notated in the general information system. The clinical physicist of the NKI-AVL estimated that in 2006 for approximately 80% of the prostate cancer patients a MRI was made. This number accounts for the large number of MRI scans made for prostate cancer patients at the NKI-AVL.

Although Karolinska uses the MRI for breast cancer patients and both scans for prostate cancer treatment planning in 2006, the number of plans based on these imaging techniques lacks behind on the number of scans made by the NKI-AVL and Carl Gustav Carus.

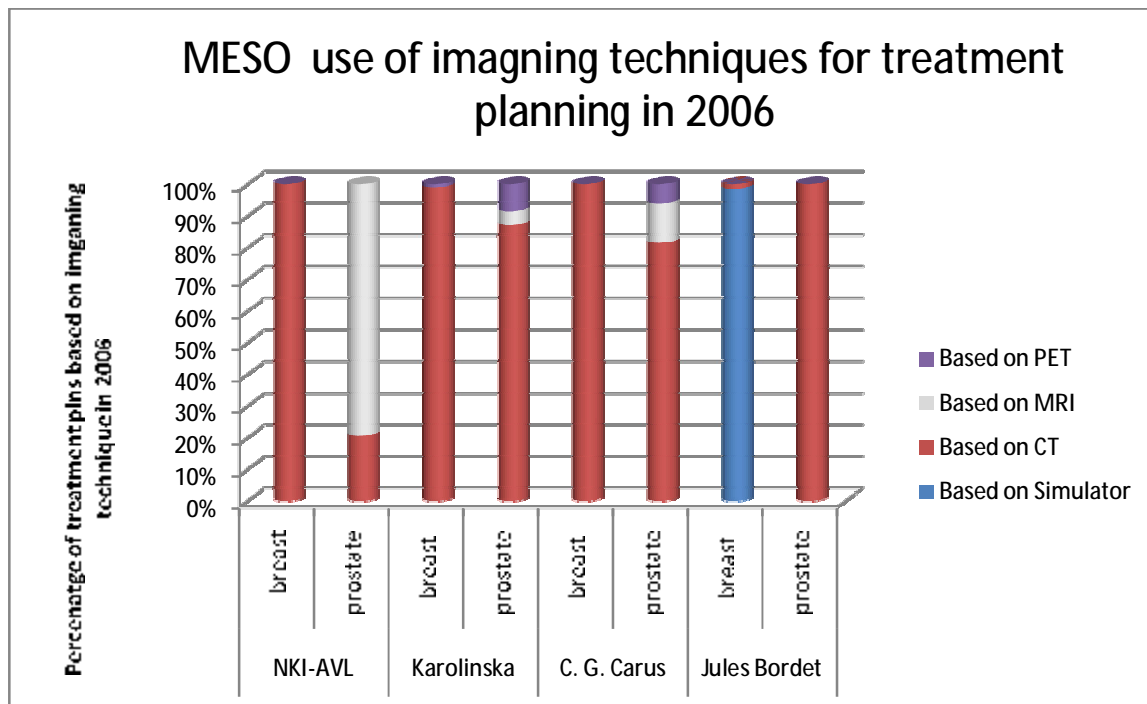


Figure 35: MESO treatment planning

6.4.7 New technologies

The indicator *new technologies* describes the use of Intensity Modulated RadioTherapy (IMRT), Image Guide RadioTherapy (IGRT) and Adapted RadioTherapy (ART) at the centers. This indicator is measured on a MESO level and describes the quality aspect safety, as these technologies make it possible to deliver the radiation more precisely targeted and with a more precise dose than the conventional techniques, resulting in less healthy tissue radiation.

Figure 36 shows the use of these new technologies at the centers at a MESO level. We observe that the NKI-AVL lays ahead when it comes to the use of IMRT for both breast and prostate cancer patients, while Carl Gustav Carus lays ahead in the use of IGRT and ART for prostate cancer patients. At Karolinska the technologies are in use, but only for prostate cancer patients and with much fewer patients than the NKI-AVL and Carl Gustav Carus. Jules Bordet was furthest behind as none of the mentioned technologies were used in 2006.

An important factor that enables the use of these new techniques is the availability of LineAcc's equipped with a CONE BEAM. The availability of these CONEBEAMS explains partially the differences in use of the new technologies between the centers.

In 2006 Jules Bordet did not have any LineAcc's with a CONE BEAM, which explains the fact that for 2006 they are not using these technologies. In 2007 IMRT has been introduced at Jules Bordet, but IGRT and ART treatments can only be started when the LineAcc with a CONE BEAM arrives in 2008.

Carl Gustav Carus used the fact that they are ahead in the use of IGRT and ART for prostate cancer patients for their marketing as they made a press release on the use of the new technologies, which explains their high scores on this indicator.

The low score of Karolinska on this indicator can be explained by the fact that in 2006 they had only one out of the twelve LineAcc's equipped with a CONE BEAM. In 2008 this number will rise to four.

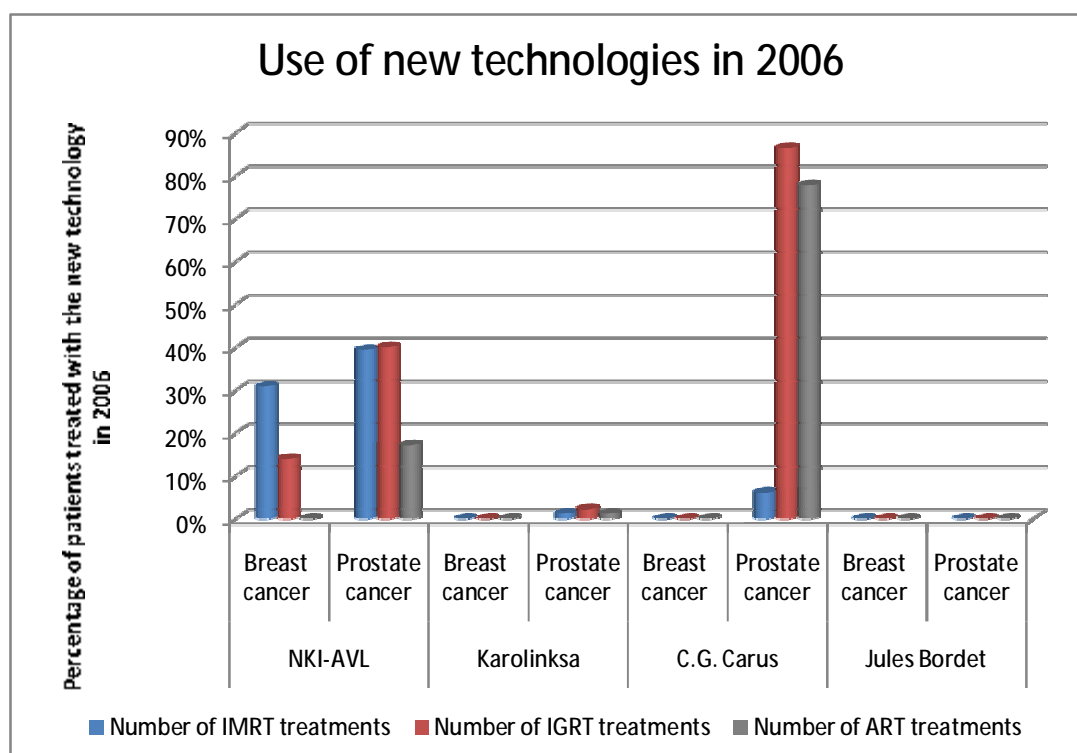


Figure 36: Percentage of treatments with new technologies IMRT, IGRT and ART; measured on a MESO level

Segments per treatment for IMRT

For IMRT an individual indicator is developed, which is *number of segments per treatment plan*. This indicator stems from Cionini's indicator number of fields, which is no longer interesting, as IMRT has partly taken over this technology. Although this indicator might give a clear view of the quality of the individual treatment plans, it was not possible to collect the data needed for the calculation of the outcomes, as this data is not reported in the information systems. Next to this, only the NKI-AVL is the only centre experienced in the use of IMRT and therefore it is too early in time for this indicator to be of real comparison value.

7 Conclusions and recommendations

This chapter describes the conclusions that are derived from the analysis described in the previous chapter and formulates recommendations for each of the partners and for further research. The conclusions are outlined in paragraph 7.1 and the recommendations in paragraph 7.2.

7.1 Conclusions

First, conclusions for the employee results are formulated (7.1.1), then for the customer results (7.1.2) and society results (7.1.3), and finally for the key-performance results (7.1.4). The conclusions are described per indicator, and when indicator outputs influence each other, these effects are also described.

7.1.1 Employee results

This paragraph draws conclusions for the employee results: workload, work pressure, turnover and sick leave. Conclusions are drawn on a MACRO level.

Workload

Based on the data found for this research, we conclude that the workload, in terms of patients per employee, varies greatly between the benchmarking partners. This makes us aware of the possibility that there are other factors contributing to the workload than just the number of patients per employee. An import factor: different responsibilities of the employees, has been mentioned.

A second factor that has not been taken into account is the complexity of the treatments. Unfortunately there is no international definition available for determining the differences in treatment complexity and therefore also this factor could not be taken into account when analyzing the data.

Based on the two factors mentioned above, the reliability of the performance indicator *patients per employee* is presumable low for determining at which centre the workload is highest. Therefore, we are careful with drawing conclusions based on the found output for this indicator and we do not determine improvement actions for the centers.

Work pressure

The number of hours of overtime worked by the employees was not retrievable from the current information systems at the different centers. This means that for this research the indicator work pressure was not useful. To be able to use this indicator in the future, the overtime worked by employees should be reported accurately by the different centers.

Turnover and sick leave

Due to lack of data, no conclusions can be drawn regarding the indicator sick leave. A better reporting system is necessary to be able to analyze this indicator in future research.

For the indicator turnover, we found a low rate at Carl Gustav Carus. Although the high unemployment rate in Western Germany could partially explain this low rate, other factors might also be involved.

For the NKI-AVL we found a turnover rate, which is higher than at the other centers (for which this data was available). We were not able to determine if the workload or the work pressure is a reason for this high turnover, due to the reliability of these indicators.

A possible explanation for this high turnover rate is the unemployment situation in the Netherlands, as there currently is a low unemployment rate. This means that it is relatively easy for employees to find another job. Recently an employee satisfaction study is performed at the NKI-AVL. This report might contain other explanations for the high turnover rate.

7.1.2 Customer results

This paragraph draws conclusions for the customer results: patient satisfaction, risk analysis, electronic patient record, multidisciplinary approach, appointment planning system, and waiting times. There are indicators on both MACRO and MESO level.

Patient satisfaction

When compared to the other centers, the NKI-AVL is furthest in the patient satisfaction quality cycle. Carl Gustav Carus follows and Jules Bordet and Karolinska are the least involved in measuring patient satisfaction in a proactive way. When we look at the patient satisfaction continuous quality cycle, we observe that each of the centers can still, in a more or less way, improve their patient satisfaction measurement methods.

Risk analysis

The Karolinska and the NKI-AVL have a relative comparable risk analysis system, and are in the third quarter of the continuous quality cycle. Finishing this cycle could provide more insight in the effects of the risk analysis on the decrease in misses and near-misses. Carl Gustav Carus and Jules Bordet have much room for improving their risk management system.

Electronic patient record

We conclude that the NKI-AVL is the only partner that does not have a complete EPR in place that has the same functions as a paper patient record. According to the NKI-AVL the missing functionalities will be introduced within the next couple of years.

None of the centers shares their EPR with others that require their information, such as general practitioners or physicians in other hospitals. The general idea is that this is not going to be the case in the near future, due to the extensive privacy issues concerned. Some of the partners see a role for the European Union to regulate and standardize the privacy issues.

Furthermore, in 2008, all centers have a different EPR; Jules Bordet has developed it in house, and the other partners use an EPR from a commercial organization. This will increase the problems with connecting the EPR's in the future.

Appointment planning system

Two different appointment-planning systems are observed. At the NKI-AVL and Carl Gustav Carus patients receive their appointment schedules once a week and at Karolinska and Jules Bordet, patients receive their appointment schedule at the beginning of the treatment.

Based on the quality aspect patient-centeredness, the latter system is preferred, as this allows patients to plan their normal life activities around the treatments. Based on the quality aspect efficiency, the first system is preferred, as this leaves more room for last minute changes in the treatment schedules of patients.

Multidisciplinary meetings

We presume that at Jules Bordet the multidisciplinary meetings are best organized, as they have most different professionals present at their meetings and they also use the EPR as input and output system for the results. At the NKI-AVL, Karolinska and Carl Gustav Carus the organization of the multidisciplinary meetings can be improved by having more professionals present. At the NKI-AVL using the EPR, instead of the paper chart, for distributing the outcomes could also improve the quality of the multidisciplinary meetings.

Waiting times

For breast cancer patients the NKI-AVL and Carl Gustav Carus seems to perform better than Karolinska and Jules Bordet, especially for W1 and W2. For W3 the differences are less obvious.

For prostate cancer patients the NKI-AVL is performing better than Carl Gustav Carus and Jules Bordet for W2 and W3, but the Carl Gustav Carus and Jules Bordet perform better for W1.

Based on the found differences between the registrations of the waiting times in the centers and the problems with the data from the prostate cancer patients from Karolinska, we conclude that the definitions of Cionini (2007) are somewhat ambiguous. For W3 the data is more reliable, as each center was able to measure the T3 and T4 according to the definition by Cionini (2007).

Concluding, based on the found data, differences are observed in the waiting times at the centers. However, because the T's determined by Cionini (2007) are ambiguous, conclusions based on this data should be drawn with great care. Keeping this in mind, there is an indication that Karolinska and Jules Bordet can improve W1 and W2 for breast cancer patients, and there is an indication that the NKI-AVL can improve W1 for prostate cancer patients.

7.1.3 Society results

This paragraph draws conclusions for the society results: publications and clinical trials. Both indicators are measured on MACRO and MESO level.

Publications

Two indicators for publications: *number of publications* and *impact points per publication* are taken into account for this research. Based on the outputs of these indicators, we presume

that the NKI-AVL has both the highest efficiency as they produce the most articles in a year, and the highest quality in terms of impact points per article. However, we do not take into account the number and impact points from the publications of OncoRay, connected to Carl Gustav Carus.

Based on the size of Karolinska, we presume that they are lacking behind when it comes to publishing articles, as well as Jules Bordet when compared to its peer: Carl Gustav Carus.

Clinical trials

The number of patients included in a clinical trial turned out to be an indicator that was difficult to measure for two of the four centers. Carl Gustav Carus was able to give an estimation, Jules Bordet was not. Furthermore, we presume that data collection over 2006 only, was a too short period of time to have a reliable figure on the average number of patients included in a trial.

Based on the indicator outputs, we presume that a separate research department for radiotherapy, such as the NKI-AVL and Carl Gustav Carus have, has a positive effect on the number and quality of publications and on the number of patients included in a clinical trial.

7.1.4 Key performance results

This paragraph draws conclusions for the key performance results: efficient use of the resources, LineAcc downtime, quality control and dosimetry, tolerance levels, overhead of the radiotherapy department, treatment planning, and new technologies. There are indicators on both MACRO and MESO level.

Efficient use of the resources

LineAcc's

The indicator *number of patients treated per hour that the LineAcc is in use in 2006* is preferred over the indicator *number of patients treated per LineAcc working hour in 2006*.

When we look at the outcomes of the first indicator, we observe that at Jules Bordet the LineAcc's are used in the most efficient way, as they treat approximately 18% more patients per hour than Karolinska, which scores the lowest. Therefore, Karolinska has the best reason to try to increase the number of patients treated per LineAcc per hour and hereby improve their outcome of this indicator.

Jules Bordet scores high on this indicator, which might be explained by the fact that they perform a lot of their maintenance outside operating hours of the LineAcc.

Simulators and CT's

The NKI-AVL is using both the simulators and the CT-scans efficiently, while the simulators and the CT-scans at Carl Gustav Carus have the lowest efficiency. Jules Bordet uses their CT-scan most efficient, which is probably induced by the fact that there is no room for an extra CT-scan. Therefore, they have to work efficient in order to treat all their patients.

