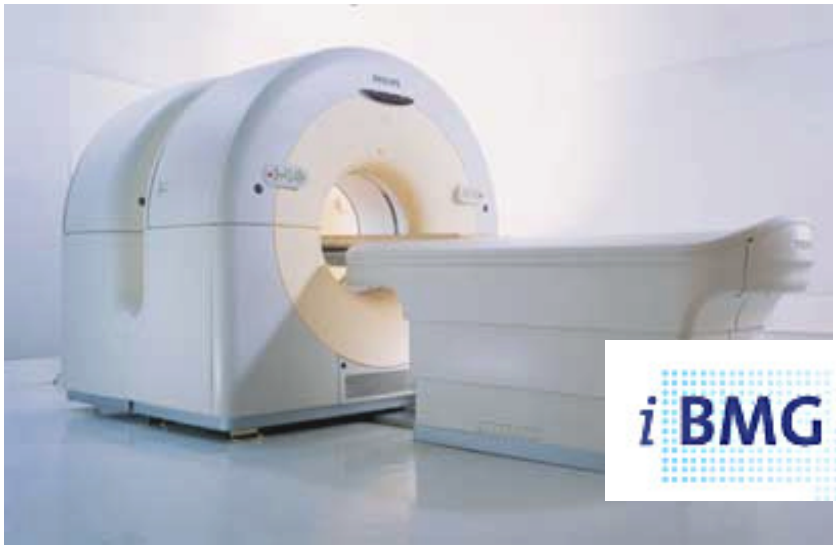

# The influence of hospital competition on the diffusion of the PET-CT scanner in the Netherlands

**Master thesis**


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Health Economics, Policy and Law
May 2013

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ERASMUS UNIVERSITEIT ROTTERDAM

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**Disclaimer**
Respondents in this study speak as private persons. Their opinions can therefore not be used to bind their employers in any way.

*Voor mijn ouders*
*die mij altijd stimuleren en mij hun energie schenken wanneer de mijne ontbreekt*

Met dank aan Rob Gaillard die een extra paar ogen en oren voor me vormt, zorgt dat ik niets uit de actualiteit mis en kritische vragen blijft stellen

# Abstract

***Background***

Managed competition is introduced to change the incentives and market so that the efficiency of health care delivery improves. Price competition however may meet difficulties in the health care sector and may lead to a *medical arms race.* Hospitals compete for physicians' loyalty by making available the latest technology. The resulting excess capacity increases total health expenditure. Competition also increases the marketing costs for hospitals to build a reputation as a modern hospital. The Dutch Health Inspectorate (IGZ) states that there is an overcapacity of PET-CT scanners in the Netherlands. If the PET-CT is only used for proven cost-effective indications, the Netherlands would only need 9 PET-CT scanners in comparison to the at least 44 scanners we currently have. To understand the diffusion of the PET-CT scanner in the Netherlands, this study identifies all relevant actors that are involved in the diffusion process and focuses on the incentives that influence the (individual) decision-making process of the actors and the influence of hospital competition on these incentives.

***Methods***

Prior theoretical studies are collected to gain insight into the existing knowledge about the decision-making process used when purchasing medical technology. To map the current distribution of the PET-CT scanner in the Netherlands, grey literature is also used. Interviews are used to get a clear view on which theoretical incentives are relevant in practice. Interviews are held with actors on micro, meso and macro level. The interviewees were asked to fill in a short questionnaire with multiple-choice questions and propositions that form the starting point of the semi-structured interviews. Indicators are attributed to the theoretical concepts to make them measurable. The interview data are analyzed by open labeling, followed by attribution of these labels to the theoretical indicators.

***Results***

The distribution of PET-CT scanners in the Netherlands is not optimal. In certain regions and for certain indications overcapacity or overconsumption exists whereas for others a shortage occurs. Hospital managers and specialists are identified as the most important decision making actors for medical technology. Their primary incentive seems to be the provision of needed care. The insurer and the industry are ranked to both have an average influence on the diffusion process and operate primarily from economic incentives. The antitrust authority and other governmental institutions are attributed no or limited influence on the diffusion process.

***Conclusions***

Hospitals use medical technology to build a reputation as a modern hospital and to attract patients and physicians. Quality competition therefore seems to have a positive effect on the diffusion of PET-CT technology in the Netherlands. The existence of price competition, and therefore its influence on the diffusion process, is less clear. The Dutch system is still in transition and insurers will probably become more important influencers of the diffusion process in the future. This might increase price competition and the influence of it on the diffusion of medical technology.

# Dutch abstract

***Achtergrond***

Gereguleerde concurrentie is geïntroduceerd om de prikkels en markt dusdanig te veranderen dat de efficiëntie van de zorg verbetert. Prijsconcurrentie kan echter moeilijkheden ondervinden in de gezondheidszorgsector en kan mogelijk leiden tot een *medical arms race.* Ziekenhuizen concurreren voor de loyaliteit van artsen door de nieuwste technologie beschikbaar te maken. De resulterende overcapaciteit verhoogt de totale uitgaven voor de gezondheidszorg. Concurrentie verhoogt ook de marketing kosten die ziekenhuizen maken om een reputatie op te bouwen als modern ziekenhuis. De Inspectie van de Gezondheidszorg (IGZ) concludeert dat er een overcapaciteit van PET-CT scanners bestaat in Nederland. Als de PET-CT alleen wordt ingezet voor indicaties waar kosteneffectiviteit bewezen is, heeft Nederland maar 9 scanners nodig in plaats van de minimaal 44 die er op dit moment zijn. Om de diffusie van de PET-CT scanner te begrijpen, identificeert deze studie alle relevante actoren die betrokken zijn bij het diffusieproces. De focus hierbij ligt op de prikkels die het individuele beslissingsproces van de actoren beïnvloeden en op de invloed van ziekenhuisconcurrentie op deze prikkels.

***Methoden***

Theoretische studies zijn verzameld om inzicht te verkrijgen in de bestaande kennis over het beslissingsproces om medische technologie aan te schaffen. Om de huidige distributie van PET-CT scanners in Nederland in beeld te brengen, is er ook grijze literatuur gebruikt. Interviews zijn gebruikt om duidelijkheid te krijgen over welke theoretische prikkels relevant zijn. Interviews zijn afgenomen met actoren van micro, meso en macro niveau. De respondenten zijn gevraagd om een korte vragenlijst in te vullen met multiple choice vragen en stellingen die vervolgens het startpunt zijn van de semigestructureerde interviews. Indicatoren zijn toegekend aan de theoretische concepten om deze meetbaar te maken. De interviews zijn geanalyseerd door de data eerst open te labelen om deze labels vervolgens aan de theoretische indicatoren te koppelen.

***Resultaten***

De distributie van PET-CT scanners in Nederland is niet optimaal. In bepaalde regio's en voor bepaalde indicaties bestaat er overcapaciteit of overconsumptie terwijl er voor anderen een tekort bestaat. Ziekenhuismanagers en medisch specialisten zijn geïdentificeerd als de belangrijkste beslissers bij de aankoop van medische technologie. De primaire prikkel van deze actoren lijkt het leveren van benodigde zorg te zijn. De zorgverzekeraar en de industrie kregen elk een gemiddelde invloed op het diffusieproces toegekend en lijken te opereren vanuit economische prikkels. Aan mededingingsautoriteit en andere overheidsinstanties werd geen tot zeer weinig invloed op het diffusieproces toegekend.

***Conclusies***

Ziekenhuizen gebruiken medische technologie om een reputatie te creëren van een modern ziekenhuis en om patiënten en artsen aan te trekken. Concurrentie op kwaliteit lijkt hierdoor een positief effect te hebben op de diffusie van PET-CT technologie in Nederland. Het bestaan van concurrentie op prijs, en dus ook de invloed van prijsconcurrentie op het diffusieproces, is minder duidelijk. Het Nederlandse systeem is op het moment nog in transitie en er is reden om aan te nemen dat de zorgverzekeraar meer invloed zal krijgen op het diffusieproces van medische technologie. Dit verhoogt op termijn mogelijk de concurrentie op prijs en de invloed van deze concurrentie op de diffusie van medische technologie.

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# 1. Introduction

It is widely accepted that the development, adoption, diffusion and utilization of new medical technology accounts for the majority of the growth in health care expenditures (Newhouse, 1992; Cutler and McClellan, 2001; Pauly, 2005; Chernew, 2011). Managed competition is introduced to change the incentives and market so that the efficiency of health care delivery improves (Enthoven and van de Ven, 2007; Chernew *et al*., 1998; Baker, 2001). Price competition is introduced among insurers and health care providers; in this way managed competition increases incentives for cost containment and can be an effective tool to reduce health care expenditures. Price competition however may encounter difficulties in the health care sector due to the existence of insurance (Arrow, 1963) and information asymmetry (Devers *et al.,* 2003; Folland *et al.,* 2010). Therefore competition may lead to a *medical arms race.* Thereby organizations compete on quality and with top end, often unnecessary, technology (Robinson and Luft, 1985). Hospitals compete for physicians' loyalty by offering the best facilities and making available the latest technology (Devers *et al*., 2003; Berenson *et al*., 2006; Kessler and McClellan, 2000). The service additions and expansions are often described as duplicating services that are already available in the community. The resulting excess capacity increases total health expenditures (Devers *et al*., 2003). Competition also increases the marketing costs for hospitals to build a reputation and brand name (Devers et al., 2003; Enthoven, 1993). It is difficult to draw theoretical conclusions on the effects of competition among hospitals and this results in two opposing policy perspectives: either to stimulate or to diminish hospital competition (Kessler and McClellan, 2000).

Marcel Levi (CEO of the Amsterdam Medical Centre (AMC)) and Anton Westerlaken (CEO Maasstad hospital, Rotterdam) argue for less competition among hospitals in the Netherlands. According to them hospitals are competing for patients with top-end technology that leads to immense efficiency losses (Altijd wat, NCRV 2012). The Health Inspectorate (Inspectie voor de Gezondheidszorg) states that there is an overcapacity of PET-CT scanners in the Netherlands (IGZ, 2008). If the PET-CT is only used for indications wherefore a scan is proved (cost) effective, a ZonMW study (2007) shows that the Netherlands would only need 9 PET-CT scanners in comparison to the at least 44 scanners we currently have (RIVM, 2011). This study first determines whether both studies (IGZ, 2008 and ZonMW, 2007) are still up to date. But if so, this positively means that Dutch people have easy access to top clinical care. But it also creates the problem that demand will increase due to over-supply. This is a highly undesirable side effect due to the high investments associated with PET-CT scanners and the already increasing public health care expenditures. This makes it highly relevant to understand how the current distribution occurred and how potential overcapacity could be avoided.

To understand the diffusion of the PET-CT scanner in the Netherlands, this study identifies all relevant actors that are involved in the diffusion process and researches their innovation-decision process. The focus hereby lays on the incentives that influence the (individual) decision-making process of the actors and the influence of hospital competition on these incentives. To structure this research the following central research question will be answered:

*Did hospital competition influence the diffusion of PET-CT scanners in the Netherlands, and how can this existing or non-existing influence be explained?*

This question is answered with the help of the following sub questions:

- Which actors were involved in the distribution process of the PET-CT scanner in the Netherlands?
- What incentives influence these actors' decision-process?
- Which of these incentives occurred due to hospital competition?

The theoretical relevance of this study lies in the fact that the influence of hospital competition on the use of technology is yet unknown. According to microeconomic principles, hospital competition is supposed to decrease the total public health care expenditures (Enthoven, 1993; Folland *et al., 2010*). But the occurrence of a medical arms race can potentially drive health care costs further up due to over-use of technology. This study is practically relevant in the Netherlands given the ongoing political debate on the reduction of growth rates in public health care expenditure and the influence that technology has on these growth rates. The liberal party (VVD) and the labor party (PvdA) have opposing views on the efficacy of competition in the health care sector (PvdA, 2012 p. 44; VVD, 2012 p. 22). So research on the influence of competition on the use of technology and thereby health care expenditure is necessary to support future policy-making decisions and evaluate past ones.
This study furthermore shows the relevant actors in the distribution process of the PET-CT scanner and the incentives that influence their behavior. These insights can be used to influence the distribution process of a new technology in the future so that an optimal distribution can be achieved.

This thesis first gives a general theoretical background on (managed) competition in health care. Chapter 3 gives a short technological description of the PET-CT scanner and an overview of the development and the clinical use of the scanner. An international context is given in chapter 4 and chapter 5 gives an overview of the current situation in the Netherlands. Chapter 6 illustrates the decision-making process in the Netherlands by identifying relevant actors and the incentives that influence the actors' decision-making processes. Chapter 7 addresses the methods used. Finally, chapters 8-11 contain the results of this study. Hereby chapter 8 focuses on the current situation in the Netherlands, chapter 9 on the incentives of the actors that are involved with the purchase-decision of a PET-CT scanner, chapter 10 on competition and collaboration and chapter 11 discusses the international and future implications of this study. Chapter 12 reaches a conclusion by answering the central research question, discusses potential limitations of the study and gives policy implications and recommendations for further scientific research.

## 2. Theoretical Framework

In the past decade the diffusion of new medical technology was the primer driver of per capita spending growth in health care (Chernew, 2011). Consumers and providers demand high quality medical care and thereby rely on the availability of expensive technologies. Also, a continuous improvement of the best practice procedures is expected (Baker and Scott, 2004). This, despite the fact that it is widely accepted that the development, adoption, diffusion and utilization of high technology accounts for the majority of the growth in health care expenditures (Newhouse, 1992; Cutler and McClellan, 2001; Pauly, 2005; Chernew, 2011). Although Smith *et al*., (2009) argue that previous studies allocate too big a role for technology in health care spending growth; they conclude that 27-48% of health care spending growth can be allocated to technology since 1960. A distinction must be made between the growth in health care expenditures and actual health care expenditures. Because whereas the diffusion of new technology can be seen as a primer driver of per capital spending growth over the past decades (Chernew, 2011), it is difficult to define for what percentage technology accounts in the total health care expenditure. But evidence suggests that new medical technology results in increased health care expenditures rather than reduction (Bodenheimer, 2005). One reason for this growth is the substitution of old technologies by new, more expensive ones. A second reason is the treatment expansion effect. The new technology does not only make the treatment more expensive but it also increases the total number of procedures conducted (Cutler and McClellan, 2001; Chernew *et al*., 1997). Furthermore complementarities may arise when the use of old technologies is required for the application of new technology (Chernew, 2011). The use of complementary services may increase the costs of a new technology as much as 50% (Chernew, 2011). But

social wastefulness is likely to increase with additional services of minimal medical benefit instead of the more often considered, increased prices (Kessler and McClellan, 2000).
The rapid technological change started with X-rays and lab tests and later became subject to complex procedures and treatments such as diffusion of intensive care units and radiation therapy (Chernew, 2011). Recently technologies as prescription drugs and imaging experienced rapid spending growth (Chernew, 2011). The higher availability of MRI, CT, PET and radiation oncology is associated with increased use of these services per capita and higher spending on these services (Bodenheimer, 2005).

### *2.1 Managed competition*

To create incentives for innovation and efficiency, managed competition is introduced in the Netherlands (van de Ven and Schut, 2008; Enthoven, van de Ven, 2007). Competition changes the incentives and market so that the efficiency of health care delivery is improved (Chernew *et al.,* 1998; Baker, 2001). The health care sector however, has unique characteristics wherefore competition must be managed closely in order to obtain equitable, accessible and affordable health care for everyone. Managed competition creates the balance between the liberal preferences of individual choice and responsibility and the guarantee of universal access (Enthoven, 1993). It is based on microeconomic principles to create maximum value for consumers (Enthoven, 1993). The goal is to change health care providers into competing economic units and to use market forces to reduce prices and excess capacity and increase quality and satisfaction (Enthoven, 1993; Kessler and McClellan, 2000; Folland *et al.,* 2010). However, contrary to neoclassical economic theory multiple studies show that hospitals in more competitive environments are associated with higher costs per case and per day than less competitive environments (Berenson *et al.,* 2006; Devers *et al.,* 2003). This may partly be due to the conflicting incentives that are created by the competitive system to use high-end technology. Hospitals might engage in a medical arms race (MAR) wherefore the use of technology can (partly) become socially wasteful (Robinson and Luft, 1988). This theoretical difference resulted in two opposing policy perspectives: either to stimulate or to diminish hospital competition. But according to Kessler and McClellan (2000) the studies that claim that competition reduces patient welfare, did not identify the presumed effects on health care costs and patient outcomes. And without this information, nothing can be said about patient welfare. And they also argue that even in MAR models competition can increase welfare; as long as prices are set properly and the total costs are smaller than the total health outcomes gained (Kessler and McClellan, 2000). The MAR model might be outdated due to the improvement of price competition and the rise of managed care plans. Evidence shows that this leads to a more cost effective utilization of medical technology (Kessler and McClellan, 2000). Other aspects of health care such as the occurrence of managed care plans, the existence of insurance and quality competition make it even more difficult to draw conclusions on the effects of competition in hospital markets (Kessler and McClellan, 2000). Another reasons why managed competition could lead to higher costs is that it does not only lead to lower production costs but also to a higher productivity and a greater influence of consumer preferences and demand (van de Ven and Schut, 2008; Enthoven, van de Ven, 2007; Schut and Doorslaer, 1999)

The use of medical technology complicates the concept of managed competition even further. The basis of competition theory is that competition increases social welfare via increasing value for consumers (Motta, 2004). But in the case of medical technology, it is not straightforward who these consumers are. While in practice, the hospital is the direct consumer of the medical device because they buy the device from its manufacturer; they are strongly influenced by other parties. The need assessment regarding a medical technology by the board of a hospital is probably strongly influenced by the physician group, who are again influenced by their patients (Devers *et al.,* 2003; Berenson *et al*., 2006). However it is possible that when the board of the hospital is forced to lower prices because of competition, the influence of the other parties diminishes. Due to the high investment in both installation and operating costs, the financial part

of the purchase decision will be influenced by the reimbursement decision of health insurers and/or other regulatory institutions (Zweifel, 2000).

For this reason, paragraph 2.2 does not use the term *consumer* but explains the role and unique characteristics of the different parties within the health care system. Due to these characteristics, the sector is subject to highly imperfect competition. The incentives that occur for different parties are described in the following paragraph.

### *2.2 Unique characteristics and imperfect competition in the health care sector*

#### *Patients*

Competition is supposed to be the way to create a system that is based on informed choices of consumers who are responsible for the cost consequences of their choices (Enthoven, 1993). In the managed competition model, competing health insurers are expected to make the best purchase decisions on behalf of their insured (patients) and patients choose health insurer according to their individual preferences (van de Ven and Schut, 2008; Enthoven, van de Ven, 2007). According to health economic theory, individuals value other things in life besides health and therefore the pursuit of health care is influenced by a budget constraint and a time constraint. The time it costs to obtain medical care cannot be used for consumption or work and therefore it has an opportunity cost (Zweifel, 2000). When competition changes prices or waiting times, this will influence the trade-off that the consumers make (Folland *et al.,* 2010).
But even though health insurers are supposed to make the trade-off for the patients, the patients still make their own decisions to some extent and these are strongly influenced by insurances. Insured patients incline to use more (expensive) health care than as they would if they had to pay it out of pocket; this effect is known as ***moral hazard*** (Arrow, 1963). Not only health insurance causes moral hazard, the presence of disability insurance and sick leave payments also increases the use of medical care because it changes the opportunity costs. So even in countries with a public health system, such as the UK, the amount of medical care used is strongly influenced by insurance (Zweifel, 2000). The result of limited price elasticity for health care services is imperfect competition among health organizations. Notice hereby that price competition does not mean that competition only occurs on price; it might better be called *value-for-money- competition* (Enthoven, 1993). Moral hazard also influences medical technology; when the insurance gives access to new technology on the same conditions as the old, this creates an incentive for patients to demand the new technology (Zweiffel, 2000). Patients frequently associate technology with higher quality care and therefore feel disadvantaged when denied the new technology (Teplensky *et al.,* 1995). Managed competition introduces price competition among health insurers to increase price elasticity among patients and thereby to decrease moral hazard. The insurer is given incentives to bargain for lower prices for health care services wherefore competition among health care providers increases (van de Ven and Schut, 2008; Enthoven, van de Ven, 2007).
Next to moral hazard, the ***heterogeneity*** of and ***information asymmetry*** within health care services influence the decision-making process of patients. Health care service is not a homogeneous product (Pisano, 2006). The variety of disciplines and the combination of diagnosing, advising and treating patients in one service makes health care services very complex. This makes comparison and valuation of services even more difficult (Gaynor and Vogt, 1999). The great information asymmetry between the receiver and provider of health care makes it hard for patient and insurer, to make well-considered choices about the purchase of health care (Devers *et al.,* 2003). It is hard to make a value-for-money decision if you cannot value the product (Enthoven, 1993).

And even well informed patients might wish to shift the decision-making authority for a great deal to the physician. This is because being sick is a great burden for your environment and the patient would become the source of negative externality when he decides about the necessity of the amount of medical care. By shifting this responsibility to the medical professional, the

patient avoids any liability (Zweifel, 2000). The presence of insurance also increases the willingness to shift authority to the physician because the patient is insulated from the financial consequences of the choices that the physician makes (Zweifel, 2000).

