The Dutch health system reform: CREATING VALUE

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Introduction

In the introduction of this thesis we first describe the recent history of Dutch health care reforms and stipulate the goals of the 2006 reform. We then place the Dutch reform within an international context. Based on the goals of the 2006 reforms and the current insights of the international literature we come to the research questions of this thesis.

Health care policy in the 1980s: cost containment

During the 1980s the government came up with a manifold of regulations and laws to constrain supply in order to drive down health care costs. In 1982 the law “Wet Tarieven Gezondheidszorg” was established, which introduced top down limited budgets for hospitals. If the annual budget was exceeded, the fees of hospitals and medical specialists were reduced proportionally for the following year.[1] The government managed to keep health care costs in the period 1980-1990 roughly stable around 7.5-8.0% of Gross Domestic Product (GDP), where in the period 1970-1980 costs rose sharply from 5.9% of GDP to 7.5% of GDP (see Figure 1).[2]

Although cost growth was fairly modest under the Wet Tarieven Gezondheidszorg, the law had two major weaknesses. First, the top down budget system without competition between providers hampered efficient allocation of resources and economic incentives to improve quality of care were lacking. Second, the representatives of the health insurers (sickness funds and private insurers) had no real incentives to negotiate the lowest possible price with health care providers. Sickness funds were namely fully reimbursed retrospectively for their members’ health care costs by the government. Last, the yearly budgeting process encouraged a short term horizon and resulted in many conflicts between government, health insurers and health care providers.[3]

Figure 1  The share of health costs in relation to GDP in the Netherlands
The move away from a supply driven health care system: the 1990s and 2000s

The budgets that constrained supply caused waiting lists for hospitals. In the late 1990s it happened often that medical specialists stopped working somewhere during fall, because they ran out of budget for that specific year and refused to work for free.[4] Under the pressure of public opinion policy makers felt the need to move towards a demand driven system. The Ministry of Health released the agenda for change in their report “Demand in Charge - Vraag Aan Bod”.[5] Based on the concept of managed competition described by Enthoven, a system of regulated competition was proposed.[6] Goals of this reform were to increase productivity of health care providers by enabling competition between them, and increase accessibility of care. To improve quality of care the government stimulated transparency about quality of care what also enhanced freedom of choice for patients.[5]

The introduction of managed competition in the Netherlands

In 2006 the law “Zorgverzekeringswet (Zvw) - Health Insurance Act (HIA)” came into effect, reforming both the insurance market as well as the product structure of hospitals and introducing transparency about quality of care. In the next paragraphs we describe these reforms.

Health insurance reform

With the introduction of the Zvw, the distinction between private health plans and public sickness funds was abolished. Health insurance became obligatory, and health plans were obliged to accept every citizen for a standardized package at the same premium. Every health plan became allowed to set its own premium, but plans cannot differentiate between patients within the plan. A risk-equalization fund compensates health plans for differences in risk loads, and premiums became subsidized for low-income households. A mandatory deductible was introduced, that can be voluntary increased to reduce premiums. The standardized package is defined by the government and is rather comprehensive; health plans are free to offer additional packages and can provide both in kind or refundable insurance to subscribers.[7] Within the Zvw health plans are expected to contract selectively based on price and quality on behalf of their subscribers. They became able to differ the amount of deductible per provider per treatment, to stimulate patients to go to preferred suppliers.[5,8]

Product reform and transparency of quality of care

In 2006 a product-based reimbursement system was introduced for hospitals, the so called ‘diagnosis treatment combinations’ (DTCs (DBC’s in Dutch); a form of ‘diagnosis-related groups’ (DRGs)).[9] The notion that standardization of quality reporting at the level of health care products was a prerequisite for regulated competition led to the founding of the institute ‘Transparent Care’ (Zichtbare Zorg). This institute worked together with providers and professionals in all health care sectors to create a nationwide, standard set of quality indicators for each sector for relevant conditions.[10] Also health plans played a role in making quality of care transparent, via a variety of initiatives ranging from measuring patient experiences by Customer Quality Indexes and analyzing their administrative data.[11]

In the next paragraph we place the Dutch effort to reform health care in an international context.

The 2006 reform in international perspective

In the last decades in all Western countries health care costs outpace the growth of Gross Domestic Product (GDP).[12] At the same time studies argue that health outcomes are insufficient and/or do not meet the demand of citizens.[13] Therefore governments across the globe are trying to curb cost curves and to improve quality of health care. In the next section we describe how these reforms take place and what effects they seem to have on costs and quality of care.
Three typical waves of health reform
As described by Cutler health care reform typically follows three waves.14 In the first wave following increasing capabilities of medicine such as the introduction of antibiotics in the 1940s, the desire to achieve access to care for both poor and rich are pursued. Examples which illustrate this pursuit are Medicaid and Medicare in the US and the Sickness funds in Europe (e.g Germany and the Netherlands). After universal coverage is (partly) realized the wave of rationing, controls and expenditure caps is entered. Countries are willing to accept spending above efficient levels to meet distributional goals, but finding it hard to afford, because the growing health care costs outpace the growth of GDP. In order to slow down cost growth, cost-containment policy measures are issued. Enthusiasm for the rationed model then gradually fades because of three reasons Cutler describes: first there is a limited supply of health care services that meets an exceeding demand. Secondly profound inefficiencies occur under cost-containment policies as providers have very limited incentives to work efficiently and third, many of the of the cost-containment measures yield one time savings, but the long term rise in health care costs continues. This brings us at the third wave of health care reform: the wave of incentives and competition in which most Western countries are today. Examples of these strategies are: managed care in the US[15], the introduction of competition between sickness funds in Germany[16] and incentives for professionals to keep costs down, by assigning General Practitioners (GPs) as fund holders which was applied most profoundly in the UK.[17] But also the described reforms during the third wave have severe (potential) drawbacks such as adverse selection when insurers compete, denying patients the necessary care they need once providers become risk-bearing and enduring inefficiency and suboptimal quality of providers being the most prominent ones.[14]

In recent history two prominent systems to overcome these drawbacks have been discussed in the literature: managed competition and the concept of value-based competition. In the next sections we describe the content of these concepts.

Managed competition
An answer to (some of) these drawbacks is the concept of managed competition. Managed competition is characterized by payers who act on behalf of their subscribers by contracting high-quality cost-effective providers, trying to create a demand-driven system. In order to avoid adverse selection, payers are compensated for more health consuming subscribers and community rating regardless of health status is established. Consequently, payers accept all eligible persons who choose them.[6]

Enthoven and Tollen propose competition on the ‘integrated delivery systems’ (IDSs) level.[8] IDSs are ‘built on the core of a large, multi specialty medical group practice, often with links to hospitals, labs, pharmacies, and other facilities and often with a sizable amount of revenue based on per capita prepayment.’ Examples of IDSs include health plans such as Kaiser Permanente, HealthPartners, and medical groups such as the Cleveland Clinic, the Mayo Clinic, and Geisinger Health System. Enthoven and Tollen argue that per capita prepayment is a powerful way to align providers’ and patients’ interests. It encourages providers to avoid errors and to treat patients cost-effectively. In addition IDS’s can find opportunities for cost reduction across the full spectrum of care, in contrast to stand-alone providers which can only realize cost reduction within their own organization.[8]

Evidence suggest that systems of managed competition (such as Health Maintenance Organization (HMOs) in the US), manage to drive down the costs of health care, but produce rather similar outcomes in terms of quality of care, compared to other types of health insurance systems.[15,18] Nonetheless, critics of managed care state that these cost savings of HMOs may be (partly) attributable to purchase advantages rather than operational efficiencies of providers.[15]
Value-based competition
Porter and Teisberg proposed to structure the health care market based on their value-based competition (VBC) theory, that has both similarities and differences with the concept of managed competition.[19] Like the concept of managed competition the VBC theory includes a focus on transparency of costs and outcomes of care. Compared to the concept of managed competition, the VBC theory has a significant difference and that is the role of payers and customers the VBC theory envisions. Where the concept of managed competition advocates health care systems where payers contract integrated delivery systems (IDSs), the VBC theory stipulates that informed customers should choose the best integrated provider units (IPUs) based on outcomes of care. IPUs are practice units that focus on specific areas of medicine (e.g. specific (groups of) diagnosis) where they are able to excel and are able to provide the highest value to patients compared to their competitors. IPUs should be reimbursed via bundled payments around the full cycle of care per condition.[8,19,20]

Porter and Teisberg argue that IPUs face competition from all other IPUs treating the same condition and are therefore motivated to excel, whereas it is unlikely that a vertically integrated systems will contain the highest value providers in every single service area.[21] Implicitly, the VBC theory and the concept of managed competition differ in their judgment of transaction costs in health care. Where the VBC theory assumes that the gain in additional competition outweighs the additional transactional costs, the concept of managed competition assumes that the additional transactions may lead to fragmentation of care.[21,22]

Research questions and outline of this thesis
Within this thesis we try to examine what the first effects are of the 2006 reform in the Netherlands. Given the fact that the literature describes varying results about the introduction of managed competition, the specific Dutch regulatory and institutional context and the Dutch culture that is focused on achieving consensus rather than dissent, it is not clear what managed competition will bring in the Dutch context. The health reform of 2006 tries to improve efficiency, quality and accessibility of care in order to ultimately provide higher value of care to patients, preferably with a lower macro cost growth. Therefore in this thesis we will examine the first effects of the introduction of managed competition in the Netherlands on costs, efficiency, quality, accessibility and ultimately value of care. This thesis is structured in three parts: part I focuses on quality of care, in part II we investigate the health system performance and in part III we analyze strategies to (further) improve value of care. In the figure below we summarize the structure of this thesis.