MRI-scans and PET-scans

In most cases, the radiotherapy department does not own the MRI-scans and PET-scans, and therefore no data is available on the exact use of these machines by the radiotherapy

department. As it would broaden the scope of this research to gather the data needed to perform these analyses, no conclusions are drawn about this indicator.

LineAcc downtime

We presume that despite the difference in how the data is measured, and the interpretation of the term downtime, the NKI-AVL and Karolinska perform the most planned maintenance per LineAcc. However, this does not result in a lower amount of hours spent for non-planned maintenance. Because non-planned maintenance can give more problems than planned maintenance, we presume that Jules Bordet is performing best when it comes to maintenance efficiency, as they have the lowest non-planned maintenance.

Quality control and dosimetry

Based on the data found on these indicators we assume that, despite adjustments by the clinical physicists of the NKI-AVL, these indicators are still not discriminating enough in order to base recommendation on the outcomes.

Tolerance levels

Based on the output of the indicator, the NKI-AVL has the narrowest tolerance levels and Jules Bordet the widest. This means that these levels might result in a higher strain on the efficiency for the NKI-AVL. The tolerance levels that the NKI-AVL applies to their LineAcc's are stricter than the national standard, which means that the NKI-AVL has room to increase these levels if necessary. However, the results of this research are not valid enough to base such an important decision upon.

At Jules Bordet, tolerance levels are wider. Therefore, we assume that the LineAcc's do not have to be adjusted to these levels quite as often as the LineAcc's at the NKI-AVL. This might explain the good score of Jules Bordet on LineAcc downtime.

Based on this analysis, we see that for this indicator a center has to make a carefully weighted decision on lowering the tolerance levels, which increases the quality of the treatment, but might lower the efficiency or increasing the tolerance levels, which has the opposite effect.

Overhead of the radiotherapy department

Due to problems with the definition of the term overhead and large differences between the centers in how they keep track of their expenses, there is too little information to base a conclusion upon.

Treatment planning

MACRO

For this indicator we observe the use of four imaging techniques: simulation, CT, MRI and PET. We observe that Carl Gustav Carus is ahead in using the range of imaging techniques available for treatment planning, especially the PET-scan.

The NKI-AVL uses all the imaging techniques, but the PET scan is not used as often as Carl Gustav Carus does. Karolinska also uses the different imaging techniques, but lacks behind

on the number of cases in which this happens. Jules Bordet does not use MRI and PET for making treatment plans, and relies much more on the simulator for making treatment plans, which are of a lower quality than plans based on a CT-scan.

The fact that Jules Bordet only has 0,5 CT-scan available, means that they probably do not have the opportunity to give every patient a CT-scan. This means that they have to weigh carefully which patient to simulate with a CT-scan image and which can suffice with a simulator image.

MESO

Based on the assumption that treatment plans made with a CT-scan together with a MRI or PET-scan, are of a higher quality than plans based on a CT-scan alone. We state that the quality of the treatment of prostate cancer patients was highest at the NKI-AVL. Furthermore, the quality of the treatment of breast cancer patients is highest at Karolinska, as they are the only one using all the imaging techniques for breast cancer patients. The quality of the treatment plans for breast cancer patients at Jules Bordet is lowest, as these plans are primarily based on simulator images.

New technologies

We assume that the use of the new technologies IMRT, IGRT and ART improve the quality of care. Based on the outcomes, we determine that improvement can be made at Karolinska and Jules Bordet, as they hardly use these new technologies. We presume that for this research, the NKI-AVL is the best practice for the use of IMRT in breast cancer patients and Carl Gustav Carus is the best practice for the use of IGRT in prostate cancer patients.

7.2 Recommendations

This paragraph defines improvement suggestions for each of the benchmarking partners. The recommendations for the NKI-AVL are described in paragraph 7.2.1, for Karolinska in 7.2.2, for Carl Gustav Carus in 7.2.3, and for Jules Bordet in 7.2.4. In paragraph 0 also recommendations for future research are formulated.

7.2.1 Recommendations for the NKI-AVL

Register what improvement actions follow from the patient satisfaction questionnaires and from the risk analysis system, hence finishing the quality cycle

Based on the analysis we found that the NKI-AVL is a best practice for the indicator patient satisfaction, since the analyses of the patient satisfaction questionnaires lead to improvement suggestions. However, it might help to track the improvement suggestions and determine if they actually lead to improvements. The outcomes of this analysis can be used for marketing purposes, as patient a high patient satisfaction helps to get more patients to the NKI-AVL.

For the risk analysis the NKI-AVL is performing as one of the best, as they have a clear misses and near-misses reporting system that is available online for all employees. For the risk analysis methodology, we presume that using the outcomes of the system can improve the insight of the centre in the number of misses and near-misses that have led to improvement actions. Determining these improvement actions is the final step in the quality cycle. As the NKI-AVL soon starts with the implementation of a hospital wide safety management system, this final step could be taken into account in the development of this system.

Upgrade the EPR so that it can be used in multidisciplinary meetings.

At this moment the EPR at the NKI-AVL is not functioning as a *complete* EPR. The NKI-AVL plans to implement these functionalities within the coming years, but as they are already behind on the other centers, we suggest speeding up this process.

The availability of a complete EPR is important for quality of the multidisciplinary meetings. By using the EPR online during the multidisciplinary meetings, the NKI-AVL can ensure itself that there are no mistakes made when recording the treatment plan for the patients. Both Karolinska and Jules Bordet have experiences with this way of organizing the multidisciplinary meeting and can therefore be used as best practices to learn from.

Improve the appointment planning system by making appointments earlier available for patients.

To improve the quality aspect patient-centeredness, we suggest a change in the patient appointment planning system. At this moment patients receive their radiation treatment appointments one week in advance. Being able to provide these appointments earlier to the patients is assumed to be more patient-centered. This is supposed to give patients more control over their own agendas. A pilot is suggested with a small group of patients, to find out if a new appointment planning system reduces the number of appointments to be rescheduled. For this pilot, curative patients who are over 65 years old can be included. The age limit of 65 is used, as it is probably the younger patients who are suggested to have a

busier schedule, as they might be working or have young children. Palliative patients are excluded from the pilot, as their sessions often do not take longer than five days. At Jules Bordet a program connected to the Varian system is used to plan the patients' weeks in advance. Therefore Jules Bordet is a best practice for appointment planning, from which the NKI-AVL might be able to learn.

Register waiting times for all patients

As the waiting times of the patients an important indicator for patient-centeredness, it is important to know what the waiting times are for the individual patients. Therefore they should be registered for all patients, and not only for breast cancer and prostate cancer patients.

Determine if planned downtime can be decreased

We determined that the NKI-AVL has the most planned downtime per LineAcc. A possible explanation for this high downtime is the fact that the NKI-AVL has lower tolerance levels, which could explain more adjustments to the LineAcc's. Decreasing the downtime improves efficiency and therefore this option should be explored, for which Jules Bordet could be a best practice to learn from.

7.2.2 Recommendations for Karolinska

Provide insight in number of radiation oncologists

In Sweden there are no radiation oncologist, only medical / radiation oncologists. This results in a problem with a number of the indicators for which the number of radiation oncologist is either the nominator of the denominator. Therefore we recommend developing a method which makes it possible to give an accurate estimation of the percentage of time a radiation oncologist spends on radiotherapy related subjects. This enables future researchers to make international comparisons for employee results.

Improve the risk analysis system by registering what improvement actions follow from this system

For the risk analysis Karolinska is performing as one of the best, as they have a clear misses and near-misses reporting system, that is available for all employees. For the risk analysis methodology we presume that using the outcomes of the system can improve the insight of the centre in the number of misses and near-misses that lead to improvement actions.

Determine if the data collection for waiting times is reliable and improve the waiting times for breast and prostate cancer patients

Although there was no full insight in the waiting times data from Karolinska, we found that based on the data provided by Karolinska they are not performing as good as the other centers when it comes to the waiting times. Therefore we suggest that first the data collection method for the waiting times is reviewed to determine where the large difference in the waiting time for prostate patients comes from, and try to find a solution for improving this data. The next step should be to find an explanation for the high waiting times. Due to the lack of insight in the actual data, we are not able to make more specific recommendations.

Find ways to improve the radiotherapy research activities

In this area improvement options for Karolinska can be identified, as we found in this research that Karolinska is not performing according to what can be expected. When we look at the absolute number of publications, we expect Karolinska to have a high score, as they are the largest institute. However, they published fewer articles than Carl Gustav Carus, which is a smaller institute and for which the publications from OncoRay are not taken into account. Also on the indicator impact points per article, Karolinska stays behind on the NKI-AVL with more than 50%. Finally, the percentage of patients included in a trial was less than 1% on both MACRO and MESO level. Therefore we recommend Karolinska to put effort in improving all aspects of their research activities. Both the NKI-AVL and Carl Gustav Carus could be used as best practices to learn from.

Improve LineAcc efficiency

Karolinska should first determine whether the low outcome of this indicator is caused by the recent problems with the older LineAcc's. When these are determined to be a cause of the problem, this could be an incentive for Karolinska management to invest in new LineAcc's. When the relation between older LineAcc's and the low outcome of this indicator cannot be determined, other factors that influence the efficiency should be researched.

Use the new technologies introduced in radiotherapy

We found that Karolinska does not use new technologies for breast cancer patients and only little for prostate cancer patients in 2006, for which there might be a relation with the low results in research. However, to be able to perform as one of the best radiotherapy centers in Europe, new technologies should be used and developed. For the use of IMRT the NKI-AVL can be a best practice and for IGRT and ART, Carl Gustav Carus is a good partner to learn from. However, it is important not only to focus on the technologies mentioned in this research, but also look ahead and prepare for using technologies that are now in an experimental phase.

7.2.3 Recommendations for Carl Gustav Carus

Analyze patient satisfaction questionnaires and find improvement options

At Carl Gustav Carus patient satisfaction questionnaires are dispersed, but not analyzed. To be able to improve the patient satisfaction, analyzing these patient satisfaction questionnaires can lead to improvement actions. They can also show areas patients are satisfied with, which can be used for marketing.

Develop and implement a risk management system

We found no structured methodology for analyzing risks at Carl Gustav Carus. Implementing a risks management system to keep track of misses and near-misses at the centre could pinpoint problems in the different processes inside the centre. The NKI-AVL and Karolinska have a fairly extensive risk management system and can therefore be the best practices Carl Gustav Carus can learn from. To get a head start over the other centers, they should make sure that the methodology for analyzing risks includes the reporting of the improvement actions that stem from the risks analysis system.

Improve the appointment-planning system by making appointments earlier available for patients.

To improve the quality aspect patient-centeredness, we suggest a change in the patient appointment planning system. At this moment patients receive their radiation treatment appointments one week in advance. Being able to provide these appointments earlier to the patients is assumed to be more patient-centered. This is supposed to give patients more control over their own agendas. A pilot is suggested with a small group of patients, to find out if a new appointment planning system reduces the number of appointments to be rescheduled. For this pilot, curative patients who are over 65 years old can be included. The age limit of 65 is used, as it is probably the younger patients who are suggested to have a busier schedule, as they might be working or have young children. Palliative patients are excluded from the pilot, as their sessions often do not take longer than five days. At Jules Bordet a program connected to the Varian system is used to plan the patients' weeks in advance. Therefore Jules Bordet is a best practice for appointment planning, from which Carl Gustav Carus might be able to learn.

Improve the efficiency of the CT's

Based on the data found for this research, the CT's at Carl Gustav Carus are not used efficiently, as they diagnose the least patients per CT. A way to improve the efficiency of the CT's is to share the machine with other disciplines in the hospital.

Find ways to decrease the non-planned maintenance

We found that at Carl Gustav Carus the number of planned-maintenance hours is lower than at the other centers. However, the number of non-planned maintenance hours is highest. The assumption is that the less hours of planned-maintenance are used, the more hours of non-planned maintenance will be necessary. Therefore a small increase in the number of planned maintenance hours might decrease the number of non-planned maintenance hours. At Jules Bordet they have in total a little more hours of downtime, but a much better proportion between planned and non-planned maintenance, therefore Carl Gustav Carus might be able to learn from them.

7.2.4 Recommendations for Jules Bordet

Report and analyze near-misses in the new quality management system

At Jules Bordet there are different systems for risk management. All of the systems aim at misses; near-misses are not analyzed. As Jules Bordet started a project to improve the quality management systems, we recommend including the reporting of near-misses in this system. Analyzing near-misses can lead to improvement actions, which might avoid real-misses. At the NKI-AVL and Karolinska the risks management systems are further developed, which mean that Jules Bordet might be able to learn from them.

Review number of professionals present at multidisciplinary meetings

At Jules Bordet there are many different professionals present at the multidisciplinary meetings. This means that the ideas of all these professionals can be taken into account when taking the treatment decisions. However, we presume that there is an optimum for the number of different professional present (quality) and the efficiency of the meeting. As the

number of professionals present is much higher than at the other centers, they might want to review if the presence of all these professionals is contributing to the quality and not decreasing the efficiency.

Improve the efficiency of the simulator

We found that the use of the simulator is not very efficient at Jules Bordet. A reason for this low number of patients diagnosed with the simulator might be the fact that patients get a time slot of forty-five minutes at the simulator. These forty-five minutes are also used to prepare the support and immobility devices in the same room. At this moment there is no other option due to lack of space, but when Jules Bordet moves to the new building, it might be a good idea to make a separate room for preparing these devices, so the simulator can be used more efficient.

Use the new technologies introduced in radiotherapy

We found that Jules Bordet was not making use of the new technologies for breast cancer and for prostate cancer patients in 2006. To be able to perform as one of the best radiotherapy centers in Europe, new technologies should be used and developed within the centre. This also means that financial means should be available to purchase resources necessary to provide these high technological treatments. For the use of IMRT the NKI-AVL can be a best practice to learn from and for IGRT and ART, Carl Gustav Carus is a good partner to learn from. However, it is important not only to focus on the technologies mentioned in this research, but also look ahead and prepare for using technologies that are now explored.

8 Discussion

In this research two models have been used, which are: the benchmarking process model of Van Hoorn (2006), and a framework for benchmarking based on the EFQM Excellence model combined with the transformation process model in which performance indicators are developed. In this chapter the use of these models is discussed and, where necessary, adjustments are suggested for use of these models in future research. Paragraph 7.1 discusses the model of van Hoorn (2006) and in paragraph 7.2 the framework and indicators used for this research are redefined.

8.1 Adjusted benchmarking process model

Although the benchmarking process model of Van Hoorn was a good guideline for performing this research, some adjustments can improve this model for use in future benchmarking research.

Contingency factors are constant factors

During the literature review of the contingency theory, questions raised regarding the use of the term contingency factors, which are developed to describe the fit between the structure of the organization and the internal and external circumstances. For a benchmark we are not interested in the internal fit in one organization, but in the differences between several organizations. Therefore, we suggest not using the term contingency factors, but the term constant factors (versus variable factors). The constant factors describe what cannot easily be changed by the organizations. Therefore, recommendations for the academic radiotherapy centers involved in the research should not be based on the constant factors, as these are difficult to change.

Stakeholder analysis

While the research starts with describing the process and the contingency factors, we found that information was needed from employees of the centers (the stakeholders) in order to describe these factors. So the stakeholder analysis was actually already performed during this phase of the research. Therefore, for future research we suggest to accomplish the stakeholder analysis earlier in the benchmark, at least before the process and contingency factors are described. Hence, the stakeholder analysis should become a separate step in the process model.

Develop a framework

The fourth step of Van Hoorn's benchmarking process model is developing comparable performance indicators. Performing only this step can result in missing some aspects of the process being benchmarked. To avoid this, we add an extra step in the model of van Hoorn, which is: developing a benchmarking framework. The added value of a benchmarking framework is that a better connection between the different indicators can be generated and it makes sure that the research focuses on all aspects of the process being benchmarked.