### *Health care providers*

According to competition theory, an insurer will contract the most efficient supplier, who can therefore provide the most services and can have the highest profits (Kessler and McClellan, 2000). But in the health care sector this relation is less straightforward than in other industries. Insurance also affects the behavior of physicians who act as a patient's agent. The quantity and prices of services are therefore likely to reflect the insurance conditions (Zweifel, 2000). In combination with the information asymmetry whereby a health care provider can easily abuse the situation and order unnecessary tests (Devers *et al.,* 2003) and the fee-for-service system, incentives to be the most efficient health care provider are almost non-existent.
Competition also increases the influence of patient preferences; physicians tend to fulfill demands and expectations of patients because otherwise they will go to the competition (Enthoven, 1980; Schut and Doorslaer, 1999). And due to the ongoing demand for high end and new technology, providers still have an incentive to increase the use of new technologies (Chernew *et al*., 1998). A fee for service system stimulates the demand for technology even further; when a General Practitioner for example talks to patients longer to avoid unnecessary, expensive tests, he does not receive payment because he did not perform a service. It is a punishment for the most efficient workers (Enthoven, 1993). On the other hand, demand might be choked when a capitation system or managed care is applied (Zweifel, 2000).

### *Hospital managers*

Hospitals' competitive strategy is based on multiple factors such as economic and demographic developments, regulation, purchaser behavior, hospital market structure (competitors), medical technology and labor supply (Luke, Begun and Walston 1999 in Dever *et al.,* 2003). Hospitals choose for economics of scale, whereby specialist hospitals occur or economies of scope where 'one-stop-shopping' is possible (Dever *et al.,* 2003). This means that diagnosis and treatment plan is carried out within a single hospital (Berenson *et al.,* 2006).
Technology and the image of a technological leader can be used to attract physicians, patients, students and researchers (Devers *et al.,* 2003; Berenson *et al*., 2006; Kessler and McClellan, 2000). The technology might create revenues on its own but more often it used to create complementary services (Zweifel, 2000). A better diagnostic imaging device can for example increase the number of heart surgery procedures (Chernew *et al.,* 1998; Baker, 2001). The innovation pulls people in an expensive treatment option (Chernew *et al*., 1998) although the service additions and expansions are often described as duplicating services that are already available in the community (Devers *et al.,* 2003). The resulting excess capacity can cause higher demand and increases total health expenditures (Devers *et al.,* 2003). The investments become socially wasteful when the costs for technology exceed the benefits (Kessler and McClellan, 2000).

Competition also increases the marketing and advertisement costs for hospitals to build a brand name and an image (Devers *et al.,* 2003; Enthoven, 1993). Reputation is very important in the hospital market. It would be commercial suicide to admit that the hospital does not offer the latest technology (Pauly, 2005). Some services are of higher reputational value than others; heart surgery performance seems to be, for example, an absolute must have (Berenson *et al.,* 2006). A good reputation can justify higher prices and creates higher demand and therefore increases quantity of services conducted (Zweifel, 2000).

### *Health insurers*

As discussed above, the incentives for health care providers and hospital managers to improve efficiency are very limited. The government is therefore dependent on the willingness of insurers to increase efficiency at system level. But even if insurers increase efficiency, the

incentive exists to keep profits for themselves by not directing lower costs to their subscribers in case of price reductions (Gaynor and Haas-Wilson, 1999). In theory, competition prevents such profits because it should drive down prices to marginal costs (Folland *et al.,* 2010). According to Enthoven (1993) competition would even be most effective at the annual premium level because people understand this price and can best respond to it. In practice however, consumers seem insensitive for premium prices, partly due to collective employer-contracts (Schut and van de Ven, 2005) and insurers are able to make high profits.

### *Industry*

Technology developers keep developing expensive medical technologies because of the ever high demand for new technology (Chernew *et al.*, 1998). The health care sector is however complex and changes rapidly (Pisano, 2006). Medical innovation is high-risk due to regulation, long development processes, high (sunk) costs and high chances of failure (Pisano, 2006). This results in a barrier for market entrance. On the other hand, technology in the health care sector is often no subject to price drops or is even associated with price increases (Porter and Olmsted Teisberg, 2004). The recovery model is therefore beneficial, especially when the incumbents negotiate strategically with insurance companies to create competitive advantages (Gaynor and Haas-Wilson, 1999).

### *Antitrust authority*

The health sector is also a complex industry for antitrust authorities. The justification of the authorities is that competition increases social welfare (Gaynor and Vogt, 1999). This is indeed proved to be so in industries like computers or financial markets (Porter and Olmsted Teisberg, 2004). But in the health care sector this relation is influenced by quality, safety, consumer choice, innovation and charity (Gaynor and Haas-Wilson, 1999). Hospital directors argue that it is impossible to function in a competitive environment because hospitals are non-profit institutions and patients will suffer from it (Gaynor and Vogt, 1999). The effects of competition on quality, innovation, patient care and social value are uncertain due to complex measurement (Baker and Scott, 2004).

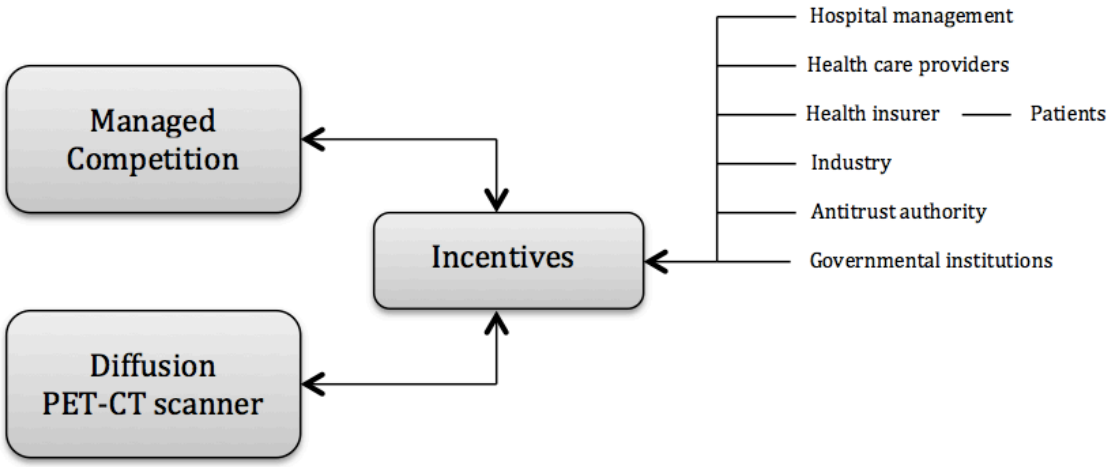


*Figure 1: Conceptual model*

Figure 1 gives the conceptual model of this study. As shown, the actors have certain incentives that influence the diffusion of PET-CT scanners in the Netherlands. On the other hand, the diffusion and therefore availability of PET-CT technology can also influence the incentives of the actors. Managed competition creates incentives for the actors to improve efficiency and innovation and influences the diffusion process indirectly. The existing incentives of the actors also influence the amount and success of managed competition. The specific incentives are further described in chapter 6.

# 3. The PET-CT scanner

Medical imaging technology is evolving rapidly and great advances are made in the development and use of imaging techniques (Jersusalem *et al.,* 2003; Townsend, 2004). From 2001 to 2006 the PET-CT scanning device emerged from research domain to mainstream clinical applications for oncology (Townsend, 2004; Jersusalem *et al.,* 2003). Although PET-CT is used in cardiology and neurology, the most important clinical application of PET is currently cancer diagnosis (staging), therapy monitoring and the assessment of recurrence (restaging) (Seemann *et al., 2004*; Mawlawi and Townsend, 2009; Townsend, 2004). This evolution in application is of major influence the rising healthcare costs (Jersusalem *et al,* 2003).

This chapter first briefly describes the PET-CT combined technology and gives an overview of the (international) clinical development. For more detailed information on the technological features please refer to appendix 1. This chapter concludes with the effects of the PET-CT scanner on patient management and the cost-effectiveness of the PET-CT scanner.

## *3.1 Technology combined PET-CT*

### *PET technology*

The Positron Emission Tomography (PET) scanning device shows a four-dimensional (spatial distribution and time) distribution of a radioactive substance within the human body. It is a 'functional' imaging technique which measures biochemical processes (Schoder, 2003). A radioactive pharmaceutical is administered to the patient and this substance interacts with the human body through a metabolic process (Townsend, 2004). The substance is localized through the detection of radiation that occurs due to the radioactive decay of the substrate (RIVM, 2011). Depending on the radiotracer, PET can, for example, assess blood flow, metabolism, protein synthesis and gene expression (Schoder, 2003). But the most commonly used radiopharmaceutical is the glucose analogue 18-F-fluorodeoxyglucose (18F-FDG) which is used for tumor detection and staging **(**Ziegler, 2005; Seemann *et al., 2004*; Jersusalem *et al.,* 2003). Malignant cells are associated with an increased metabolic activity and therefore with an increased uptake of $^{18}$F-FDG (Jersusalem *et al.,* 2003; Townsend, 2004; Seemann *et al., 2004*). The malignant cell uptakes the FDG in the same way as glucose but the FDG is not further metabolized. A single scan can therefore, after a given time after injection of the radiotracer, show activity concentrations that are proportional to the FDG consumption (Ziegler, 2005). FDG is also well suited for PET-scans due to its long half-life time (110 minutes). This is convenient for transportation from a cyclotron and also compatible with whole body PET imaging times (>30min) (Jersusalem *et al.,* 2003; Townsend, 2004; Ziegler, 2005).
A PET scan thus consists of three phases. First a suitable pharmaceutical has to be selected and produced. Second, this substrate must be administered to the patient. And last, the imaging of the distribution of the pharmaceutical in the patient takes place (Townsend, 2004).

### *PET-CT technology*

The Computed Tomography (CT) scanner has, like a PET scanner, multiple detectors that rotate around the human body (RIVM, 2011). An x-ray tube is linked to an x-ray detector array located on the other side of the patient. The CT scanner uses the photoelectric absorption to show contrast between tissues. It therefore gives clear images of bones and longs and with the current refined CT technology it is possible to distinguish all types of tissues. This results in a detailed image of the human anatomy (Prince and Links, 2006).

A PET scan is a first step for cancer diagnosis but due to the lack of an anatomical reference frame (Seemann *et al.,* 2004), more information is needed for an appropriate treatment decision (Townsend, 2004). In the combined systems the functional imaging of PET can be combined with the anatomic imaging of CT and can be used to localize the exact location of the radiotracer uptake (Schoder, 2003). Because the scans are conducted under the same conditions, the

alignment of the two images is far more accurate than when the images of two separate scans are fused by software methods afterwards (Townsend, 2004). The scanner improves patient as well as physician convenience by reducing scan times and by making only a single imaging session necessary (Blodgett *et al*., 2006; Townsend, 2004; Seemann *et al.,* 2004).
A disadvantage of the combined PET-CT technology is the motion artifact. This occurs because CT scan times are much shorter than the PET scan times. Voluntary but also involuntary movement such as respiratory or organ movement can result in serious mislocation and therefore wrong diagnoses or treatment decisions (Schoder, 2003; Mawlawi and Townsend, 2009). More information on this issue can be found in appendix 1.

### *3.2 Development PET-CT*

Up until the mid 1990s anatomical and functional images were acquired in different departments and read by different specialists. The development of the PET-CT prototype was initiated with the goal to use CT images for attenuation and scatter correction (see appendix 1 for more information) for the PET emission data (Mawlawi and Townsend, 2009). The objective was to create a combined system so that anatomical and functional information could be acquired in a single scan session (Mawlawi and Townsend, 2009). The co-registered images should overcome the lack of enthusiasm of the use of image fusion technology and physicians would be stimulated to routinely use fused images (Beyer and Townsend, 2006). The clinical evaluation of this first prototype was conducted from 1998 to 2001 in University of Pittsburgh Medical Center (Blodgett *et al*., 2006; Beyer and Townsend, 2006). And in December 2000, the PET-CT scanner was chosen as Medical Invention of the Year by TIME Magazine (Beyer and Townsend, 2006).
In response to the growing demand from medical professionals, commercial manufacturers developed devices for clinical use (Schoder, 2003). The first commercial PET-CT device (Discovery LS, GE Healthcare) arrived the clinic in 2001 (Beyer and Townsend, 2006) but involved little integration of the two separate technologies (Mawlawi and Townsend, 2009). After a few months, Siemens introduced the ICTI (Mawlawi and Townsend, 2009) and within 2-3 years the sale of PET scanners (without CT) virtually came to an end (Beyer and Townsend, 2006). In mid-2008 3000 PET-CT devices were in clinical operation worldwide (Mawlawi and Townsend, 2009). The replacement rate of PET-CT for PET-only has been enormous and is unique for medical imaging (Beyer and Townsend, 2006). Currently five manufacturers offer around 20 different PET-CT designs (Mawlawi and Townsend, 2009, Beyer and Townsend, 2006, Townsend, 2004).

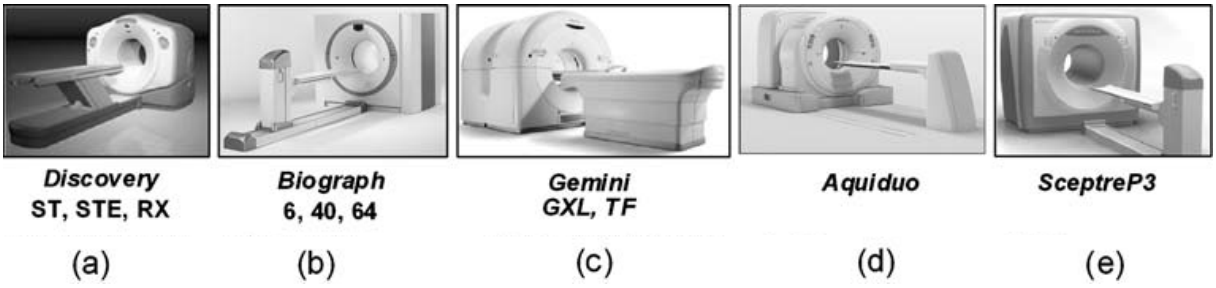


*Figure 2: Types of PET-CT scanners (Townsend, 2004)*
*A: General Electric Healthcare – Discovery series*
*B: Siemens Medical Solutions – Biograph series*
*C: Philips Healthcare – Gemini series*
*D: Toshiba Medical Corporation: Aquiduo*
*E: Hitachi Medical: Sceptre P3*

Although the medical professions of surgeons and oncologists rapidly embraced the PET-CT scanning device (Beyer and Townsend, 2006); initially there were some concerns among radiologists and nuclear medicine clinicians (Mawlawi and Townsend, 2009). Traditionally radiologists operate the CT scanner while nuclear medicine clinicians operate the PET scanner.

The radiologists saw the combined device as a CT scanner with the possibility to show a new contrast agent; while the nuclear medicine staff saw the device as a nuclear device with improved attenuation correction (Beyer and Townsend, 2006). It was therefore uncertain who should interpret the combined PET-CT images (Blodgett *et al.*, 2006). Nuclear medicine physicians furthermore argued that they didn't need the anatomic information to interpret the PET images (Beyer and Townsend, 2006). And radiologists and nuclear medicine clinicians claimed that fusion software programs could provide similar results so that PET-CT was an unnecessary device (Schoder, 2003). The technology was labeled "disruptive" and was considered to be the death of nuclear medicine (Beyer and Townsend, 2006). Studies however showed that the combined PET-CT scanner is far superior to any attempt of image fusion based on fusion software, especially for head, neck, abdomen and pelvis area (Schoder, 2003). And time showed that the fusing of medical specialties by the PET-CT scanner brought nuclear medicine to the forefront of medical diagnostic practice (Beyer and Townsend, 2006).

### *Results for patient management*

The PET-CT device is used most commonly for diagnosing and staging of lung tumors, lymphomas, head and neck tumors, colon cancer, esophageal cancer, gastric cancer, pancreas tumors, gynecological tumors, thyroid tumors and metastases of breast cancer (Von Schulthess and Hany, 2008). The specialists of lung disease, hematology and surgery are the most common applicants for PET-CT scans (ZonMW, 2007). The PET-CT-scanner is less effective for evaluation of treatment because the inflammatory response of the body increases the F-FDG uptake and it is therefore difficult to distinguish between inflamed and tumor tissue. But in tumors the FDG uptake will only increase over time while the uptake of glucose will decrease in inflammatory cells (Biersack, 2009). When taken into account this time factor, the PET-CT can be used to identify the inflammation source within the patient. This only is used in rare cases whereby the inflammation source is unknown and the inflammation cannot be controlled (Von Schulthess and Hany, 2008). For cardiology the PET-CT is used mainly to show the blood perfusion of the heart. And for neurology the PET-CT can be used for diagnosis of Alzheimer's decease, brain tumors and epilepsy. F-FDG is however not an effective radiotracer for PET-CT for neurology applications due to the high glucose uptake of the human brain (Gilman and Aquino, 2005).

As figure 3 shows, the interpretation of images has improved with the introduction of the PET-CT technology and physicians assess the images with more confidence. In 6% of the cases cancer was only detected by PET-CT fusion images and not by PET or CT alone (Schoder, 2003). In many cases (up to 29%) the disease was either upstaged or downstaged with the assessment of a PET-CT. And studies show a change in patient management in a significant number of cases but numbers vary between 10 (Beyer and Townsend, 2006) to 36,5% (Mawlawi and Townsend, 2009) of the cases (Jersusalem *et al.,* 2003; Schoder, 2003).

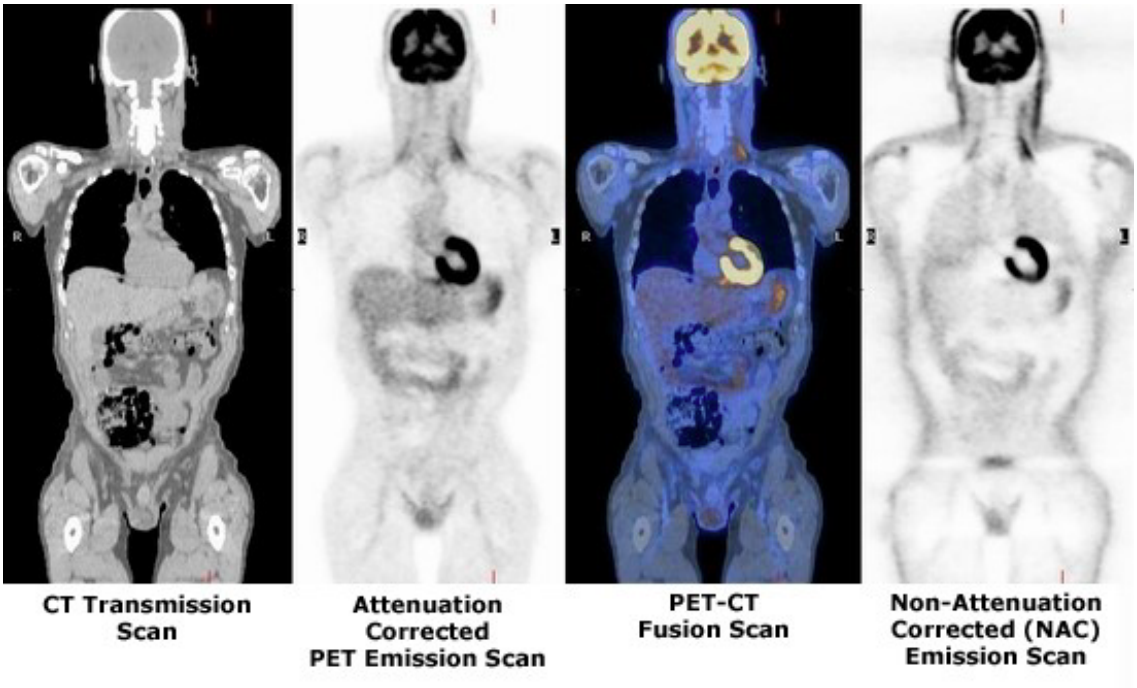


*Figure 3: Differences CT, PET, PET-CT images (Med Harvard, 2012)*

### *Costs and cost-effectiveness*

In the last decade the PET-CT captured the medical market. But the technology is expensive, so that raises the questions what organizations really need a PET-CT scanner and how cost-effective the scanner is. Not every hospital or clinic needs a PET-CT device; it depends on the patient population that is served in the institution. According to Schoder (2003), most primary and secondary care facilities would not need the newest PET-CT technology, as complicated and advanced malignancies are referred to tertiary centers.

The costs of PET-CT are sometimes used as a critique. The PET-CT technology however also cuts costs because the examination time is decreased and patient throughput is increased due to CT based attenuation correction (Schoder, 2003). PET-CT technology is considered potentially cost-effective because it can optimize treatment and prevents unnecessary treatment (Schoder, 2003; Jerusalem *et al.,* 2003). More research is needed to prove cost-effectiveness for most indications. Because costs (and therefore cost-effectiveness) are highly country specific, this issue is later addressed in more detail for the Dutch market.

### *Need assessment PET scan*

The World Health Organization recommends 2 PET scanners per million people (MEDEC, 2010 in Martinuk, 2011). And the Royal College of Radiologists in the UK recommend 0,66 PET-scanner per million people (Martinuk, 2011). In 2005 the Federal Knowledge center for health care (KCE) concluded that Belgium has an overcapacity of PET scanners (13). Based on diagnostic accuracy only 0,95 PET scanners per million people are needed. This number of needed scanners decreases to 3 when an evidence-based approach is used whereby the influence of PET on mortality or morbidity is taken into account. The KCE report shows that there is a conflict of interest between optimizing the use of current capacity and the efficient use of resources in health care. It is up to policy makers to decide whether the overcapacity of the PET scanner should maintain for clinical research or that efficiency gets priority (KCE, 2005).