Figure 2: Structure of this thesis
Part I: quality of care
In the first part of this thesis we look at the quality of care within the Dutch health care system. In chapter 1 we start by evaluating the current reliability of care pathways within (Dutch) hospitals based upon a review of the literature. We then continue in chapter 2 by drafting a quality requirement framework for acute hospital care based upon a cross sectional survey of 27 (out of 104) Dutch emergency departments. In chapter 3 we describe the development of the Customer Quality Index for Dutch hospitals in the period 2006 to 2009 and relate the performance of hospitals to the level of transparency and competition they face.

Part II: health system performance
In the second part we focus on the health system performance. In chapter 4 we describe how costs, productivity and accessibility of hospital care have developed within the period 2006 to 2009 by analyzing all clinical and dayclinical DTCs within this period of time. In chapter 5 we provide the results of a regional study around the city of Eindhoven were GPs worked with report cards. These report cards displayed quality indicators for four diagnosis (breast cancer, hip and knee replacement, cataract surgery) of the four nearby located hospitals. These indicators were used by GPs to guide patients when they were referred.

Part III: value of care
In the third part we focus on how to (further) improve value of care. In chapter 6 we measure the developments in costs and quality of care in the different health care sectors (hospital care, intramural elderly care, mental care, etc.) using the VBC framework of Porter and Teisberg. In chapter 7 we present a new method to make the trade-off between accessibility and quality of care for one specific diagnosis (breast cancer) to optimize value of care from a societal perspective. In chapter 8 we use the methodology of chapter 7 to gauge how the hospital landscape in the Netherlands would look like if one would optimize the value of care.


9. DTCs also include outpatient care and the fee for specialists, but are largely similar to DRGs


How reliable is your hospital?
A qualitative framework for analyzing reliability levels

Objective
Many approaches and methods have been developed to reduce errors in the health care delivery process and to increase patient safety. One of the approaches suited to improve patient safety is reliability theory. This paper adds a qualitative dimension to the application of reliability theory in hospitals. Based on a review of the literature, we identified a framework of qualitative elements that can be used to diagnose, understand and thereby improve upon the level of reliability in (department of) a hospital.

Results
Based on the literature search, we identified four interconnected elements that are crucial for hospital reliability. These four elements are: process optimization and standardization; outcome measurement and monitoring; responsibilities and accountability of medical professionals; and organizational culture.

Discussion
Substantial effort has been made in the last decade to improve patient safety. The actual improvement in safety has been fairly modest, which is understandable because most hospitals currently have fairly unreliable processes in place.

Using the framework presented here, hospitals can gauge the reliability of their processes and practices. Recognizable characteristics provide insights into where improvement is needed and possible. In addition, this framework provides a way to view the relationship between different patient safety building blocks and a means to link them conceptually. An integrated approach is needed for hospitals to achieve a higher reliability level with particular attention to the interconnected elements that affect patient safety.
Introduction

Ever since the report ‘To err is human’ was published in 1999, patient safety has been high on the agenda of health care professionals, managers, and policy makers. Many approaches and methods have been developed to reduce errors in the health care delivery process, thereby decreasing adverse events and increasing patient safety.[1]

One of the approaches suited to improve patient safety is reliability theory. This theory has been successfully applied in high-reliability sectors such as the nuclear power and air traffic control sectors. Like the health care sector, these are sectors where work is done at the interface between the social (human behavioural) and technical components of complex systems.[2-4]

A high reliability organization is an organization that is extremely well focused on preventing failure, on expecting the unexpected, and ensuring that the errors that unavoidably will occur will not result in catastrophic events.[5-7] As we will see, high reliability organizations stem from, amongst others, high reliability processes.

The reliability of a process is operationalized by determining the number of defects that occur for every 10 opportunities. The unit of measurement for reliability is therefore $10^{-x}$ (see Table 1).[1]

Table 1 Process reliability levels[5]

<table>
<thead>
<tr>
<th>Definition</th>
<th>Defect rate</th>
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<tbody>
<tr>
<td>Chaotic or undefined reliability-focused processes</td>
<td>More than two defects out of 10 (less than 80% success)</td>
</tr>
<tr>
<td>$10^1$</td>
<td>One or two failures out of 10 (80% to 90% success)</td>
</tr>
<tr>
<td>$10^2$</td>
<td>Five failures or less out of 100 opportunities (95% success)</td>
</tr>
<tr>
<td>$10^3$</td>
<td>Five failures or less out of 1,000 opportunities (99.5% success)</td>
</tr>
</tbody>
</table>

In comparing sectors, reliability studies have invariably described health care delivery processes as ‘chaotic’ (i.e. less than $10^{-1}$ reliability).[5,8,9]

This paper adds a qualitative, evolutionary dimension to the concept of organizational reliability in a health care organization. Based on a review of the literature, we identified a framework of qualitative elements that can be used to indicate and improve the level of reliability in a hospital. Managers and professionals can determine the reliability level of their hospital or department and determine if their hospital should be on the left or right side of the boxes shown in Figure 1.

Methods

For an overview of methods, practices, and concepts that could be used to improve the reliability of hospitals, we conducted a literature review. The syntax entered into PubMed was: ‘patient safety

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1 The definition of the ‘process’ obviously influences the reliability level that will be found. For example, the process from intake to discharge (including medication, diagnostics, surgery, etc.) of a patient may be taken as one process. But one could also consider the process of administering medication as a separate process. For comparing practices it is crucial to use the same definitions between these practices.

2 In this paper we do not focus on what would be the best unit of measuring reliability, but rather on concepts, practices and methods which determine and/or influence reliability. Nonetheless it is important to say that precise measurement of reliability is crucial for actually improving reliability over the course of time.
Figure 1  Average risk in various industries and activities of fatal outcome per process initiation (adapted from Amalberti et al. (8). The reliability levels in this study are higher than in Table 1 because process failure here is expressed in terms of ‘fatal outcome’).3,4

AND reliability’. We screened the abstracts of 899 papers for relevance, and selected 41 pertinent papers that were read in greater detail. The 34 papers that described a valid method, practice, or concept that improved the reliability of hospital processes were included in our framework. In addition we screened key papers on this topic and checked references of included papers. Only Dutch and English studies were included.

Analysis
First we categorized the results based on how the presented method, practice or concept improved patient safety. We labeled each study with the most appropriate key words and then focused on the commonalities between the studies based on these key words. Subsequently we found that the core categories revolved around four interconnected elements, which we subsequently developed further on the basis of the papers investigated. This step led to the development of the evolutionary model described below.

Results
We identified four interconnected elements that are crucial for hospital reliability. Figure 2 shows these four elements: process optimization and standardization; outcome measurement and monitoring; responsibilities and accountability of medical professionals; and organizational culture.

These four elements are discussed below; specifically, we describe what hospital characteristics are associated with low and high reliability processes for each element. Our findings are summarized in Table 2, where we distinguish the common characteristics for each level of reliability using the scale presented in Table 1.

3 ASA stands for American Society of Anesthesiologists and is a 5 point scale for pre-operative risk, ASA 1 meaning low risk, ASA 5 meaning high risk.

4 Figure 1 does not contain a y-axis. Therefore boxes with the various activities could be positioned otherwise in height, as the height of the boxes is arbitrary.

5 We conducted the review on April 21, 2010.
Process optimization and standardization

The potential gain in reliability by standardization is visible in medical activities such as anesthesia and blood transfusion, where the failure rates are orders of magnitudes lower than in other parts of medical work (see Figure 1). Historically, in these areas of medicine processes have become more standardized and professionals fulfill their tasks as a streamlined part of standardized, sociotechnical routines. To achieve comparable failure rates, standardization is essential for many other medical processes as well. Achieving such a goal implies articulating the goals of the process and carefully mapping the processes involved.\[5\] Processes need to be stripped of unnecessary variation and complexity using protocols, checklists, decision aids, and assisted with automated reminders generated by electronic medical records.\[5,10-15\] If processes are always performed in concordance with each other, bundling these processes to ensure that all processes are properly executed further improves reliability.\[16\] Reliable processes are designed in such a way that the default processes are the right processes; forms, organizational routines and/or material constraints structure the process in such a way as to ensure optimal safety.\[17\] Once this is achieved, adding failure identification and failure mitigation can create additional redundancy. This results in ‘fail-safe’ processes, thereby further improving reliability.\[18,19\]

Outcome measurement and monitoring

A first step towards reliable health care is to register outcomes, especially adverse outcomes.\[17,20,21\] Hospitals begin by registering adverse events (such as pressure ulcus rates) and reporting incidents at a local (department) level and informing professionals about their performance.\[22\] At baseline, there is no focus on performance benchmarking; at best there might be some attention on (mediocre) outcomes elsewhere. More reliable hospitals register these outcomes centrally over the full cycle of care across departments and include them in the planning and control cycle. The next step is benchmarking with other hospitals, a process facilitated by information technology; this facilitates rapid-cycle improvement of processes and aids in root cause analysis of accidents.\[5,21,23\] An even higher level of reliability can be reached with permanent benchmarking with best-in-class and the simultaneous use of statistical process control.\[5\]