Evaluate implementation

The last step of the benchmarking process described by van Hoorn is the implementation of the improvement actions. Hence, van Hoorn does not evaluate whether or not the improvement actions determined at the end of the benchmark actually led to the improvement of the quality and efficiency. Therefore, we add an extra step at the end of the model in which the implementations are evaluated, as this really shows the results of the benchmarking study.

Emphasize continuity

Almost every benchmark concludes that there were indicators developed that did not result in improvement actions for the partners. A first explanation is that the definitions for some of these indicators were not clear, and therefore the partners were not (yet) able to provide the necessary data. Second, for some of the indicators the outputs proved not to discriminating. Both were also witnessed during this study.

However, with the right adjustments, these indicators can result in improvement actions in future benchmarking research. Repeating this benchmark in order to retrieve more leads for improvement emphasizes the continuity of the benchmarking process, just like this is mentioned in benchmarking literature.

A new benchmarking process model

Implementing the adjustments described above in benchmarking process model of Van Hoorn (2006) results in a new benchmarking process model as presented in Figure 37.

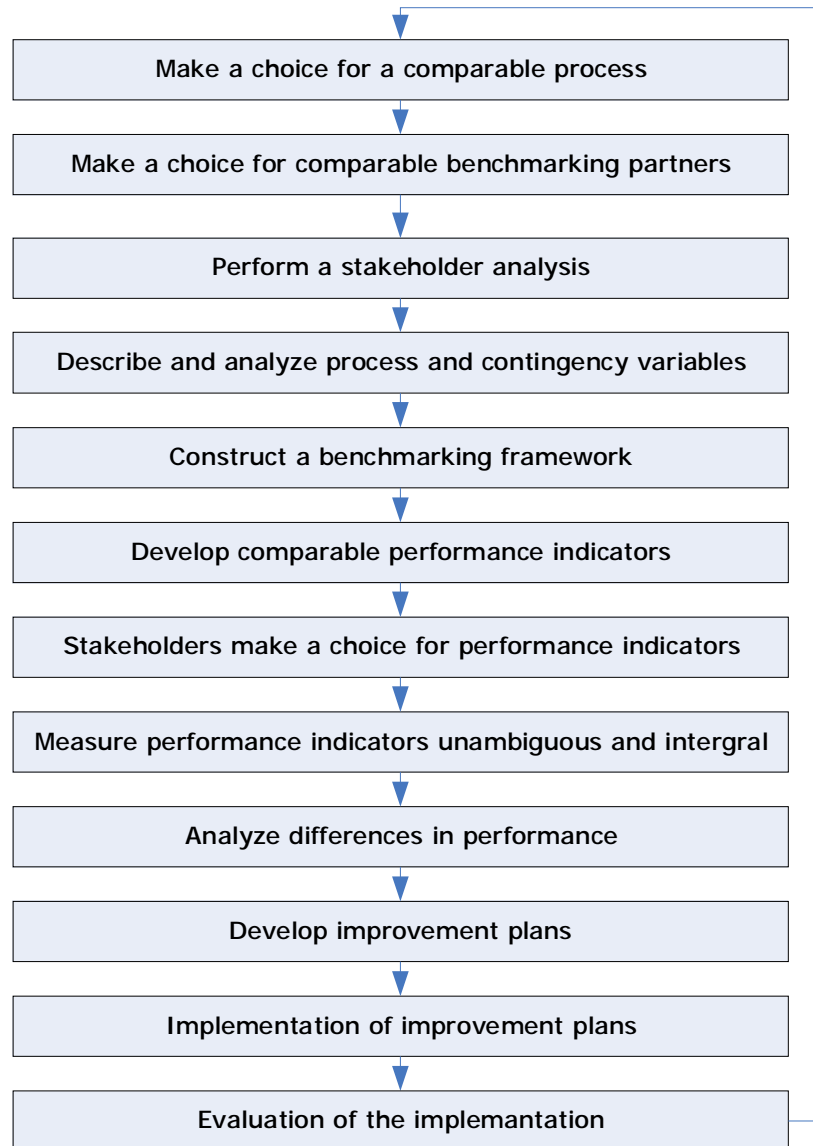


Figure 37: Adjusted benchmarking process model

8.2 Adjusted methodology

This paragraph describes changes in the methodology that improve the data needed for benchmarking radiotherapy departments.

Visit the benchmarking partners two times instead of once

For this research one visit was paid to the three benchmarking partners of the NKI-AVL. For future research it is advised to plan at least two visits. The first visit can be paid to the centers when the long-list of indicators is finished. During this visit the long-list should be discussed with the stakeholders of the centre. This way, the definitions of the indicators can be formulated in such a way that they can be measured at each institute, and the process and constant factors for the centre can be defined. The second visit can focus primarily on collecting the data for the indicators.

Measure the indicators prospectively instead of retrospectively

For a number of indicators the retrospective focus of the research resulted in problems with gathering the data. For most of the indicators looking up the data in already existing documents takes more time than when it is measured for the purpose of the study only. This way we can also make sure that the data gathered is actually required, instead of finding the most corresponding data. Two examples of indicators for with the retrospective focus gave problems are described:

- Waiting times: when the definitions of the T's are known beforehand, it is much easier to prospectively gather this data for a number of patients for a certain amount of time.
- New technologies: we discovered that what is a new technology now might have been non-existing two years ago. When we determine what the new technologies are and measure these prospectively, a better distinction can be made.

Use different tumor groups for analyses at MESO level

Based on the number of patients diagnosed with breast cancer and prostate cancer, these forms of cancer are chosen as the MESO level of this research. However, during the research we found that especially prostate cancer is not the best candidate, as the urgency for treatment is not very high. This originates from the fact that prostate cancer tumors are usually slowly growing tumors.

For future research patients with head and neck cancer might be a better group, as these patients do have a high urgency but there are also a lot of new technologies used for this group of patients. Another option might be lung cancer patients, as for this group there is also a lot of new technologies available and the group is quite large.

Palliative patients are probably not a good choice. However, they have a very high urgency. Usually there are not many new technologies for treating these patients and they often get priority in the planning system.

8.3 Adjusted shortlist of indicators

An adjusted shortlist of indicators is developed, which is better manageable for use in future research. Therefore we define for which indicators the definition needs to be adjusted for use in future research (8.2.1). We also determine which indicators were not discriminating enough or have another reason not to be included in future radiotherapy benchmarking research (8.2.2). Finally a renewed shortlist of performance indicators is described (8.2.3.).

8.3.1 Adjustments of used indicators

This paragraph describes some adjustments in the definition of the indicators used for this research. These adjustments are based on the experiences with the application of the developed framework and the indicators in the case study.

Workload

When we integrate the treatment complexity in the indicator *workload*, the outcomes of this indicator become more reliable, as treatments with a higher complexity have a higher workload than low complexity treatments. At this moment, there is no international standard for describing treatment complexity. In The Netherlands the T1-T4 system is used, which can be found in appendix H. This Dutch model can provide a basis for an international standard for describing treatment complexity in radiotherapy. For the indicator *workload* to become even more reliable, also the job descriptions of each of the employees need to be known, as these differ among the centers.

Electronic Patient Record

The electronic patient record is a hospital wide system. Hence, the radiotherapy department management does not have much influence on the output of this indicator. We therefore suggest to pay more attention to the information systems used at the radiotherapy department and to determine if they can completely be integrated with the hospital wide EPR.

Waiting times

Based on the analysis in paragraph 6.2.6 we found that the definitions from Cionini (2007) for determining the waiting times are somewhat ambiguous. We therefore, redefine these definitions in order to be more comparable. However, it is important for future research to discuss these new definitions with the partners before measuring them.

Based on our findings from the case study, suggestions for the T are for breast cancer and prostate cancer patients are constructed. Table 22 shows these new definitions and defines an extra measurement point. This extra point is the date the previous treatment ended, which makes it possible to extract the delay caused by these previous treatments from the total waiting time, which polluted our data.

Breast cancer	
W1	Day the patient was discussed for the first time in a multidisciplinary meeting
W2	Day the previous treatment ended (surgery or chemo / hormonal therapy)
W3	First radiotherapy consult
W4	Day the treatment plan is finished
W5	Day the patient receives the first radiation fraction
Prostate cancer	
W1	Day the patients was entered in the hospital information system
W2	Day the hormonal therapy ended
W3	First radiotherapy consult
W4	Day the treatment plan is finished
W5	Day the patient receives the first radiation fraction

Table 22: Redefined waiting time indicator for breast cancer and prostate cancer

For this research, we defined the T's for breast cancer and prostate cancer. When other tumor groups are defined as MESO level, new definitions for the T's should be developed, as there can be differences in the standard treatment processes.

Society results

Although the definitions for society results are clear and could be measured reliable, the validity of this data can be questioned. This questionable validity is caused by the short period of time for which this data was measured. Large publications and clinical trials have a longer cycle time than one year and there are also years in which no clinical trials are running.

For example, at the NKI-AVL in 2006 there was no clinical trial for prostate cancer running and therefore no patients were included in a clinical trial. However, in 2004, a large study ended and in 2007, a new large study started for in which 41 prostate cancer patients were included. When this data is taken into account, the NKI-AVL has a much better output on the indicator *clinical trials*. Therefore, based on the longevity of the research processes, longer data collection times should be taken into account to collect valid data for these research indicators. We suggest a five-year data collection period for society results indicators, but statistical analysis should be able to determine the minimum and maximum measurement period.

For future research it might also be of interest to get more insight in the research areas, such as physics, clinical research, and radiobiology, the centers are performing well at.

Efficient use of the resources

Use of Simulators

Simulators are used less, as the technology is becoming outdated. Analyzing the efficiency of this machine does not give much insight in the efficiency of the department. We therefore suggest leaving the simulator out of this indicator.

Use of CT's

This indicator can better be defined as: the minutes (of treatment) per patient per CT instead of the total number of patients per CT, as described by Cionini. This new indicator takes into account that not all patients need to have a CT-scan.

The complexity of the treatment also influences the duration of the treatment per CT. Therefore we take into account that distinguishing between the complexities of different treatments increases the reliability of this indicator. A suggestion for distinguishing between complexities is given in appendix H.

LineAcc downtime

The definition of downtime is divided in planned and non-planned maintenance. These terms were supposed to be unambiguous. However, during the research it turned out that the partners did not interpret these terms in the same way. For example, the question rose if quality control is part of planned maintenance. Therefore, for future research a more clear definition of planned and non-planned maintenance should be used. Planned maintenance should include maintenance, quality control and time reserved for research activities. Non-planned maintenance is defined as all adjustments done to the LineAcc's outside planned maintenance hours.

It is also important to determine which part of the planned maintenance is done outside the operating hours of the LineAcc's, as this type of maintenance does not put pressure on the efficiency of the LineAcc.

Overhead

For this research the term overhead was supposed to be unambiguous. However, it turned out that each center has a different financial system, and that overhead did not mean the same for each of the partners. For use of this indicator in further research activities, a thorough understanding of the financial situation and a clear definition of overhead are needed. This means that during future visits to the centers, also an interview with the hospital controller needs to be planned.

Treatment planning

In treatment planning the MRI and PET-scan are increasingly used for verification. For future use of this indicator, it is important to determine how we can measure the percentage of operating hours the MRI and PET-scans are used by the radiotherapy department.

Also we need to determine a method with which we can retrieve information regarding the number of scans made for verification purposes, from the information systems of the centers.

New technologies

Based on the discussion with the clinical physicists of the NKI-AVL, an indicator that measures the use of new technologies used in radiotherapy such as IMRT, IGRT and ART was included in the shortlist of indicators used for this research. When gathering data for this indicator at the different partners, it seemed that the partners do not interpret the terms IMRT, IGRT and ART in the same way. Therefore the definition of this indicator turned out to be ambiguous.

For use of this indicator in future research, inclusion criteria need to be developed in order to determine if a treatment can be defined as IMRT, IGRT or ART. These definitions need to be developed on beforehand in collaboration with clinical physicists and radiation oncologists.

Nevertheless, for future research IMRT, IGRT or ART might not be the newest technologies available, as the developments of other techniques continue. When this is the case, clear definitions for these new technologies need to be developed.

8.3.2 Indicators removed from the shortlist

Sick leave, employee turnover and work pressure

These indicators are not selected for the renewed shortlist, as their outputs depend too much on external factors, such as the unemployment rate of the country. Also the fact that the data necessary for determining the outputs of these indicators is not registered by the partners is a reason not to include these indicators in the renewed shortlist.

EPR introduced

As described above, the EPR is a hospital wide system and therefore the radiotherapy department does not have enough power to influence the development of this system.

Multidisciplinary approach

At each of the centers, multidisciplinary meetings are held and they are organized in more or less the same way. Therefore, for future research we suggest to leave the indicator of Cionini (2007) out of the shortlist.

However, this research did point out that there are differences between the centers in the use of information technology during the multidisciplinary meetings. Hence, we suggest taking into account this new indicator instead.

Peer reviewed articles and impact points

From the three indicators used to determine the quality of the research outcomes, we decided that the indicators "impact points per publication" and "patients in clinical trials" are valid for our new shortlist. Hence, the indicator "total number of peer-reviewed articles" is not included. The latter is not selected, based on the suggestion that the number of impact point per publication is a better measure for the quality of the research department.

Treatment planning with, and use of, CT and simulator

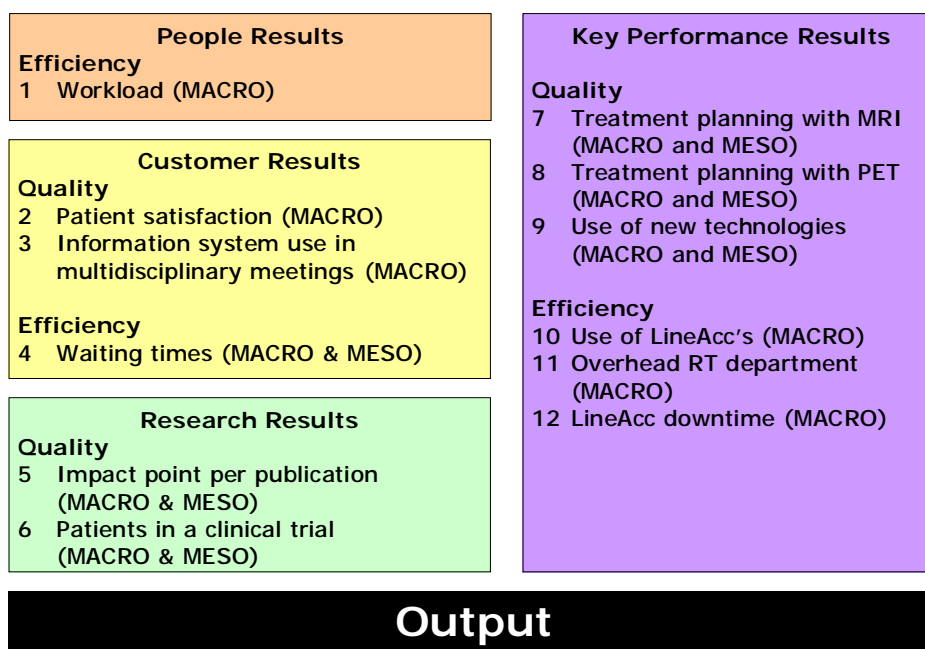
These are left out as the CT is almost standard and the simulator will probably not be used for treatment planning in the near future.

Equipment for quality and control programs, instrumentation for dosimetry and quality control, Quality control of the LineAcc's

The outputs of these indicators are not discriminating as described in paragraph 6.4.3 and 6.4.4. Based on the results from this study we cannot define a new indicator that would be discriminating enough. Therefore these indicators are left out of the renewed shortlist.

8.3.3 Renewed shortlist of indicators

Based on the new definitions for the indicators mentioned in paragraph 8.2.1 and the indicators that are removed from the shortlist, a renewed shortlist is suggested for future research. This new list contains twelve indicators of which six are only measured on MACRO level and six are measured on both MACRO and MESO level. Seven indicators measure quality and five indicators measure efficiency.