# 4. International context

Table 1 illustrates the use of the PET scanner in 6 western countries. The US has by far the highest number (6,5) of PET scanners per million people (Buck *et al.,* 2010). The purchase of the PET(-CT) scanner is not regulated in the US. The US does not use cost-effectiveness data but the coverage of a service depends on the reasonability and necessity to diagnose or treat an injury or illness (Chambers *et al.,* 2010). It is actively debated what reasonable or necessary means. Chambers *et al.* (2010) furthermore doubt the statement of Medicare, Medicaid that cost-effectiveness is not taken into account. But the study could not identify an implicit threshold. For the FDG-PET scan for Alzheimer's disease included a discussion of QALYs. These were used as outcome measure instead and were no part of the cost-effectiveness analysis, which is the case in some other Western countries (Chambers *et al.,* 2010). Neighbor Canada has the lowest number of PET scanners per million people (0,86). But this number differs greatly between the different provinces in Canada due to regional reimbursement policy and clinical guidelines. Quebec has the highest number per million people (1,5) and British Colombia the lowest (0,22). This number does not take into account the PET scanners that are available for research (11) and private clinics (7). These scans are not covered by insurance (Martinuk, 2011). In the Netherlands 1,5 PET scanners are available per million of people, in Belgium 1,26 (Senate, 2012) and in Germany 1,2 (Buck *et al.,* 2010). In Belgium only certified centers receive reimbursement for conducted scans. There are 13 certified scanners and the 1,26 is based on this number (KCE, 2005). In Germany the PET scanner is only used for NSCLC lung cancer (Buck *et al.,* 2010). The number of PET scanners in the UK has increased rapidly in the past years. In 2005 the UK had 0,35 PET scanners per million people (ZonMW, 2007). In 2012 the UK had 58 scanners (ncri-pet, 2012) and a population of 64,4 million (Office for national statistics, 2013) this makes 0,9 PET scanners per million people. In the UK the PET scanner is not used for routinely diagnosing cancer but only for complex health problems, restaging and evaluation of cancer treatment (RCR, 2012; NHS, 2013).

*Table 1: Overview of international number of scanners, purchase decisions and reimbursement*

| **Country** | **Scanners per million people** | **Purchase decision maker** | **Evidence needed** | **Reimbursement process** | **Details** |
|---|---|---|---|---|---|
| US | 6,5 | Since 2005 there is no prohibition on the purchase of PET scanners anymore; regional organizations can decide to purchase a scanner. | Services must be *reasonable and necessary* to diagnose or treat an illness or injury | Indications approved by Medicare or for research | New scanners must at least make 714 scans per year. |
| NL | 1,5 | Board of directors clinical centers and hospitals | Clinical effectiveness | Price per scan (differs for cardio/neuro scans and oncology scans) | |
| Belgium | 1,26 | Only certified centers can conduct scans. To get certification you need to be a university, have radiotherapy, multidisciplinary expertise and quality control. | Diagnostic accuracy | Consists of 4 parts:<br>1) annual price per year per center for infrastructure<br>2) Price for staff and organization<br>3) Price per scan (only for limited indications)<br>4) Price per FDG doses | Obligation to register every PET activity: staging, indication, type of tumor, reason for referral |
| Germany | 1,2 | | Cost-effectiveness | Only for 1 indication: Lung Cancer *(NSCLC)* | |
| UK | 0,9 | NHS | Cost-effectiveness | For limited indications (NHS system) | |
| Canada | 0,86 | Regional level (province) | Depends on province | Strictly regulated: case-by-case | Radiopharmaceuticals are considered *experimental medicines*, and are strictly regulated |

# 5. Situation in the Netherlands

## *5.1 Distribution*

In the year 2000 only 3 PET-scanners were available in the Netherlands (VUMC, UMCG and UMC St. Radboud). In 2003 the first combined PET-CT technology was installed in Maastricht. In 2005, 16 PET-CT scanners were in operation in the Netherlands (ZonMW, 2007) and by 2009 this number further had increased to 44 (RIVM, 2011). Figure 4 shows the distribution of PET-CT scanners in the Netherlands in 2005 (ZonMW, 2007).

In the Netherlands there are only four locations with a cyclotron. This means there are only 4 suppliers of the radioactive specimens that are used for PET-CT scans. These are the Technical University of Eindhoven; VUMC Amsterdam; Kernfysisch Versneller Instituut of the University of Groningen (RIVM, 2011) and recently the Medical Centre of Alkmaar (Haarlems Dagblad, 2012).

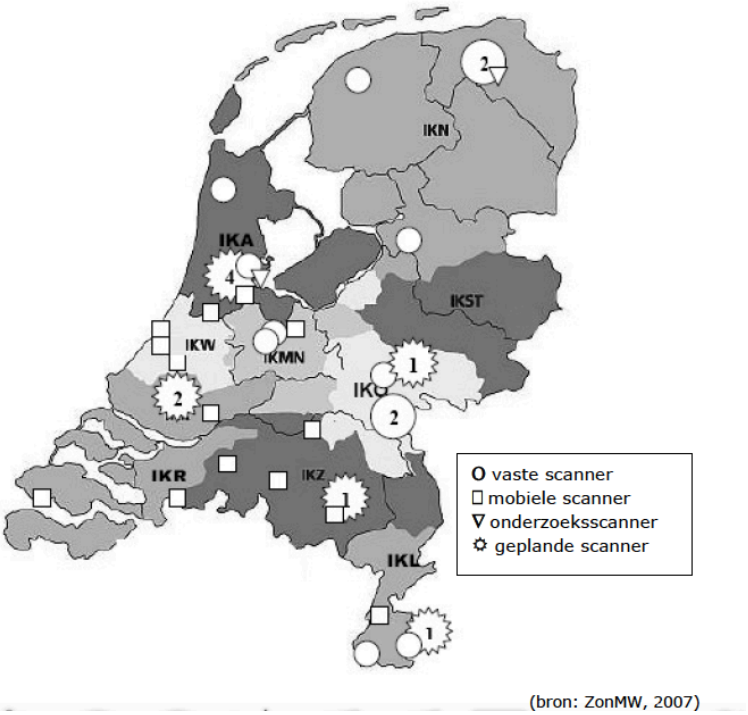


*Figure 4: Distribution PET scanner in the Netherlands*

### *5.2 Clinical Use*

The Health Inspectorate states that there is an overcapacity of PET-CT scanners in the Netherlands (IGZ, 2008). If the PET-CT device is only used for indications wherefore the scanner is proved (cost)effective, ZonMW states that only 18.000 scans are needed per year. One PET-CT scanner can, when used optimal, conduct 2000 scans per year (according to ZonMW and IAEA). In the Netherlands this would mean only 9 scanners are needed (ZonMW, 2007). Table 2 gives an overview of the need assessment (carried out by ZonMW, 2007) and the current capacity of the PET-CT technology.

*Table 2: Actual use, needed capacity and actual capacity of PET technology*

| | **Actual Use** Total PET scans (2005) | **Needed Capacity** ZonMw need assessment (max) | **Actual Capacity*** Total scanners available in NL |
|---|---|---|---|
| Total PET scans | *16.296* | *17.836 (16.836 + 1.000**)* | |
| Number of scanners with 2080 scans per scanner per year | *7,8* | *8,6* | *16 (end 2005) 24 (end 2006) 44 (end 2009)* |
| Number of scanners with 1250 scans per scanner per year | *13,0* | *14,3* | *16 (end 2005) 24 (end 2006) 44 (end 2009)* |

** Assuming that every PET-CT scanner is full-time available for PET*
*** 1.000 scans for cardiology and neurology scans*

The need assessment of ZonMW (2007) is based on the requirement that scientific evidence must be provided for the effectiveness of the appliance of PET-CT for a certain indication. ZonMW or CVZ (College van Zorgverzekeraars) studies must provide this evidence. When these studies are not available, data of the KWF (Cancer fund) are used which are based on the indications that are acknowledged in Belgium. There, only evidence for diagnostic accuracy must exist (ZonMW, 2007). The need assessment does not enclose the whole range of application of the PET-CT scanning device. It only covers routine use of PET-CT and not the clinical

'problematic' cases whereby earlier conducted diagnostic research did not give enough information for correct diagnosis and treatment (ZonMW, 2007).
The difference in numbers of actual scans made and the need of scans according to ZonMW differs significantly across indications (as shown in table 3).

*Table 3: Actual scans vs. need assessment ZonMW (2007) per indication.*

| | **Number of scans in 2005** | **ZonMw need assessment** | |
|---|---|---|---|
| | | *min* | *max* |
| *Cervical Cancer* | Unknown | 0 | 0 |
| *Breast Cancer* | 290 | 0 | 0 |
| *Colorectal Carcinoma* | 1.480 | 2.095 | 5.237 |
| *Brain Tumors* | 145 | 0 | 0 |
| *Head and neck cancer* | 613 | 75 | 1.458 |
| *Lung Cancer (NSCLC)* | 6.523 | 2.880 | 5.118 |
| *Lung Cancer* | 1.441 | - | - |
| *Lymphomas* | 1.345 | 2.462 | 2.462 |
| *Melanoma* | 438 | 1.293 | 1.293 |
| *Oesophagus Carcinoma* | 223 | 281 | 468 |
| *Ovarian Tumors* | Unknown | 800 | 800 |
| *Prostate cancer* | Unknown | 0 | 0 |
| *Thyroid carcinoma* | 175 | 0 | - |
| *Remaining* | 1.615 | 0 | 0 |
| ***Total Oncology*** | **14.288** | **9.988** | **16.836** |
| *Cardiology*<br>*Neurology* | 628 | 600 | 1000 |
| ***Total all indications*** | **14.916** | **10.486** | **17.836** |

### *5.3 Costs & Finance*

Studies show different price tags for the PET-CT scanner. DeWever *et al.* (2009) estimate the price of a PET-CT scanner between 1,2 and 1,4 million euro. The IAEA (2010) values the PET-CT at 2,2 million and ZonMW (2007) names a price tag of 2,5 million. All prices are excluding 10% installation costs. In context, the PET-CT technology is approximately four times more expensive than a MRI-scanner which is ten times more expensive as a CT-scanner (RIVM, 2011).
The costs per scan differ between countries and are estimated at £635-1300 ($1030-2109) in the UK, €600-1000 in Germany ($885-1474) excluding €180-260 ($265-383) for radioactive substrate, $952,83 (median price) in the US (Buck *et al.,* 2010) and €700-1600 ($1032-2359) in the Netherlands (ZonMW, 2007). The price of radioactive substrate (F-FDG) is €250,- per dose. The costs per dose decrease when a private/own cyclotron is used. The costs however to build a cyclotron are estimated on 2,2 million euro (ZonMW, 2007).
The costs per scan consist of staff expenses, tracer costs, depreciation costs, maintenance costs and overhead (ZonMW, 2007). The price for the hire of a mobile scanner in the Netherlands is €6000,- per day (8 hours, including 2 staff members) plus an additional €200,- per patient.
In the Netherlands a distinction is made between a whole body PET scan, used for oncology and a partial PET scan, used for cardiology and neurology. It depends on the specialism wherefore the PET-CT is applied, what *registration code* can be used for the *care activity*. When a GP requests a PET scan, the radiologist or nuclear medicine specialist receives the following reimbursement tariffs (NZa, 2012):

DBC 120500 PET partial; neurology, cardiology. Tariff: € 1024,90
DBC 120501 PET whole body; oncology. Tariff: € 1454,80.

Specialists in the hospital however most often request the PET scan and for them the care activity "PET-CT" is always part of a *care product* and a hospital receives reimbursement for the

total care product. Most care products that include the PET-CT are part of the B-segment in the Netherlands; this means that the insurer can negotiate on the tariff that is reimbursed for the care product. The PET-CT can be part of a care product for radiotherapy that falls in the A-segment. This means, insurers have to reimburse a national determined tariff. The NZa determines what procedures are subject to either A or B segment but in general only WBMV (Special Medical Procedures Act) treatments are A-segment. For WBMV procedures are treatments that are rare and/or extremely costly wherefore it is considered not profitable to offer the service by too many providers. For example, multiple types of organ transplantation, neurosurgery and radiotherapy are WBMV procedures.

### *Cost-Effectiveness*

The only evidence for cost-effectiveness of the PET scanner is available for non-small cell lung cancer and colorectal liver metastases (Buck *et al.,* 2010). Especially for dementia, the additional value of a PET technology is controversial (NVNG, 2007). Because clinical use is based on best practice (effectiveness and accuracy) and not on cost-effectiveness, there is a great difference between the clinical use and the assessed evidence based need of PET-CT. More studies are needed to provide evidence on the cost-effectiveness of the PET-CT scanner with other indications.

## 6. Decision-making process and incentives to use medical technology in the Netherlands

As described above, the capacity of PET-CT scanners in the Netherlands exceeds the evidence-based needs. On the positive side, this means that Dutch people have easy access to top clinical care. But it also creates the problem that demand will increase due to over-supply. This is a highly undesirable side effect due to the high costs of PET-CT scans and the already increasing public health care expenditures. Based on the theory as discussed in chapter 2, this chapter describes the incentives that possibly influenced different actors in the decision-making process of the adoption of the PET-CT scanner in the Netherlands. First all the relevant actors are identified and then the theoretical incentives are discussed per actor.

### *6.1 Relevant actors in the decision-making process*

The relevant actors are identified with the help of the ZonMw (2007) report where the distinction is made between micro, meso and macro level actors. The micro level actors decide when and for what indications the PET-CT is applied (based on cost-effectiveness, clinical effectiveness or only diagnostic accuracy) (ZonMW, 2007). Important decision-makers on the use of the PET-CT scanner are the **referral specialists**; they decide which patients need a PET-CT scan. After this referral, the **nuclear medicine specialists** and/or the **radiologists** carry out the scan. The specialists of lung disease, hematology and surgery are the most common applicants for PET-CT scans (ZonMW, 2007). Patients are not identified as actors in this study because they are assumed to have little or no influence on the decision process on the purchase of technology. Physicians act on their behalf and therefore their influence is considered covered by this actor. **Hospital managers** decide on the capacity of PET-CT scanners in the Netherlands. The decision to purchase a PET-CT scanner is made by the Board of Directors of hospitals. The boards often set up a committee to give an advice on the purchase of new expensive technology (ZonMW, 2007). The macro actors are responsible for the efficient use of collective resources. The most important in the Netherlands are the **NZa** (Dutch Health Authority), the **DBC-onderhoud** ('Diagnosis-Treatment- Combination' maintenance organization) and the **NMa** (Dutch Antitrust Authority). The DBC maintenance organization decides whether a technology gets its own DBC and the NZa determines the prices for each A-segment DBC (ZonMW, 2007). The NMa is responsible for the maintenance of a competitive environment.

*Table 4: Overview of involved actors on micro, meso and macro level*

| | **Micro**<br>*Health professional* | **Meso**<br>*Health organization* | **Macro**<br>*Health system* |
|---|---|---|---|
| ***Involved actors*** | • Physicians: referrer specialists, nuclear medicine specialist, radiologists | • Hospitals<br>• Insurers<br>• Industry | • NZa<br>• DBC-onderhoud<br>• NMa |
| ***Decision point*** | • Appliance of PET-CT | • Capacity PET-CT<br>• Purchase policy | • Efficient use of collective resources |

### *6.2 Incentives different actors*

The goal of health care is delivering value to patients. This may seem crystal clear but according to Porter and Olmsted Teisberg (2007) the current system is not structured that way. Physicians tend to define success as delivering their specialty well. They want to see more patients and increase the revenue of their practice. Hospitals want to increase revenues and achieve an operating surplus. Health insurers also want to increase revenues and increase number of insured. But patients want value, not more doctor visits, procedures or tests (Porter and Olmsted Teisberg, 2007). The goal of value creation must align the interest of all actors involved in the medical process. In order to attain this alignment, knowledge of incentives is needed to explain and influence individual behavior. Incentives derive from interaction between aimed objectives and practical limitations (Zweifel, 2000). The alternative courses of action result in different utilization levels for the choosing individual wherefore incentives will always exist when choices must be made (Jensen, 1994). Hereby, next to self-interest, feelings of altruism and emotions of shame, self esteem, honor and pride influence behavior (Rocha and Goshal, 2006). People care about failure and success (Jensen, 1994). Health professionals are supposed to be the perfect agent for their patients and evidence shows that people do have altruistic motives but the fact that one is willing to donate their own time, energy or resources does not indicate that one is a perfect agent. Evidence suggests that people cannot make decisions without concern for their own preferences (Jensen, 1994). People's preferences are based on rational and non-rational behaviors, whereby non-rational is defined as harmful for the individual (Rocha and Goshal, 2006). People are often reluctant to change their harmful behavior because of irrationality. Self-image is a major determined of behavior (Jensen, 1994).
This paragraph describes rational and irrational incentives for all actors that could have influenced the decision-making process for the diffusion of the PET-CT scanner in the Netherlands.

#### Health professional

The health professionals have multiple, sometimes contradictory, incentives to use the PET-CT scanner and technology in general. An economic incentive is that the provider is paid per scan. This means that the professional wants to increase the number of scans made to generate income. This incentive is, in case of the PET-CT scanner, probably more important for the nuclear medicine specialist and the radiologist because the referral specialist can receive payments for other medical procedures. Other incentives that increase the use of the technology are that the professional wants to meet the demand and expectations of their patients (Enthoven, 1980). But due to the perception of patients that technology is associated with high quality and the moral hazard effect, patients often request unnecessary technology (Teplensky *et al.,* 1995).
Individual perception on the technology and 'innovativeness' of the physician also may influence the use of technology (Berwick, 2003). It is also dependent on whether the health organization stimulates the use of technology by, for example, praising physicians that use the new PET-CT scanner or on the contrary restrain the use of the technology (Berwick, 2003). There is a certain amount of prestige and status associated with costly technological care and the amount of

prestige attributed to the technology can be an incentive to use it (Enthoven, 1980).
On the other hand, professionals want to meet the requirements of the health insurance companies and the greater public, to increase efficient allocation of resources and reduce health care costs. This incentive is more frequently applicable for the referral specialist, whereas the nuclear medicine specialists and radiologists carry out the scans on request of a referral specialist.

## Health organization

### *Hospitals*

To meet the ultimate goal of health care, patient value, only one incentive can be justified to purchase medical technology: the provision of needed services (Porter and Olmsted Teisberg, 2007; Teplensky, 1995). In practice this is not the only incentive as became clear in chapter 2 already. Hospitals use technology to obtain the image of a technological leader. This reputation can attract new patients, physicians and it can increase prices and quantity of services conducted (Teplensky, 1995). Another reason to invest in technology is existence of complementary services due to this technology. As mentioned in chapter 2, the innovative technology can pull patients into an expensive treatment trajectory that increase hospital revenues (Chernew *et al.,* 1998).
Emotional incentives can also play a role in the purchase of medical technology., for example,, the hospital manager might have a passion for technology or the hospital manager wants to brag about the innovativeness of his hospital to other hospital managers. These emotional incentives are highly associated with the amount of prestige that is attributed to a certain technology. The risk aversion of a hospital manager and his perception of costs and revenues of the technology may also influence the decision-making process (Teplensky, 1995).

### *Insurers*

For cost containment reasons, health insurers try to reduce the capacity by using an effective purchase strategy (ZonMW, 2007). However, also for insurers reputation is of major importance. Patients must be kept satisfied otherwise they will go to another insurer. And again (individual) emotional incentives may be important in the decision-making process (Jensen, 1994).

### *Industry*

The industry wants to increase revenues and therefore wants to increase the quantity of scanners sold. Individual incentives of the head of the sales department or the CEO may also be the status that is acquired by the revenues made and the quantities sold (Stanley, 2010).

## Health system

### *NZa*

The goal of the Dutch Health Authority is to create transparent, efficient, equitable and accessible health care. They want to achieve this by supervision of and maintenance with the health care providers and insurers (NZa, 2013). It is likely however that the employees are also influenced by personal, irrational incentives to achieve certain NZa goals.

### *DBC-onderhoud*

DBC-onderhoud has a prior goal to create transparency for health care services in order to decrease health care costs. This organization is, as are all other organizations, subject to personal eager to be successful (Jensen, 1994).

### *NMa*

The Dutch Antitrust authority maintains the competitiveness of all industries, including health care. The rational behind competition is that it increases total welfare but they do not or only limited take into account that some competition harming activities might increase social welfare. In competition cases individual power and non-rationality can play an important role as well.

# 7. Methods

## *7.1 Research design*

The problem as defined in the introduction requires a holistic, systemic approach that takes into account all relevant actors within the system. This study obtains more insight in the incentives of the different actors that influenced the distribution of the PET-CT scanner in the Netherlands. This increases the understanding of the decision-making process in the Netherlands on medical technology. And with this understanding comes the possibility to influence this process in the future. This qualitative study is based on previous scientific studies and collected data.

## *7.2 Data collection*

To obtain triangulation to prevent that the findings of this study are based on chance or biased by particular persons or parties, several data sources will be used for this research. First theory and empirical evidence is obtained from prior scientific studies. After this grey literature is used. And the main information resource of this research will be data collected from qualitative interviews. The participants are also asked to fill in a short questionnaire.