Responsibilities and accountability of medical professionals

A classic hospital is organized in departments in which individual physicians care for patients. That is to say, physicians are individually responsible for the quality of care delivered, and their accountability to management or to other professionals in the hospital is limited.\[2\] To improve
the quality and reliability of processes, it is crucial that physicians, nurses, and other professionals start working together in teams clustered around medical conditions.[24] By working and training together in a dedicated team, communication failures are drastically reduced and group performance levels – in routine and non-routine situations – improve significantly.[11,19,25,26] The clinical leadership of these teams is accountable to colleagues and central management for the results the team achieves.[2,27] Reaching higher levels of reliability, such teams become more and more competent (‘self-steering’) at handling unexpected situations and dealing with the inevitable errors that will occur. This means that centralized patient safety routines can be delegated more and more to the ‘front-line’, thereby increasing the responsiveness of the organizations.[11,28] Highly reliable teams possess skills such as rule-based decision making and task allocation.[19,29] Where possible these teams use rules and/or checklists to make decisions regarding diagnosis and treatment of patients. Tasks regarding care for patients are allocated in such a way that they are conducted by people who are most suited for doing them, rather than on hierarchy. This results in an environment where mechanisms are in place to migrate decisions to those most suitable for the task regardless of their rank.[6] These teams have situational awareness: they have a constant awareness of what is happening around them, and a constant focus on events that may happen and about which they cannot be fully informed.[25,29]

**Organizational culture**

Culture is a crucial element in achieving reliable processes in health care. Health care processes that are not reliable are often accompanied by a reactive working culture in which there is a denial of vulnerability (the ‘iron man mentality’) along with ‘blaming and shaming’ with no explicit focus on patient safety.[8,30] Concepts for educating young professionals such as ‘see one, do one, teach one’ are prevalent in unreliable organizations, and new technologies are introduced without proper training of personnel. In reliable organizations, leaders instill a zero-tolerance culture in which patient safety is everyone’s responsibility; there is a sense of the bigger picture of patient safety and related issues.[21,31-35] In this environment, leaders view safety problems as problems with their system rather than with their employees.[32] Proper training of personnel and application of a system-wide approach to risk and safety management by the leadership results in prioritization of permanent improvement of quality and patient safety. All professionals within such an organization recognize that their individual behavior can improve patient safety and that a safe environment is not an exogenous condition which is only created by the leadership of the hospital.[36,37] In a reliable health care culture, the mentality of ‘intent, vigilance, and hard work’ is abandoned. People realize that only a systematic approach can improve patient safety and that trying to work longer hours will not resolve fundamental issues which create chaotic processes. In this environment critique of personnel is appraised and used to continuously create better processes and procedures.[5]

In high reliability organizations we find resilience and a focus on what went right and why, instead of a focus only on what went wrong. This means that there is an awareness why and how the hospital is successful in managing patient safety and what the factors are which create the safe environment. By knowing that, the factors which create the safe environment are ‘exported’ as best practices to other processes and departments across the hospital, thereby improving the reliability of the hospital. At the same time, in ultra safe environments there is a permanent awareness of things that might go wrong, a so-called ‘preoccupation with failure’ and ‘collective mindfulness’. This means that people on the work floor know that inevitably things will go wrong, even in processes that are well organized. This collective awareness of front-line health care teams is then used to permanently monitor processes on possible failure. By doing so the errors that occur are recognized in an early stage and are mitigated in such a way that fatal outcomes are avoided.[6,38,39]
The Dutch health system reform: creating value

Table 2: Reliability framework based on literature review and analysis

<table>
<thead>
<tr>
<th>Phase:</th>
<th>Phase 0 Health care as craft</th>
<th>Phase 1 Watchful professional</th>
<th>Phase 2 Collective professionalism</th>
<th>Phase 3 Highly reliable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability level</td>
<td>$10^{-1}$ (&lt;80% of processes are without defects)</td>
<td>$10^{-1}$ (90% of processes are without defects)</td>
<td>$10^{-2}$ (99% of processes are without defects)</td>
<td>&lt;$10^{-3}$ (99.5% of processes are without defects)</td>
</tr>
</tbody>
</table>

Elements:

| Process optimization and standardization | • No articulated processes.  
• Transfers between professionals/processes are ad hoc and therefore error-prone.  
• Lack of routine and lack of experience. | • Protocols available for essential processes.  
• There is vigilance and a focus on individual discipline.  
• Checklists for processes used by individuals. | • Decision aids, alarms, and reminders built into the care delivery processes.  
• Desirable outcome is the default modus.  
• Process standardization and collective checklists lead to complexity reduction. | • Redundancy in processes, thereby creating fail-safe processes. |

| Outcome measurement and monitoring | • No structural measurement of process and/or outcome indicators and therefore no insights into quality of care. | • Registration of adverse events but no insight into trends.  
• Some process or outcome indicators are monitored, but there is no benchmarking. At best, the focus is on mediocre performance elsewhere.  
• Quality monitoring is not part of the planning and control cycles. | • Structural real-time measurement (statistical process control) of process and outcome indicators.  
• Continue benchmarking with best of class. | • Continual screening for possible unsafe events before unsafe events occur. |

| Responsibilities and accountability of medical professionals | • Professionals have individual autonomy.  
• Patient safety is the responsibility of individual professionals; no overall control. | • Limited individual autonomy.  
• Individual medical professional is responsible for quality and safety of care.  
• Overall control of safety by introduction of meetings, norms and limits. | • Limited collective autonomy for teams (professionals and managers around one medical condition).  
• Central control and accountability based on process measures. | • Teams with situational awareness.  
• Very strict control, but at the same time large responsibilities delegated to the ‘front-line’ (decentralized). |

| Organizational culture | • No explicit focus on patient safety.  
• Taking risks is equal to high status.  
• Absence of self-critical attitude; ‘denial of vulnerability’.  
• Learning by doing. | • Respect for each other’s roles; addressing safety issues is possible beyond professional boundaries.  
• Individual effort can improve outcomes (from reasonable to excellent).  
• ‘Zero-tolerance’ for violating standards.  
• Teams in which individual performance is of minor importance compared to overall performance.  
• Collective drive to achieve a high quality and safe environment.  
• Safe introduction of new techniques.  
• Focus on improving safety issues – even when things go well already. | • A preoccupation with possible failure. |
A synthesis of the literature: linking concepts into a reliability framework

The elements described above, which collectively determine the reliability level of a hospital, are summarized in Table 2. The presented framework distinguishes four phases of reliability per element. When hospitals make their processes more reliable they gradually move from phase 0 until they finally reach phase 3.

Although the four presented elements are interconnected, hospitals do not per se have to be in the same phase for the four different elements. Different departments within the same hospital may be in different phases. In addition it is also possible that a particular department is in phase 1 for e.g. the element ‘process optimization and standardization’ and is in phase 2 for the element ‘outcome measurement and monitoring’.

Discussion

Using the framework presented here, hospitals can gauge the reliability of their processes and practices. Recognizable characteristics provide insights into where improvement is needed and possible. In addition, this framework provides a way to view the relationship between different patient safety issues and a way to link them conceptually.[28] Recognizing the state of reliability within their hospitals, professionals and managers can use the presented framework as a starting point to implement these concepts, methods and practices that suit their specific situation best.

This framework differs from other quality and safety frameworks such as the Baldrige and ISO frameworks as it specifically focuses on aspects of health care processes at the front-line, rather than on competences of organizations regarding quality management systems, strategic planning, etc.[40,41] It also distinguishes itself from previous relevant frameworks as it not only links the level of organizational reliability with process and cultural characteristics of an organization, but also distinguishes four interconnected elements, with per element a detailed description of tangible process characteristics.[2,5,6] In addition it describes the evolutionary aspects of these elements by defining characteristics per phase. However, the feasibility, efficiency, and effectiveness of this new framework requires further evaluation and validation through empirical research.

It seems that hospitals around the world are still mostly in reliability phase 0 or 1. Progress in patient safety has been modest despite many patient safety- and quality-related initiatives.[42] Improving reliability requires improvement in all four interconnected elements, and it seems difficult for hospitals to make progress in all these interconnected elements at the same time. Some areas of medicine such as anesthesia and blood transfusion have already shown that it is possible to achieve a significantly higher reliability level by standardizing and optimizing processes. As high reliability on an organizational level primarily stems from high reliable processes, only creating a safe culture will not substantially improve reliability. In line with previous studies we find that culture seems to be the result from an organization’ shared values and its structure, practices and processes it has in place. Because shared values and beliefs are so interconnected with the ‘being’ of the organization it is almost impossible to change that independently, as culture seems to be an ‘emergent property’.[43]

Therefore the focus of hospitals should be on standardizing processes, measuring and monitoring outcomes as well as focusing on medical professionals’ responsibilities and accountability. By doing so the needed cultural change will ‘emerge’, which could be reinforced by given special attention to the cultural change. After making health care processes reliable hospitals can start

6 We thank one of the anonymous reviewers for suggesting the term ‘emergent property’ and thereby strengthening our conclusions.
with implementing more sophisticated high reliability organization concepts such as resilience and situational awareness.[5]

In conclusion, substantial effort has been made in the last decade to improve patient safety. The actual improvement in safety has been fairly modest, which is understandable because most hospitals currently still have phase 0 or phase 1 processes in place. An integrated approach is needed for hospitals to achieve a higher reliability level. Given the current state of patient safety in most hospitals, particular attention to the characteristics within the interconnected elements that affect patient safety at the process level is needed to become more reliable than they are now.

Competing interests
We declare to have no competing interests.
References


Improving the quality of emergency medicine care by developing a quality requirement framework: a study from The Netherlands

Abstract

Background
In The Netherlands, mainly inexperienced physicians work in the Emergency Departments (EDs) on all shifts, including the evening and night shifts, when no direct supervision is available. In 2004 a report of the Dutch Health Care Inspectorate revealed that quality of care at EDs was highly variable. Based on this report and international studies showing significant potential for quality improvement, stakeholders felt the need to improve the quality of Emergency Medicine (EM) care. Based on the literature, a baseline measurement and a panel of experts, The Netherlands recently developed a nationwide quality requirement framework (QRF) for EM. This article describes the content of and path to this QRF.