8.4 Overall conclusion

Although there were skeptics regarding the improvements expected as an outcome from this research, the results show that international benchmarking of radiotherapy centers can be valuable. The fact that not all international differences are taken into account does not reduce the value of the recommendations much.

Using the adjusted models and indicators in future benchmarking of radiotherapy centers can lead to even more improvements. The adjusted models can also be a starting point for benchmarking other processes within cancer centers or general hospitals.

During this research we consciously avoided making a ranking between the centers, and only point out which centre is a best practice for each indicator. This way the recommendations that stem from this research really focus on *learning from each other* and not on 'naming and shaming'.

This research showed that benchmarking is really a valuable tool when partners are willing to learn from each other.

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Appendix A: Radiotherapy

As this research focuses on the radiotherapy department of the different comprehensive cancer centers, this appendix will give a short description of radiotherapy treatments. First the development of radiotherapy over the years is described, then the two types of radiotherapy treatment are discussed and finally the role of dosimetry in radiotherapy is explained.

Development of radiotherapy as a treatment for cancer

The ionizing radiation used in radiotherapy was discovered at the end of the 19th century (Mieszkalski, Brady, Yaeger, & Class, 2001). In 1895 the existence of X-rays was discovered by Roentgen and in 1898 Marie and Pierre Curie discovered radium (Souhami & Tobias, 2005). Coutard marked the beginning of clinical radiotherapy as a medical discipline with his presentation on the evidence that advanced laryngeal cancer could be cured with protracted, fractionated radiotherapy at the International Congress of Oncology in Paris in 1922 (Mieszkalski et al., 2001).

In the early years of radiotherapy treatment, the X-rays and γ -rays did not have sufficient energy to penetrate the human body deep enough to treat tumors that lay deep inside the body (Froma, Hegeman, & Welleweerd, 1999). After the Second World War this improves with the introduction of the Cobalt-60 machines and in the 1960s the introduction of the linear accelerators made it possible to reach energy levels of more than 30 Mega Volt (MeV) (Souhami & Tobias, 2005). The last decades, innovation in radiotherapy treatment was predominantly in the area of the computer hard- and software. The computer is irreplaceable in modern radiotherapy treatment (Froma et al., 1999).

Two types of radiotherapy

Radiotherapy can be given to patients with cancer in two different ways; teletherapy and brachytherapy. Teletherapy is also known as external radiotherapy, because with teletherapy the radiation source is at a distance from the patient, generally 80 – 100 cm (Mieszkalski et al., 2001). With teletherapy the therapeutic X-rays are generated by a linear accelerator by "acceleration of electrons down a cylindrical 'waveguide' terminating in the deliberate bombardment of a fixed target by electrons traveling almost at the speed of light" (Souhami & Tobias, 2005). The X-ray beam generated by the linear accelerator has an energy level of up to 30 MeV, which can penetrate deep inside the body and there attack cancer cells.

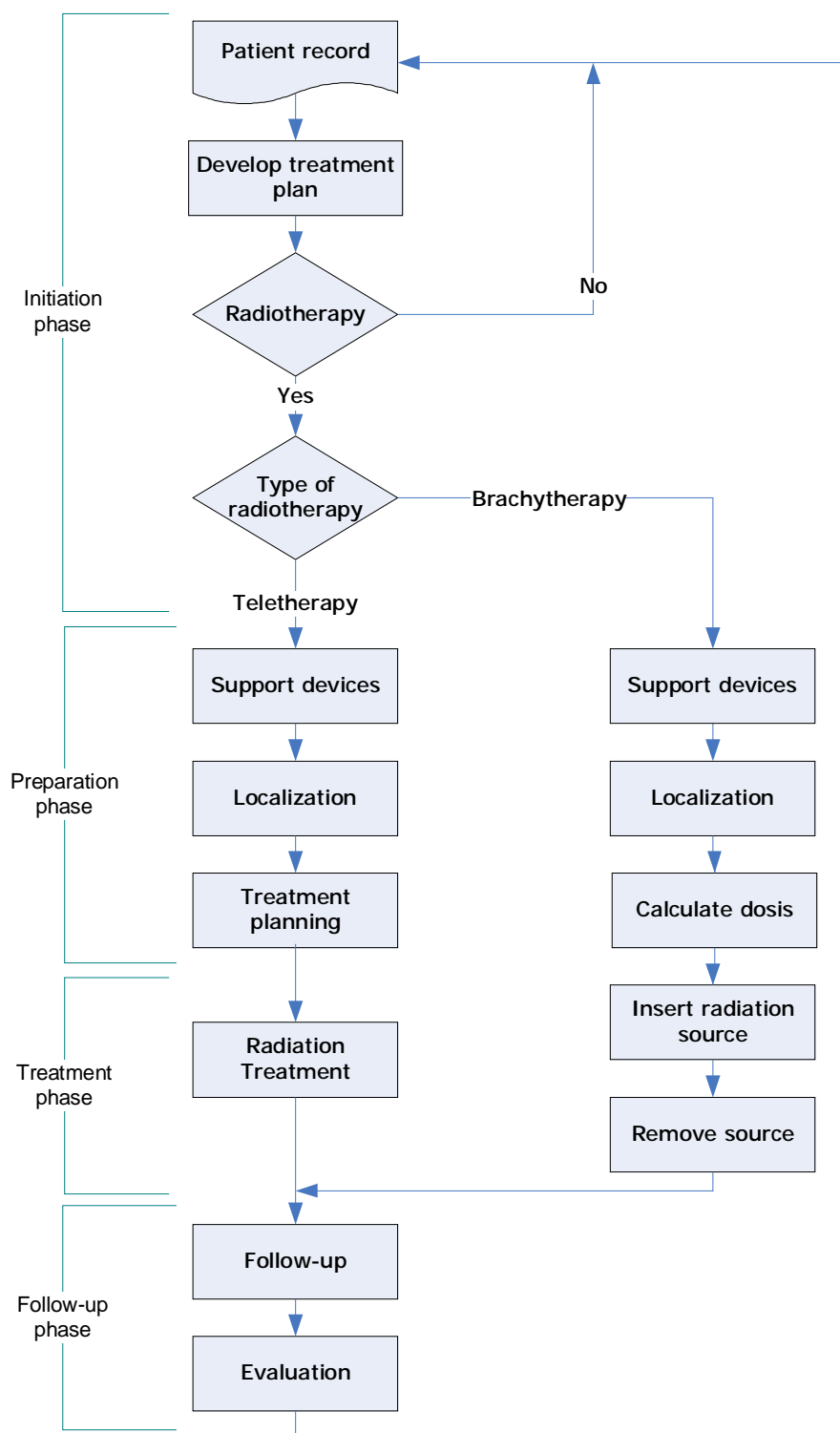
Another type of radiotherapy is brachytherapy. As with brachytherapy the distance between the radiation source and the target is very short, brachytherapy is also known as internal radiotherapy. With brachytherapy either sealed radioactive isotopes such as ^{60}Co , ^{137}Cs , and ^{226}Ra , are inserted into the tissue that needs to be irradiated (Souhami & Tobias, 2005). Unsealed sources such as ^{131}I are physically ingested and then taken up by the end organ (for ^{131}I this is the thyroid) where the radioactive emission takes place. The sealed isotopes are removed after a predetermined amount of time, the unsealed isotopes cannot be recovered from the body (Souhami & Tobias, 2005). As brachytherapy has a different process from teletherapy, this will not be included in this study, which will therefore focus primarily on the use of teletherapy at the different centers.

Dosimetry

Radiation kills all cells when the doses given is high enough, therefore radiotherapy is given in fractions (Froma et al., 1999). A radiotherapy treatment consists of one or more radiation fractions given to the patient each day, five days a week. For each kind of tumor, different radiation fractions schemes are known in literature and are constantly revised as a result of research done in this field. These radiation schemes are based on a consideration between the chance of curing the patient by killing cancer cells and the chance of complications by killing cells in the normal tissue surrounding the tumor (Dolsma, Froma, Hegeman, Keus, & Ru, 2001; Froma et al., 1999).

The dose of radiation given with radiotherapy treatment is measured in Gray (Gy). The total amount of radiation given to a patient is the sum of the individual fractions. For example a patient that has had twenty treatments of 2 Gy has had a total of 40 Gy. By administering the radiation from different angles, the doses in the tumor will be higher than the doses in the surrounding tissue.

Appendix B: Radiotherapy process flow diagram



Appendix C: Long-list of indicators

Cionini (2007)	Definition	Nominator	Denominator
Workload	Measures human resources' productivity	Total number of patients treated in one year	Number of employees (a) radiation oncologist (b) Medical physicist (c) Radiat on technologist
Use of Linear Accelerators	Efficiency in LineAcc use	Total number of patients treated in one year	Number of LineAcc's
Waiting time	Treatment delay	TWT – sum of the waiting times (in days) WTL, WTL, WTL, WTL	
Clinical record quality	This indicator measures the completeness of personal and clinical data in the clinical record.	Sum of ratings as defined in the article	Number of controlled records, see appendix C.1 for list
Patient experiences	Cionini sees the return rate of questionnaires as the indicator	Number of questionnaires returned	Total number of questionnaires
Multidisciplinary approach	Describes frequency of Multidisciplinary treatment programs	Number of new patients whose initial treatment plan has been discussed at least once in a multidisciplinary setting	Total number of new patients treated in the period
LA downtime for non-planned maintenance	Measures downtime LA's for non-planned maintenance	Number of days of machine downtime for non planned maintenance (NPM)	Number of days of machine downtime for planned maintenance (PM)
Instrumentation for dosimetry and quality control (QC)	Instrumentation adequacy for dosimetry and QC	Achieved score	Maximum score, see appendix C.2 for list
Equipment QC programs	Availability of programs for QC of equipments	Achieved score	Maximum total score, see appendix C.3 for list
Treatment planning with CT	Frequency of treatment plans with device and contouring of volumes of interest (VOI) on multiple slices	# of treatment plans processed through different devices and contouring on multiple slices	Total # of treatment plans processed by the TPS
Number of fields used per planned treatment volume	Geometrical complexity of the treatment	Total number of planned fields for all PTVs	Number of PTVs
Shaped fields	Practice of shaped fields	Total number of shaped fields	Total number of fields
Portal verification	Frequency of portal verification	Total number of portal verifications in a week	Total number of fields in a week

NVRO (2007)	Definition	Nominator	Denominator
Pain management	Improve care for patients that do not benefit from radiation on painful bone metastasis	Total number of patients treated for painful bone Metastasis for which a pain score is notated before and after treatment	Total number of patients treated for painful bone Metastasis
Risk analysis	The NVRO asks two questions that should be answered yes or no: Are all incidents and methodology based on their cause? Does this induce improvement actions? (example)		near-misses reported according to a certain
Organization of brachytherapy	Describes if brachytherapy is organized according to Dutch standards		
	<p>"A) Voldoet uw afdeling met betrekking tot de brachytherapie aan de Algemene Kwaliteits Eisen zoals deze in 2006 door de ALV van de NVRO zijn goedgekeurd? Zo ja, wie vormen het zogenaamde brachyteam? Noem radiotherapeuten, fysici en laboranten. Geef aan hoeveel dagdelen per week deze personen effectief aan brachytherapie besteden.</p> <p>B) Opgeve aantallen patiënten voor brachytherapie van blaas, prostaat en cervix."</p>		
Follow-up	Measures how centers control their follow-up policy		
	<p>"De indicator wordt opgedeeld in verschillende subitems:</p> <ol style="list-style-type: none"> 1. Follow-up beleid. 2. Benaderingsresultaten late toxiciteit: (zie ook indicator proctitis en complicatieregistratie): <ol style="list-style-type: none"> a. Analyseert u de behandelresultaten van uw instituut/afdeling voor het mammacarcinoom (locoregionale controle) en het rectumcarcinoom (locale controle). Ja/nee (per tumorsite). b. Zo, ja vergelijkt u uw behandelresultaten met gerapporteerde nationale of internationale resultaten. Ja/nee (per tumorsite) c. Benaderingsresultaten late toxiciteit: (zie ook indicator proctitis en complicatieregistratie): <ol style="list-style-type: none"> a. Verzamelt u actief gegevens over late toxiciteit ook van patiënten die ontslagen zijn uit follow-up? Ja/nee. S.v.p. specifiek aangeven per tumorsite mamma en rectum. b. Analyseert u de verzamelde gegevens? Ja/nee. Graag aangeven per tumorsite. c. Indien u gegevens over late toxiciteit verzamelt en analyseert, vergelijkt u deze instituutspecifieke gegevens met gerapporteerde (inter)nationale resultaten? Ja/nee?" 		
Waiting times	Measures how long the waiting time for RT is after initial surgery or Chemotherapy	Number of MAMMA patients with 'borstbesparende' surgery that starts RT within 28 days after surgery or chemotherapy	Number of MAMMA patients with breast saving surgery
	<p>Wachttijd conform NABON (Nationaal Borstkanker Overleg Nederland) – aantal dagen vanaf laatste operatie (O.K. datum) en startdatum radiotherapie; of aantal dagen vanaf laatste chemotherapiekuur tot startdatum radiotherapie.</p> <p>Indien datum laatste chemotherapiekuur niet bekend is, wordt voor de wachttijd de O.K. datum gebruikt met notitie chemotherapie ja.</p> <p>Norm: 100% van patiënten start binnen 28 dagen na laatste operatie of laatste chemotherapie.</p> <p>Wachttijd NVRO: aantal kalenderdagen vanaf moment aanmelding tot startdatum radiotherapie. Norm: 80% van patiënten moet binnen 21 dagen starten met radiotherapie. Met een maximaal acceptabele wachttijd van 28 dagen."</p>		
Quality control MAMMA and prostate carcinomas Planning	Measures if RT treatment plans are set up according to national and international guidelines.		