### *Scientific literature*

Prior theoretical studies are collected to gain insight in the existent knowledge on the decision-making process on the purchase of medical technology. First theoretical studies are collected to help understand the unique characteristics of health care systems and the underlying incentives of different actors for the use of medical technology. The theoretical incentives of managed competition are discussed and the practical constraints are identified with the help of empirical research. Than, the development of the PET-CT scanner is mapped based on prior case studies in the Netherlands. An international context is given based on prior theoretical and case studies. This international context is given in order to understand what the findings of this study can contribute to understand the diffusion of PET-CT in other countries.
Existing scientific literature is collected by using a number of databases: Scopus, Google Scholar and PubMed. Keywords were used as a starting point and then a snowball method is used.

### *Other literature*

In order to understand the Dutch situation, grey literature such as governmental reports, newspaper articles and websites are used to map the current distribution of the PET-CT scanner in the Netherlands. In combination with the earlier collected scientific literature, the grey literature is used to identify the relevant actors of the decision-making process and the incentives that possibly influenced the actors' decision-making.

### *Interviews*

Interviews are used to get a clear view on which theoretical incentives are actually relevant in practice in the Netherlands. To achieve this, interviews are held with actors of micro, meso and macro level. The in chapter 5 identified actors, will be interviewed (see table 5). The theoretical incentives as described in chapter 2 and 5 will be the basis of the interviews. Table 6 gives an overview of interview topics, sub topics and indicators. All interviewees are asked about the incentives of all actors. In this way a more subjective view is obtained about the actual incentives of the actors.
The interviews will be semi-structured and conducted in Dutch because respondents are Dutch native speakers and this simplifies their participation to this research. In total at least 10 interviews will be conducted as shown in table 5.

### *Questionnaire*

In order to obtain comparable data, the interviewees have been asked to fill in a short questionnaire with multiple-choice questions and propositions. These questions and propositions formed the departure point of the semi-structured interviews. The questionnaire therefore contains the same topics as the interviews and is also shown in table 6.

*Table 5: List of interviewees*

| Actor | Function | Number of interviews |
|---|---|---|
| **Physicians** | Head of department of referrer specialism | 2 |
| | Head of department of nuclear medicine & radiology | 2 |
| **Hospitals** | Member board of directors | 1 |
| **Insurer** | Employee health insurer, specialist in medical (imaging) technology | 1 |
| **Industry** | Employee of sales department medical (imaging) technology | 1 |
| **NZa** | Employee with knowledge medical technology | 1 |
| **DBC-onderhoud** | Employee with knowledge medical technology | 1 |
| **NMa** | Head of the health department | 1 |
| **Total** | | **10** |

*Table 6: General interview topics and questionnaire topics*

| Topic | Sub topic | Indicator |
|---|---|---|
| Use of PET-CT scanner | - Technology perception | - Expectancy<br>- Status/prestige |
| | - Clinical use of PET-CT scanner | - Use cost-effectiveness studies<br>- Use guidelines<br>- Influence physicians autonomy |
| High costs medical technology | - Reason high costs | - Complementary, expansion effect<br>- Replacement old technology |
| Hospital competition and medical technology | - Incentives competition and medical technology | - Medical arms race<br>- Cooperation<br>- Mergers<br>- Efficiency |
| | - Role antitrust authority | - Influence NMa on use medical technology |
| Decision-making process NL | - Relevant actors | - What actors |
| | - Incentives different actors (see table 7 for detailed indicators per actor) | - Ethic incentives<br>- Economic/social incentives<br>- Technological/personal incentives |

*Table 7: List of specific indicators*

**Micro actors**

**Physicians**

*Economic and social incentives:*
- Financial gain
- Meet demand and expectations of patient
- Fear for malpractice suits
- Moral hazard
- Meet requirement of health insurance companies

*Technological and personal incentives:*
- Gain knowledge in technology
- Perception of technology
- Interested in technology
- Status that is associated with the use of the technology

**Meso actors**

**Hospital**

*Ethic incentives:*
- Provision of needed care

*Economic and social incentives:*
- Reputation: attract patients and physicians
- Increased revenue: complementary services or higher prices/quantity

*Technological and personal incentives:*
- Perception of technology
- Interested in technology
- Status that is associated with the purchase of technology

**Insurers**

*Ethic incentives:*
- Provision of needed care

*Economic and social incentives*
- Cost containment to increase revenues
- Reputation
- Meet demand and expectations of patient

*Technological and personal incentives*
- Perception of technology
- Interested in technology
- Status that is associated with the purchase of technology

**Industry**

*Ethic incentives:*
- Provision of needed care

*Economic and social incentives*
- Increase revenues

*Technological and personal incentives*
- Personal status/success associated with high sales and revenues

**Macro actors**

**NZa**

*Economic and social incentives*
- Create transparent, efficient, equitable and affordable system

*Technology and personal incentives*
- Perception of technology
- Personal/ managerial success factors

**DBC**

*Economic and social incentives*
- Create transparent, efficient, equitable and affordable system

*Technological and personal incentives*
- Perception of technology
- Personal/ managerial success factors

**NMa**

*Economic and social incentives*
- Create and maintain competiveness in health care sector

*Technological and personal incentives*
- Perception of technology (cost/revenues)
- Personal/ managerial success factors

### *7.3 Data analysis*

Data analysis has a descriptive form because the data is based on qualitative data. As shown in tables 6 and 7, indicators are attributed to the theoretical concepts to make them measurable. The interviews are analyzed by open labeling of the answers of the respondents in a qualitative data analyses program. These labels are attributed to the theoretical indicators. Indicators may be deleted or added during and after the labeling process due to the use of a semi-structured interview technique and the related unexpected answers. The questionnaires are used to obtain some direct comparable data and the results are discussed separately and graphs can be used to illustrate the results.

Conclusions are drawn on what incentives of what actors influenced the diffusion of the PET-CT scanner in the Netherlands and how hospital competition influenced these incentives. And future implications are given on how the decision-making process can be influenced with a new technology. The assumption made here is that the results of the study on the diffusion process of the PET-CT scanner in the Netherlands could be generalized to some extent to other (new) medical imaging technology and to a lesser extent maybe even to other medical technology. This is because for medical imaging technology it is expected that the same actors are involved in the decision making process. For other medical technology generalization might only be possible for lesser extent because although the general actors such as insurers, hospital managers and government are the same, different groups of specialists will influence the diffusion process.
The discussion section gives comments and discusses additions to and limitations of this research. Furthermore implications for further research and recommendations to improve health policy are given.

## 8. Current situation in the Netherlands

### *8.1 Practice*

In chapter 5 of this thesis the conclusions of IGZ (2008) and ZonMW (2007) studies were discussed. Both studies claim that there is an overcapacity of PET-CT scanners in the Netherlands. The respondents of this study however do not necessarily agree with this conclusion. Two respondents argue that the current capacity is good (1,8). Two respondents mention that there is an overconsumption of scans in certain regions and for certain indications but for others an under consumption exists (6,9). As discussed in chapter four, the studies of ZonMW (2007) and IGZ (2008) also show this difference across indications. The respondents mention the Randstad (Utrecht-Amsterdam-Rotterdam-Den Haag area) as the area of overcapacity. Four respondents agree with the final conclusion of the studies that there is an overcapacity of PET-CT scanners (2,4,7,10). When you approach the capacity question arithmetically, you come to the conclusion of an existing overcapacity (7). Modern scanners can, in theory, perform up to 20 scans a day. Taking into account that there are approximately 45 scanners in the Netherlands, on average these conduct less than 10 scans per scanner per day (7). In the university hospital of Groningen (UMCG) 20 minutes is scheduled for children (7-8 min scanning time) and for heavier adults (>90kg) 45 minutes (30-35 minutes scanning time). The standard scanning times in this hospital are 8.00-17.30 (Monday 10.00-18.00) and they conduct 15-16 scans per day. By the end of this year (2013), they will install a second scanner. The expectation is that the second scanner is used up to 50-75% of capacity from the start and (research related) demand increases so that the scanner will eventually be used fulltime. In the St. Antonius hospital in Nieuwegein 60 scans are performed per week. The standard scanning hours are 8.00-17.00, 5 days a week so that counts up to 1 hour and 20 minutes per patient. Both hospitals conduct scans in evening hours and weekends when waiting times become too long (>14 days). The Amsterdam Medical Center (AMC) expanded standard scanning times to evenings and weekends because their 3 PET-CT scanners couldn't meet the demand in standard office hours. Noticeable is that all those hospitals conduct far more scans than is assumed

achievable in the ZonMW (2007) study (2000 scans per scanner per year). For this matter, the ZonMW study might not be up to date due to the technological improvement of the scanners.

The conclusion that there exists an overcapacity of PET-CT scanners in the Netherlands must be nuanced according to respondent 7. First, it must be taken into account that the demand for PET-CT scans in the outer parts of the country does not exceed 1000 scans per scanner (7). This might be one reason why scanners are often not used full time (1,2,10). He also argues that in the beginning of the diffusion process of the MRI, some argued that only 10 MRI scanners were needed in the Netherlands, but currently there are hospitals that have 6-7 MRIs. The application of MRI is wide spread across indications and specialisms. So one must take into consideration that at the start of a diffusion process, you cannot know what an innovation will become in the future. When you limit the use of PET-CT you can restrain scientific development. So it is hard to find a balance between efficiency and further development. Furthermore, according to respondent 7, a nuance must be made for the future. The indications wherefore PET-CT is applied are still increasing, therefore there is probably no structural overcapacity of scanners. The industry is also developing and researching new tracers for cardiology and neurology indications, wherefore demand might increase in the future. Respondent 9 adds that the PET-CT can be used for R&D of pharmaceuticals in order to show whether the substances do what they are supposed to do.
Respondent 7 estimates that the number of scanners will not exceed 50 in the Netherlands and respondent 9 agrees that the diffusion rate has flattened. Most academic hospitals have one or more PET-CT scanners (Leiden will install one in the near future), all radiotherapy institutions have one and the bigger peripheral hospitals as well. Some hospitals are considering a second one because their scanner conducts 3000 or more scans per year. But despite these arguments, 5 respondents argue that the number of scanners will further grow in the future (1,2,6,8,10). Only 2 of them argue that this will result in future overcapacity (2,10). And one respondent argues that overcapacity will occur if we don't change the current purchase processes(4). Respondent 8 says that demand will grow but he estimates that this demand can be met by current capacity. The respondents again point out the difference in regions and across indications. Respondent 9 argues that the under- and overconsumption of scans for certain indications must diverge and that the current capacity can meet that average demand. Two respondents mention the difference of the functions of academic and peripheral hospitals; not all hospitals need the latest technology (1,10). And although the respondents agree that PET-CT can no longer be exclusively used in university hospitals (as is suggested by Schoder, 2003), they are reserved with regard to the purchase of PET-CT scanners by smaller peripheral hospitals (1,2,6,7,8,9,10).

### Clinical use

The respondents confirm the clinical application of PET-CT technology as is described in chapter 3 and add the use of PET-CT for melanoma. The PET-CT is often used to determine whether there are metastases and therefore whether surgery is needed or useful. One specialist argues that a PET-CT scan is too often requested for lung cancer with known metastases; with this prior knowledge a scan becomes useless because surgery is already excluded from the treatment options (9). Three specialists point out that PET-CT is used as a problem solving technique for patients with unknown problems of mostly inflammation (1,9,10). It is still used for these cases in relatively small volumes, as in chapter 3 discussed but it is increasing and in Groningen, now up to 20% of the requests has to do with inflammation problems (10). As mentioned earlier, the application of PET-CT is further developed for cardiology and neurology indications.

The advantage of PET-CT is that it is not restricted to certain organs but can quickly give a great amount of information (9). It might therefore be useful to apply the scan earlier in the diagnostic cycle, instead of first doing an echo, a CT, a bone scan etc. (7,9,10). The process can be accelerated (7,9) and this can also result in lower costs (7).

## Costs and Finance

The reimbursement system in the Netherlands is complicated as figure 5 shows.

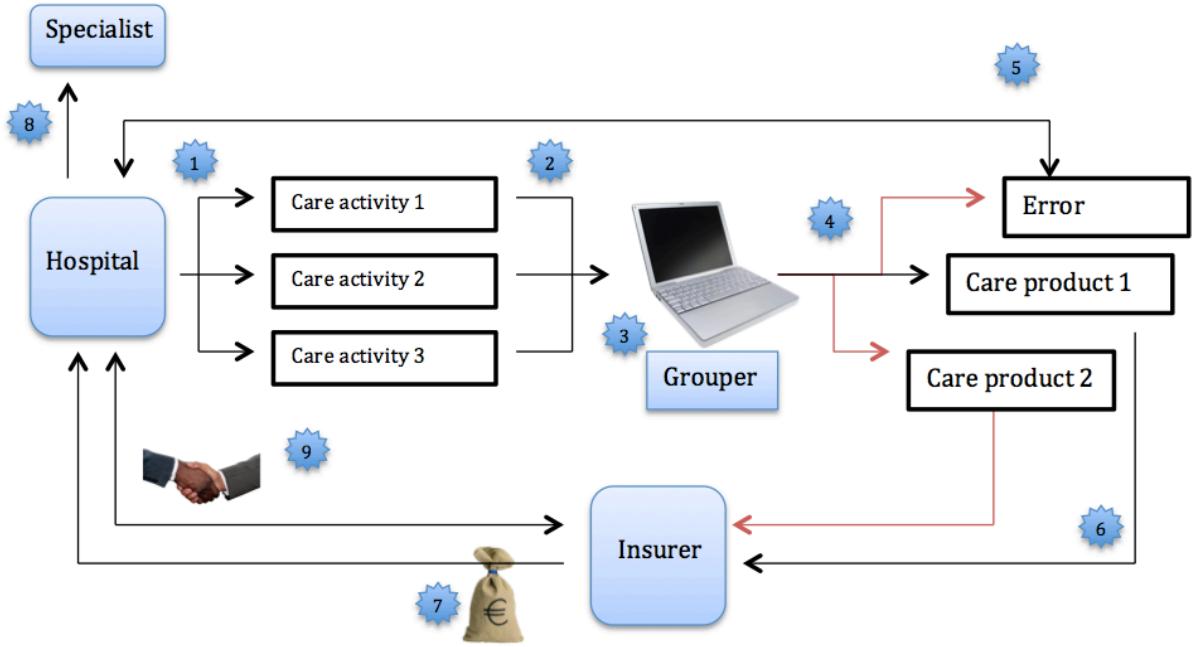


*Figure 5: Reimbursement system in the Netherlands*

1) *Hospital conducts care activities*
2) *Hospital registers care activities and registers for what diagnosis the activities are conducted*
3) *The automatic "grouper system" analyzes the registered activities and diagnoses*
4) *The system determines whether the care activities can be expected with the registered diagnosis. If not, there is an error, the hospital has to register again. If so, it is determined what Care product is applicable (in this example care product 1).*
5) *The care product or error is communicated to the hospital that has to agree.*
6) *The insurer is notified of the provided care product*
7) *The insurer reimburses the care product to the hospital (sometimes with a maximal volume per scanner or technology)*
8) *The hospital pays the involved specialist (salary, result basis or per activity/product)*
9) *At the end of the year, the budget of the hospital is checked: when exceeding the agreed budget of the insurer: hospital pays insurer*

A PET-CT scan is a care activity that a hospital can register to the grouper. The grouper than determines what care product is provided by the hospital. When care activities don't agree with the registered diagnosis (for example a PET scan for a broken leg), the grouper reports an error. As long as the registration is not done properly, the hospital does not receive payment. This is a good stimulant for hospital to register correctly (6). The DBCs and care products were introduced in order to get more information on what procedures are conducted for what diagnoses and also to restrict the number of procedures a physician can conduct for one diagnosis (6). Since January 2012 the DOT system is introduced to increase transparency. The system (partly) overcomes the problem that health care providers can order unnecessary tests and that there are no incentives to be an efficient health care provider (Devers *et al.*, 2003). An undesirable side effect of the care product system is that managers hire consultants that figure out what activities are characteristic for a higher (and more expensive) care product (6). Physicians often do not know the exact tariffs for care products but they do know what the cost centers of their treatment are. A hospital can have the general policy to register expensive procedures in order to obtain a higher care product. But the database of DBC onderhoud shows deviations of, for example, the number of scans conducted by the hospital. So, this policy will not go unnoticed and when there is no legitimate reason for a higher number (such as different patient population), the higher number will not be tolerated (6). Specialists and scientific

organizations filled the care products with combinations of care activities and care products are never changed without consulting those parties.

The tariffs for a care product are based on the average costs, so when for a specific diagnosis, 30% of the patients receives a PET-CT scan, this costs are included in the tariff (6,9). The insurer only receives information on what care product is provided and has no information on what care activities are conducted (6). DBC onderhoud has all the information that is available through the grouper system. Insurers increase pressure for reduction of the tariffs for care products (2,9). But 8 respondents mention that the annual budget negotiations between hospitals and insurer are more important; an insurer does not influence the application of an individual scanner but influences the total budget of a hospital.

The tariffs of care products are often 'contaminated' by new technologies. For example, the DaVinci robot does not have its own registration code yet. This means that the costs of the technology that is mostly used for urology indications, are influencing the tariffs of urology surgery. In this way innovations are invisible for DBC onderhoud and it is unsure what the (cost) effectiveness of the new technology is, for what patient population it is used and what the consequences are for traditional treatment (6). DBC onderhoud gets applications to tag new innovations with unique registration codes. The scientific advisory board of DBC onderhoud assesses the applications on multiple criteria: effectiveness, safety, demand, costs, patients' opinions and ethical aspects. There are three possible conclusions of the advisory board: 1. the innovation has to further developed for 2-3 years and can then apply for a registration code again, 2. CVZ is asked for its opinion towards the reimbursement of the technology, or 3. a temporary code is assigned and more data must be collected on the innovation (6).

As shown in chapter 5.4, different price tags are associated with the PET-CT scanner. This study unfortunately cannot cast light on the differences because one respondent argues that the scanner now costs €2,5 million whereas another mentions €1,5 million. The costs for an individual scan depend on agreements that a hospital makes. In one hospital the ratio for scans conducted for internal departments of a hospital for research purpose versus clinical use versus research for extern parties is 1:2:4.
There is reason to assume that the running costs of a PET-CT device did decrease in the past years due to technological improvement of the scanners; a lower FDG dose is needed per scan and maintenance costs are lower but it is difficult to decrease costs further due to the infrastructure needed (7). This contradicts the statement made by Porter and Olmsted Teisberg (2004) that technology in the health care sector is not subject to price drops and is even associated with price increases.

The business cases of hospitals for a medical device such as the PET-CT are mostly based on a 5-10 year period (6). But as two respondents point out, when a new device comes onto the market and the 5-10 year period has not ended yet, a hospital gets behind when it doesn't adopt the new technology (1,2). Old technological devices are sparsely resold to other countries. The idealistic idea that the scanners can be used in Africa is unrealistic because of the lack of knowledge to operate the scanners (2). But scanners can be sold to, for example Eastern and Southern European countries (4,10).

### Cost-effectiveness

When asked, medical specialists mention non-small cell lung cancer and lymphomas as indications wherefore the PET-CT proved to be cost effective (1,9,10). Respondent 10 mentions that cost-effectiveness studies are taken into account for oncology indications but not for other indications. Some collective research projects of university hospitals also conduct cost-effectiveness studies (10) but the studies are complex and expensive and often researchers are satisfied when they can include an indication in the medical guidelines for PET-CT use (1). Medical guidelines only take cost-effectiveness into account when studies are available (1,6,10).

So the assumption made in chapter 5.3 that clinical use is based on best practice and not on cost-effectiveness seems to be correct. As already identified, this can explain immense gap between the need assessment of ZonMW (2007) and the actual use of scans. Cost-effectiveness studies are assumed to be necessary but two respondents are critical on the study designs. Respondent 2 says that by making the right assumptions and choosing favorable variables in cost-effectiveness studies you can always get to the desired outcome. Respondent 6 wonders who should decide what is cost-effective, who decides what is the value of technology? The studies can be subject to conflicts of interests. Furthermore, the outcome of the studies is dependent on whether you include macroeconomic information such as sick leave (6).

### *8.2 Decision makers purchase decision PET-CT*

*Table 8: Decision makers in the Netherlands (additions to table 4 are shown with an *).*

| | **Micro**<br>*Health professional* | **Meso**<br>*Health organization* | **Macro**<br>*Health system* |
|---|---|---|---|
| ***Involved actors*** | • Physicians: referrer specialists, nuclear medicine specialists, radiologists<br>• Scientific organizations*<br>• University hospitals* | • Hospitals<br>• Insurers<br>• Industry | • NZa<br>• DBC-onderhoud<br>• ~~NMa*~~<br>• VWS* |
| ***Decision point*** | • Appliance of PET-CT scans<br>• Guideline development* | • Capacity PET-CT<br>• Purchase policy | • A or B segment*<br>• WBMV procedure* |

In chapter 5 the most relevant actors of the decision making process are identified with the help of the ZonMW study (2007). During the interviews respondents were asked to rank the relevance of these actors and to identify other actors that possibly influenced the diffusion process of the PET-CT scanner. The respondents all allocated minimal influence to the **regulatory authorities** as the **NZa, NMa and DBC onderhoud**. One respondent identified the **Dutch ministry of Health** as a potential influencer and ranked its influence as high (score 4 out of 5). Respondent 6 argues that VWS can have a very high influence (5) when they decide the care activity falls within the WBMV. But since this is not the case with PET-CT scanners, the influence is non-existing. All other respondents value the influence of the ministry with an average of only 1,38. Two respondents mentioned the role of the **Dutch college of health insurers (CVZ)**. CVZ can decide whether or not a new technology is reimbursed within the basic benefits package. However, the health insurance act states that all care is included in the basic benefits package unless CVZ has a reason to exclude the service from the package (CVZ, 2008). CVZ must thus make an active decision based on collected data. This takes time and the diffusion process of the new medical technology is often already started without a registration code, as described earlier. So before CVZ is even asked to make a decision. Because of this and because the PET-CT is not excluded from the package, the influence of CVZ is not further taken into account in this study.
Other actors that were identified by the respondents are the **university hospitals** and the **scientific organizations** that both carry out research on PET-CT that can be used for guideline development. And all respondents argued that the **medical guidelines** have a very high influence on the application of individual scans.