Methods
To conduct a baseline measurement, the panel needed to identify measurable entities related to EM care at EDs. This was done by formulating both qualitative and partly quantitative questions related to the following competence areas: triage system, training of personnel (physicians and nurses), facilities and supervision of physicians.

27 out of 104 Dutch EDs were sampled via a cross-sectional study design, using an online survey and standardized follow-up interview in which the answers of the survey were reviewed.

Results
In the QRF, EM care is divided into a basic level of EM care and six competence certification areas (CCAs): (acute) abdominal aortic aneurysm, acute coronary syndrome, acute psychiatric behavioral disorder, cerebral vascular accident, pediatric critical care and infants with low birth weight. For the basic level of EM care and for every CCA minimum prerequisites for medical devices and training of personnel are established. The factors selected for the QRF can be regarded as minimum quality standards for EM care. A major finding of this study was that in The Netherlands, none of the 27 sampled EDs demonstrated compliance with these factors.

Conclusion
Our study shows that Dutch EDs fall short of what the expert consensus panelists considered minimum prerequisites for adequate EM care. The process of systematic enquiry allowed this information to come to light for the first time, which resulted in the implementation of a QRF for Dutch ED personnel, that is intended to improve quality of EM care over time. This is an important development for the worldwide EM community as the QRF shows a way to generate interim standards to improve the chances of appropriate delivery of EM care when the gold standard of providing fully qualified EPs is not initially achievable.
Background

In the last few decades, emergency medicine (EM) has developed as a specialty at different paces in different countries. While the Dutch health care system delivers good quality care compared to some other health care systems, EM is still an evolving specialty in The Netherlands.[1-4] Since the founding of The Netherlands Society of Emergency Physicians (NVSHA) in 1999, the need for improving the quality of Dutch EM care has received more attention.[5] This growing attention led to preliminary recognition of emergency physicians (EPs) in 2008, with the possibility of recognition as a medical specialty in the future. From 1999 on EM training programs became more standardized and a separate EM residency was created in 2004, which was officially recognized in 2008.

There is currently a consensus in The Netherlands that emergency departments (EDs) should be staffed 24/7 with EPs. Nonetheless, the shortage of EPs has prevented most EDs from being fully staffed with EPs; instead, EDs are mostly staffed by physicians who recently graduated from medical school and/or medical residents who work under the supervision of medical specialists or EPs. In the Dutch system, the choice to seek supervision or advice is up to the (junior) physician who is seeing the patient. Even when supervision is requested, the patient is not always seen by the supervising specialist during the patient’s time in the ED, and supervision is often only provided by telephone. Thus, relatively inexperienced physicians working at Dutch EDs have substantial responsibilities for patient care.[5,6]

In 2004 the Dutch health care inspectorate recognized that the quality of EM care could be improved and published a report addressing the quality of EM care in The Netherlands.[7] The relevant conclusions can be summarized as follows:

- The ambitions of EDs to provide high quality EM care do not always match their actual ability to do so.
- The quality of EM care varies at each ED.
- There is a need to develop requirements for a minimum level of training and competencies for physicians who work in EDs.
- Medical devices are not always available and personnel are not always trained to treat patients according to the latest standards of care.

In addition to the specific Dutch circumstances, also international studies indicate that quality and safety of (EM) care can be improved.[8-12] In addition, studies show that a better quality of care can lower complication rates and thereby lower growth of health care costs.[11] One of the strategies to actually improve the quality and safety of (EM) care is to treat patients via standardized clinical pathways according to the best available evidence.[13]

To achieve the goal of a better quality of EDs with experienced professionals who are working according to the best available evidence, the government and other stakeholders realized that apart from appropriate facilities and quality monitoring systems, it is essential to have well-trained medical professionals working at EDs. Ideally this would mean that all EDs would be staffed 24/7 with EPs, but with the understanding that it will take at least 10 years to train a sufficient number of EPs to staff all Dutch EDs and thereby resolve quality issues, stakeholders in the Dutch health care system felt the need to find interim ways to improve the quality of care at EDs.[6]

Accordingly, the Dutch Ministry of Health created an expert panel to develop a quality requirement framework (QRF) for basic EM care at EDs. In addition, the expert panel had to formulate basic prerequisites for more complicated acute conditions that are usually treated initially by personnel working in the ED. These were termed competence certification areas (CCAs) next to the basic
In this article, we introduce the QRF, which was developed primarily via expert panel consensus and by reviewing current guidelines, and which was designed to provide the minimum prerequisites necessary for acceptable basic level EM care. In addition, we report the baseline performance of Dutch EDs with regard to the factors identified as the minimum prerequisites for basic EM care.

**Methods**

The Ministry of Health first assembled a panel of 20 experts that consisted of stakeholders (mostly non-EPs but rather stakeholders such as trauma surgeons, ambulance personnel, nurses, etc.) that could formulate a QRF. The panel began by conducting a literature search for existing QRFs related to the basic level of EM care that might be useful for addressing the Dutch situation. Although some studies regarding EM quality requirements and performance indicators were found, none were regarded by the expert panel as completely applicable to the specific situation of EM care as an evolving specialty in The Netherlands.

The panel then realized that a baseline measurement was needed to describe current practices, to select the most appropriate factors to include in the QRF, and to evaluate the impact of the QRF over time. To determine appropriate CCAs, the panel reviewed guidelines from Dutch scientific associations and studied current practices to determine the minimum standards for CCAs in terms of personnel training and facilities (medical devices, available infrastructure).

Six CCAs were selected based on the priorities and judgment of the expert panel.

**Baseline measurement: questionnaire and follow-up interview**

To conduct a baseline measurement, the panel needed to identify measurable entities related to EM care at EDs. This was done by formulating both qualitative and partly quantitative questions related to the following competence areas: triage system, training of personnel (physicians and nurses), facilities and supervision of physicians.

EDs were sampled via a cross-sectional study design, using an online survey and standardized follow-up interview in which the answers of the survey were reviewed. This resulted in a physician-created survey comprised of 120 mostly multiple-choice questions that were filled out by the medical and/or managerial heads of the EDs. The application ‘SurveyMonkey’ was used for the survey, and answers were recorded in Microsoft Excel version 2007. To encourage truthful answers, anonymity in the final report that was presented to the stakeholders was guaranteed for the individual EDs that filled out the questionnaire. Examples of the questions are shown in Table 1.

---

**Figure 1** Composition of the quality requirement framework

<table>
<thead>
<tr>
<th>(Acute) Abdominal Aortic Aneurysm</th>
<th>Acute coronary syndrome</th>
<th>Cerebral Vascular Accident</th>
<th>Pediatric critical care</th>
<th>Infants with low with height</th>
<th>Acute psychiatric behavioral disorder</th>
</tr>
</thead>
</table>
An onsite interview to review the answers was subsequently conducted with two researchers, one of them being a physician who was present at all interviews. The interviews were held with the medical/or managerial heads of the ED who had previously filled in the questionnaire. The interviewers did not receive special training in conducting structured interview techniques. As each answer was reviewed one by one, any corrections to the answers were typed in during the interview and checked with the interviewees. The baseline measurement was conducted from March to June 2009, and the QRF was established in December 2009.

**Participating hospitals**

Currently, there are 92 hospitals in The Netherlands. Most have one ED, but several have two locations with EDs. In total there are 104 EDs.[6] A requirement of the baseline measurement was that it be representative of all 104 EDs in The Netherlands. The final baseline measurement included a total of 27 EDs in three different regions across the country, including both rural and urban and large and small EDs, which were associated with different types of hospitals (academic, large peripheral teaching hospitals and general hospitals). The sample of 27 EDs is compared to the nationwide average representative in terms of type of hospital, as displayed in Table 2. As 52 of 104 (50%) nationwide EDs are located in rural areas, the rural EDs are slightly overrepresented (16 out of 27 or 60%).[21]

<table>
<thead>
<tr>
<th>Table 1 Examples of questions used for baseline measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Area of competence</strong></td>
</tr>
<tr>
<td>Basic level of EM care: physicians</td>
</tr>
<tr>
<td>Basic level of EM care: nurses</td>
</tr>
<tr>
<td>CCA: cerebral vascular accidents</td>
</tr>
<tr>
<td>CCA: (acute) abdominal aortic aneurysm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2 Participating hospitals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regions</strong></td>
</tr>
<tr>
<td>Number of EDs</td>
</tr>
<tr>
<td>Average of patient visits per ED per year (2008)</td>
</tr>
<tr>
<td>(min-max)</td>
</tr>
<tr>
<td>Academic hospitals</td>
</tr>
<tr>
<td>Large peripheral teaching hospitals</td>
</tr>
<tr>
<td>General hospitals</td>
</tr>
</tbody>
</table>

The baseline measurement provided an overview of current ED practices regarding the following: triage system, training of personnel (physicians and nurses), facilities and physician supervision.
These results were presented to the expert panel. The criteria that the expert panel used to select quality requirements were:

- Differentiation between EDs: if all EDs in the sample already met the quality requirement, it was not included in the QRF.