<p>1. Ieder instituut/afdeling moet aangeven of op alle (conformatie-) bestrahlingsplannen een onafhankelijke controle van monitor-eenheden wordt uitgevoerd.</p> <p>2a. Zo ja, dan moet aangegeven worden of dit geschiedt voor de derde fractie en of een actieniveau van ten hoogste 5% wordt gehanteerd, bij overschrijding waarvan de oorzaak van afwijkingen direct wordt uitgezocht.</p> <p>2b. Indien niet, moet aangegeven worden op welke punten er niet aan voldaan wordt.</p> <p>3. Ieder instituut dat deze controles uitvoert moet aangeven hoe wordt gewaarborgd dat dit ook bij alle (conformatie-) bestrahlings-plannen gebeurt.</p>			
Quality control linear accelerators	Determined if LA are often enough controlled for their position and quantity of radiation		
<p>Ieder instituut/afdeling moet aangeven of in hun protocol periodieke controle van de hieronder weergegeven parameters is opgenomen. Zo ja, dan moet aangegeven worden of in de praktijk aan de aanbevelingen voldaan wordt. Als het antwoord ontkennend is, moet aangegeven worden op welke punten er niet aan voldaan wordt.</p> <p>1. De correcte werking van de interlock die zorgt dat de bestraling onderbreken wordt als de iemand de bunker betreedt (deur open of lichtsluis gepasseerd) moet minimaal drie-maandelijks gecontroleerd worden.</p> <p>2. Minimaal maandelijks moet gecontroleerd worden of de projectie van de kruisdraad ter plaatse van het isocentrum binnen een cirkel met een doorsnede van 2 mm blijft, als de collimator over de maximaal mogelijke hoek geroteerd wordt.</p> <p>3. Minimaal maandelijks moet gecontroleerd worden of de lichtveldpositie ter plaatse van het isocentrum overeenkomt met de elektronische uitlezing hiervan, binnen 2 mm per collimatorblok.</p> <p>4. Minimaal maandelijks moet gecontroleerd worden of de symmetrie voor fotonenbundels beter is dan 3%, volgens de definitie van de NCS.</p> <p>5. Minimaal tweewekelijks moet gecontroleerd worden of de absolute dosimetrie van zowel fotonen- als elektronbundels binnen 2% overeenkomt met de initiële kalibratie.</p> <p>6. Minimaal jaarlijks moet gecontroleerd worden of de dosisafgifte niet meer dan 3% varieert als functie van de gantryhoek.</p> <p>Deze punten zijn wellicht niet allemaal van toepassing voor niet-conventionele versnellers. Het wordt aan de afdelingen/instituten zelf overgelaten om hiervoor overeenkomstige punten te definiëren. "</p>			
Complications for Prostate patients	Measures safety of Prostate treatment	Number of prostate patients with level 3 or 4 gastrointestinal toxicity	Number of prostate patients treated
<p>"Wat is het percentage graad 3 of 4 lage gastrointestinale toxiciteit volgens de definitie van de RTOG bij patiënten na radiotherapeutische behandeling van een prostaatkarcinoom jaarlijks gemeten gedurende de eerste 3 jaar na de behandeling?</p> <p>RTOG Low GI (Cox et al, Int J Radiation Oncol Biol Phys, 1995: 31:1341-1346)</p> <p>Grade 3: Diarrhea requiring parenteral support/severe mucous or blood discharge necessitating sanitary pads/abdominal distention</p> <p>Grade 4: Acute or subacute obstruction, fistula or perforation; GI bleeding requiring transfusion; abdominal pain or tenesmus requiring tube decompression or bowel diversion.</p> <p>Stratification: Welk percentage van deze patiënten werd met een lage dosis radiotherapie bestraald (≤ 70 Gy)? Welk percentage van deze patiënten werd met een hoge dosis radiotherapie bestraald (≥ 74 Gy)? Welk percentage van deze patiënten werd met een gehyponfractioneerd schema bestraald?"</p>			
Multidisciplinary approach	Describe if multidisciplinary meetings are held and how these meetings are organized		

A.	Beschikt u over een multidisciplinaire	bespreking	voor specifieke	tumorgroepen	worden	besproken.
1.	Mammacarcinoom:	voor	ja/nee,	postoperatief	ja/nee	ja/nee
2.	Rectumcarcinoom	voor	ja/nee,	postoperatief	ja/nee	ja/nee
3.	Urologische tumoren:	voor	ja/nee,	postoperatief	ja/nee	ja/nee
Indien Ja is	er altijd een	behandeling	bij	bespreking	aanwezig?	
B. Is er iets afgesproken rond de organisatie van de multidisciplinaire bespreking:	terugkoppeling	radiotherapeut	de	afspraken	afspraken	afspraken
over	van de multidisciplinaire bespreking:	vaste manier van aanmelden	ja/nee, notulen	ja/nee, vaste voorzitter	ja/nee, afspraken	ja/nee?
Zijn er afspraken over verantwoordelijkheden,	dossiervoering	en uitvoering	van het beleid?	Zijn deze afspraken schriftelijk vastgelegd?		
<p>Samenvatting</p> <p>De werkgroep is van mening data aan een multidisciplinair overleg minstens de volgende professionals moeten deelnemen: radiotherapeut-oncoloog, internist-oncoloog, chirurg-oncoloog en/of orgaan-specialististen zoals uroloog of maag-darm-lever-arts afhankelijk van de betreffende tumoursite en een patholoog en radioloog. De wijze waarop een multidisciplinair overleg georganiseerd kan worden is afhankelijk van het "type" ziekenhuis.</p>						
Patient experiences		The NVRO wants to know if patient experiences are being measured and if this is done with a validated questionnaire				

Benchmarking studies	Definition	Source	Nominator	Denominator
Sick leave	Measures percentage of time that employees were on sick leave in 2006, without sick days related to pregnancies, and including long term illnesses	van Lent, 2005	Number of sick days per employee in 2006 without sick days related to pregnancies, including long term illnesses	Number of days worked, including sick days, excluding holidays, per employee in 2006
Employee turnover rate	Measures employee satisfaction by determining the percentage of employees that left the RT department in 2006.	van Lent, 2005	Number of employees that designated in 2006, interra changes not included.	Total number of employees in 2006
Work pressure	Measures what percentage of the time employees have to work overtime during a week, describing the work pressure on employees in 2006.	van Lent & Roijmans, 2004	Overtime worked in 2006	Number of hours in a normal working week (FTE) for 2006
EPR introduced	Measures how far the a EPR has been introduced until this moment.	van Lent (list based on Cionini, 2007)	Number of criteria introduced in EPR	Total number of records in EPR
Peer reviewed articles published	Measures the productivity of the researchers in the RT research department	van Bokhorst, 2007	Number of peer reviewed articles published in 2006 by the RT research department	
Impact points	Measures the quality of the output of the researchers in the RT research department	van Bokhorst, 2007	Number of articles published by RT research department times impact points per journal	
Use of Simulators	Overall Equipment Efficiency of Simulators	van Lent, 2005	Number of patients treated in 2006	Number of Simulators in 2006
Use of CT's	Overall Equipment Efficiency of CT scans	van Lent, 2005	Number of patients treated in 2006	Number of CT's in 2006
Use of MRI's	Overall, Equipment Efficiency of MRI's	van Lent, 2005	Number of patients treated in 2006	Number of MRI's in 2006
Use of PET's	Overall, Equipment Efficiency of PET scans	van Lent, 2005	Number of patients treated in 2006	Number of PET's in 2006

Appendix C.1: Clinical Record Quality

From the article of Cionini, 2007.

DATA	SCORE
(1) Personal data	
(a) Name – surname	1, available data are not sufficient to recall the patient,
(b) Place and date of birth ,	2, available data are sufficient to recall the patient but not to identify him with certainty (e.g. for a mortality study)
(c) Address	3, available data allow both to recall and identify the patient
(d) Personal telephone number	
(e) Telephone number of a relative	Data necessary to recall the patient: a, d, e
(f) Name of the attending physician	Data necessary to identify and track the patient: a, b, c, d, f
(2) Risk factors data	
(a) Family risk factors	1, no information
(b) Personal risk factors (life habits, markers)	2, partial information
	3, complete information on the presence/absence of both personal and family risk factors
(3) Conditions that could interfere with the treatment tolerability	
	1, no information
	2, partial information
	3, presence or absence of previous diseases which could interfere with the treatment tolerance is clearly indicated

(4) Onset and first manifestations of the disease	<ul style="list-style-type: none"> 1, no information 2, some initial symptoms are mentioned or the time of diagnosis are mentioned 3, both are mentioned
(5) Treatment before the referral to the Centre and their effects	<ul style="list-style-type: none"> 1, no information 2, incomplete information 3, complete information both on treatment and their effects
(6) Disease staging at the time of the first visit and diagnostic methods that were used to assess it	<ul style="list-style-type: none"> 1, no information 2, incomplete information 3, complete information on staging and corresponding diagnostic methods
(7) Description of the therapeutic program and its rationale	<ul style="list-style-type: none"> 1, no information 2, incomplete information: the treatment program is reported, the rationale is missing 3, both the treatment program and its rationale are reported
(8) Informed consent	<ul style="list-style-type: none"> 1, no informed consent in the clinical record 2, the informed consent has been signed, however the content is generic 3, the informed consent form has been signed and is detailed

	<i>Appendix C.2: List Instrumentation</i>		
	Question	Score by Cionini	Definitions
1	Are there precision electrometers present?	3	
3	Is the water phantom of a 3-axis movement-type?	3	
4	Does the water phantom meet the original specifications from the mechanical, geometric and dosimetric points of view?	3	
5	Is there a dosimetric system to control the in vivo dose present?	1	For area as well as volume dosimetry
6	Are system calibration procedures for dosimetric systems to control the in vivo dose present?	1	For area as well as volume dosimetry
7	Is adequate documentation about the routine practice for dosimetric systems to control the in vivo dose present?	1	For area as well as volume dosimetry
8	Are different kinds of phantoms (anthropomorphic, water equivalent, etc.) present for each used treatment technique?	1	First define treatment techniques used, then name used phantoms.
9	Is instrumentation and systems for the QC of the treatment equipment present?	3	also in List QC, were does it belong more?
10	Are the procedures for treatment equipment instrumentation QC present?	3	

Appendix C.3: List QC (Quality Control)			
	Question	Score by Cionini	Definitions
1	Is there a list available for equipment and instruments to be submitted to QC?	5	
2	Is there a log book available with QC for single equipment or for groups of homogeneous equipments	5	Equipment – radiological installations; Instrument – tool for QC of equipment
3	Is there a dedicated protocol available for single equipment or groups of homogeneous equipments?	1	Equipment – radiological installations
4	Do the protocols comply to national and/or international recommendations?	1	Name the national and international recommendations complied to.
5	Is there a procedure present regarding the communication of the QC results to the holder of the radiological installation?	5	Holder of the radiological installation – The person that determines whether the LA can be used for patient treatment or not
6	Is there a procedure available regarding the evaluation of the results by the medical physicist and holder of the radiological installation?	1	Holder of the radiological installation – The person that determines whether the LA can be used for patient treatment or not
7	Is there an annual plan of QC tests released within the end of the previous year which specifies the QC periodicity?	1	
8	Is there staff appointed that is responsible of quality controls?	1	
9	Are specifications of tests to be carried out daily before clinical use specified for each machine?	1	
10	Are daily control forms available and completed?	1	
11	Is there a procedure present to periodically check the compliance with annual plan of QC tests?	1	
12	Is there a procedure present to periodically check the recording of results?	1	
13	Is there a procedure present to assure the correction of the non-compliant parameters?	1	
14	Are minor maintenance interventions performed locally by the Centre?	1	
	Total score	26	

Appendix D: Shortlist of indicators

Indicator	Goal (AIRE 2.1)	Quality aspect	Source	Numerator	Denominator	Definition of terms	Extra Information
Sick leave	Measures percentage of time that employees were on sick leave in 2006, without sick days related to pregnancies and including long term illnesses	Efficiency	van Meurs	Number of sick days per employee in 2006 without sick days related to pregnancies, including long term illnesses	Number of days worked, including sick days, excluding holidays, per employee in 2006		We will differentiate between different professions as far as possible.
Workload	Measures human resources' productivity over 2006	Efficiency	Cionini, 2007	Number of patients treated in 2006	Total number of employees in 2006		We will differentiate between different professions as far as possible.
Employee turnover rate	Measures employee satisfaction by determining the percentage of employees that left the RT department in 2006.	Quality	van Lent, 2005	Number of employees that designated in 2006, internal changes not included.	Total number of employees in 2006		We will differentiate between different professions as good as possible.
Work pressure	Measures what percentage of the time employees have to work overtime during a week, describing the work pressure on employees in 2006.	Quality	van Lent & Roijmans, 2004	Overtime worked in 2006	Number of hours in a normal working week (FTE) for 2006	A normal working week differs between the countries, this will be taken into account	We will differentiate between different professions as far as possible.
EPR introduced	Measures how far the a EPR has been introduced until this moment.	Quality	van Lent (list based on Cionini, 2007)	Number of criteria introduced in EPR	Total number of records in EPR	The list of records can be found in the worksheet EPR	
Treatment of near misses	Measures how misses and near misses are treated within the centre	Quality	Based on the NVRO (2007)	Number of near misses reported in 2006	Number of near misses reported in 2006 which led to an improvement action		
No shows	Determines how often LA's were not in use due to no shows in 2006	Efficiency	van Meurs	Number of canceled sessions in 2006	Total number of sessions in 2006	A 'no show' is when a planned patient does not show up or is canceled within a week before the planned treatment, so no new patient can be planned	
Discussed in multidisciplinary meeting	Determines how often patients are discussed in a multidisciplinary meeting	Quality	NVRO, 2007	Number of MS patient was discussed in			As there is no standard for the number of MDA, it is difficult to discuss. There is no selection factor for this indicator.

Indicator	Goal (AIRE 2.1)	Quality aspect	Source	Numerator	Denominator	Definition of terms	Extra information
Waiting times	Measures the treatment delay.	Efficiency	Gionini, 2007 and NVRO, 2007	TWT = sum of the waiting times (in days) Wt1, Wt2, Wt3 per treatment in 2008.	Number of patients treated in 2008	Wt1, interval in days from referral to moment where RT treatment decision is made, Wt2, interval in days from RT treatment decision to the day that the treatment plan has been completed and Wt3, interval in days from the day that the treatment plan has been completed to beginning of treatment.	It is not sure if all three Wt's can be obtained. If not, we will look at the total time from TWT, without splitting it in three parts.
Peer reviewed articles published	Measures the productivity of the researchers in the RT research department	Efficiency	van Bokhorst, 2007	Number of peer reviewed articles published in 2008 by the RT research department		Only articles published in peer reviewed journals	Although these are not indicators in the form of nominator / denominator, they fit best in society results
Impact points	Measures the quality of the output of the researchers in the RT research department	Quality	van Bokhorst, 2007	Number of articles published by RT research department times in pact points per journal			Although these are not indicators in the form of nominator / denominator, they fit best in society results
Patients in trial	Describes the number of patients that are included in a trial.	Quality	Moonen	Number of patients that have participated in a trial in 2008	Number of patients treated in 2008		
Treatment planning with CT	Measures how often CT is used for treatment planning and therefore describes the complexity of the treatment	Quality	Gionini, 2007	Number of treatment plans based on at least one CT scan in 2008	Total number of treatment plans processed by the Treatment Planning System in 2008		Discussed definition of Cionini with E. Damen
Treatment planning with MRI	Measures how often MRI is used for treatment planning and therefore describes the complexity of the treatment	Quality	Adapted from Gionini, 2007	Number of treatment plans based on at least one fMRI scan	Total number of treatment plans processed by the Treatment Planning System in 2008		Discussed definition of Cionini with E. Damen
Treatment planning with PET	Measures how often PET is used for treatment planning and therefore describes the complexity of the treatment	Quality	Adapted from Gionini, 2007	Number of treatment plans based on at least one PET scan in 2008	Total number of treatment plans processed by the Treatment Planning System in 2008		Discussed definition of Cionini with E. Damen

Indicator	Goal (AIRE 2.1)	Quality Source aspect	Numerator	Denominator	Definition of terms	Extra information
Equipment QC programmes	Availability of programmes for QC of equipments	Quality	Cionini, 2007	Achieved score	Maximum score	See Worksheet List QC from Cionini (2007)
CONE BEAM's available	Measures average number of CONE BEAM's available per LA in 2006.	Quality	Damen	Number of LA's equipped with a CONE BEAM in 2006	Number of LA's in 2006	
Segments per treatment	Measures the average number of segments per treatment for Step-shoot IMRT in 2006.	Quality	Damen	Number of segments per IMRT treatment plan made in 2006	Total number of patients treated in 2006.	Only possible for Step-Shoot IMRT. Not possible for dynamic IMRT.
Cross hair position	Determines the difference between the tolerance level that was used for the cross hair position by the centre and the national minimal requirements.	Quality	Based on NVRO, 2007 and report 9 of the NCRD (p. 16)	Tolerance level for the cross hair position in mm in 2006.	National minimal requirements for the cross hair position in mm in 2006.	Verifies the correspondence between the mechanical axis of the collimator and the light beam axis. Verification takes place by checking the displacement of the projection of the cross hair while turning the collimator around its axis
Field symmetry of photon beams	Determines the difference between the tolerance level that was used for the field symmetry of photon beams by the centre and the national minimal requirements.	Quality	Based on NVRO, 2007 and report 9 of the NCRD (p. 41)	Tolerance level for the field symmetry of photon beams in % in 2006.	National minimal requirements for the field symmetry of photon beams in % in 2006.	
Electron beam dosimetry	Determines the difference between the tolerance level that was used for the electron beam dosimetry by the centre and the national minimal requirements.	Quality	Based on NVRO, 2007 and report 9 of the NCRD (p.55)	Tolerance level for the electron beam dosimetry in % in 2006.	National minimal requirements for the electron beam dosimetry in % in 2006.	
Gantry angle dependence	Determines the difference between the tolerance level that was used for the gantry angle dependence by the centre and the national minimal requirements.	Quality	Based on NVRO, 2007 and report 9 of the NCRD (p. 62)	Tolerance level for the gantry angle dependence in % in 2006.	National minimal requirements for the gantry angle dependence in % in 2006.	
Instrumentation for dosimetry and QC	Instrumentation adequacy for dosimetry and QC	Quality	Cionini, 2007	Achieved score	Maximum score	See Worksheet List Instrumentation from Cionini (2007)