Notable is that all respondents value the influence of **patients** in the purchase decision of a PET-CT scanner non-existent to low. This confirms that assumption made that patients are not an

individual actor in the purchase decision of PET-CT scanners. The influence of patients is valued somewhat higher for the application of individual PET-CT scans. The **referral specialists** have the greatest influence on the application of individual scans. In addition to the in chapter 5 named specialist (lung, surgery and hematology), the PET-CT is also increasingly used for inflammation diseases and internists are a more commonly referee.
For the purchase decision of a PET-CT scanner, the **Board of Directors of the hospital** and **medical specialists** are seen as the most important decision making actors by 9 out of 10 respondents and their influence is scored very high by all respondents except 1 (high). Four respondents made the distinction between nuclear medicine specialist and radiologists and referral specialism (1,7,9,10). They argued that the **imaging specialists** need the support of the referral specialists to positively influence the decision to purchase (1,7,10). Respondent 10 confirms that the PET-CT scanner brought nuclear medicine to the forefront of medical diagnostic practice (Beyer and Townsend, 2006). Two other respondents mentioned that the nuclear medicine has developed, improved and expanded greatly in the past decade. The **partnerships of specialists** (maatschappen) were ranked the same as the individual specialist by all but two respondents. The two respondents argued that the partnership had a slightly bigger influence. It must however be noted that not all specialists are organized in a partnership. In some hospitals, partnerships don't exist and physicians are in salaried employment (1,10). And hospitals can also choose to pay specialists on a result basis, hereby the specialist most often gets a budget (9).

The respondents of the University hospitals furthermore pointed out that there are some overall differences between academic and peripheral hospitals because the purchase decision is also influenced by the application of research. This incentive is further discussed in chapter 9.2.

The current influence of the **insurers** in either the purchase decision process of the PET-CT scanner or the application of individual scans is somewhat unclear. Respondents rank the influence of insurers on the purchase decision 2-4 and the influence on the application of individual scans 1-4. One respondent mentioned the insurer as most important decision maker because the business case is dependent on its reimbursement policy; an opinion shared by Zweifel (2000). But he nuances his argument later in the interview when he heard the scanner was less expensive than he originally thought. The **guidelines of insurers** were only ranked with 1 by two respondents, while the rest ranked them similar with the influence of the insurer or slightly higher. This is noticeable because the respondent from the health insurance company claimed there are no insurance guidelines for the use of PET-CT so it is impossible that those can have influence. The diversity of answers and the confidence of respondents about the correctness of their answers, suggests that it is (partly) a case of perception how the current role of the health insurer is seen.
Respondents saw the current role of the **industry**, the producers of PET-CT scanners, as medium important whereby some categorized the industry slightly higher than others.

# 9. Incentives

Some respondents say one thing, some another but they all agree that the primary incentive to purchase a scanner and to conduct individual scans is of ***ethical*** nature: to meet patients' medical need and to improve quality of care. Some mention the decrease of waiting time, others the additional value of the scanner for diagnostics and another explains it more general: that it is to meet patients' demand. But similar with Porter and Olmsted Teisberg (2007) most respondents also identify secondary incentives to purchase medical technology. ***Economic and social incentives*** are pointed out by naming the influence of insurance and patients on different actors. Other incentives that are mentioned address **technological incentives** as well as motives of a more **personal** nature. This paragraph discusses the incentives of the different

actors. Hereby the incentives and indicators that are mentioned in chapter 5 are used as basis. Some indicators are added after data analysis; this is shown with an asterisk.

### *9.1 Health professional*

#### *Ethic incentives*

| 1. Provision of needed care |
|---|

1. As mentioned above, all respondents identified the ethic incentive of provision of needed care as the primary motive to purchase medical technology or to conduct individual scans. Physicians are one actor wherefore this counts. But as discussed further below, the arguments of Jensen (1994) that people cannot be perfect agents because they cannot make decisions without taking into account their own preferences and of Rocha and Goshal (2006) that people base their decisions on irrational behavior are confirmed by showing the secondary incentives of the health professionals.

#### *Economic and social incentives*

| 1. Financial gain<br>2. Meet demand and expectations of patient<br>3. Fear of malpractice suits<br>4. Moral hazard<br>5. Meet requirement of health insurance companies |
|---|

1. Three respondents carefully mentioned the financial incentives of physicians. Physicians that do not work in salaried employment, receive a fee for the total care product they provide or a budget. When a PET-CT scan is conducted, this can lead to a classification for a care product with a higher tariff. One respondent argues that all specialists should work in salaried employment in order to take away this incentive. One respondent that mentions the financial incentives of specialists thinks it is not a big issue with the PET-CT scanner because of the use of radiation and radioactive substrate (5). He assumes that specialists will prioritize patients' wellness. Respondents 1 and 9 mention, that some specialist do not refer their patients while there is a clear indication for a scan, just because their own hospital does not have a PET-CT scanner in their possession. The reason for this behavior is unclear; it can be financially motivated (the purchase of individual scans can be a disadvantage) or it might be due to practical objections (send patients to another hospital) (in correspondence with Zweifel, 2000) or competition incentives (afraid to lose patient to competitive hospital).

2. & 3. One respondent thinks that specialists find it hard to say no to a patient (6). One specialists mentioned prior scientific research on a central nodes procedure by breast cancer treatment that shows that higher educated people receive the procedure more often than lower educated people (1). It is therefore implausible to state that it has no influence. He however argues that although patients' ideas are considered in treatment determination they are not decisive. And because of information asymmetry the physician has a task to explain to the patient why a certain procedure is (not) necessary. Only when a patient denies a treatment, a physician must respect his whishes. 6 respondents however point out that, although increasing, only very small volumes of patients became more demanding (1,4,5,7,9,10). So, there is no evidence in this study that the point Zweifel (2000) made that patients prefer to shift authority to the physician is outdated.

One respondent notices that some specialists are afraid to misdiagnose or to diagnose in an advanced stadium (4). Thus, some physicians conduct more scans in order to confirm their diagnosis. Three other respondents discuss that scans are sometimes conducted for complex

patients because diagnosis could not be established with other instruments (earlier mentioned problem-solving technique) (1,9,10). In university hospitals this happens more frequently because complex cases are often referred to tertiary institutions. Respondent 9 points out that PET-CT is sometimes conducted because the guidelines or care products say to do so. This can be the case by small cell lung cancer with known metastases. No respondents identified a fear for malpractice suits.

4. Moral hazard is identified in multiple forms. The first is the one shortly mentioned above, moral hazard among patients. Patients do sometimes ask for unnecessary procedures, but they tend to accept denial of the professional when he can explain his reasoning. So the problem, that providers have an incentive to increase the use of new technologies due to ongoing demand (Chernew *et al*., 1998), is not of particular importance in practice. It is unsure whether patients would deny procedures more often when they are not reimbursed. Three respondents argue that insurance only influences the application of PET-CT when there is no reimbursement. But one of them argues that specialists still apply for a scan even when the scan is not reimbursed. The other form of moral hazard occurs due to the availability of scanners. When there is no restriction and the capacity is higher specialists conduct scans more often according to respondents (1,2,4,8,10) (Enthoven, 1993). Respondents argue that this probably does not increase efficacy of care (2,4,9,10) but for specialists it is interesting (2,10). But it is difficult do define what scans are unnecessary (4,6). It is therefore unclear whether it is socially wasteful as defined by Kessler and McClellan (2000). When a hospital does not possess a scanner or the waiting times are long, referral specialists sometimes will use other instruments for diagnosis (1,9).

5. The requirements of the insurer do not have an important influence on specialists. The insurer however wants to raise awareness among physicians on economic impact of their decisions. They should decide for themselves whether the scan is truly necessary. But there already is a control mechanism because the referral specialist applies for a scan and the nuclear medicine specialist checks the indication and when deviating, asks for more detailed information and a motivation for the application (1,9,10). But this happens very infrequent because, although there is a theoretical incentive to order unnecessary tests (Devers *et al.,* 2003); it assumed that most doctors do not request unnecessary scans and nuclear medicine specialists don't deny needed scans (1,9,10). In the future the insurer may have influence on the indications for which scans are reimbursed. Five respondents (1,2,6, 8,10) however think that the insurer itself does not have the instruments to do this. It must be in dialogue with medical specialists. But even then, respondents 1,6 and 10 argue that the insurer should not interfere in this matter.

### *Technological and personal incentives*

1. Gain knowledge in technology
2. Perception of, and interest in, technology
3. Status that is associated with the use of the technology
4. Technological features*
5. Medical guidelines*

1. Respondent 2 argues that the prestige of a physician might be important. He ironically illustrates this as follows: "Suppose I am a brilliant lung specialist: it would be a waste if I don't have the latest technology at my disposal". Respondent 7 disagrees that this is a bad thing and even states that top-specialists should be able to demand the best instruments to work with. Otherwise it is indeed a waste of talent. Specialists want to facilitate their patients in the best possible way and also want to keep up to date with medical practice for their own development (1,7,10). Respondent 10 confirms this; he works for his current hospital because he can use all top-end technology for nuclear medicine. This confirms that hospitals can attract physicians

with top-end technology (Devers *et al.,* 2003; Berenson *et al.,* 2006; Kessler and McClellan, 2000).
Respondent 1 mentions that when it is not cost-effective for your hospital to purchase a medical imaging device, the problem of lack of personal development of the specialist, can be solved when the specialist can analyze the scan himself. Now, this happens in the hospital where the scan is conducted and the referrer specialist only gets the report with (9) or without the scan (1). Furthermore, then a scan is conducted elsewhere; it is more difficult to analyze the scan with referee and nuclear medicine specialist together (9). One specialist argues that the physicians themselves are willing to cooperate with other hospitals but the specialists in his hospital do not want to use the scanner of another hospital in the region because this delivers lower quality scans, so the collaboration should be the other way around (10). Respondent 1 is not afraid to lose patients when they are referred to another hospital for a scan; according to him the patient will come back when the doctor-patient relationship is good.

2. Three respondents identify a difference between younger and older physicians in the application of individual scans (1,4,10). Experience can explain this difference whereas older specialists might know better for what indications a PET-CT can be useful. Another explanation can be that younger specialists have a better knowledge of technology and therefore use it more often (as mentioned by Berwick, 2003). Another reason is the trust a referral physician has in the capabilities of the nuclear medicine department of the hospital (1,9,10). Respondent 2 points out that with the introduction of a new technology, many specialists apply it complementary to the old technology. It happens that specialists unnecessarily request a PET-CT and an isolated CT scan because this would show a slighter better view. There are even specialists that still order Gallium scans that are disadvantageous due to high radiation and long scanning times. This practice supports the point that new technology drives up costs due to complementarity (Chernew, 2011).
In the purchase decision of a scanner, individual preferences can play a role. Partnerships of specialists promote innovation and development (4). The role of the referral physicians diminishes the risk that a scanner is bought for the personal interest of nuclear medicine specialists. The personal incentive is much lower for referral physicians and they tend to ensure that the decision is based on proved clinical effectiveness, according to three respondents (1,7,10).

3. Three respondents refer to the PET-CT scanner as a "nice toy for physicians" (2,5,8,9). They hereby do not mean that the imaging device has no clinical value but it shows that interest of physicians goes beyond the clinical value. Respondents 7 and 9 argue that an oncology center should have a PET-CT device and respondent 1 argues that you are not a complete nuclear medicine specialist when you cannot offer your patients a PET-CT scan. But the latter means that this can also mean that you refer your patients to another hospital.

4. The radiation and radioactive substance that is associated with PET-CT can be a reason to be reserved to request a PET-CT scan. It is not an easily accessible device (1,5,7). Respondent 10 however argues that this should only be considered with young children without oncological problem or with women with a high risk on the development of breast cancer. But when you take the background activity into account, most patients do not have objections to participate with a scan.
A technological issue that influence the requests of PET scans is that when a specialist already applies for a CT scan, it is easy to conduct a PET simultaneously (10).

5. Four respondents identify that medical guidelines have a major influence on the decision to conduct an individual scan (1,6,9,10). Respondent 5 sees the guidelines as a way to control the number of scans conducted. But according to respondent 9, the medical guidelines also have to be embraced by medical specialist. And sometimes the device is not used in large European studies wherefore it is not likely to end up in a guideline while a specialist can have positive

experiences with the device for certain indications (9). Respondent 10 argues that the influence of personal interest and preferences is already diminished by strict medical guidelines, especially for oncology. For infectious diseases, guidelines are less refined wherefore personal interest and knowledge has more influence. According to respondent 1, scientific literature is also very important for clinical use of scans. Guidelines are only updated once every five years, so studies that are published in the mean time are often also used as guidelines.

### *9.2 Health organization*

#### Hospitals

#### *Ethic incentives*

1. Provision of needed care

Again, all respondents identified the ethic incentive of provision of needed care as the primary motive to purchase medical technology or to conduct individual scans. It is however unsure whether all hospitals that have a scanner really need one in terms of medical need (2,3,4,7,8,9,10). So other incentives influence the purchase decision as well.

#### *Economic and social incentives*

1. Reputation: attract patients and physicians
2. Increased revenue: complementary services or higher prices/quantity

1. The respondents agree that a PET-CT scanner on its own does not make a big difference for the reputation of a hospital. Respondent 8 depicts that it is not about one device but about whole treatment cycles. Respondent 7 and 9 agree but also argue that it is implausible as hospital, if you claim to be a high quality oncology center whereas you do not have the latest technology, which includes a PET-CT. If you want to excel in oncology, you have to invest in both human capital as in technology (7).
Respondents 1 and 5 both add that the knowledge of a patient is limited and most patients have nothing to do with complex devices as the PET-CT. They come to the hospital to get a quick diagnosis and an accurate treatment for relatively simple problems. In most cases it is not effective for a hospital to specifically market the PET-CT scanner for the small percentage of patients that does need it. For the university hospital of respondent 10 this is different because they attract patients to the hospital because of the research they conduct with high-end medical devices and unique radioactive substances. But those patients only come to this hospital to undergo the PET-CT scan and afterwards are send back to their own hospitals for further treatment.

So reputation building might not occur on the basis of one imaging device as the PET-CT scanner but confirm theory (Teplensky *et al.*,, 1995; Pauly, 2005) medical technology does play a crucial role in hospital marketing strategies. Respondent 2 ironically states that when a regional hospital purchases a new PET-CT scanner, the alderman comes to 'open the new scanner' and an article appears in the local newspaper. A small, peripheral hospital shows that it is more than just a regional hospital! It is used to show that you're the best hospital in the region (7). Patients do not know where the new scanning device is used for but it is a signal that it is a state of the art hospital and patients than assume that it is a good quality hospital. All respondents confirm the importance of the role of medical technology in marketing activities of hospitals. Respondent 6 adds that some patients believe that every treatment that includes technology is the better one. Something that is doubted by four respondents who all four independently mentioned the Davinci robot to substantiated their point.

So it seems that especially the image and marketing value of medical technology is used to attract patients to a hospital (Teplensky *et al.,* 1995). And as shown under the heading *health professional* the availability of medical technology is used to attract physicians to the hospital.

2. In theory, hospital managers use a business model to decide whether a technological device can or should be purchased, based on cost-effectiveness. Four respondents argue that this indeed is (mostly) the case in practice (1,7,9,10). But for some smaller peripheral hospitals it is doubted (1,2,6,7,8,9,10). How is the return on investment determined? What costs are included (6)? Yet another respondent argues that it is the problem of the hospital when they make a poor investment decision (5).

Two nuclear medicine specialists identify a financial problem with the sharing of technology. The tariff for a medical procedure differs when the procedure is done outside the hospital. It is unclear whether the external purchase of individual scans is indeed disadvantageous, but the finances are more visible: each scan is paid for separately whereas if the hospital possesses its own, all costs (device, personnel etc.) are already included in the overall budget except the FDG doses (9). But the income of the referring hospital might decrease; so, it might be more cost-effective for hospitals to purchase a scanner themselves (1). Hospitals with low volumes of patients probably conduct the scans at a loss. This is one of the problems with sharing technology (7). Smaller hospitals that are not capable of buying their own scanner are enthusiastic about collaboration agreements but bigger hospitals only want to get their own facilities. Especially when the hospital has its own radiation therapy or the collaborating hospitals are not close to each other. It must be a win-win situation.

A reason for university hospitals to expand capacity is the possibility to devote relatively more attention to research. This is important because scans conducted for research bring in twice the amount of money (financed by industry and charity) as to scans for clinical patients. And the department is (partly) dependent on this extra revenue (10). A specialist also mentions that the board tries to restrain collaboration with other hospitals in the region. The specialist assumes that the reluctance of the board comes from a competitive perspective because they wish to restrain the incoming scans as well, while this can increase the hospitals income.

### *Technological and personal incentives*

1. Perception of, and interest in, technology
2. Status that is associated with the purchase of technology
3. Research*

1. & 2. In coherence with the use of medical technology to increase the reputation of a hospital is the status that is associated with technology (conform Enthoven, 1993). To illustrate that status can be associated with certain health activities, respondent 5 mentions the case of ERs of hospitals. Many hospitals suffer losses in order to keep their ER open. But under the guise of "If we don't have an ER, we are just like a normal office", they still provide emergency care. This confirms that some care activities are subject to higher reputational value than other (Berenson *et al.,* 2006). Three respondents argue that hospitals are like all other companies, they always want to be bigger and more successful (4,5,8). Respondent 7 argues that, in general, he does not have this experience with the PET-CT. He can only name 2 or 3 cases whereby the purchase of the technology wasn't based on a decent business case but was to show off to competitors. In those cases it was about status to possess the scanner earlier than the competitor, but, according to the respondent, the hospitals didn't receive more patients because of it.

3. University hospitals play a role in the diffusion of medical technology in the Netherlands (2,4,6,7,10,1). Educational events are organized where researchers from university hospitals present their recent studies to other specialists (7,10). The literature they publish can be of

major importance for the number of requests for scans (1). Respondent 10 mentions that the university hospitals operate from a scientific point of view and only have influence on the knowledge diffusion. They do not advise hospitals to purchase certain technologies. According to respondents 2 and 4, this would not be effective anyway because 'Dutch people generally don't let anyone tell them what to do'.

### Insurers

#### *Ethic incentives*

1. Provision of needed care

In the Dutch health system, insurers act on behalf of their insured and have the task to obtain high quality, accessible and affordable care (3,5,6,8). They try to find a balance between these aspects (8). Concentration of health care illustrates the difficulty to find this balance, whereas concentration can increase quality of care but also diminishes accessibility (8). The NZa supervises the health insurers to guarantee the quality, affordability and accessibility of health care (3,5,8). This is in line with the theory sketched earlier in this thesis (van de Ven and Schut, 2008; Enthoven, van de Ven, 2007)

Two respondents mention the situation in the US, where providers must get permission for certain, complex, expensive procedures (5,8). The insurance companies decide whether a procedure is allowed, based on strict protocols. In the Netherlands this is an undesirable situation, due to delay of the access to health care (10) and because the health care provider should make medical decisions, not the insurer (8). Five respondents argue explicitly that it is undesirable that the health insurers influence the medical decisions of physicians (1,2,6,8,10). But in contrast, many respondents reserve a role for the insurer in order to optimize capacity of medical technology as is further discussed below.

#### *Economic and social incentives*

1. Cost containment to increase revenues
2. Meet demand and expectations of patient
3. Reputation

1. In the system of managed competition, insurers have a financial incentive to deliver affordable and efficient health care (3,5,8). In the Netherlands, the government further increased this incentive by expanding the freedom of insurers to contract only specific health care providers and by reducing the public risk equalization fund (3). Health insurance companies can influence the provision of care indirectly by contracts and agreements (3,5,6,8) (van de Ven and Schut, 2008; Enthoven, van de Ven, 2007). Recently, the process of contracting care providers develops rapidly and health insurers are increasingly competing to attract patients with their purchase strategies (3,6,8). According to respondents 3 and 6, this process must however still be improved so that the insurance companies can fulfill their role as directors of health care (3) and to counteract tendencies to 'killer contract' hospitals (6). The NZa is responsible to prevent these contracts but how can they determine what is a killer contract?