- Feasibility for the majority of EDs: the majority of EDs should be able to reach compliance within a 1-year period (only for the basic level of care) according to the ED management and expert panel (Table 3).[17]

### Table 3: Selection of quality requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Differentiation: 100% compliance found?</th>
<th>Feasible to implement within 1 year?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triage system available and trained personnel that can conduct proper triage</td>
<td>Yes</td>
<td>n/a</td>
</tr>
<tr>
<td>Trained personnel available 24/7 physicians: Advanced Life Support, ABCDE, Advanced Trauma Life Support or in hospital training program</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Trained personnel available 24/7 Nurses: Trauma Nursing Core Course, Emergency Nursing Pediatric Course or in hospital training program</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Facilities (X-ray, echo, ECG, resuscitation equipment, direct lab availability)</td>
<td>Yes</td>
<td>n/a</td>
</tr>
<tr>
<td>Supervision of medical specialist 24/7 available and formalized in consent</td>
<td>Yes</td>
<td>n/a</td>
</tr>
</tbody>
</table>

### Costs of QRF

Lastly we calculated the costs of implementing the QRF for hospitals. Per requirement we calculated the costs of implementation using data regarding the nationwide number of physicians and nurses working on EDs multiplied by the costs of a specific training, using the Dutch prices of the international certified courses (for requirements in rows 2, 4, 5 and 6 in Table 4).[6] For the requirements in rows 1, 3 and 7 we calculated the labor costs of junior physicians working in EDs (requirements in row 1 and 7) and the costs of supervising EPs or medical specialists (requirement in row 3). If a prerequisite was already met at some point in time during the physician or nurse working in the ED, no costs were included as rescheduling of the training would then be sufficient.

### Results

Table 4 (see next page) shows only the results of the baseline measurement test that concerned the training of personnel (physicians and nurses). All EDs showed full compliance in the other competence areas (triage system, facilities, supervision), as shown in Table 3. None of the 27 sampled EDs met the (minimum) standards of the quality requirements that were identified by the expert panel regarding the training of personnel. In addition, we present the annual costs per requirement to achieve nationwide compliance for all EDs in the first year of implementation.

As all elements of Table 4 were regarded as minimum prerequisites for providing quality EM care, the expert panel decided to translate the findings shown in Table 4 into the QRF (Table 5 on page 31). The panel gave the recommendation that all Dutch EDs should comply to this QRF within 1 year.
Table 4  Results of baseline measurement of the basic level of EM care and costs for implementation

<table>
<thead>
<tr>
<th></th>
<th>Number of EDs that meet the requirement before start of employment for ED physicians or nurses</th>
<th>Number of EDs that meet the requirement at some point in time during physician or nurse working in ED</th>
<th>Estimated costs of implementation per year nationwide (first year of introduction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A training program in which the physician works supernumerary</td>
<td>23/27 (85%)</td>
<td>n/a</td>
<td>€ 374,000 - € 561,000</td>
</tr>
<tr>
<td>2. Advanced Life Support training for physicians working on the ED as part of the training program</td>
<td>14/27 (52%)</td>
<td>22/27 (82%)</td>
<td>€ 43,000 – € 65,000</td>
</tr>
<tr>
<td>3. Evaluation conversation between head of ED and new physician after the training program in which the taught competencies are discussed</td>
<td>17/27 (63%)</td>
<td>n/a</td>
<td>€ 64,000 – € 96,600</td>
</tr>
<tr>
<td>4. During the training program training in the ABCDE systematic, comparable to the level of the Advanced Trauma Life Support®</td>
<td>0/27 (0%)</td>
<td>13/27 (48%)</td>
<td>€ 6,100,000 - € 11,300,000</td>
</tr>
<tr>
<td>5. Per shift availability of one nurse with specific training in trauma nursing, comparable to the level of the Trauma Nursing Core Course®</td>
<td>12/27 (44%)</td>
<td>19/27 (69%)</td>
<td>€ 113,000 - € 226,000</td>
</tr>
<tr>
<td>6. Per shift availability of one nurse with specific training in pediatric nursing, comparable to the level of the Emergency Nurse Pediatric Course®</td>
<td>2/27 (7%)</td>
<td>10/27 (37%)</td>
<td>€ 230,000 - € 460,000</td>
</tr>
<tr>
<td>7. Doctor present at the ED during opening times of the ED</td>
<td>26/27 (96%)</td>
<td>n/a</td>
<td>€ 0 - € 830,000</td>
</tr>
</tbody>
</table>

**Total: € 7 million - € 14 million**

n/a = not applicable

* Although this requirement applies to the ED and not to individuals, many EDs have only one (specialized) nurse scheduled per night shift, resulting in the situation that if the nurse meets the requirement the ED also does. Therefore, we display the percentages of both the EDs that comply before the start of employment (mostly EDs with multiple (specialized) nurses per night shift) and the percentage of EDs that meet the requirement at some point in time during the nurse working in the ED.
### Table 5  The quality requirement framework

<table>
<thead>
<tr>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic level of care: physicians</strong></td>
</tr>
<tr>
<td>• A training program in which the physician works supernumerary in which competencies given below are taught and tested(^a)</td>
</tr>
<tr>
<td>• During the training program a training in the ABCDE systematic, comparable to the level of the Advanced Trauma Life Support® training is required</td>
</tr>
<tr>
<td>• At all times, the ED should be able to have a physician who is trained in resuscitation (ALS or training provided by hospital(^b)) and intubation within 5 min at the bed of the patient</td>
</tr>
<tr>
<td><strong>Basic level of care: nurses</strong></td>
</tr>
<tr>
<td>• Per shift availability of one nurse with specific training in triage</td>
</tr>
<tr>
<td>• Per shift availability of one nurse with specific training in trauma nursing, comparable to the level of the Trauma Nursing Core Course®</td>
</tr>
<tr>
<td>• Per shift availability of one nurse with specific training in pediatric nursing, comparable to the level of the Emergency Nurse Pediatric Course®</td>
</tr>
<tr>
<td><strong>(Acute) Abdominal aortic aneurysm (AAA)</strong></td>
</tr>
<tr>
<td><strong>Indication:</strong></td>
</tr>
<tr>
<td>• Clinical suspicion of (acute) abdominal aortic aneurysm</td>
</tr>
<tr>
<td><strong>Facilities:</strong></td>
</tr>
<tr>
<td>• Direct availability of vascular surgeon</td>
</tr>
<tr>
<td>• Direct availability of CT scan</td>
</tr>
<tr>
<td>• Availability of endovascular stenting procedure in the hospital</td>
</tr>
<tr>
<td>• Presence of intensive care.</td>
</tr>
<tr>
<td><strong>Acute coronary syndrome (ACS)</strong></td>
</tr>
<tr>
<td><strong>Indication:</strong></td>
</tr>
<tr>
<td>• Patients with acute coronary syndrome and ST elevation on the electrocardiogram (ECG)</td>
</tr>
<tr>
<td>• Patients with acute coronary syndrome without ST elevation on the ECG, but with other indications for PCI such as NYHA-4, diabetes mellitus, hemodynamic instability</td>
</tr>
<tr>
<td><strong>Facilities:</strong></td>
</tr>
<tr>
<td>• Direct availability of interventional cardiologist</td>
</tr>
<tr>
<td>• Cardiac catheterization facilities: fractional flow reserve, intravascular ultrasound, defibrillation, balloon pump, ablation technique, resynchronization therapy</td>
</tr>
<tr>
<td><strong>Acute psychiatric behavioral disorder</strong></td>
</tr>
<tr>
<td><strong>Indication:</strong></td>
</tr>
<tr>
<td>• Patients with an (acute) behavioral disorder possibly due to intoxication, suicidality or psychiatric condition</td>
</tr>
<tr>
<td><strong>Facilities:</strong></td>
</tr>
<tr>
<td>• Direct availability of psychiatrist and psychiatric nurse.</td>
</tr>
<tr>
<td>• A room at the ED, which is suited to treat confused patients and to conduct clinical investigation</td>
</tr>
<tr>
<td>• Availability of a psychiatric department in hospital</td>
</tr>
<tr>
<td><strong>Cerebral vascular accident (CVA)</strong></td>
</tr>
<tr>
<td><strong>Indication:</strong></td>
</tr>
<tr>
<td>• Acute CVA (hemorrhagic and non-hemorrhagic)</td>
</tr>
<tr>
<td><strong>Facilities:</strong></td>
</tr>
<tr>
<td>• Direct availability of neurologist</td>
</tr>
<tr>
<td>• Direct availability of CT scan</td>
</tr>
<tr>
<td>• Nursing team familiar with thrombolysis procedure</td>
</tr>
<tr>
<td><strong>Pediatric critical care</strong></td>
</tr>
<tr>
<td><strong>Indication:</strong></td>
</tr>
<tr>
<td>• Severely ill children</td>
</tr>
<tr>
<td><strong>Facilities:</strong></td>
</tr>
<tr>
<td>• Direct availability of pediatrician</td>
</tr>
<tr>
<td>• Residents have had training in treating children in need of intensive care comparable to the level of Pediatric Advanced Life Support® training</td>
</tr>
<tr>
<td>• Presence of pediatric intensive care unit</td>
</tr>
<tr>
<td><strong>Infants with low birth weight</strong></td>
</tr>
<tr>
<td><strong>Indication:</strong></td>
</tr>
<tr>
<td>• Imminent birth with gestational age under 32 weeks and or a birth weight less than 1,250 g</td>
</tr>
<tr>
<td><strong>Facilities:</strong></td>
</tr>
<tr>
<td>• Direct availability of gynecologist and pediatrician</td>
</tr>
<tr>
<td>• Neonatal intensive care unit</td>
</tr>
</tbody>
</table>

\(^a\) No specific time length for the training program is defined

\(^b\) Training by hospital usually has a duration of 2–4 h and is often not standardized
Discussion

The factors selected for the QRF can be regarded as minimum quality standards for EM care. For instance, the now compulsory ABCDE training for relatively inexperienced physicians is essential for appropriate care at EDs as these physicians may treat acutely ill patients. A major finding of this study was that, in The Netherlands, none of the 27 sampled EDs demonstrated compliance with these factors. This was surprising since the Dutch health care system is perceived as one that delivers good quality care compared to that in other countries.[1-4] Based on our findings, other countries may wish to survey their EDs as well, as overall health care system performance and the actual compliance to quality standards for EM care may not be in concordance with each other.