Indicator	Goal	Quality aspect	Source	Numerator	Denominator	Definition of terms	Extra information
Use of Simulators (Overall Equipment Efficiency)	Overall Equipment Efficiency of Simulators in 2006.	Efficiency	Adapted from Cionini, 2007	Number of patients treated in 2006	Number of Simulators in 2006		
Use of CT's (Overall Equipment Efficiency)	Overall Equipment Efficiency of CT's in 2006.	Efficiency	Adapted from Cionini, 2007	Number of patients treated in 2006	Number of CT's in 2006		
Use of MRI's (Overall Equipment Efficiency)	Overall Equipment Efficiency of MRI's in 2006.	Efficiency	Adapted from Cionini, 2007	Number of patients treated in 2006	Number of MRI's in 2006		
Use of PET's (Overall Equipment Efficiency)	Overall Equipment Efficiency of PET's in 2006.	Efficiency	Adapted from Cionini, 2007	Number of patients treated in 2006	Number of PET's in 2006		
Use of Linear Accelerators (Overall Equipment Efficiency)	Overall Equipment Efficiency of LA's in 2006.	Efficiency	Cionini, 2007	Number of patients treated in 2006	Number of LA's in 2006		
Treatments per Radiotherapist	Overall efficiency of Radiotherapists in 2006.	Efficiency	van den Bent & Roijmans, 2004	Number of patients treated in 2006	Number of Radiotherapist in 2006		Watch for differences in job descriptions
Treatments per Clinical Physicist	Overall efficiency of Clinical Physicists	Efficiency	van den Bent & Roijmans, 2004	Number of patients treated in 2006	Number of Clinical physicist in 2006 available for RT only		Watch for differences in job descriptions
Overhead RT department	Measures percentage of overhead costs and therefore determines the efficiency of the RT department	Efficiency	van Meurs	Overhead costs of the RT department in 2006	total costs of the RT department in 2006	Overhead costs are all costs not directly related to the treatment of patients.	
Idle time resources	Measures how long resources were not used during working hours in 2006.	Efficiency	van Meurs	Number of idle hours during working hours in 2006	Number of working hours including idle time		Downtime is a part of idle time, so these are connected
LA downtime for non planned maintenance	Measures downtime LA's for non-planned maintenance	Efficiency	Cionini, 2007	Number of days of machine downtime for non planned maintenance (NPM) in 2006	Number of days of machine downtime for planned maintenance (PM) in 2006	A day is defined as a day of downtime when the number of treated patients is reduced to < 1/3 of the planned patients (Cionini, 2007)	Downtime is a part of idle time, so these are connected

Appendix E: interview questions

Interview Head of Radiotherapy department

Questions

Organization structure

How is the RT department organized?

Changes in department

What are some important recent changes in your department?

Research indicators	Definition	Answer
Peer reviewed articles published*	Number of peer reviewed articles published in 2006 by the RT research department (Only articles published in peer reviewed journals)	
Publications on MAMMA carcinomas*	Number of peer reviewed articles published on MAMMA carcinomas in 2006 by the RT research department	
Publications on Prostate carcinomas*	Number of peer reviewed articles published on Prostate carcinomas in 2006 by the RT research department	
Impact points*	Number of articles published by RT research department times impact points per journal	
Impact points on MAMMA publications*	Number of articles published by RT research department on MAMMA carcinomas times impact points per journal	
Impact points on Prostate publications*	Number of articles published by RT research department on Prostate carcinomas times impact points per journal	
Patients in trial	Number of patients that have participated in a trial in 2006	
MAMMA patients in a trial	Number of MAMMA patients that have participated in a trial in 2006	
Prostate patients in a trial	Number of Prostate patients that have participated in a trial in 2006	
Researchers	Number of RT researchers in 2006	

* Only articles in peer reviewed journals.

Annual report

Is there an annual report available for the RT department?

If no,

- Is there a section in the annual report of the entire hospital / institute that covers the RT department?

Can I see the mentioned documents?

Long-term plan

Is there a long-term plan available for the RT department?

If no,

- Is there a section in the long-term plan of the entire hospital / institute that covers the RT department?

Can I see the mentioned documents?

Year plan

Is there a year plan available for the RT department?

If no,

- Is there a section in the long-term plan of the entire hospital / institute that covers the RT department?

Can I see the mentioned documents?

Marketing

Is there a marketing plan available for the RT department?

If no,

- Is there a marketing plan for the entire hospital / institute that covers marketing of the RT department?

If yes,

- Who writes it?
- What are the chapters /subjects?
- How long does it exist?
- What is the main reason a marketing plan is developed?

Can I see the mentioned documents?

Competitors

- Who are the competitors?
- How close is the competition?
- Is there a strategy to stay ahead of the competition?
- Do you think competition is becoming more important?

Risk analysis: Availability of a risk management system

Are all misses and near misses reported according to a certain methodology?

If no,

- How are they reported then?

If yes,

- Do these reports lead to improvement actions?
- How many misses were reported in 2006?
- How many near misses were reported in 2006?
- How many improvement actions were implemented in 2006 based on misses or near misses?

Can I see the mentioned documents?

Electronic Patient Record (EPR): Use of EPR within the centre

- Is there a form of EPR used within the centre?

Extra questions

- If you were not able to answer some of these questions, whom should I address to get an answer?
- Are there any strategic issues, not addressed today, that you think are worth mentioning?

Interview head patient care

Questions

Clinical record quality for MAMMA and Prostate patients

I need access to some patient records. How can we arrange this?

Multidisciplinary approach:

Use of Multidisciplinary Meetings (MM) at the RT department

- Are MM's used at the centre?
 - MAMMA patients specific:
 - Prostate patients specific:
- How many MM's are there in a week at which at least one radiotherapist is present?
 - MAMMA patients specific:
 - Prostate patients specific:
- Who should be present at these meetings and who are present at these meetings?
- What are the agreements around the organization of the MM's regarding:
 - Enrolment for the meeting
 - Notes on the meeting
 - Chairman
 - Follow-up of appointments made
- Are these agreements around the organization of the MM's written down?
 - *If yes, can I see this document?*

Electronic Patient Record (EPR):

Definition EPR: when the radiation oncologist can make his notes regarding the patients in this electronic file.

- Is there a form of EPR used within the centre?
- What information is available online?
- What information will be available online within the next two years?
- Is the EPR also available for people outside the centre?
 - If yes, for whom?

DATA: (For 2006 and 2007 if available)

Radiotherapists

Number of Radiation oncologist	
Number of FTE for Radiation oncologists	
Number of PhD's among Radiation oncologists	
Number of Radiation oncologists in training	
Number of job openings for Radiation oncologists	
Hours in a work weeks (how many hours is 1 FTE for radiotherapists)	

Resources

# of LA's	For RT dept only	For the entire hospital
# of LA's with Cone Beam		
# of CT's		
# of simulators		
# of MRI's		
# of PET scans		

Interview Radiation Oncologists with MAMA specialization

Questions

Multidisciplinary Meetings for MAMMA patients:

- Are MM's for MAMMA patients used at the centre?
- How many MM's for MAMMA patients are there in a week at which at least one radiotherapist is present?
- Who should be present at these meetings and who are present at these meetings?
- What are the agreements around the organization of the MM's for MAMMA patients regarding:
 - Enrolment for the meeting
 - Notes on the meeting
 - Chairman
 - Follow-up of appointments made
- Are these agreements around the organization of the MM's for MAMMA patients written down?
 - If yes: *Can I see these agreements?*

8.4.1 "One Stop' breast cancer clinic

Get a picture of the whole process so a Visio diagram can be made.

- Are MAMMA patients treated in a separate way?
- What tests are done?
- Are all tests done in one day?
- How long till the diagnosis is available?
- What equipment is reserved?

Treatment results: Loco (regional) control:

- Are the treatment results for the MAMMA carcinoma of the centre analyzed?
 - Which tumor sites are analyzed?
- Are the results reported within the centre?

- Are the results nationally reported?
- Are the results inter-nationally reported?

Treatment results: Late toxicity:

- Is the centre actively involved in collecting data about late toxicity of patients who are discharged of follow-up?
- For which tumor sites is this data collected?
- Does the centre itself analyze this data?
 - For which tumor sites?
- Are results compared to national results?
- Are results compared to inter-national results?

Interview Radiation Oncologists with Prostate specialization

Questions

Multidisciplinary approach:

Use of Multidisciplinary Meetings (MM) for Prostate patients at the RT department

- Are MM's for Prostate patients used at the centre?
- How many MM's for Prostate patients are there in a week at which at least one radiotherapist is present?
- Who should be present at these meetings and who are present at these meetings?
- What are the agreements around the organization of the MM's for Prostate patients regarding:
 - Enrolment for the meeting
 - Notes on the meeting
 - Chairman
 - Follow-up of appointments made
- Are these agreements around the organization of the MM's written down?
 - If yes, can I see this document?

Rapid diagnosis for prostate patients

- Are Prostate patients treated in a separate way?
- What tests are done?
- Are all tests done in one day?
- How long till the diagnosis is available?
- What equipment is reserved?

Prostate patients with complications

- Does this centre use the RTOG Low GI grading system for complications with Prostate patients?
- If yes,
- Is this score recorded for all Prostate patients?
 - Can we collect information regarding these scores?
- If no,
- Are complications scores registered for Prostate patients?
- Which grading system does the centre use?

Interview Radiotherapy department manager

Questions

Annual report

Is there an annual report available for the RT department?

If no,

- Is there a section in the annual report of the entire hospital / institute that covers the RT department?

If yes,

- Who writes it?
- What are the chapters / subjects?

Can I see the mentioned documents?

Long-term plan

Is there a long-term plan available for the RT department?

If no,

- Is there a section in the long-term plan of the entire hospital / institute that covers the RT department?

If yes,

- What is the scope?
- Who writes it?
- What are the chapters /subjects?

Can I see the mentioned documents?

Year plan

Is there a year plan available for the RT department?

If no,

- Is there a section in the long-term plan of the entire hospital / institute that covers the RT department?

If yes,

- Who writes it?
- What are the chapters /subjects?

Can I see the mentioned documents?

Marketing

Is there a marketing plan available for the RT department?

If no,

- Is there a marketing plan for the entire hospital / institute that covers marketing of the RT department?

If yes,

- Who writes it?
- What are the chapters /subjects?
- How long does it exists?
- What is the main reason a marketing plan is developed?

Can I see the mentioned documents?

Competitors

- Who are the competitors?
- How close is the competition?
- Is there a strategy to stay ahead of the competition?
- Do you think competition is becoming more important?

Risk analysis: *Availability of a risk management system*

Are all misses and near misses reported according to a certain methodology?

If no,

- How are they reported then?

If yes,

- Do these reports lead to improvement actions?
- How many misses were reported in 2006?
- How many near misses were reported in 2006?
- How many improvement actions were implemented in 2006 based on misses or near misses?

Can I see the mentioned documents?

Electronic Patient Record (EPR): *Use of EPR within the centre*

- Is there a form of EPR used within the centre?
- What information is available online?
- What information will be available online within the next two years?
- Is the EPR also available for people outside the centre?
 - if yes, for whom?

Financial data

- Overhead costs RT department in 2006
 - *What are the overhead costs made by the RT department in 2006?*
- Total costs RT department in 2006
 - *What are the total costs made by the RT department in 2006?*

Extra questions

- If you were not able to answer some of these questions, whom should I address to get an answer?
- Are there strategic issues not addressed today that you think are worth mentioning?

Appendix F: Results partners

In this chapter step 5 of the benchmarking process model is executed. For all four benchmarking partners the results for the performance indicators from the short-list are measured and described.

NKI-AVL

Leadership indicators

Annual report

At this moment the radiotherapy department of the NKI-AVL does not prepare an annual report of the department itself. Information on the performance of the department can be found in the annual report of the NKI-AVL, but this report contains only the major developments from the last year. For 2008 the radiotherapy department is planning to produce an annual report, which will in first instance contain mostly performance data and will be preliminary for internal use.

Year plan

The radiotherapy department of the NKI-AVL does produce a year plan. In this plan is written by the head of radiation oncologists, chairman of the CPZ and includes the following chapters:

- Objectives Cluster Radiotherapy
- Evaluation 2007
- Outline 2008
- Production appointments
- Year plans 2008: detail level

According to the manager of the radiotherapy department originally it was decided that the year plan would be structured according to the INK model guidelines, but this is no longer the case.

Long-term plan

The NKI-AVL does not have a long-term plan for the radiotherapy department, but the manager of the radiotherapy department has an investment plan till 2012 and the head clinical physicists has a 10-year material budget plan written in 2008. The NKI-AVL itself wrote a 10-year plan in 2008.

Competitors

In the Amsterdam area, where the NKI-AVL is located, there are two academic and four general hospitals. The academic hospitals: the Free University of Amsterdam (VU) and the Amsterdam Medical Centre (AMC) both have a radiotherapy department with respectively five and three LineAcc's. With eight LineAcc's in the close surrounding, the NKI-AVL has a high level of competition. The manager of the radiotherapy department believes that

competition is becoming a bigger issue as the legislation regarding top clinical care is changing and it will become easier for other hospital to offer radiotherapy to their patients.

Marketing

At the NKI-AVL, marketing has only recently become an issue. As the NKI-AVL does not have its own marketing strategy, the manager of the radiotherapy department hired an external agency in July 2007 that is helping the department to position themselves in the marketplace. Currently the main focus in this project is to guarantee a growth of the department; the aim is to increase the number of patients with 5% per year.

'One stop' clinics

At the NKI-AVL a 'one-stop' clinic exists for a number of diagnoses, such as breast and prostate cancer patients. This means that new patients will be diagnosed within one day. For breast cancer patients this day is organized as follow. First the patients meet with a breast cancer care nurse where information about the rest of the day is given. Then a mammography is done. If indeed something can be seen on the mammography a biopsy and an ultrasound of the breast will be performed. The radiology and the pathology report are then discussed in a multidisciplinary meeting which takes place during the lunch break. After this meeting the patient meets again with the breast cancer care nurse or immediately with a surgeon, medical oncologist or radiation oncologist. During this appointment the treatment process is discussed. Of course, if it was decided that the patients does not have cancer, the patient is send home without further appointments.

For prostate cancer patient the 'one-stop' clinic is organized in quiet the same way, although different diagnostics are used. First the PSA of the patient is measured in the blood. Then optionally an ultrasound and/or biopsy can be performed.

People indicators

MACRO Employees	Number	FTE	In training	Vacancies
Total number of employees	229	197	-	n.a.
Number of Radation oncologists	18	15	8	n.a.
Number of Clinical Physicists	10	9	3	n.a.
Number of Radiation technologists	135	119	n.a.	n.a.
Number of Researchers	17	9	n.a.	n.a.
Number of employees designations	20*	-	-	-
Number of sick days per employee	5%†	-	-	-

*not including AGIO's, students, interns and research department employees; †only percentage for whole RT department is known

MACRO Patients	Number
Total number of patients treated in 2006	4141
Total number of new patients treated in 2006	3804
Total number of patients in a trial treated in 2006	184

MESO Patients	Number
Number of breast cancer patients treated in 2006	859
Number of prostate cancer patients treated in 2006	320
Number of breast cancer treatment plans processed by the TPS in 2006	1328
Number of prostate cancer treatment plans processed by the TPS in 2006	378
Number of breast cancer patients in a trial in 2006	90
Number prostate cancer patients in a trial in 2006	0

Policy and strategy indicators

Patient satisfaction

At the NKI-AVL patient satisfaction is measured with every patient and analyzed and reported to all employees of the radiotherapy department every two months. This report contains among other thing the number of questionnaires filled out by patients, the mean score patients give for the radiotherapy department and their treatment, and the comment patients wrote on their questionnaire. When the comments are serious, the person responsible for the section is made aware of the problem, so that actions can be taken. For the less serious comments, it is advised to the employees of the sections mentioned to try to take action.