The insurer has a financial incentive to decrease the number of services conducted by providers (within the boundary of their accessibility duty) and to create an efficient system (3,5,8). In case of medical technology, an insurer wants to develop a system whereby technology is used optimally and devices run on full capacity as much as possible (5,8). To achieve this, an insurer can deny reimbursement for scans made by a certain hospitals on the basis of existing regional capacity; the hospital will then not be able to purchase a (second) scanner (3,5). Currently this happens infrequently but increasingly. And when hospitals want to finance a new device with a

loan, the involved bank increasingly consults insurance companies on the need of such a device in the particular region (8). But perceived and actual need of regions can change and then the insurance companies are still bound to previous agreements even though they are outdated at the time (8). So it is not as easy to control capacity of devices in retrospect, as is suggested by respondents 3,4 and 5. Respondents 3 and 5 argue that the health insurance should not direct the purchasing process of an individual scanner but they should focus on the overall care and technology packages of hospitals. Insurers do not even have the resources to direct the purchase decisions of hospitals effectively according to respondent 2. On the contrary, respondent 5 argues that the insurer make volume contracts with hospitals on the number of scans. His argument is that when the number of scans is reduced, it becomes unprofitable for hospitals to keep their (or buy a new) scanner and the therefore the number of scanners will decrease. This argument is confirmed by the notion of respondent 8 that when you introduce an unlimited reimbursement policy, the number of scans will increase. But two objections are made that insurance companies determine the needed capacity in a region. The first was shortly addressed above: 5 respondents argue that the insurer should not have any influence on the medical decisions of a physician. But when the insurer makes volume contracts with hospitals, a physician will be influenced in his decision making to request a scan. Furthermore, when the insurer decides on needed capacity, this brings along a new political playground of conflicts of interest whereby the financial incentive becomes dominant instead of patients welfare (1,10). It can decrease medical development because with strict guidelines, the PET-CT can no longer be used for indications wherefore outcomes are not yet defined. But as is discussed earlier, medical guidelines are adjusted every 5 years and even in between the clinical use changes. This is only possible when physicians have the freedom to conduct scans for new indications.
The second objection is that the insurer might not have the instruments and information to determine the right capacity of a region (2,6).

The first objection might (partly) be overcome by the introduction of networks or collaboration between multiple actors (4,7,8,10). In this way, the insurer is not the only responsible party but determines capacity together with hospitals, specialists, (8,10) (local/regional) government (4,10) and the industry (7). And although discussions, on for which indications a scan is conducted, will probably occur more in the future (8), the insurance company does not want to dictate a physician what to do (8). The insurance company can compare utility of services and health outcomes of hospitals and physicians (5,8). They can confront hospitals and physicians with those results and ask for an explanation. The goal is that physicians become more aware of their actions and are, if needed, willing to change their behavior in order to increase efficiency (8). Insurers and hospitals have a joined responsibility to provide good quality, accessible and affordable care according to respondent 6. This respondent however doubts that the comparison of hospitals is made with the proper information because good quality information is not available for insurers (second objection). He argues that this information gap can be filled by DBC onderhoud that has substantial information on health outcomes and procedures (through the grouper system) that were conducted in order to achieve those outcomes. This information is now classified and it is also highly sensible for bias, so a fair information system should be developed whereon insurers can base their comparisons.

2. & 3. Insurers are dependent on their insured, it is therefore important that they meet the demand and expectations of the patients on who's behalf they act (van de Ven and Schut, 2008; Enthoven, van de Ven, 2007). When insurances for example contract health care providers too strictly, this will result in patient dissatisfaction and possible loss of insured (1). Furthermore, the NZa can decide that an insurer meets the duty of care deliverance but abuses its market power at the same time when their insured are dissatisfied.
Medical technology can also be used to create a reputation for the health insurer in the same way as it does for a hospital (6,7). For example, they could present themselves as being the first to reimburse a PET-MRI scan for children because the radiation of a CT scan is damaging (7). Or they might maintain less cost-effective treatments because of the perception of the technology of

their insured as shown by Teplensky *et al.* (1995) (6). But again, it is uncertain how efficient marketing for such a small patient population that needs access to such high complex care components is.

### *Technological and personal incentives*

1. Perception of, and interest in, technology
2. Status that is associated with the purchase of technology

1. & 2. The general perception of, and interest in, a technology may influence the behavior of an insurer. The balance, between concentration and accessibility, mentioned earlier, is also difficult to find because what is *assumed* accessible is dependent on the political and public opinion. For example, according to respondent 7 a contradiction occurs in the Netherlands in relation to radiotherapy. All 21 radiation therapy institutions in the Netherlands got approval from the Dutch government (radiation therapy is refunded under the WBMV) to install satellites because it was too stressful for the patient to travel during their treatment cycle. And now there should only be 10 or 12 PET centers? So it is not defined what is accessible; is that 30 or 60 minutes travel for an expensive scan for non-emergency care (8)? In practice you see that when society as a whole decides that a certain procedure is unfeasible within the standard care, the minister of health (VWS) decides what happens; this is seen in the proton therapy discussion in the Netherlands (8). If the public opinion is that it is feasible within standard care, hospitals and insurers make the decision locally.

The perception within an insurance company of a technology but also of a hospital, finds its way in the reimbursement decisions. When a small local hospital wants to purchase a new high tech device, the insurer probably will deny reimbursing the scans. But when a high-end research facility wants to buy the same device, the insurer could agree. Furthermore, the tariff determination is not evidence based but is based on a convincing argument especially in the early stages of the diffusion process of medical technology, when little evidence is available (7).

## Industry

### *Ethic incentives*

1. Provision of needed care

1. While the respondents identified the provision of needed care as primary incentive to purchase a scanner, it doesn't seem to be for the seller of the device. The primary goal of the industry is assumed to be to increase revenues. But most respondents do not see this as a problem; other actors are responsible to achieve an efficient health care system. Only one respondent (4) argues that the industry should focus more on their social responsibility. But although not the primary incentive, a vision to provide good quality care is the basis for the development of new devices (6,7). The industry is also prepared to collaborate with health insurance companies and health professionals in order to optimize the application of medical devices (6,7). But the industry will provide devices to all hospitals that pay for it, even when they are sure it is not necessary to provide this type of care. This however does not occur often and these cases are sometimes even financed by donations instead of public resources (7).

### *Economic and social incentives*

1. Increase revenues

1. As explained above this incentive is identified as the primary incentive of the industry; they have to keep their shareholders satisfied. Several respondents describe the lobby actions of

the industry; they are present at congresses for radiologists and nuclear medicine physicians (1), their salesmen contact hospitals in multiple ways to check whether there are some new purchasing ideas in the pipeline (7), they spend a lot of money on marketing (2) and they show physicians running devices in national and international institutes (7,10). The lobby activities decreased in the past 10-20 years (1) and also changed because the physicians no longer make the decisions on their own (7). Now special Decision Making Units are formed that include the suppliers, purchase managers, department manager and the physician. This suggests that the board indeed got more influence through the introduction of competition, as was discussed in 2.1. The board does only decide whether a purchase is done and does rarely influence the process of what party can deliver the new device (7, 10). And the industry does not influence whether the device is purchased but influences what type is purchased (5,7). Respondent 6 argues that the industry is often muttered about undeserved; they possess a lot of know-how and are prepared to work together with different actors on, for example, research (6,7,10). Institutions and patient organizations should approach the industry more often in order to optimize this collaboration and to use the know-how of the industry more efficiently (6).

#### *Technological and personal incentives*

1. Personal status/success associated with high sales and revenues

1. Siemens has the target to be in the top 2 players in an industry, if this is not the case they exit the industry and focus on another. It is likely that the manager of a certain industry achieves personal success when he meets this target (Stanley, 2010). There is no obvious reason to assume that GE and Philips have entirely different types of corporate goals - and therefore personal goals for managers. There is no indication that the personal status or success that is associated with high sales and revenues is higher or lower in the medical devices industry than in any other industry.

### *9.3 Health System*

#### Government

#### *Economic and social incentives*

1. Create transparent, efficient, equitable, accessible, high qualitative and affordable system
2. Create and maintain competiveness in health care sector

1. All governmental institutions have the incentive to contribute to the provision of efficient, equitable, accessible and affordable care.

**DBC Onderhoud** creates more *transparency* in the utilization of health care with the registrations of all procedures conducted and associated health outcomes (6,8). This information on admissions, surgeries, days spent in the hospital etc, can be used to make useful statements on the quality of health institutions and the necessity of certain procedures (6).

The government introduced the managed competition system to obtain an *efficient* and *affordable* health care system. The **NZa** is one of the supervisors of this system; it supervises the *equitability* of care and assesses whether the health insurers meet their *care duty* (they provide *affordable* and *accessible* health care). The NZa plays a double role because it also establishes the tariffs of the A-segment health products (8).

It is the social responsibility of the ministry of health (**VWS**) to provide good *quality* care for all Dutch citizens (8). They also have the task of health care planning for extraordinary care

(including WBMV care) (5,8). And some of this care such as the trauma helicopter services and treatment centers for burns is also publicly financed (8).

The government gives incentives and freedom to the health insurers to be efficient and health care purchasers. Only when the insurers fail to do so, the government interferes by, for example, limiting access to technology (5). The incentive to create the most efficient system is that the insurance premiums are partly paid by the Dutch taxpayer (5). Six respondents (1,3,4,5,8,10) agree that the government should not interfere within the health care system (except for high complex special care) because it can for example delay health deliverance by creating unnecessary bureaucracy (10).

2. Based on competition theory, the **NMa** and **NZa** have incentives to create and maintain the competitiveness in the health care sector. The NMa focuses on the more liberated markets while the NZa focuses on building of new markets (3). The NMa assesses cartel formations (with input of the NZa) and evaluate mergers. The later role is being diminished however with the introduction of the health care specific merger test (3,5). Hereby multiple stakeholders such as surrounding GPs, patient organizations, the works council (OR) and clients council (cliëntenraad) are consulted. IGZ (Dutch healthcare inspection) also gives a vision on effect of the merger on quality (5). The NMa assesses the merger after the NZa gives a green light for the merger (3,5).
The NZa has the lead for cases of substantial market power. This means a hospital can behave independent from patients, competitors or insurers. The NZa does not have to proof abuse of market power but can directly use multiple instruments, such as maximum price setting to control the market power of the hospital (5).

### *Technological and personal incentives*

1. Perception of, and interest in, technology
2. Personal/ managerial success factors

1. The NMa and the NZa are not involved with micro decisions such as the purchase of a scanner; therefore the perception of, and interest in, technology will not influence their behavior. The ministry of health (VWS) can decide whether a technology is subject to the WBMV act, so it is possible that perception of, and interest in, influences their behavior but this study did not find such an indication. DBC Onderhoud is involved with more micro decisions, especially when subject to innovations. The perception of, and interest in, technology can influence their behavior, as is shown by the 2 respondents of DBC onderhoud who expressed a specific interest in the DaVinci robot. They want to 'catch' it in a DBC in order to make the utilization more transparent. It might be that this urge to catch this technology is higher due to the general perception and knowledge of the robot.

2. There is no indication that the personal/managerial success factors (Rocha and Goshal, 2006; Stanley, 2010) influence the governmental institutions more or less than within any other organization or industry. Noticeable is that the governmental institutions rate themselves as almost non-influential in the purchase decision of hospitals; it is therefore likely that personal and managerial success factors of personnel of government institutions do not influence the diffusion of PET-CT scanners.

## 10. Competition and Collaboration

As described earlier, the competitive strategies implemented by hospitals can have great influence on demand creation and total public health care expenditures (Dever *et al.,* 2003). Therefore it might be necessary to find a balance between a full market system and

collaboration between hospitals to reduce excessive technology supply. This chapter discusses the opinions on this matter of the respondents of this study.

### *10.1 Competition in theory and practice*

The theory behind competition (Enthoven, 1993; Kessler and McClellan, 2000; Folland *et al.,* 2010; van de Ven and Schut, 2008; Enthoven, van de Ven, 2007) is clear for all respondents: competition can create incentives to be more efficient and innovative. According to respondent 3, competition is possible on quality when prices are set, on price as well as on quality even if there is quality norm that providers have to meet and when prices are regulated, price competition can occur above or under a certain threshold. Respondent 5 points out that price rates are released (moved towards B-segment in the Netherlands) in order to create a downwards pressure on prices. When a license is needed for a procedure (in case of WBMV treatments), released prices however create an upward pressure on prices and therefore these procedures should be subject to A-segment DBCs. When health care providers compete on prices for the PET-CT service, it will become unprofitable for providers that are less efficient or offer the service in low volumes. These organizations are then forced to dispose their PET-CT service. Respondent 5 points out that hospitals are independent organizations and can therefore buy themselves an expensive toy and it is their problem if it turns out to be unprofitable. Unfortunately other respondents argue that in current practice, these unnecessary costs still turn up on the account of the health insurers and therefore are paid by Dutch citizens and government.

But as shown in chapter 8.2 the insurer increasingly influences the decisions of hospitals by strict contracting of health care services. This is because the competition among insurers is increasing and the government releases regulation, as was pointed out by van de Ven and Schut (2008) and Enthoven, van de Ven (2007) and this is confirmed in several interviews. The risk adjustment system is reduced (3); insurers increasingly bear the risk and have more freedom of choice. Respondent 6 however notices that competition among insurers is still limited because the basic benefit package is equal and they mostly compete on complementary services. And he argues that the decision triangle of patient, insurer and health provider makes competition in health care complicated, as is identified in chapter 2. In managed competition the insurer is supposed to act on behalf of the patient and the patient can choose their insurer according to their own preferences (van de Ven and Schut, 2008; Enthoven, van de Ven, 2007). But when the policy holder becomes a patient, these preferences can suddenly change (6).

#### Price competition

The university hospitals argue that they probably experience a lower competition level than peripheral hospitals. The number of patients is still higher than they can handle and is still increasing because they benefit from the recent discussion on quality and concentration and dispersion of health care services. Furthermore, they do not identify price competition between academic hospitals. But both university and peripheral hospitals have pricing agreements with surrounding hospitals; smaller peripheral hospitals in the region can buy PET-CT scans at a discount (dependent on the number of scans purchased). Respondent 1 says that the total demand does not increase by lowering prices of individual PET-CT scans but the volume conducted by one hospital does increase. He argues that pricing agreements among hospitals have a diminishing effect on prices because a hospital that outsources scans, shops around and makes a pricing agreement with the hospital who offers the best price/ quality ratio. This suggests that respondent 5 is correct and hospitals with lower efficiency and higher prices will be forced to dispose their PET-CT services. But competition does not necessarily lead to less capacity; it leads to better price-quality ratios (5) (the *value-for-money* competition as described by Enthoven, 1993).

According to managed competition, the health insurer is the buyer of health care and therefore also the end user and buyer of medical technology (van de Ven and Schut, 2008; Enthoven, van

de Ven, 2007). But insurer as well as industry admits that they do not discuss purchase decisions or sales strategies with each other. This is in contradiction with the theory of Gaynor and Haas-Wilson (1999) that these negotiations are crucial for the industry due to the high risk of medical technology. Instead, hospitals form their own purchasing strategy for medical technology as is shown in chapter 8.2. Respondent 3 points out that the competition might still not be optimal because it did not find its way to the upper part of the supply chain yet. Insurers negotiate with hospitals about prices and when the pressure to lower prices for hospitals becomes stronger, the hospitals will increasingly pressure the industry to lower the purchasing costs of medical technology (see figure 6). Respondents 1, 2 and 3 admit that there is still much to achieve with purchasing strategies of hospitals. Respondent 2 notices that there is an active purchase strategy for care instruments but not for technology. Hospitals should work together in order to create a better bargaining position versus the industry. Respondent 3 argues for more combined purchases in order to obtain discounted rates. Respondents 7 and 10 argue that such combined purchases already exist; there are Siemens and Philips centers in the Netherlands that buy all devices at either one of the manufacturers. The radiology and nuclear medicine department of the hospital of respondent 10 has been such a Siemens center for the past 30 years. But if they want to buy a new device, they are legally obligated to invite European tenders to respond. In this way the purchase decision takes up to three years. With the purchase of a second PET-CT, they can directly buy a Siemens device; that allows speeding up the purchasing process to one year. Respondent 6 notices that the industry – hospital negotiations are nontransparent and take place in a 'give and take' fashion, without parties using pre-set financial benchmarks/norms (in Dutch: *handjeklap*).

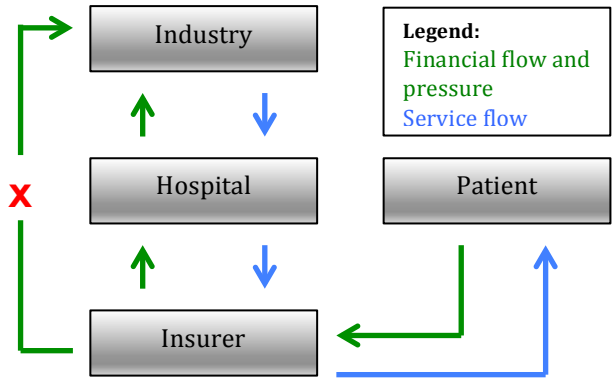


*Figure 6: The financial pressure of the insurer does reach the industry directly*

In the Netherlands competition among imaging manufacturers is limited to three suppliers: GE, Philips and Siemens. Respondent 7 mentions that GE and Siemens are the number 1 and 2. GE has the largest share in the American market and Siemens in the European market, whereby Siemens covers around 75% of the Dutch market. Siemens invested heavily in R&D and became one of the top players in imaging but Philips was the first manufacturer of the new PET-MRI. The high investment costs for medical imaging technology, the need to continuously invest in R&D to keep up with the rapid technological progress and the regulatory requirements (approval from FDA needed), creates a market barrier and minimizes the chance for market entrance by other manufactures (Pisano, 2006) (7). A new emerging development for manufacturer competition is that hospitals do not just buy a new medical device but they outsource the responsibility for technology in the same way they outsource the laundry and catering services. Hereby a manufacturer of scanning devices facilitates the technological aspect of the treatment cycle. Hospitals get the flexibility to choose for devices they find most useful. The manufacturer will install, maintain and upgrade the technological features so that the hospital does not need to worry about any of it and the hospital can return to its primary task: deliver good, qualitative care. This new form of collaboration between hospitals and industry is not meant for cost

containment but rather for quality improvement. Clearly this new way of contracting changes the negotiations between manufacturer and hospital.

According to multiple respondents, it is difficult to establish how price competition occurs between hospitals because of the non-transparent negotiations between insurer and hospital and the heterogeneity of products. Prices are not set on the basis of one treatment or procedure but contracts are signed for the whole care package of a hospital or department, as respondents 1,2,4 and 8 point out (figure 5). Several respondents mention the recent case of the Achmea-Slotervaart hospital negotiations where health insurer Achmea decided not to contract the Slotervaart hospital in Amsterdam because negotiations reached a deadlock. All Achmea insured- patients of the Slotervaart hospital were denied reimbursement in the future. The insurer was allowed to make this decision because it still fulfilled its *duty of care* as defined by the Dutch Health Authority because patients could seek alternative care in one of the other hospitals in Amsterdam. But in practice, losing all the Achmea patients it proved not to be sustainable for the Slotervaart hospital . The CEO, Aysel Erbudak was expelled and the negotiations with Achmea continued. Three respondents repeatedly mentioned the importance of the role of the health insurer in order to increase competition in the health care system. They welcome the action of Achmea in the discussions with the Slotervaart . Respondent 6 however argues that Achmea has a powerful position in this case because it would be a fiasco for the Slotervaart hospital to lose all Achmea patients. So it might be a good thing that health insurers claim their bargaining position, but in practice it seems to be no option to not get to a compromise.

### Quality competition and Medical Arms Race

Hospitals compete on quality by creating so called *streets of care.* The enormous rise of *mammacare units* is a good example of this phenomenon; here women with (potential) breast problems are examined, diagnosed, treated and guided in an efficient, fast care cycle. The department of respondent 4 even won an award issued by Achmea Zorg for making a care street for Cerebro Vasculair Accidents (CVA), which increased quality enormously. But according to respondent 7, the average patient does not make profound decisions based on quality information or prices. Word of mouth advertising is more important and a patient has to feel safe and familiar (7). Respondent 4 also confirms this and his department also improved the convenience of their patients by introducing one contact person for patients and relatives. One respondent stretches this need of convenience with the anecdote that if –say- parking facilities are not sufficient, patients will complain - but if you do not have a PET-CT scan, most of them will never notice.

Hospital competition is seen in the strategic choices that hospitals make. Four respondents argue that especially the larger peripheral hospitals increasingly choose and focus to be for example an excellent oncology center and to dispose another department in order to improve their competitive position. Devers *et al.,* (2003) made the distinction between economies of scale (specialize) and economies of scope (one-stop-shopping). In practice both strategies seem to be combined in these *care streets*. The introduction of care streets is also in line with the earlier mentioned discussion on quality and concentration and dispersion of health care services. The Dutch Inspection for Health (IGZ) stimulated this trend with the introduction of volume standards. This means that hospitals have to conduct certain procedures with a minimum volume and otherwise they are not allowed to perform the procedures in the future. Respondent 6 states that the edge is taken of these volume standards because hospitals are inclined to increase demand and thereby their volume in order to meet the volume standards. But it is not ruled out that some health organizations already adjusted their strategy on these standards. According to respondent 7, it is important for a hospital to excel in a certain treatment groups because general practitioners refer their patients to high quality treatment centers for certain diseases. Patients intend to follow their GP's advice because of trust and the existence of information asymmetry. This confirms the theory on this matter by Zweifel (2000) as discussed in chapter 2.2.