Previous studies demonstrated that patient safety can be compromised in EDs, especially during evenings, weekends and night shifts, because of the double jeopardy of recently graduated physicians who are likely to have both little experience plus limited supervision.[10,22] In The Netherlands, mainly inexperienced physicians work in the ED on all shifts, including the evening and night shifts when no direct supervision is available. The QRF seeks to improve this situation, establishing minimum standards prerequisite for providing quality care, because without training in the ABCDE approach to patient management, an inexperienced physician is unlikely to be able to provide even temporary stabilizing care to potentially acutely ill patients.

The QRF is an important example approach for other EM communities as it shows a way to generate interim standards. This is one strategy to improve the chances of appropriate delivery of EM care when the gold standard of providing fully qualified EPs is not initially achievable. Following the development path of this QRF may help other countries in which EM is still an evolving specialty to develop a QRF suitable for their situations. Especially in the 12 European countries in which EM is not yet recognized as an independent specialty, this type of QRF can provide a minimum standard. At the same time, it can function as a stimulus for countries to recognize EM as an independent specialty, as countries can refer to this QRF and compare it with their own situations at EDs. If the presented minimum quality standards in this QRF are not in place yet, this may be an extra argument to position EM as an independent specialty to spur quality improvement. By creating an independent EM specialty, EDs can more explicitly focus on how to deliver and monitor appropriate EM care, instead of viewing EDs as one of the places where specialists treat their patients.[23]

Implementation of the QRF in The Netherlands

The presented consensus-based process for QRF development is typical for the Dutch consensus culture. This approach has both disadvantages and advantages. A disadvantage of a consensus-based approach is that it is time consuming: there is a 6-year period between the first report of the Inspectorate regarding EM care and the actual formulation of the QRF. In addition, the consensus approach may lead to compromises on issues that hinder further improvement of quality of EM care. For instance, the QRF decision that hospitals can self-determine training programs (such as ALS training) instead of making internationally certified ALS training compulsory could be regarded as such an issue.[5]

On the other hand, for now there seems to be broad support for the QRF within the Dutch EM care community, especially because many stakeholders (including the relevant associations of providers and professionals) were represented in the expert panel. We therefore believe that the implementation of the QRF can be successful (meaning full compliance of EDs) as long as the Inspectorate closely monitors actual implementation of hospitals. It is also worth noting that the Inspectorate embraced the QRF and made it compulsory for EDs from 2011 on. The Ministry of Health also requested the Inspectorate to conduct an evaluation 2 years after the QRF had been introduced to evaluate its impact. Recently, the results of the first 2011 initial assessment of the
Inspectorate, which visited 33 EDs randomly (thus different from the sample in our study), were published. This assessment showed that 5 out of 33 EDs did fully comply with the QRF. The 28 EDs that did not fully comply were given 6 weeks time to comply with the standards of the QRF. After this time, the Inspectorate made a repeat visit. These visits showed that 27 EDs showed full compliance to the QRF and that one ED was not able to meet the standards of the QRF. This ED has been forced to shorten its ED opening hours to comply with the QRF.[24]

Surprisingly, the presentation of the QRF, the baseline measurement and also the recent assessment of the Inspectorate did not receive much attention in public debate, although one newspaper article stated that this study revealed that the quality of EDs can be substantially improved.[25]

The availability versus quality trade-off

In addition, the requirements may promote the concentration of EM care as a higher volume of patients is needed to fund training of personnel following the prerequisites. Particularly for the CCAs (such as ACS and CVA) there is a growing body of literature that shows that there is a positive ‘volume outcome’ association.[26-28] Following this, concentration of care, at least for CCAs with a positive volume outcome association, seems desirable. This may also result in a concentration of EDs, but this is not necessarily the case, as most of the volume of care at EDs does not come from CCA patients.

On the other hand, accessibility of care is important; in The Netherlands a law states that every citizen should have an ED within 45 minutes travel distance. But following this 45 minutes norm, calculations show that The Netherlands would need only 45 EDs, assuming that EDs were spread optimally over the country.[29] Hospitals, however, are very reluctant to abandon their EDs as significant quantities of patients enter the hospital via the ED. The societal debate regarding the appropriate number of EDs has recently resulted in a national agreement among hospitals, insurers and the government, aiming at a significant reduction of the numbers of EDs in The Netherlands. According to this agreement, hospitals that close their EDs will receive some financial compensation from a national fund.[30]

Cost-effectiveness

We estimated that the additional costs of implementing this QRF for the basic level of EM care, excluding the CCAs, for all 104 Dutch EDs will total 7–14 million euros in the first year.[6] After the first year, the yearly cost will be between 3 and 8 million euros per year. Compared to the annual cost of hospital health care in The Netherlands, which is 17 billion euros, the cost seems relatively small. When the societal costs of inadequately trained physicians are considered, the return on society’s investment in training is likely to be substantial.[6,11]

Limitations

The developmental process of creating the QRF presented here may have suffered from several limitations. First, selection bias may have occurred as the study sample has slightly more rural EDs than the national average, although in the analyses no substantial differences between the different types and locations of hospitals were encountered regarding the organization and staffing of EDs. Second, although a follow-up interview was conducted after the online survey and a stable interviewer was present at all interviews, there were various types of respondents, yielding potentially inter-interview variability in responses. Additionally, the survey utilized was newly created without the benefit of (previous) validation. Third, the QRF does not set minimum standards for outcome or process performance indicators, nor does it measure the actual performance of EDs. These elements are often a part of other initiatives intended to improve the quality of EM care.[31]
Fourth, the optimal number and choice of CCAs can be debated. Notably, this was discussed as part of the baseline measurement; the ED professionals and the expert panel agreed on these six CCAs, but the question of which CCAs to include remains the subject of ongoing discussion. In December 2009, a directive regarding obstetrics was published in The Netherlands. The directive establishes minimum quality requirements for hospitals regarding 24/7 availability of obstetrics and pediatricians.[32] Thus, childbirth is an example of an item that has potential as a CCA that may be a valuable addition to this QRF. Last, according to the requirements of the QRF, some CCAs may be considered as (too) limited. For instance, adding neurosurgical capability to the CCA regarding CVA would be considered desirable by many experts.

**Conclusion**

This study showed that Dutch EDs fall short of what the expert consensus panelists considered minimum prerequisites for adequate EM care. The process of systematic enquiry revealed this information for the first time, resulting in the implementation of a QRF for Dutch ED personnel that is intended to improve the quality of EM care. Although further testing is needed following implementation to document its effectiveness, this model, as well as the specific process involved in setting up the QRF, could be useful for other countries that face similar EM situations, i.e., that have limited or no standards for ED personnel.

**Endnotes**

a As trauma care already has its own quality requirements regulated via the Dutch association of Trauma centers, this was left out of the quality requirement framework and is subsequently not part of this paper.

b The main stakeholders involved are: The Dutch Association of Ambulances (RAV), The Dutch Association of Academic Hospitals (NFU), The Netherlands Society for Emergency Physicians (NVSHA), V&VN Dutch Nurses’ Association, The Dutch Association of General Practitioners (NHG), The Dutch Association of Hospitals (NVZ), The Dutch Association of Intensive Care medicine (NVIC), The Dutch Association of Medical Specialists (OMS), The Dutch Association of Trauma Centers (LVTC) and The Ministry of Health (MinVWS).

c Hospitals can self-determine the length, content and manner of training (skills practice vs. lecture vs. cases) in any way an individual hospital chooses, although efforts are underway to standardize this to some extent.

**Competing interests**

The authors declare that they have no competing interests.

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Improving the quality of emergency medicine care by developing a quality requirement framework
References


Dutch health care reform: did it result in better patient experiences in hospitals?

A comparison of the Consumer Quality Index over time

Abstract

Background
In 2006, the Dutch hospital market was reformed to create a more efficient delivery system through managed competition. To allow competition on quality, patient experiences were measured using the Consumer Quality Index (CQI). We study whether public reporting and competition had an effect on the CQI between 2006 and 2009.

Methods
We analyzed 8,311 respondents covering 31 hospitals in 2006, 22,333 respondents covering 78 hospitals in 2007 and 24,246 respondents covering 94 hospitals in 2009. We describe CQI trends over the period 2006-2009. In addition we compare hospitals that varied in the level of competition they faced and hospitals that were forced to publish CQI results publicly and those that were not. We corrected for observable covariates between hospital respondents using a multilevel linear regression. We used the Herfindahl Hirschman Index to indicate the level of competition.

Results
Between 2006 and 2009 hospitals showed a CQI improvement of 0.034 (p<0.05) to 0.060 (p<0.01) points on a scale between one and four. Hospitals that were forced to publish their scores showed a further improvement of 0.027 (p<0.01) to 0.030 (p<0.05). Furthermore, hospitals that faced more competition from geographically close competitors showed a more pronounced improvement of CQI-scores 0.004 to 0.05 than other hospitals (p<0.001).

Conclusion
Our results show that patients reported improved experiences measured by the CQI between 2006 and 2009. CQI levels improve at a faster rate in areas with higher levels of competition. Hospitals confronted with forced public publication of their CQI responded by enhancing the experiences of their patients.
**Background**

In the last two decades, several Western countries introduced some form of managed competition in their health care system.[1,2] Common goal of these reforms is creating a demand driven system that provides more patient centered care.[3] To achieve this goal the quality of health care providers needs to be assessed and publicly reported.[4,5] Patients and health plans may then use quality information to make informed choices between health care providers.