There is no report on the improvement actions actually performed based on the comments from patients' questionnaires.

Risk analysis

At the radiotherapy department of the NKI-AVL two methods are used to do risk analysis. The first method is the use of the Safety incidents reporting (VIM) system, which has recently replaced the patient incidents reporting (MIP) system. The VIM system is an online tool that gives employees the opportunity to report safety incidents. The Reporting Committee Radiotherapy (MCRT) analyzes these VIM reports and other incident reports according to the PRIMA methodology and produced a report with their findings four times a year (MCRT, 2006). Figure 38 shows an example of an analysis done by the MCRT. From this figure it can be determined that between September and December 2006, 221 incidents report were analyzed.

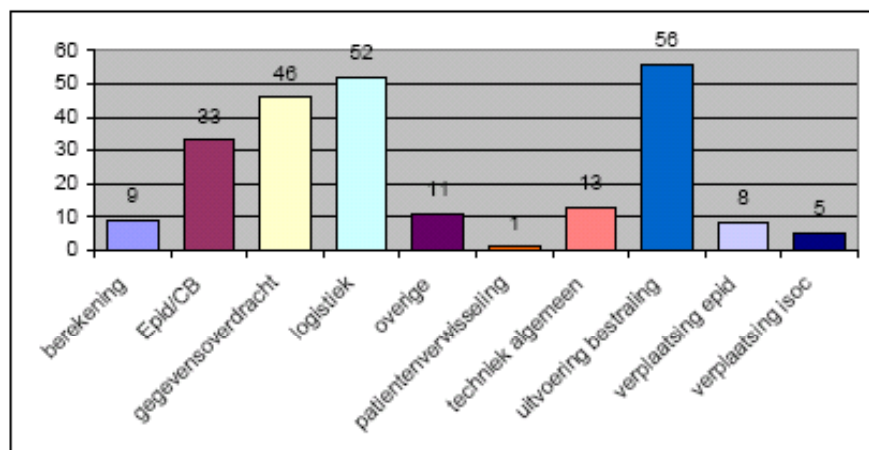


Figure 38: Example of an analysis done by the MCRT, in this case this graph shows the number of incidence reports (MCRT, 2006)

In the coming year, the NKI-AVL will start the development of a hospital wide Safety Management System, as hospitals are obliged to introduce such a system. This will be the next challenge in the area of risk management.

Multidisciplinary approach

At the NKI-AVL multidisciplinary meetings (MM) are held for each tumor group, most of them on a weekly basis. At these meetings the presence of at least one surgeon, one medical-oncologist, one radiation oncologist, one radiologist and one pathologist is obligatory. Others can also attend these meetings, such as nurses, residents, nurse practitioners, etc.

At the NKI-AVL there is no enrolment for the MM's and there is also no chairman appointed. The conclusions that are drawn during these MM's are recorded in the (paper) patient record.

For the MESO level there are no differences in the MM's for prostate patients. For breast cancer patients the frequency of the MM's is higher. Two times a week there is a post-operative MM, two times a week the MM for the new patients at the 'one-stop' breast cancer clinic and once a week the more difficult cases are discussed. At this last meeting there is also always a plastic surgeon present.

Due to a close relationship with general hospitals without a radiotherapy facility, radiation oncologists of the NKI-AVL will attend MM's at these hospitals when they are asked to. Almost every radiation oncologist at the NKI-AVL has their own general hospital at which he or she visits the multidisciplinary meetings.

Electronic patient record

At the NKI-AVL a start has been made in the introduction of the electronic patient record, called the Electronic Hospital Information System (EZIS). In 2008 the following information regarding the patient is online available.

- Correspondence with other physicians, such as general practitioner
- AKL (blood test results)
- Radiology results
- Surgery results
- Histology
- OBC (treatment centre, such as scope results)
- MMB (function not identified)
- List of medication used by the patient
- Trials a patient is included in
- Appointments
- DBC's used

In 2008 it is not possible for the physicians to make notes in this electronic file, so the paper record is still the most important record. For 2009 it is planned that this online reporting will be possible and that also online radiology and blood tests and medication prescriptions can be requested. When these functionalities have been introduced, the NKI-AVL will have a electronic patients record as defined in this research: a paperless patient record.

EZIS is not accessible for people outside the NKI-AVL, such as referees or general practitioners. EZIS is accessible from outside the centre for NKI-AVL employees with an Internet connection and a special log on device.

The radiotherapy department has its own information system, MOSAIQ, which was introduced in 2007. This system contains all information regarding the radiotherapy treatment of patients, such as treatment plans, number of fields and support devices needed.

Partnership and resources indicators

MACRO and MESO	Number	Breast cancer	Prostate cancer
Number of treatment plans processed by the TPS	3974	1330	378
Number of treatment plans based on at least 1 CT scan	3974	1330	378
Number of treatment plans based on at least 1 MRI scan	n.a.	n.a.	n.a.
Number of treatment plans based on at least 1 PET scan	n.a.	n.a.	n.a.
Number of radiotherapy sessions†	78449	26430	8581
Number of IMRT treatments†	1022	265	126
Average number of segments per IMRT treatment †	31	10	29
Number of IGRT treatments†	591	120	128
Number of ART treatments†	72	0	55*

*Number of treatment plans for ART treatment; † based on data sheet all RT patients 2006.

MACRO - Partnerships and resources - Resources	Number
Number of LineAcc's	9
Number of Simulators	1
Number of CT's	2
Number of MRI's	0
Number of PET's	0
Number of LineAcc's with a Cone-Beam	5
Number of working hours per LineAcc	2167
Number of Idle hours per LineAcc	n.a.
Number of hours of downtime for PM per LineAcc	1040
Number of hours of downtime for NPM per LineAcc	247

MACRO - Partnerships and resources - organization	Number
Hours in a workweek (1 FTE)	36 (45)*
Overtime worked	n.a.**
Number of days worked	260
Total costs radiotherapy department	€11.216.000
Overhead costs radiotherapy department	€947.507†

*45 hours for radiation oncologists, 36 for all other employees; ** n.a. means that the data is not available at the centre; † sum of general costs, building costs and divers costs.

MACRO and MESO - Partnerships and resources	Number	Breast cancer	Prostate cancer
Number of publications	53	12	6
Number of impact points	297	71	33
Number of patients in a trial	184	90	0

Karolinska

Leadership indicators

Annual report

There is no annual report for the radiotherapy department and the annual report of the Karolinska hospital is only available in Swedish and therefore not analyzable for this study.

Year plan

The radiotherapy department of the Karolinska institute does not have a year plan.

Long-term plan

There is also no long-term plan for the radiotherapy department.

Competitors

In 2008 the Karolinska institute had only one competitor called Ray Clinic. This radiotherapy centre is located approximately 30 km north of Stockholm and has only one LineAcc operated by a radiation oncologist and physicists of the Karolinska institute, as they do not have their own personnel yet. It is expected that this will change soon. The head of the cancer centre and the manager of the radiotherapy department do not think that Ray Clinic will have a very long life expectancy, as they are too dependent on others. The head of the cancer centre states that the Karolinska institute has a monopoly on radiotherapy treatment in Stockholm.

At this moment some patients of the Karolinska institute are treated at Ray Clinic as there is a capacity problem in the radiotherapy department of the Karolinska. The manager of the radiotherapy department does not think this is a good strategy, as they are now keeping their own competitor in practice.

Marketing

There is no marketing strategy, mainly because there is also very little competition in Stockholm. Therefore it is not necessary to get more patients to go to Karolinska. Competition and marketing are not very big issues at the radiotherapy department of the Karolinska hospital.

'One-stop' Clinics

There are no 'one-stop' clinics at Karolinska. Two main reasons are brought forward to explain why they do not have such clinics. The first reason is that this would mean a big strain on the efficiency of the machines used that already have a capacity problem. The second reason is that both the head of the cancer centre and the radiation oncologist with a breast cancer specialization say that the psychological effect of getting the diagnosis within one day is not studied enough. Therefore more psychosocial research needs to be done in order to compare the positive results of the early diagnosis with the possible negative effects.

The radiation oncologist with a breast cancer specialization explains that when it is determined that the tests need to be done in one day, than this can always be arranged.

This is though only for exceptional reasons. In a normal procedure it will take three or four days to have the diagnosis available.

People indicators

MACRO Employees	Number	FTE	In training	Vacancies
Total number of employees	153	n.a.	n.a.	n.a.
Number of Radiation oncologists	101**	n.a.	n.a.	n.a.
Number of Clinical Physicists	21	n.a.	n.a.	n.a.
Number of Radiation technologists	140	n.a.	n.a.	10*
Number of Researchers	--	--	--	--
Number of employees designations	n.a.	--	--	--
Number of sick days per employee	n.a.	--	--	--

*In 2008; **these are all oncologists, as there are no separate radiation oncologists in Sweden

MACRO Patients	Number
Total number of patients treated in 2006	5652
Total number of new patients treated in 2006	n.a.
Total number of patients in a trial treated in 2006	37

MESO Patients	Number
Number of breast cancer patients treated in 2006	1718
Number of prostate cancer patients treated in 2006	2439
Number of breast cancer patients in a trial in 2006	0
Number prostate cancer patients in a trial in 2006	2

Policy and procedure indicators

Risk analysis

At the Karolinska hospital there is a risk management system that deals with patient related risks. This system is a computer system that has been developed by an external ICT company and is functional since 2008. It enables all employees to report misses and near misses online but is not an anonymous system as the employee has to log-on under its own name. Employees are though encouraged to report misses and near misses as this can only improve the quality of care.

The data from the system is analyzed by the evaluation department and the radiotherapy department gets information monthly in a small report and annually in a bigger report. According to the radiotherapy department management the information is used to identify where improvements can be made, but these analyses and improvement actions are not written down, they are only discussed within the radiotherapy department meetings.

Multidisciplinary meetings

According to the head of the cancer centre all patients at Karolinska are discussed in a multidisciplinary meeting, but he believes that the integration with research and education can improve.

For all multidisciplinary meetings the information regarding the patients that need to be discussed is collected by a secretary. During the meeting the summary of the discussion and the physicians present are entered directly into the ERP of the patient. The responsible medical - radiation oncologist presents his or her own cases, so there is no chairman.

For the breast cancer patients there is a multidisciplinary meeting every week for approximately two hours. In the first half the post-operative patients are discussed and in the second half the pre-operative patients are discussed. Sometimes patients are even presented real time. At these meetings at least the following persons should be present:

- 'Breast and endocrine' surgeon
- Medical oncologist / Radiation oncologist
- Radiologist
- Pathologist (only first half)
- Cytologist (only second half)

Further other people can join the meetings as this meeting is for educational purposes too, but their presence is not obligatory.

For prostate cancer patients there are two curative multidisciplinary meetings a week, one at the southern hospital and one at Radiumhemmet. Furthermore every other week a meeting is held where only palliative patients are discussed. At these meetings at least the following persons should be present:

- Urology surgeon
- Medical oncologist / Radiation oncologist
- Radiologist
- Pathologist

Further other people can join the meetings as this meeting is for educational purposes too, but their presence is not obligatory.

Electronic patient record

Two years ago a new EPR was introduced, called Take Care. The radiation oncologist with a prostate cancer specialization feels that there is a resistance towards computerized systems within Karolinska and he gives two reasons. First, the new Take Care system is not designed in a user friendly way. There are too many pop-up screens and therefore it takes longer to fill-in something in the EPR than it would when filling-in the paper version. The second reason is that the older generation of physicians is not used to working with computers, which means it will take them even longer to get acquainted with the system. He does see many opportunities for ICT within hospitals in the future.

The radiation chart for patients receiving radiotherapy are available both digital and hard-copy. The new system AREA should make the hard-copy redundant, which will happen within the next year. A problem is that some of the older LineAcc's are not equipped to produce digital images. Before these LineAcc's are replaced a completely paperless ERP is not yet possible. When this problem is solved, Karolinska will have a full EPR.

Partnership and resources indicators

MACRO and MESO	Number	Breast cancer	Prostate cancer
Number of treatment plans processed by the TPS	3510	1718	2439
Number of treatment plans based on at least 1 CT scan	5261	1718	2439
Number of treatment plans based on at least 1 MRI scan	100	0	122
Number of treatment plans based on at least 1 PET scan	20	17	240
Number of radiotherapy sessions	83674*	--	--
Number of IMRT treatments	--	0	31
Number of IGRT treatments	--	0	55
Number of ART treatments	--	0	30

*Sessions of 16 minutes;

MACRO - Partnerships and resources - Resources	Number
Number of LineAcc's	12
Number of Simulators	3
Number of CT's	2
Number of MRI's	0,1
Number of PET's	0,15
Number of LineAcc's with a Cone-Beam	1
Number of working hours per LineAcc	28224
Number of Idle hours per LineAcc	5872
Number of hours of downtime for PM per LineAcc	230*
Number of hours of downtime for NPM per LineAcc	30*

*Measured in days;

MACRO - Partnerships and resources - organization	Number
Hours in a workweek (1 FTE) (all; physicians; LineAcc nurses)	40; 44; 32.26
Overtime worked	n.a.
Number of days worked	260
Total costs radiotherapy department	n.a.
Overhead costs radiotherapy department	n.a.

MACRO and MESO - Partnerships and resources	Number	Breast cancer	Prostate cancer
Number of publications	24	4	5
Number of impact points	55	14	12

Carl Gustav Carus

Leadership indicators

Annual report

Within the Carl Gustav Carus hospital a number of annual reports are produced each year in which some activities of the radiotherapy department are mentioned. Examples of these annual reports are the report of the hospital, the report of the University Cancer Centre, the report of the research department and the report of OncoRay. The radiotherapy department itself does not produce an annual report, but special events are reported in the other annual report produced within the hospital.

Year plan

The radiotherapy department does not develop a year plan, but there is a year plan for the whole UCC in which radiotherapy related subjects are discussed, but not in a separate section.

Long-term plan

Also for the long term plans, the radiotherapy department does not have its own plan. The UCC does have a long term plan, which is based on the three pillars of a Comprehensive Cancer Centre: clinical care, research and education.

For research in radiotherapy a new research centre called OncoRay was set up in 2005. The core projects of OncoRay are: laser generated proton treatment and basic research in new beams, molecular targeting and molecular imaging. It is planned that in 2012 a new building will be finished, which will provide place for:

- A cyclotron for proton treatment and as a reference beam for laser accelerated ion beams
- Combination of EBRT with mAb bound radionuclides
- Biological imaging for biologic ART
- In vivo dosimetry of High precision beams
- Combined modality treatments

Competitors

The competition for the radiotherapy department of the Carl Gustav Carus is close. In Dresden there are two private practices that offer radiotherapy, one with two LineAcc's and one with one LineAcc.

A problem in Germany is that there is a law that stems from the 1880's which states that private practices have a prime on ambulatory patients (outpatients), which place a strain on the arrival of new patients. At this moment there is no problem as there are too many patients for the private practices to treat, but when these private practices decide to expand, this can become a problem for Carl Gustav Carus.

Marketing

Although Carl Gustav Carus cannot ignore the competition, there is no written marketing strategy. There are though plans to ensure the inflow of patients. Within two years it will be possible for physicians at Carl Gustav Carus to choose for a 'private practitioners' contract.

This will mean that they can treat ambulatory patients. Physicians with such a contract, are not involved in research activities.

Another way to stay ahead of the competition is collaboration. Carl Gustav Carus joins in on Multidisciplinary Meetings of three referring hospitals in the area and has an on demand arrangement with approximately 10 hospitals in the area. These meetings result in approximately one third of the Carl Gustav Carus patients.