### Influence of competition

In line with the opposing policy perspectives identified by Kessler and McClellan (2000), the respondents cannot find consensus about the current influence of competition on the purchasing decision for a PET-CT scanner. Two respondents rank it as 1 and two interviewees rank it as 5, the rest in between. Especially noticeable is that respondents seem to be sure about the correctness of their answers, some even tended to get somewhat emotional about the topic. The difference between university and peripheral hospitals is put forward as one reason for the divergent answers on current competitiveness. University hospitals have a unique competitive position due to the research they conduct and because complex patients are referred to the academic hospitals; therefore they have no difficulty to attract patients. Another reason mentioned for the diverging answers is the difference between regions in the Netherlands; one region could be more competitive than another (for example rural vs. urban).

Remarkable is that all micro actors (medical personnel) argue that there should be less competition than the current level. Two meso actors and one macro actor argue for less competition as well, while one meso and two macro actors are great supporters of competition. The third macro actor argues that competition in the hospital market is complex and that together we are responsible for good health care. According to this respondent 'hard' competition between providers is not the way to achieve this.

## *10.2 Collaboration in theory and practice*

### Clinical collaboration

All respondents accept two agree that hospitals should collaborate more in the field of medical technology. One respondent does not have enough insight in the current situation and according to respondent 5 hospitals should not collaborate with each other. It would be collaboration with the direct competition and this is an ordinary cartel. Competition theory shows that cartels are wrong: they distort market power by increasing prices and decreasing market entrance. But even this respondent points out that some degree of collaboration is needed in the health care industry. He, for example, notices the importance of the earlier mentioned *care streets*. The health care market cannot perform properly without this form of vertical collaboration. Two other exceptions on his statement for less cooperation are the collaboration between general practitioners in order to provide high quality care during weekends and evenings and the concentration of high complex procedures such as heart-lung transplantations. But his exceptions go even further; he does actually agree with the other respondents that, in a situation with fewer scanners, specialists could refer their patients to a hospital that possesses a PET-CT scanner. He hereby points out the necessity of clear agreements among the referring hospital and the scan conducting hospital on price and number of referrals and the maximal waiting time. The insurer can supervise these agreements when needed. So even respondent 5 argues that hospitals should make more agreements in the field of medical technology. Other respondents mention these kinds of agreement under the heading "more collaboration".

So all respondents agree that not all hospitals need to have a PET-CT scanner for themselves. Several respondents foresee some practical objections with the sharing of medical technology. The first problem is which hospitals get the scanner? This would be a difficult negotiation. Respondent 5 states that negotiations are unnecessary because it becomes unaffordable for certain hospitals to purchase a scanner when competition among hospitals is high. The negotiations are also highly undesirable according to this respondent because when hospital managers start talking, 'who knows what else they will talk about'. He again reserves a role for the health insurers here. They can decide what hospitals are the best choices to get the technology. Or another option is that competition reveals the best hospitals to get the scanners. Respondent 8 argues that networks of specialists, hospital managers, integrated cancer centers and health insurers should decide to which hospitals in every region the technology should be assigned. The other four respondents from hospitals that identified this "who" problem see this

problem overcome by the hospitals themselves. Interviewee 1 argues that a part of the agreement can be that the hospitals that gets the technology is also responsible for maintenance of the scanner and therefore bears a greater risk than the others. Respondent 1 also points out that a proper image-sharing database must be developed. Some hospitals now still rely on their CD-burner and a courier service that brings the CD with the PET scan data to the hospital that identifies further treatment: a frankly unprofessional practice (1).

## Research collaboration

### *University hospitals*

According to respondents 6 and 10, university hospitals do work together in the field of research whereas they do not collaborate in the clinical field. Universities work in consortia to determine for what indications a technology can be applied and in order to optimize the follow-up treatment. Universities apply for research subsidies together and perform cost-effectiveness studies. The research groups agree beforehand who is first or second author of a scientific publication. Respondent 6 argues that this collaboration should be intensified and expanded internationally. In this way, research outcomes are better comparable and it is possible to faster obtain a large enough patient/research group.

The purchase of medical technology is currently done autonomous. Both 6 and 10 argue that this should be done with more collaboration as well. But respondent 6 argues that the Dutch antitrust authority will not allow this collaboration. Respondent 10 thinks that the NMa would not have a problem with such collaborative projects when it is clear whom benefits from the project and when the results of the projects are shared. Recently the universities of Groningen, Nijmegen, Utrecht and Twente applied for a research subsidy from the NWO (Dutch Scientific Organization) for an extensive PET-MRI research. The goal of this research was to study for what indications and patients the upcoming PET-MRI could be useful in clinical practice in the Netherlands. According to respondent 10 such a study was never performed for the PET-CT and this could partly explain why we currently have an overcapacity in some areas in the Netherlands. Unfortunately the subsidy was not granted and so time will show what happens with the PET-MRI that is now purchased in Amsterdam (VUmc) and Twente (UT). According to respondent 7 other university hospitals such as Groningen, Utrecht and Maastricht are considering a purchase of the newest imaging device as well. For most university hospitals the focus of the PET-MRI will be on research. Only in Utrecht, the primary reason might be clinical use because of the plans to open a children oncology center. The advantages of the PET-MRI are highest for children because no radiation is used for MRI in contrast to CT.

### *Industry*

The industry needs FDA approval in the US and a CE mark in the EER in order to enter the market with a new technological device. In order to get this approval, studies must be conducted and results must be handed in. For these studies the industry works together with clinics in the US as well as in Europe. But these research collaborations should not, and do not, end when the technology is approved. The industry develops the technology with a certain vision and this vision must be proved in clinical practice (6,7). The industry works mostly with university hospitals and only works together with peripheral hospitals for small publications. The industry helps the early adopters of the new technology with the planning, organization and financing of research studies. The cost effectiveness studies are thus conducted in cooperation with industry and multiple university hospitals. This is remarkable when bearing in mind the perspective of respondent 2, who argues that cost-effectiveness studies are not that useful because assumptions and variables can be determined in a way that will provide the desired outcome.

The manufacturers of medical imaging devices can choose to work together with pharmaceutical companies. Siemens, for example, develops its own radioactive tracers but combines the tracers with a medicine developed by Roche.

The manufacturers do not co-operate with the health insurance companies (7,8). But the industry does have its own contacts with all insurers. According to respondent 7, who works for

the industry, this collaboration can be expanded in the future. In this way insurers can have advantage of the know-how in the industry. He sees an opportunity for the insurers to create working groups with the industry, insurers and the medical staff. Interestingly the respondent who works for a health insurance company also stresses the importance of networks.

### *Antitrust*

The Dutch Health authority agency is not seen as the main obstacle for collaboration between hospitals. As seen in chapter 7.2 most respondents rated the NMa with only 1 for influence on medical technology. Respondent 2 agrees with respondent 10 (see above) that the NMa does not have a problem with collaboration as long as that is transparent. He adds that there should be enough regional choice for the patient and insurer. According to respondent 3 there is quite some room for collaboration on the purchase side and for sharing technology between hospitals. Hospitals should however not make agreements about the tariffs for insurers unless absolutely necessary in order to better serve the patient. Respondent 3 cannot recall such a situation has occurred.

The goal of the introduction of the *health care specific merger assessment* is to overcome the problem of complex measurement (Baker and Scott, 2004) and the uncertain influence of mergers on price, quality and innovation (Gaynor and Vogt, 1999; Porter and Olmsted Teisberg, 2004).

## 11. International comparison

The Dutch health system shows similarities and differences with all 5 countries identified in chapter 4. It seems that the Dutch system is in line with the US system in the sense that health care providers can decide whether to purchase a medical imaging device and because the practical implication of the theoretically required *clinical effectiveness* in the Netherlands seems comparable to the *reasonable and necessary* need in the US. In the US it is actively debated what *reasonable and necessary* means (Chambers *et al.,* 2010) and the definition of *clinical effectiveness* or the *best-practice* situation in the Netherlands is also uncertain. The two systems however differentiate where US insurers have a far more important role in the guideline development and maintenance. A system that is explicitly called undesirable by respondents 5 and 8. As discussed earlier, other respondents also have objections to reserve this role for insurers. But in the Netherlands insurers can make volume agreements with hospitals and this may lead to indication-based guidelines in the future. But multiple respondents point out that the insurer should not, and isn't able to, make these guidelines decisions on its own. Networks of involved actors such as insurer, specialist, scientific organizations, hospital managers and possibly the government should make volume-guidelines. It is unsure what actors are involved with guideline development in the US. Noticeable is that, despite the stricter indication related guidelines, the number of scanners in the US is far higher per million people than in the Netherlands. The results of this study suggest that scanners might be used more efficiently in the Netherlands than in the US, where at least 714 scans per scanner must be made per year. The Netherlands has negative experience with such volume criteria because health care providers increased volumes in order to the meet the criteria (6). Respondents of this study do identify that the capacity is not optimal in the Netherlands either: not all scanners are used at full capacity (1,2,4,7,8,9,10). Respondent 4 points out that in Belgium the scanning times per day are much longer than in the Netherlands. It might be more efficient to expand standard scanning times to evenings and weekends so that fewer devices are needed to meet medical demand. Respondent 7 argues that this is not possible for every hospital due to the need of FDG doses, transport and the substrates' half-life.

In the UK and Germany strict guidelines based on indications are maintained for clinical use of PET-CT. This is assumed to be undesirable in the Netherlands because it can restrict medical development. For the same reason, the Canadian system of case-to-case reimbursement

decisions is supposed undesirable as well. In the UK, the number of scanners increased rapidly but the scanners are not used for all routine diagnostics. Respondent 7 and 9 argue that the PET-CT might be more effective when applied at the beginning of every oncological diagnostic cycle, so that other -relatively less expensive- scans become unnecessary and total costs might decrease (7). In Belgium only certified centers can purchase a PET-CT but capacity is still not controlled optimally. This situation looks similar to the WBMV (so certification inclined) procedure of radiotherapy in the Netherlands; for this procedure, it is also unsure what the optimal capacity is and if this is currently available (7). Another difference between the Dutch and the Belgium system is that the reimbursement of an individual scan is divided into four components in Belgium while the reimbursement of a scan is combined with other care activities in the Netherlands. A similarity is that providers have to register all conducted PET-scans with their indication and the patient's stage of treatment. It would be useful to compare the registration systems so that more information can be obtained on quality and (cost)effectiveness of the PET-CT (6).

The different capacity of scanners per region in the Netherlands is also found in Canada although this can be contributed to different reimbursement systems that do not exist in the Netherlands. Studies on capacity in Canada did not take into account scanners available for research or private clinics (Martinuk, 2011) because those scans are not reimbursed. In studies on the Dutch situation, these scanners are included and especially the research-related scanners form a relatively high percentage of the total number of scanners.

In Canada, the UK and Belgium diagnostics and treatment is frequently separated (4); a patient has to go to several hospitals or clinics for different stages of the treatment cycle. However, the development of care streets in the Netherlands shows a development in the opposite direction. From an international perspective, it seems that the Netherlands is not willing to change its trade off between affordable, qualitative and accessible care whereas other countries seem to have more explicit trade-offs. Dutch patients value convenience, familiar environments but also short travel times. It might be the case that Dutch patients must sacrifice some of their preferences in order to sustain the system. This may be done by following the trend of separating diagnostic and treatment activities. But perhaps more likely is that the Netherlands continues on the path to care streets. The evolution of the Dutch system is still ongoing and the capacity of care streets must be somehow controlled so that there doesn't occur an overcapacity that might have occurred with the *mamma care units* (6).

# 12. Discussion and conclusion

This chapter discusses the impact of this study and compares the results to the theory. Furthermore, potential limitations of the study are discussed. It gives future and policy implications and recommendations for further scientific research.

## *12.1 Discussion*

### *Capacity*

The distribution of PET-CT scanners in the Netherlands is not optimal. In certain regions and for certain indications overcapacity or overconsumption exists whereas for others shortages occur. Solely based on arithmetical factors, overall a surplus capacity exists. At first glance, this confirms the conclusions of ZonMW (2007) and IGZ (2008). But the indications wherefore PET-CT is used are still expanding so it is uncertain whether there is a structural overcapacity. And in order to achieve the goal of accessible health care in the Netherlands, scanners are also available in the peripheral areas of the country where medical demand is low and scanners are not used on full capacity. Complicating, the optimal capacity cannot be defined on the basis of cost-effectiveness because studies are not available for most PET-CT indications (also mentioned by

Jerusalem *et al.,* 2003 and Schoder, 2003). Cost-effectiveness studies are generally seen as necessary, but are also critiqued because the outcomes are highly dependent on chosen variables, assumptions and study design. Respondents do identify the need for change in the diffusion processes of medical technology in order to increase overall efficiency and are reserved on whether smaller peripheral hospitals need their own PET-CT device. However, they do not confirm the statement of Schoder (2003) that only tertiary hospitals need the newest PET-CT devices.

### *Impact of the study*

This study creates more understanding about the motives and incentives of different actors that influence the diffusion process of the PET-CT scanner. The insight in these incentives identifies the difficulties that managed competition in the Netherlands encounters. The theory of managed competition is based on the financial incentives of actors (Enthoven, van de Ven, 2008). This study however identifies that the most important decision making actors are driven by ethical and technological and personal incentives. This study also shows the non-transparency of the current system. Respondents give contradicting descriptions and explanations of processes, such as the influence of the insurer on the purchase decision of a PET-CT device. Even within organizations, contradicting views on the optimal system exist. This suggests that the system is still in transition. There is reason to believe that, due to increasing competition, either the incentives for the most important decision makers will become more financially based as well as that the insurer (with a primarily financial incentive) could become a more influential decision maker.

The currently limited influence of financial incentives of decision makers may explain the difference between the effects on the diffusion of PET-CT scanners of price and quality competition. A distinction between the two is made in the revised conceptual model (figure 7). The Dutch antitrust authority (NMa) and other governmental actors (NZa, DBC onderhoud) are effectively removed from the model, because this study shows that they have little or no influence on the incentives of actors and the diffusion process. The ministry of health (VWS) is not included in the model because the PET-CT scanner is not subject to the WBMV (Special Medical Procedures Act). Scientific organizations are added to the model because they have a leading role in the knowledge diffusion of technology in the country and thereby influence the diffusion of medical technology.

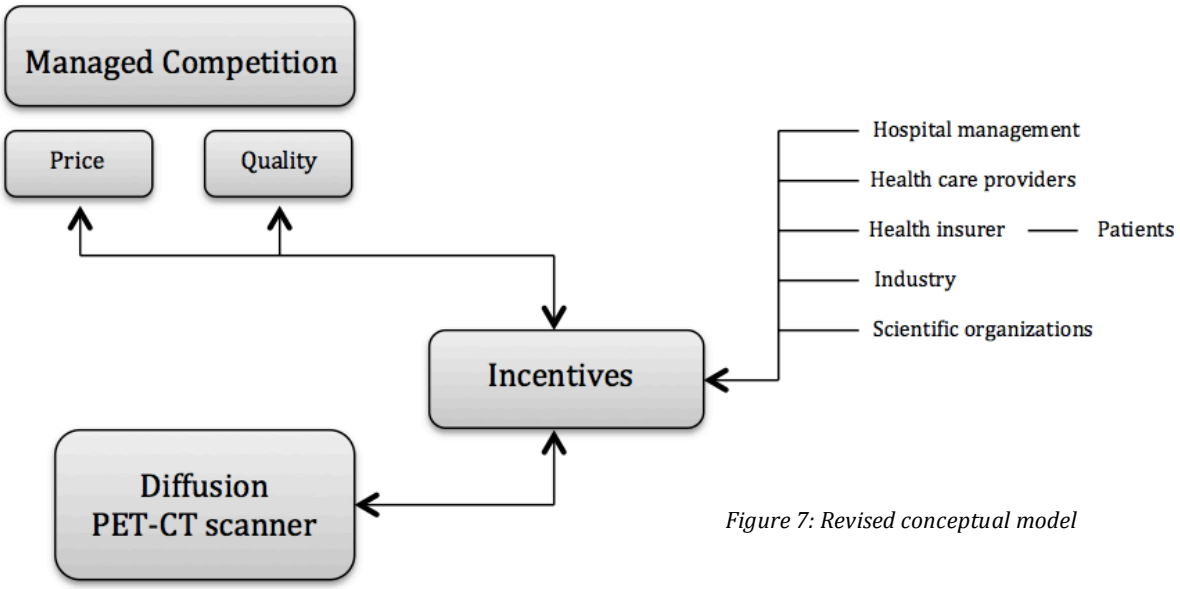


*Figure 7: Revised conceptual model*

The results of this study can contribute to the understanding of diffusion processes of other medical technology. Often, similar groups of actors are involved in the decision making process of other technologies and therefore comparable incentives are likely to exist. The study can

especially attribute to the understanding of the diffusion of diagnostic imaging devices because of the technological and application similarities of the PET-CT and other diagnostic imaging technologies. The results cannot attribute to the theoretical and practical knowledge on the diffusion of medical technology that is subject to the WBMV act because other actors, such as VWS then become the most important decision maker and other incentives are likely to play an important role.

### *Implications for the future*

This study shows that the incentives of the decision-making actors or the extent of influence of the decision-making actors should change in order to avoid a non-optimal diffusion process of medical technology in the future. The start of the diffusion process of the PET-MRI scanner underlines this. University hospitals can collaborate more efficiently on research so that the effectiveness and clinical need of a new device can be better established before the diffusion starts in the rest of the country. Collaboration in the form of networks of multiple actors (insurer, specialist, hospital management, scientific organization, industry, integral cancer centers, local government) might be needed to regulate and optimize regional capacity. Some respondents however reserve this task for hospitals or insurers respectively.

In the Netherlands managed competition is introduced to increase incentives for innovation and efficiency (van de Ven and Schut 2008; Enthoven and van de Ven, 2007). The goal is to use market forces to reduce prices and excess capacity and to increase quality and satisfaction (Kessler and McClellan, 2000; Folland *et al.,* 2010). But in the health care sector, competition seems to have no substantial impact on prices and a positive effect on excess capacity and therefore increases total health care costs. The goals to increase satisfaction and quality seem to be achieved. This study shows that not just the PET-CT but medical technology in general is used to create the positive image of technological leader and this confirms the theory of Teplensky *et al.* (1995) and Pauly (2005). This suggests that a medical arms race indeed takes place (Robinson and Luft, 1988). But it is uncertain whether imaging building via medical technology is socially wasteful because the technology does create higher value for patients. Kessler and McClellan (2000) discussed this measurement difficulty. Hospitals in the Netherlands do attract physicians with medical technology; a process identified by Devers *et al.* (2003), Berenson (2006) and others. This study also identifies a difference between university and peripheral hospitals. The purchase decision of university hospitals is often influenced by research applications of the device, as identified by Ecorys (2011).

This study suggests that in the Netherlands trade-offs are most likely made to stay in the middle of the triangle: affordability, accessibility and high quality. Other countries seem to make different trade-offs wherein affordability is increasingly important in order to create a sustainable system. The Dutch government incentivizes health insurers to re-consider and possibly change the trade-off (van de Ven and Schut, 2008; Enthoven and van de Ven, 2007) and in this way, in the future affordability may become more important in the Netherlands as well. However Dutch citizens do not seem to be ready (yet) to accept compromises on accessibility, let alone quality of health care. For the diffusion of medical technology the influence of health insurers is still very limited. This study suggests that insurers increasingly influence outcomes of health care through budgets, volumes and quality agreements with hospitals. But their influence on input is small or non-existing. This confirms the conclusion of Ecorys (2011) that this role can be further expanded and improved.

### *Limitations of this study*

This study has as few limitations. First, a limited number of respondents is interviewed. In order to confirm the conclusions of this study, further more research might be necessary. The interviewees speak their own opinions and these might differ from other opinions within or outside the organizations they work for. Further, it is hard to determine how competitive the hospital environment actually is in the Netherlands and whether this differs substantially from

the perception of the respondents. This limitation is also applicable for the actual influence of competition on the purchase decision of hospitals about medical technology. And last, the Dutch system is currently in transition, competition is stimulated but the outcomes and consequences of this transition are not yet clear.

## *12.2 Conclusions*

This study identifies hospital management and medical specialists (both referral as nuclear) as the most important decision-making actors to purchase a new imaging device. No consensus is reached on the current influence of health insurers. Respondents ranked them from no influence to high influence. The diversity of answers and the strong confidence of respondents about the correctness of their answers, suggests that it is (partly) a case of perception how the current role of the health insurer is seen. The industry is considered to have a mild influence on the purchase decision-making process and governmental institutions (NZA, DBC-Onderhoud, NMa and VWS) are considered to have no or very little influence on the purchase decision of PET-CT scanners. Scientific organizations have an important influence on the application of individual PET-CT scans due to their role in medical guideline development.

### *Incentives*

The primary incentives of hospital managers and medical professionals are the provision of required medical care. So the main motive to purchase a medical device is of an ethical nature. However, secondary incentives are also identified. For physicians, technological and personal incentives seem to have more influence on the purchase decision of a PET-CT scanner or the application of an individual scan than social and economic incentives. The status that is associated with, the perception of, and the interest in, technology all influence the decisions of physicians. The physician wants to keep his medical knowledge up to date. Strict medical guidelines can partly control the influence of personal incentives. But in practice, a clear difference exists in the utilization of the PET-CT across physicians and hospitals. For hospital management, the incentive to create a reputation of a good, high quality, modern hospital is very important when it comes to decisions about the purchase of a new medical device. The fact that specialists are, next to the incentive to provide good quality care, driven by technological and personal incentives, further increases the incentives for hospital managers to use medical technology to attract physicians. The purchase decision of university hospitals is often influenced by research applications of the device.