The public reporting of provider quality can stimulate quality improvement through informed patient choice, quality contracting of providers by health plans and/or by intrinsic motivation of health care providers.[6] Previous studies have shown that public reporting of quality information does stimulate hospitals to initiate quality improvement projects. It remains unclear if - and to what extent - the introduction of managed competition combined with public quality reporting may affect quality.[7-9]

We set out to answer this question in the context of the Dutch 2006 Health Insurance Act (HIA) reform. It was enacted to stimulate managed competition in the hospital market. We summarize the characteristics of the reform in Table 1.[2,10] Before the reforms all hospitals were financed through ‘input’ reimbursement. Hence hospital budget did not directly depend on production, but rather on historic agreements with the insurer regarding their budget.

To enable provider competition, products were defined in terms of Diagnosis Treatment Combinations (DTCs), which are to some extent comparable to diagnosis related groups (DRGs).[11] A number of initiatives were aimed at making provider quality transparent. These include widespread measurement of medical quality indicators that aim to indicate outcome utility and the measurement of the Consumer Quality Index (CQI) that aims to measure process utility. It is partly based on the Consumer Assessment of Healthcare Providers and Systems.[12] The CQI therefore is a partial measure of health care quality based on more objective consumer experiences rather than a more subjective satisfaction.[13]

From 2006 onwards health plans were increasingly stimulated to negotiate with hospitals on price, quantity and quality of care. While in 2006 negotiations were restricted to products accounting for 7% of the total hospital budget, this was increased to 34% in 2009, and is expected to further increase to 70% in the near future. Consequently, hospitals are increasingly exposed to competition.[14] However, the bargaining power of health plans remains limited due to a limited use of selective hospital contracting by health plans. In addition health plans are currently reluctant with proactive member channeling toward preferred hospitals.[15] While this may have reduced competition during 2006 – 2009, the threat of significant competition in the future may have sparked hospital policy changes.

We examined whether the patient experiences of hospital care improved in the period 2006-2009. In addition we investigated whether forced public reporting of hospitals and higher levels of competition - in line with previous studies and policy objectives - were associated with better patient experiences.[7,9,16,17]

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Key Elements of the Dutch Health Care System</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Mandatory basic health insurance for everyone, purchased through private insurers (both profit and not-for-profit are possible)</td>
<td></td>
</tr>
<tr>
<td>• Annual consumer choice of insurer and insurer products. Choice between in kind and restitution policy</td>
<td></td>
</tr>
<tr>
<td>• Open enrollment and community rating realized by a risk-equalization system</td>
<td></td>
</tr>
<tr>
<td>• Mandatory deductible of € 150, voluntary deductible up to € 650 per person per year</td>
<td></td>
</tr>
<tr>
<td>• Insurers expected to contract selectively with competing health care providers.</td>
<td></td>
</tr>
<tr>
<td>• Government requires health care providers to release quality information</td>
<td></td>
</tr>
</tbody>
</table>
Methods

Available data

Hospital care experiences of patients were measured in 2006, 2007 and 2009. Each year the questionnaire was sent to a random sample of patients who stayed at the hospital during the respective year. In 2006 31 hospitals out of total 94 Dutch hospitals participated in the measurement. This number increased to 78 in 2007 and 93 in 2009.[13]

Under Dutch law no specific ethical approval was required for our research as the respondents were informed during filling in the questionnaire that their answers may be used for research purposes.

The CQI consisted of seven quality aspects (Physician communication, Nurses communication, Pain treatment, New medication communication, Accommodation, Discharge information and Nurse services) in 2006. In 2007 eight quality aspects were added and one was deleted (see Table 2). In 2009 one quality aspect was deleted (see Table 2). All quality aspects were rated based on multiple answers which were scored at a four point scale. This scale varies between one for the lowest possible score and four indicating the highest possible score.[13]

Not all quality aspects were suitable for our analysis. The scale of the quality aspect ‘information after discharge’ was adjusted in 2007 and therefore lacks comparability between the years 2006 and later years. In the quality aspects New medication communication, Accommodation and Intake conversation, questions were deleted after analyses showed they did not discriminate between respondents. Consequently trends over time may be biased and these quality aspects were (partly) excluded from further analyses (see Table 2).[13]

Primary analyses and publication

Each year the results for the individual hospitals were case mix corrected using multilevel linear regression analyses (consumer experiences were nested within hospitals).[18] Means with comparison intervals (1.39 standard error) were calculated per quality aspect and per hospital.
adjusted for age, education and reported physical health, sex and reported mental wellbeing.

Next, hospitals were divided in three groups and given a ‘star rating’: one star if their interval was completely below the average across all providers, two stars if their interval overlaps with the average across all providers and three stars if their interval was completely above the average across all providers, so that the public could easily interpret the results of the individual hospitals.

Depending on the dominant health plan in the catchment area of the hospital, 16 out of 31 hospitals were confronted with forced publication of their 2006 results. This decision was made by the health plan without consultation of hospitals. In 2007 none of the results were publicly reported. All 2009 results will be published at the health care portal http://www.kiesbeter.nl and some results are already publicly reported at health plans’ websites. All hospitals have received their CQI results for each of the years.[20]

Secondary statistical analyses

We combined the data of the three years and conducted a multilevel linear regression analyses per quality aspect for the relevant years (2006/2007/2009 or 2007/2009). In addition we ran multilevel linear regressions for the combined quality aspects 1-3 (2006/2007/2009) and 4-12 (2007/2009), with quality aspects nested in individual respondents. In the regressions we corrected for the relevant case mix variables: age, education and reported physical health, sex and reported mental wellbeing.

We added dummies for groups of hospitals with different participation patterns to correct for different CQI scores between these groups of hospitals. To assess if hospitals which were confronted with published CQI results by health plans in 2006 outperformed hospitals which were not, we included a dummy variable for those hospitals which we included in our multilevel linear regression model. In order to identify hospitals that faced more competition from neighboring hospitals we used the Herfindahl Hirschman Index (HHI) of hospitals. This HHI was used as an explanatory variable in an ordinary least square (OLS) regression, while correcting for time effects and case mix variables. All analyses were conducted in Stata/IC version 11.0.

Results

Respondents

In 2006 8,311 respondents filled out the questionnaire. The number of respondents per hospital varied from 177 to 365 (mean = 268.10; SD=34.06). In 2007, 22,333 respondents (response = 61%) filled out the questionnaire and the numbers per hospital varied from 190 to 358 (mean = 286.32; SD = 36.61). In 2009, 24,246 respondents filled out the questionnaire (response = 57%)

<table>
<thead>
<tr>
<th></th>
<th>Respondents</th>
<th>Non-respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006 (n=31 hospitals)</td>
<td>8,311</td>
<td>unknown</td>
</tr>
<tr>
<td>% Male 2006</td>
<td>unknown</td>
<td>unknown</td>
</tr>
<tr>
<td>Avg. age 2006</td>
<td>61</td>
<td>unknown</td>
</tr>
<tr>
<td>2007 (n=78 hospitals)</td>
<td>22,333</td>
<td>14,190</td>
</tr>
<tr>
<td>% Male 2007</td>
<td>42%</td>
<td>42%</td>
</tr>
<tr>
<td>Avg. age 2007</td>
<td>61</td>
<td>63</td>
</tr>
<tr>
<td>2009 (n=94 hospitals)</td>
<td>24,246</td>
<td>18,009</td>
</tr>
<tr>
<td>% Male 2009</td>
<td>43%</td>
<td>42%</td>
</tr>
<tr>
<td>Avg. age 2009</td>
<td>60*</td>
<td>72</td>
</tr>
</tbody>
</table>

*Significant at p< 0.05
and the numbers per hospitals varied from 128 to 458 (mean = 257.93; SD = 56.30). Table 3 on the previous page shows the non-response analyses, which indicates that in 2009, respondents were significantly younger than non-respondents.

### Change in performance over time

Table 4 displays the uncorrected mean and standard deviation per included quality aspect per included year. Both means and standard deviation seem fairly constant throughout the period 2006-2009.

<table>
<thead>
<tr>
<th>Quality aspects</th>
<th>2006</th>
<th>2007</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Physician communication</td>
<td>3.43</td>
<td>0.57</td>
<td>3.41</td>
</tr>
<tr>
<td>Nurses communication</td>
<td>3.39</td>
<td>0.64</td>
<td>3.45</td>
</tr>
<tr>
<td>Pain treatment</td>
<td>3.49</td>
<td>0.65</td>
<td>3.46</td>
</tr>
<tr>
<td>New medication communication</td>
<td>n/a</td>
<td></td>
<td>3.05</td>
</tr>
<tr>
<td>Accommodation</td>
<td>n/a</td>
<td></td>
<td>3.29</td>
</tr>
<tr>
<td>Treatment explanation</td>
<td>n/a</td>
<td></td>
<td>3.47</td>
</tr>
<tr>
<td>Feeling safe</td>
<td>n/a</td>
<td></td>
<td>3.35</td>
</tr>
<tr>
<td>Respect for autonomy</td>
<td>n/a</td>
<td></td>
<td>2.97</td>
</tr>
<tr>
<td>Contradictive information</td>
<td>n/a</td>
<td></td>
<td>3.45</td>
</tr>
<tr>
<td>Discharge information</td>
<td>n/a</td>
<td></td>
<td>3.20</td>
</tr>
<tr>
<td>Ward intake experience</td>
<td>n/a</td>
<td></td>
<td>3.88</td>
</tr>
<tr>
<td>Hospital accessibility</td>
<td>n/a</td>
<td></td>
<td>3.48</td>
</tr>
</tbody>
</table>

1 The Herfindahl-Hirschman Index is a commonly accepted measure of market concentration. It is calculated by squaring the market share of each firm competing in the market and then summing the resulting numbers. For example, for a market consisting of four firms with shares of thirty, thirty, twenty and twenty percent, the HHI is 2600 (%30*%30) + (%30*%30) + (%20*%20) + (%20*%20) = 2600).
In Table 5 the result of the multilevel linear regression per separate quality aspect is presented. For the first three quality aspects (Physician communication, Nurses communication, Pain treatment) the regression spans the years 2006, 2007 and 2009. The time effects of the years 2007 and 2009 for the first three quality aspects are mixed with significant positive and negative coefficients. The latter nine quality aspects (New medication communication, Accommodation, Treatment explanation, Feeling safe, Respect for autonomy, Contradictive information, Discharge information, Ward intake experience, Hospital accessibility) show more consistent results: seven quality aspects show significant improvement in 2009 compared to 2007.