Marketing as in advertising is not possible, as in Germany hospitals are not allowed to advertise. A way to get positive media attention is to put out a press release on important research outcomes. A press release on IGRT in prostate cancer resulted in an increase in patients of almost 50%.

'One stop' clinics

At the UCC of Carl Gustav Carus hospital there are no 'one-stop' clinics. The diagnostic phase of breast cancer patients is though somewhat different from other tumor groups. Breast cancer patients are admitted to the gynecological ward for a two or three day period, in which all of the diagnostic actions are performed. This difference in policy has three reasons. First, it is easier for the patient as the women do not have to travel to the UCC every day for the tests. The second reason is of a more financial nature; as in-patients have a higher refund from the insurers it is better to keep them as in-patients. The third and last reason is that in-patients are treated with priority when it comes to in house facilities. These three reasons together explain why at Carl Gustav Carus breast cancer patients are admitted to the gynecological ward during their diagnostics phase.

People indicators

MACRO Employees	Number	FTE	In training	Vacancies
Total number of employees	78	76*	1**	4**
Number of Radiation oncologists	11	11	1	2
Number of Clinical Physicists	6	5,75	0	2
Number of Radiation technologists	20	19,5	0	0
Number of Researchers	8	7,5	0	0
Number of employees designations	2	--	--	--
Number of sick days per employee	3,10	--	--	--

* Estimation based on total number of employees and FTE radiation oncologists, clinical physicists, radiation technologists and researchers; ** estimation based on numbers for radiation oncologists, clinical physicists, radiation technologists and researchers

MACRO Patients	Number
Total number of patients	1658
Total number of new patients	n.a.
Total number of patients in a trial	165*

* Estimation that number of patients in a trial is approximately 10%

MESO Patients	Number
Number of breast cancer patients	165
Number of prostate cancer patients	81
Number of breast cancer treatment plans processed by the TPS	165
Number of prostate cancer treatment plans processed by the TPS	81

Policy and strategy indicators

Patient satisfaction

All patients that receive radiotherapy treatment get a questionnaire regarding their treatment. The return rate is estimated at approximately 50%, but this is not analyzed in a systematical way.

The questionnaires are reviewed for severe complaints, which will need to be responded to by the responsible doctor on a face-to-face basis, if possible (and the questionnaire was not filled in anonymously). If they are very severe, they will also be reported with the hospital complaint management. However, most comments in these questionnaires regard the waiting times in the clinic.

Patient planning

Patients get their appointments for the treatments every week one week ahead. Re-scheduling according to patients' preference is no problem.

Risk analysis

At Carl Gustav Carus there is no special structure or methodology for the reporting of misses and near misses, but there is an informal way of reporting.

All (near)-misses should be reported to the supervisor of the employee that discovered the (near)-miss. These supervisors can either be a medical doctor or a clinical physicist. Misses will be reported in the patients file, but will only be discussed with the patient when a patient specifically asks for this. Technical problems are reported to the manufacturer of the broken equipment, but the radiation oncologist is always responsible for the safety of the patient.

A comment of Prof. Baumann regarding this subject: "Over the last ten years, all problems that I have signed off were new problems that would not have been easy to prevent". This

means that when a problem has occurred the measures taken have been good enough to make sure that it does not happen again. "This informal reporting works because there is a very flat organization structure".

Multidisciplinary approach

At the UCC multidisciplinary meetings, called Tumor Boards (TB), started in 2002. The goal at the UCC is that every patient is discussed at least once in a TB, which has almost been achieved. There are approximately twelve tumor boards each week at which at least one radiation oncologist is present. At the TBs also a surgeon from the specific tumor group, medical oncologist and radiologist are present. At the Gastro Intestinal (also general) TBs a nuclear medicine specialist and a pathologist are also present and for the breast cancer TB a pathologist and a psycho-oncologist are present.

At CGC there is no enrolment prior to the TB, but at the TB the attendees will have to sign for presence and are documented in an especially for the TBs designed electronic tool. In this tool online notes are made, which are sent to the attendees afterwards by e-mail. When somebody does not show up for the TB, it is cancelled but this happened only twice or so a year. For most of the TBs there is no chairman appointed, but at the Gastro Intestinal TBs the head of the UCC is the chairman.

All agreements round the organizations of the TBs are recorded in the Quality Management Handbook of the hospital, and is revised every two years based on new insights.

Electronic patient record

In the CGC hospital steps have been taken towards a more digitalized patient record. There is not yet a complete Electronic patient record (EPR). Mainly because some legal issues that insist on printed copies of some documents, such as treatment plans (stored for 50 years) and other images. Therefore, the patient records are not yet completely paperless and there is not yet a full EPR also because for the daily practice of patient care, the paper patient file remains the most important document.

At CGC there are multiple online databases, which are all used for some extent by the RT department. These databases are the Hospital Information System (HIS), the UCC tool, the radiotherapy treatment system and the regional cancer registry.

The management of the radiotherapy department thinks that in the next five years these systems will to a large extent be integrated with each other, which has already been started. Up till now information on the patients needs to be added to each system separately (meaning four times). Within two years the first two systems should be connected, being the HIS and the radiotherapy treatment system. The EPR is not reachable for people outside the centre.

Waiting times

At CGC the waiting times for the individual patients are not measured. Therefore the waiting times for sixteen breast cancer patients and fourteen prostate cancer patients were collected from the patient records. After the first collection it became clear that the formulation of the different measurement points as described by Cionini (2007) was ambiguous. Therefore the formulations were adapted in order to be easier measurable.

Partnership and resources indicators

MACRO and MESO	Number	Breast cancer	Prostate cancer
Number of treatment plans processed by the TPS	752*	165	81
Number of treatment plans based on at least 1 CT scan	752	165	81
Number of treatment plans based on at least 1 MRI scan	50	0	10
Number of treatment plans based on at least 1 PET scan	125	0	5
Number of radiotherapy sessions	28690	n.a.	n.a.
Number of IMRT treatments	--	0	5
Number of IGRT treatments	--	0	70
Number of ART treatments	--	0	63

*Only 3-D plannings;

MACRO - Partnerships and resources - Resources	Number
Number of LineAcc's	3
Number of Simulators	1
Number of CT's	3
Number of MRI's	0
Number of PET's	1
Number of LineAcc's with a Cone-Beam	1
Number of working hours per LineAcc	7410
Number of Idle hours per LineAcc	2730
Number of days of downtime for PM per LineAcc	15
Number of days of downtime for NPM per LineAcc	12,5

MACRO - Partnerships and resources - organization	Number
Hours in a workweek (1 FTE)	40(42)*
Overtime worked	n.a.
Number of days worked	260
Total costs radiotherapy department†	€495.000**
Overhead costs radiotherapy department†	€3.500.000**

*42 hours for radiation oncologists, 40 for all other employees; †estimation of the UCC director; ** based on an estimation from M. Baumann

MACRO and MESO - Partnerships and resources	Number	Breast cancer	Prostate cancer
Number of publications*	24	1	0
Number of impact points*	68	1.2	0
Number of patients in a trial	167**	17**	8**

*Publications from OncoRay not included; ** Estimation that number of patients in a trial is approximately 10%

Institute Jules Bordet

Leadership indicators

Annual report

At institute Jules Bordet no annual report for the radiotherapy department is written, but a review is made of the activities done each year.

Year plan

Also no year plan is made. The head of the radiotherapy department discusses his ideas with the employees and bases his year goals on the outcomes of these informal discussions.

Long-term plan

There is no long-term plan for the radiotherapy department, which according to the head of the department induces a lack of investments in the department. This lack of funding and the shortage in staff makes it difficult for Jules Bordet to make long-term plans.

In Belgium it is not common for hospitals to have a long-term plan.

Competitors

In Belgium there is heavy competition between hospitals. This stems mainly from the difference between public and private hospitals.

Marketing

The director of JB is not very fond of marketing. She believes that offering a good quality of care is in itself the best marketing strategy, as human-to-human marketing is the best way to get patients. Therefore the availability of high technological care and good integration with research is important. The society 'Friends of Jules Bordet' collects money for JB and spends this on projects that among other things help the image of Jules Bordet.

'One-stop' clinics

JB does not have 'One-stop' clinics. The main reason is that most of the patients treated at the radiotherapy department of Jules Bordet already have been diagnosed before they enter the institute. Of all patients treated, more than two-third of the patients come from another hospital.

People indicators

MACRO Employees	Number	FTE	In training	Vacancies
Total number of employees	29	27,5	n.a.	n.a.
Number of Radiation oncologists	5	5	4	1
Number of Clinical Physicists	4	3,5	2	0
Number of Radiation technologists	16	15	n.a.	3
Number of Researchers†	--	--	--	--
Number of employees designations	1	--	--	--
Number of sick days per employee	n.a.	--	--	--

† No separate research department for RT

MACRO Patients	Number
Total number of patients	888
Total number of new patients	n.a.
Total number of patients in a trial	n.a.
MESO Patients	Number
Number of breast cancer patients	563
Number of prostate cancer patients	23
Number of breast cancer treatment plans processed by the TPS*	732
Number of prostate cancer treatment plans processed by the TPS*	30
Number of breast cancer patients in a trial	n.a.
Number prostate cancer patients in a trial	n.a.

* Based on an estimation of 1.3 plans per patient

Policy and procedure indicators

Patient satisfaction

At the radiotherapy department of JB, patient satisfaction is not measured with a questionnaire or on a structural basis. The radiotherapy department uses complaints letters from patients (which does not occur very often) to see if patients are satisfied.

Jules Bordet does send questionnaires to patients that have been hospitalized. The data of the returned questionnaires is gathered but not analyzed.

Risk analysis

At JB there are different systems available for reporting misses. Some of these systems (e.g. blood transfusions and hospital infection) are obligated by Belgium law; others are developed by JB (chemotherapy, decubitus). Near misses are not reported.

When a miss has been reported in one of the system, this miss is analyzed and discussed with the people involved in the process and possible improvement actions are shared with the employees in a formal letter.

In 2008 JB is planning on improving the quality management system at JB. They are gathering the information about all the risk analysis systems and plan to disperse this information among the employees, so all employees are aware of the different systems available. A step for the long term is to integrate all systems in one hospital wide system.

Multidisciplinary meetings

Multidisciplinary meetings have been used within Jules Bordet since the 1980s and are therefore completely embedded in the culture of the institute. This means that the recently introduced law, that obligates all cancer centers to have multidisciplinary meetings, did not have a large influence on the policies and procedures at Jules Bordet.

Each department at JB has a multidisciplinary meeting. The problem is that these meetings are organized during working hours, which is a problem for the radiotherapy department, as radiation therapy is a continue practice. They are not taken into regard when planning the meetings and therefore it is sometimes not possible to have a radiation oncologist present. Furthermore, the department provided services to a network of hospital and each hospital would like to have their own multidisciplinary meeting with a radiation oncologist from JB present, making it a quite difficult task.

At JB there are two kinds of multidisciplinary meetings for breast cancer patients.

The first is the pre-operative meeting, which takes only half an hour and only patients that might need adjuvant chemotherapy or have other special problems that need to be discussed prior to the surgery. At these meeting the one or more of the following physicians are present:

- Radiation oncologist
- Medical oncologist
- Breast surgeon
- Radiologist

The second meeting is the post-operative meeting, which can take up to two hours. Every breast cancer patients treated at JB is discussed at least once in such a post-operative meeting. At these meeting the same persons are present as with the pre-operative meeting, supplemented with one or more of the following persons:

- Pathologist
- Psychologist
- Physiotherapist
- Head nurse of hospital floor
- Data manager
- Secretary
- Residents

Only the physicians mentioned in the pre-operative section are compulsory for the meeting to start. In total between twenty and thirty people are present at the breast cancer meeting.

During these meetings the treatment decisions are online added to the electronic patient record, which means that also additional information in the patients' record can be displayed and everyone present can verify the treatment decision.

For the prostate cancer patients there are some differences. There is also one multidisciplinary meeting per week for prostate cancer patients, but a radiation oncologist is only present if there are patients to be discussed that might be a candidate for a radiotherapy treatment (many patients only get a prostatectomy and no radiation therapy), which means that on average a radiation oncologist is present every other week.

At the prostate cancer multidisciplinary meeting the same tool is used as with the breast cancer meeting.

Electronic Patient record

Jules Bordet has its own Electronic Patient Record (EPR) since 1982. In 2001 information technologist of the institute revised the EPR, which is called ORIBAS. There is however no link between the radiation charts and the EPR, and it would be very costly to link and them.

At JB there is already the possibility to send information about the patient from ORIBAS via email to the general practitioner, but the GP does not have access to the EPR. The general medical director of Jules Bordet does not think that this will be possible soon, especially due to confidentiality issues. She thinks that the European Union should have a leading role in setting standards for the confidentiality of the EPRs. Therefore, according to the general medical director of Jules Bordet, information technology will be a big challenge for the coming years.

Partnership and resources indicators

MACRO and MESO	Number	Breast cancer	Prostate cancer
Number of treatment plans processed by the TPS	2340	732	30
Number of treatment plans based on at least 1 CT scan	1350	<10	30
Number of treatment plans based on at least 1 MRI scan	0	0	0
Number of treatment plans based on at least 1 PET scan	50-100	0	0
Number of radiotherapy sessions	n.a.	n.a.	n.a.
Number of IMRT treatments	0	0	0
Number of IGRT treatments	0	0	0
Number of ART treatments	0	0	0

MACRO - Partnerships and resources - Resources	Number
Number of LineAcc's	3,75*
Number of Simulators	1
Number of CT's	0,5
Number of MRI's	0
Number of PET's	0
Number of LineAcc's with a Cone-Beam	0
Number of working hours per LineAcc	1974
Number of Idle hours per LineAcc	102
Number of hours of downtime for PM per LineAcc	84
Number of hours of downtime for NPM per LineAcc	18

* At Jules Bordet a Cobalt machine is still in place, which treats approximately 75% of the patients that could be treated with a LineAcc.

MACRO - Partnerships and resources - organization	Number
Hours in a workweek (1 FTE)	38(44)*
Overtime worked	n.a.
Number of days worked	260
Total costs radiotherapy department	n.a.
Overhead costs radiotherapy department	n.a.

*44 hours for radiation oncologists, 38 for all other employees

MACRO and MESO - Partnerships and resources	Number	Breast cancer	Prostate cancer
Number of publications	8	0	1
Number of impact points	n.a.	n.a.	n.a.
Number of patients in a trial	55	0	3

Appendix G: statistical analysis confidence interval

		Random sample	Mean waiting time	Standard deviation	Confidence interval
NKI-AVL	Prostate	15	11.4	2.8	1.437
	Breast	15	13.0	5.2	2.615
CGC	Prostate	14	44.4	24.2	12.668
	Breast	16	18.3	16.3	7.993
JB	Prostate	10	58.8	19.0	11.753
	Breast	21	34.4	16.6	7.090

For Karolinska no statistical analysis could be performed, as the initial data was not provided.

		Confidence interval
NKI-AVL	Prostate	(10.0 ; 12.8)
	Breast	(10.4 ; 15.6)
CGC	Prostate	(31.7 ; 57.0)
	Breast	(10.3 ; 26.3)
JB	Prostate	(47.0 ; 70.5)
	Breast	(27.3 ; 41.5)

As the analysis shows, the 95% confidence intervals are quite broad. This indicates that for future research a larger random sample needs to be taken in order to get more realistic performance intervals.

We also see that the 95% confidence intervals for breast cancer are less broad than the 95% confidence intervals for prostate cancer. This is in concord with the results found in the graphs, where the prostate cancer outcomes were much more apart than the breast cancer outcomes. The renewed definitions should partially solve this problem.

Appendix H: Dutch treatment complexity classification

T1	Simple treatments requiring simulation and calculation of the number of monitor units or treatment time
T2	Standard treatments requiring simulation and a 2-D treatment plan
T3	CRT treatments requiring CT information and a 3D treatment plan
T4	IMRT treatments and require CT, MRI or PET images, full 3D treatment planning and optimization and extensive verification including portal imaging and / or in vivo dosimetry