Hospital management is supposed to base their purchase decision on proper business cases; the decision to purchase a PET-CT scanner should only made when it is cost-effective for the hospital. It is however doubted if this always happens in practice. When it is not cost-effective for a hospital to purchase a device, a hospital should make proper agreements with other hospitals so that patients are never denied a scan for such practical/economic reasons. The communication between scan-requesting and scan-conducting hospitals should be optimized in the Netherlands. Scans must be available for the referring hospital and consultation between referral and nuclear specialist of two different hospitals should be improved.

Contrary to the hospital managers and physicians, the primary incentive for insurance companies is financial. The insurer has an incentive to decrease care volumes and to increase efficiency. The Dutch government further increases this incentive and stimulates competition further by diminishing the national risk equalization fund and increasing the insurers' freedom to be an efficient purchaser of care. The Dutch Health Authority supervises the insurers to guarantee accessible, affordable and high quality health care. Because of this supervision but also because of their dependence on their policyholders, insurers also have the incentive to provide the needed care. The primary incentive of the industry is to increase revenues and to satisfy shareholders. The industry does create high value for patients and most respondents don't find it necessary to change the role of the industry accept that the medical know-how of the industry could be used more efficiently. The incentives of the government are confirmed to

be the creation and guarantee of a transparent, efficient, equitable, accessible, high qualitative and affordable system.

### *Competition*

Price competition among hospitals on medical technology is not identified as a very common practice in the Netherlands. However, the influence of insurers on budget agreements with hospitals is higher since competition across insurers is increasing. This shows that the system is in transition and price competition might increase in the nearby future. Competition also needs to find its way towards the hospital <> industry negotiations. Insurers are not (yet) involved in these negotiations. The negotiations between hospital and insurer as well as between hospital and industry are not transparent and take place in a 'give and take' fashion, without parties using pre-set financial benchmarks/norms (in Dutch: *handjeklap*). Competition on quality happens far more frequent in the Netherlands. As mentioned above, hospitals use medical technology to create a positive, modern image. Patients as well as physicians are attracted with high-end technology. Hospitals also compete on quality by focusing on certain specialisms and *streets of care*.
Remarkable is that especially medical personnel argues that there should be less competition than the current level. Two macro actors are the strongest supporters of increasing competition.

*Did hospital competition influence the diffusion of PET-CT scanners in the Netherlands, and how can this existing or non-existing influence be explained?*

Quality competition did probably influence the diffusion of PET-CT scanners in the Netherlands by using it to create a positive image of the hospital and hereby attract patients and physicians. This quality and marketing competition positively affects the number of scanners in the Netherlands. Physicians are inclined to request more PET-CT scans when the capacity is higher, which again can increase the number of scans –and scanners.

The influence of price competition is less clear. The level of doubt, expressed by multiple respondents, about whether purchase decisions are always based on proper business cases, make it likely that hospitals don't always make economically optimal decisions. The insurer has a perceived middle high influence (ranked between 2 and 4) on the purchase decision of hospitals but respondents foresee a greater influence in the future. This might stimulate price competition. Insurers do increasingly influence the prices of individual care products, especially through annual budget agreements with hospitals. It is however uncertain how an insurer (maybe within networks of actors) can define optimal capacity and/or the optimal price of an individual scan. The information that is available to DBC Onderhoud from the registrations of care activities and care products could be used in the future to draw more conclusions on the necessity of care. With this information, better volume- or pricing agreements could be made. In theory, price competition increases the number of scanners negatively but it is not sure whether this effect will show in practice.

### *Policy implications*

The lack of consensus on the current influence of competition on the purchase decision of medical technology, as well as the contradicting opinions about the effects of competition, makes that this study also results in two opposing policy perspectives, as Kessler and McClellan (2000) identified. Respondents however seem to agree that something must change in the diffusion process of technology. As described above, networks might be the solution to control (regional) capacity. In order to function properly, a policy should be introduced that facilitates networks of multiple actors (including hospitals) to discuss regional capacity without being hindered by undue anti-trust regulations. On the other hand, some respondents argue that competition leads to optimal capacity and therefore it is unnecessary and undesirable that actors discuss the capacity issue with each other.

### *Further research*

For future research, in particular the diffusion process of the PET-MRI in the Netherlands should be followed closely. A comparison between the diffusion process of the PET-CT and the PET-MRI in the Netherlands can be of great value because competition among hospitals increased since the beginning of the PET-CT diffusion while other variables such as government interaction did not change. So this can increase the understanding of the influence of hospital competition on diffusion of diagnostic imaging devices.

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# Appendix

## *1. Technology background*

### PET Technology

#### *Physical principles PET*

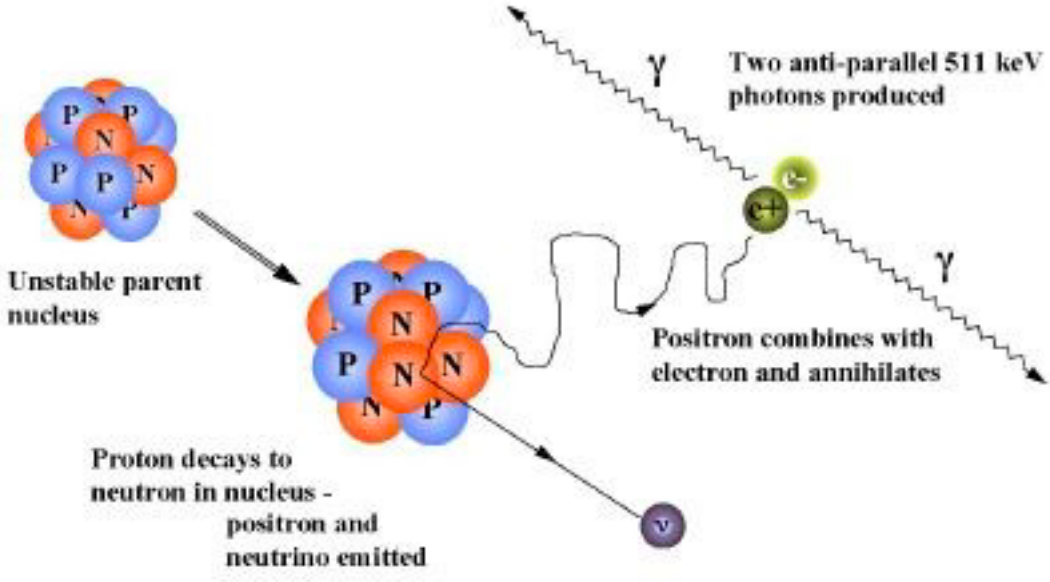


*Figure a1: Radioactive decay* (Depts Washington, 2012)

The process of radioactive decay involves the emission of a positive electron or positron ($e^+$) and an electron neutrino ($\nu^e$) (Townsend, 2004). The neutrino is hard to detect and is not used for localization (RIVM). The $e^+$ travels through surrounding tissue until it combines with an electron ($e^-$) to form a positronium (Ziegler, 2005). This positronium decays by annihilation whereby two ϒ-rays are emitted in opposite directions with energy of 511keV each. These opposing ϒ-rays are detected in coincidence by collinearly aligned detectors. This electronic collimation is the reason why PET is much more sensitive than the Single Photon Emission Tomography (SPECT) technology (Ziegler, 2005). The detected pairs of coincident photons are stored in sinograms. An image reconstruction algorithm is used to recover the underlying radioactivity distribution based on these sinograms. For the radiotracer FDG, the result is an image of FDG accumulation throughout the body (Townsend, 2004).

#### *Limitations of the PET scanner*

*Spatial resolution*

The spatial resolution of the PET-scanner for localization of the radioactive substrate is limited due to four practical issues. First, the exact location of the annihilation process is unknown because the time travelled through tissue by the positron prior to annihilation is dependent on the energy load of the positron and is therefore uncertain. Second, the angle of the two opposing ϒ-rays emitted is not 180° exact because the positron-electron combination has an impulse other than 0 prior to the annihilation process. Third, the detectors are not perfectly accurate and therefore there is always some margin to take into account in the line between two detectors. And last, the number of registered coincidences increases the accuracy for localization. And this number depends on the sensitivity of detectors and on the dose of radiotracer that is administered to the patient.

*Random events*

One limitation is that of random events. Photons from 2 unrelated annihilations are than erroneously assigned to a single positron emission because the detectors use an interval of time wherein the coincidence photons should arrive (RIVM, 2011). The latter limitation is shown in figure a2.

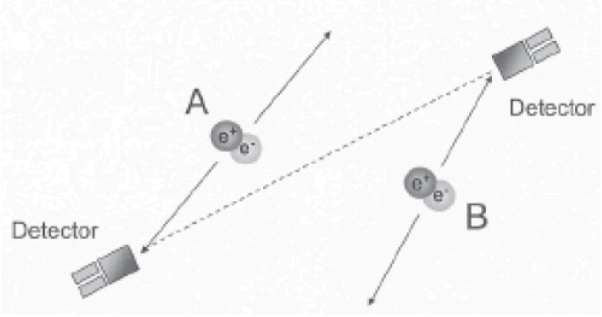


*Figure a2: Two unrelated annihilation are erroneously assigned to a single positron emission*

*Attenuation and correction*

Another image degrading issue is attenuation: photons can scatter or be absorbed due to interaction with tissue prior to detection (Prince and Links, 2006). Due to Compton scattering, a photon can deviate from the correct Line-of-Response (LOR) and therefore is detected by an incorrect detector (see figure a3) (Townsend, 2004). To minimize scatter, septa are placed between the detectors to absorb scattered photons. The septa can reduce the amount of scatter by 10-15% and improve the image contrast (Schroder, 2003). But some scattered events will always be registered.

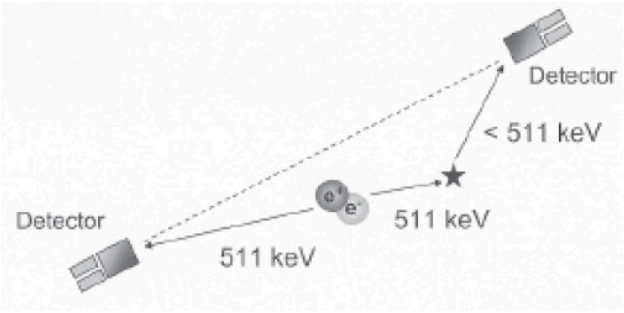


*Figure a3: A photon deviates from the Correct Line-of-Response*

Another issue of attenuation is photoelectric absorption (Townsend, 2004, Prince and Links, 2006). PET-scanners can only detect high-energy photons and because the photon energy decreases with the distance traveled through tissue, some photons that are originating from the inner of the human body, are not detected (RIVM, 2011). In order to get a correct image of the radiotracer concentration within the body, correction takes place for the emission of photons from different body parts. Attenuation correction is also needed to correct for Compton scattering.

For conventional PET imaging, an attenuation map is acquired for attenuation correction by a high-energy transmission scanner (with an external 511-keV germanium rod source) (Schroder, 2003). An iterative algorithm is then used to produce the attenuation corrected image. The high-energy transmission map is however noisy, has poor spatial resolution and has no detailed anatomic information (Seemann *et al.,* 2004).

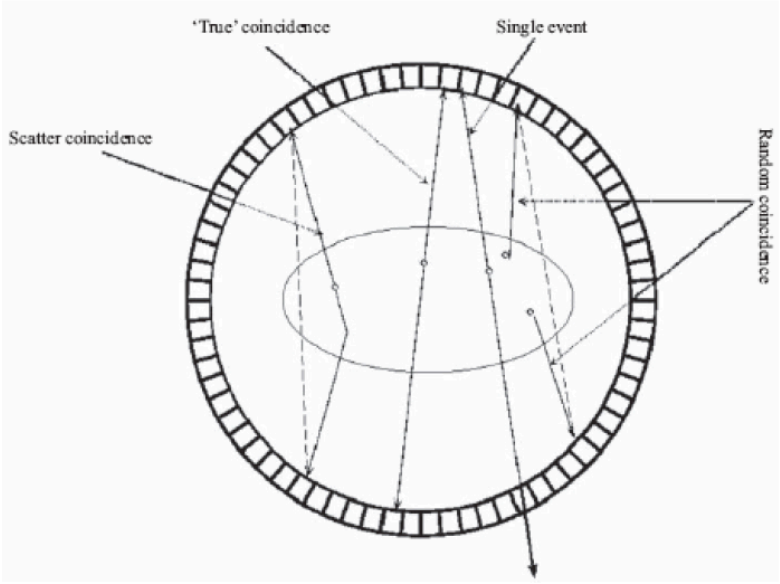


*Figure a4: overview of the various forms of detection that take place in a PET scanner (IAEA, 2009 in RIVM, 2011)*

## Technology CT

The Computed Tomography (CT) scanner has, like a PET scanner multiple detectors that rotate around the human body (RIVM, 2011). An x-ray tube is linked to an x-ray detector array located on the other side of the patient (see figure a6). In the newest CT scans 64 detectors are used (a 64-slice scan). The linear scanning motion of the tube and detectors across the subject is called translation. During the translation motion, the detectors of a CT scanner measure the transmission of x-rays through the body in many locations (Goldman, 2007).

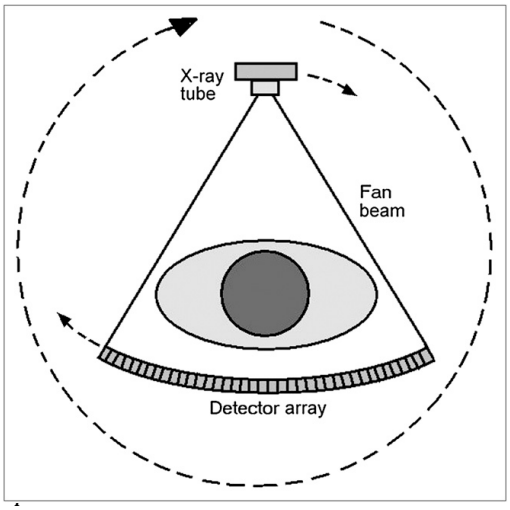


*Figure a5: CT scanner*

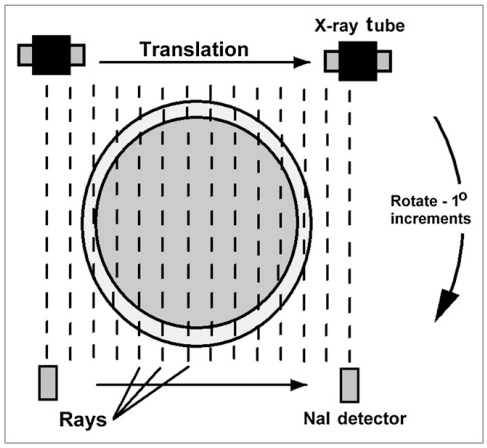


*Figure a6: Translation process*

The x-ray beam path through the human body that corresponds with each measurement is called a ray (see figure a7). In current CT scanners, the set of measurements that is made during the translation are over 750 rays per view (Goldman, 2007). After completion of the translation, the aligned tube-detector is rotated and a new translation motion is started. Modern CT scanners collect at least 1000 views over 360° (Goldman, 2007). The data of all these views are used to construct a 3D image in a similar way as with the PET scanner (Prince and Links, 2006).

Because of the use of x-rays, the detectors of a CT scanner are sensitive to a much lower energy (around 140keV) than the PET scanner detectors (Schoder, 2003). The amount of registered photons is however much higher for a CT scanning device than for PET technology. As a result, the CT scanner is faster and has a higher spatial resolution. In contrast to the PET scanner, the CT scanner uses the photoelectric absorption to show contrast between tissues. It therefore gives clear images of bones and longs and with the current refined CT technology it is possible to

distinguish all types of tissues. This results in a detailed image of the human anatomy (Prince and Links, 2006).

### Combined PET-CT technology

The technical advantages of the combined PET-CT technology are co-registration of functional and anatomic information and the use of a CT scanner for the attenuation correction. Figure a8 shows the general PET-CT scan protocol.

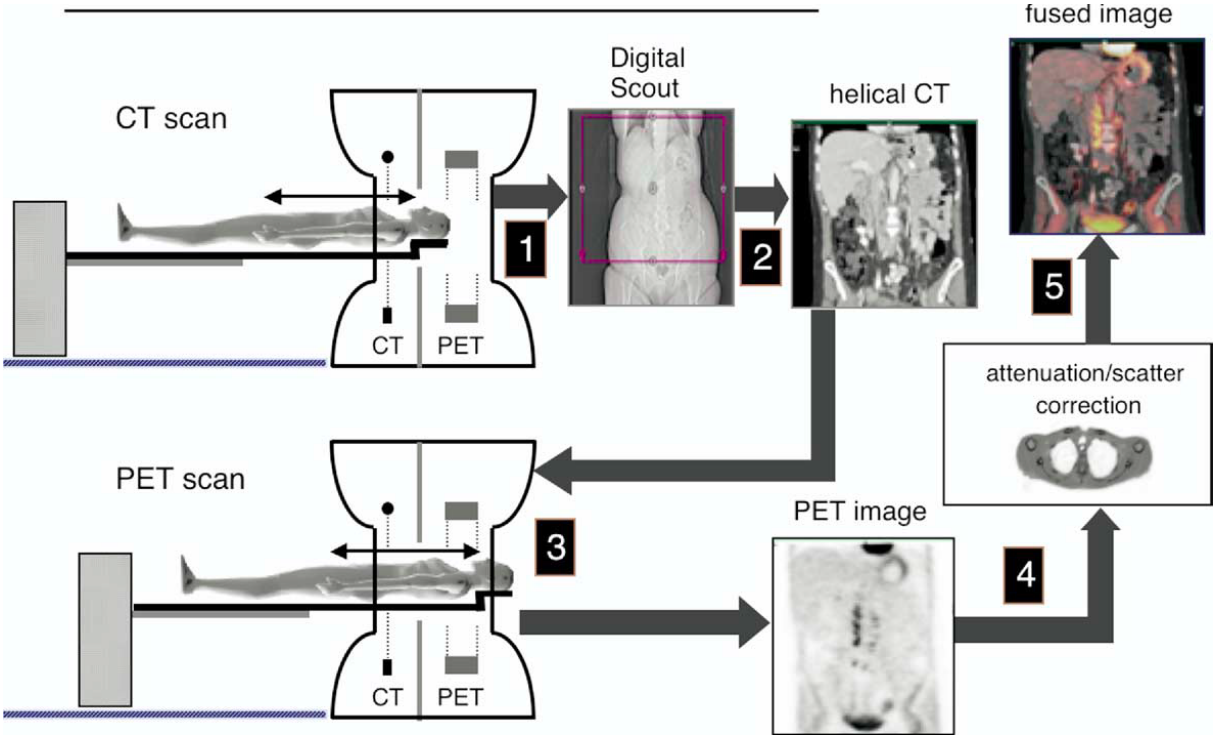


*Figure a7: "Standard PET-CT Protocol. A digital scout radiograph is first acquired, in which the full patient is visualized and the area of interest is selected (1). Patients then undergo the CT portion of the examination (2), followed by the PET portion of the examination (3), Once attenuation correction and scatter correction are performed using the attenuation coefficients from the corresponding CT portion of the scan (4), fused, accurately co-registered images are available for interpretation (5)". (Figure courtesy of David W. Townsend, University of Tennessee, Knoxville, TN in Blodgett et al 2006.)*

### Attenuation Correction

The description of the PET technology already mentioned the necessity of attenuation correction. A major technical advantage of the combined PET-CT is that the CT can be used for attenuation correction. It is much more accurate and reduces scan times by at least 40% (Townsend, 2004). Problems arise however from the fact that the CT scanner is much faster conducted than a PET scanner (few seconds vs. few minutes (Seemann et al., 2004) and this results in a motion artifact. Uncontrolled, organ motion and respiratory movement can result in mislocation (Schoder, 2003; Mawlawi and Townsend, 2009). The effects of involuntary motion must therefore be minimized (Ziegler, 2005). In order to do so, positioning of the human body is important (PET) and the patient must maintain a shallow breathing during the scan (Mawlawi and Townsend, 2009;). The motion artifact is of greater influence in the neck and head area because the patient must be positioned with the arms alongside the body, which creates a greater freedom of movement (Schoder, 2003).

Because CT images are acquired with photon energy of 140keV and PET images with photons of 511keV, algorithms have been designed to correct for the difference in attenuation of the different photon energies in different tissues (Schoder, 2003). In this way an accurate attenuation correction is provided for the PET emission images.

## *2. List of respondents*

| Organization | Function | Name |
|---|---|---|
| Achmea Zorg | Policy advisor, health care purchase medical specialists care. | P. Dohmen |
| AMC | Chairmen board of directors | Prof. Dr. M.M. Levi |
| DBC Onderhoud | Senior advisor DBC onderhoud & Advisor DBC systematiek | I. van Dijke & L. van der Meij |
| Franciscus ziekenhuis | Senior nurse, team manager | E. van Meer-Roelen |
| LUMC | Head of department clinical oncology | Prof. Dr. Ir. J.J.M. van der Hoeven |
| NMa | Program manager pharmacy and medical professionals at care cluster, direction competition | P. Beusmans |
| NZa | Economic Expert Economic medical bureau | R. Halbersma |
| Siemens Nederland NV | Business Unit Manager Molecular Imaging & Radiation Oncology | M. Hagenbeek |
| St. Antonius Ziekenhuis | Nuclear medicine specialist | Dr. R. Keijsers |
| UMCG | Nuclear medicine specialist | Dr. A.W.J.M. Glaudemans |