Publication of results consequently has a non-significant consistent positive relationship with higher performance for 10 quality aspects. The quality aspects show significant improvement ‘Physician communication’ and ‘Accommodation’ at the p<0.05 and P<0.01 level.

Table 6 shows that the combined analyses of quality aspects yields consistent results: in 2009 hospitals improved their performance with 0.034 (p< 0.05) to 0.060 (p<0.01) points compared to 2006 and 2009. Publication of results is associated with an improved the performance of hospitals of 0.027 (p<0.01) to 0.030 (p<0.05) points.
**Performance and level of competition**

The aggregated analyses of quality aspects 1-3 and 4-12 in Table 7 shows that the HHI is inversely significantly related to the performance of hospitals at the p<0.001 level, meaning that hospitals who face a higher level of competition outperform hospitals who face a lower level of competition. 

**Table 7  OLS with HHI per quality aspect with relevant years 2006/2007/2009(#) or 2007/2009**

<table>
<thead>
<tr>
<th>Coefficient of combined quality aspects</th>
<th>HHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality aspects 1-3# ****</td>
<td>-5.42 10^-6 ***</td>
</tr>
<tr>
<td>Quality aspects 4-12</td>
<td>-4.89 10^-6 ***</td>
</tr>
</tbody>
</table>

*significant at p< 0.05, **significant at p<0.01, ***significant at p<0.001 **** given the skewed distribution of the error term we estimated confidence intervals we applied a non parametric bootstrap procedure with 10,000 replications and hospital stratified sampling. Confidence intervals were based on bias corrected percentile score and the reported coefficients are within these confidence intervals, meaning that the found coefficients are significant.

The coefficient is small, but this is largely caused by the scale of the HHI, which theoretically ranges from 1 to 10,000, but in our dataset ranges from 807 to 9,133. If one multiplies coefficients by these differences, the potential impact of the HHI is equal to a coefficient of approximately 0.004 to 0.05 points on the CQI which varies in our dataset between 2.97 and 3.88. Thereby this effect is in the same order of magnitude as the found time effects in Table 6.
Discussion

We have examined the effects of the introduced transparency and competition between providers on patient experiences within the Dutch hospital market. This study is the first which systematically evaluates these effects within the Dutch setting. In addition we were able to use a dataset which enabled us to compare hospitals which were confronted with transparency early on with hospitals which were not. Our findings are as follows: First, we observe that patient experiences measured with the CQI improve over the course of years. Secondly, hospitals which are confronted with forced transparency early on are improving faster than hospitals which were not. This is evidence that the introduced transparency under the HIA may have improved quality of care, especially because patients’ trust in hospitals shows the opposite trend, this declined over the same period from 68% to 66%. [21] Thirdly, we find that higher levels of competition adjusted for case mix differences and time effects are related with better patient experiences.

Although the findings in our study are in line with previous studies our study may have suffered from possible limitations. [8, 22] First, in this study we show that Dutch hospitals are improving their performance, but the found improvements are fairly small. It is well documented that CQI differences between good and bad performing providers are in the same orders of magnitude as we have found. [23, 24] Therefore we believe that the differences in patient experiences between providers are meaningful and relevant for policy makers, health plans and hospitals. Moreover, we believe that current levels of competition are weak and our effects are likely to become stronger as competition increases. Secondly, and in line with our hypotheses and previous studies, our study indicates that a higher level of competition is related to better performance of hospitals. The effect of a higher level of competition on patient experiences is in the same order of magnitude as the found time effects. [8, 16] We use the HHI to indicate the level of competition that is calculated in 2004. Although some mergers took place within the Dutch hospital market since 2004, changes in market share over time are fairly modest. [25] In addition, most mergers took place on a board level, while merging the enterprises of the medical specialists on the multiple locations often lags several years behind. This maintains the same pre-merger level of competition between medical specialists. Therefore we believe that adjusting the HHI over the course of years would not have altered our conclusions.

Conclusions

In conclusion, our results show that patients reported improved experiences measured by the CQI between 2006 and 2009. CQI levels improve at a faster rate in areas with higher levels of competition. Hospitals confronted with forced public publication of their CQI responded by enhancing the experiences of their patients.

Competing interests

The authors declare to have no competing interests.

Acknowledgements

The health plans financed collection of the data. We wish to thank them and Stichting Miletus for making the data available to us. Also we would like to thank Dolf de Boer for his useful comments.
References


Chapter 4

The first effects of Dutch health care reform on hospitals

Ikkersheim DE, Koolman X. The first effects of Dutch healthcare reform on hospitals. Submitted.
Abstract

Introduction
In 2006 managed competition and payment by Diagnosis Treatment Combinations (DTCs) (a form of Diagnosis Related Groups (DRGs)) was introduced in the Dutch hospital market. Two types of DTCs were introduced: A-segment DTCs and B-segment DTCs. A-segment DTCs stayed at fixed costs under budget caps, but volume and price of B-segment DTCs became negotiable between insurers and hospitals. This paper investigates the first effects on hospital efficiency, quality, accessibility, and costs for the different groups of DTCs.

Methods
We use the national DTC registry, the national waiting-list registry and published reports for the years 2006-2009 to calculate indexed trends for efficiency, accessibility, price, volume, and costs per DTC group.

Results
Average productivity increased 4.6% annually. Productivity growth was most profound in the still budgeted part of care and is inversely related to the level of competition (p<0.001). Total accessibility remained stable, but improved 7.2% in the B-segment DTCs (p<0.001). Prices rose fastest within the A-segment, whereas volume rose fastest in the B-segment DTCs. Total hospital costs grew 7.1% annually.

Conclusion
The introduction of managed competition including DTCs spurred efficiency and improved accessibility somewhat. Negotiations of health insurers led to less price rises for B-segment DTCs. Although productivity is stimulated under the new DTC reimbursement system, total costs rose substantially, mainly due to volume growth, which is more profound in DTCs with open-ended reimbursement. In conclusion, the introduction of DTCs and negotiable prices seems to have stimulated hospital efficiency and accessibility. Nonetheless, mainly due to volume growth, hospital costs keep rising at a fast pace.
Background

Within the concept of managed competition payers act on behalf of their subscribers by trying to contract high-quality, cost-effective providers.[1,2] In order to avoid risk selection, payers are compensated for subscribers that consume more health care.[3,4] The goal of managed competition is to make health care more cost-effective and provide high quality of care to the public by using the element of competition between providers.

Many studies have analyzed the effect of competition on costs and quality of care. With respect to the effect of competition on prices of care, a review of studies find that a higher level of competition leads to lower prices, although the strength of this relationship differs per study.[5] Evidence from the US suggests that under fixed prices, quality improves in areas with higher competition. [6] Studies conducted in the UK show similar outcomes.[7-10] Studies looking into the effect of competition at quality in the context of free prices show more mixed as Gaynor et al. state in their review in 2012:[5]: ten studies find a positive relationship between quality and competition, where six studies find an opposite relationship and two studies find mixed relationships within the studied health care markets.

In 2006, a system of managed competition was introduced in the Dutch hospital market.[1,3] Within this paper we offer the first extensive empirical analysis of the effects of the policy in its first years of implementation. We first elaborate on the nature of the Dutch reforms.

Managed competition in the Dutch hospital market

In 2000, the Ministry of Health concluded that the performance of the Dutch health care system was insufficient to meet the demand of citizens. Due to top-down supply containment policies, there were time-significant waiting lists and limited choices for patients, and hospital performance was deemed inefficient. For instance, in 2004 productivity growth was 2.2%.[11] At that time, hospitals were given a maximum budget and were reimbursed based on parameters such as admission days, numbers of specialists, and patients in the region. Depending on income above or below median income, Dutch citizens were enrolled in a private health plans or public sickness funds. This mixed system led to different contracting policies by payers and to high transaction costs when incomes increased or decreased.[12]

These critiques of the former health care system led to enactment of the Health Insurance Act (HIA) on 1 January 2006 (see Table 1), abolishing the distinction between private health plans and public sickness funds. A basic obligatory insurance, covering the entire population, was introduced. Health insurers became obliged to accept every citizen for the basic package at the same premium and are compensated for more health consuming subscribers by a risk-equalization fund. These insurers compete based on a basic package defined by the government.[1]

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Key points of the Health Insurance Act</th>
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<tbody>
<tr>
<td>•</td>
<td>Mandatory basic health insurance for everyone, purchased through private insurers (both profit and not-for-profit are possible)</td>
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<tr>
<td>•</td>
<td>Annual consumer choice of insurer and insurer products. Choice between in-kind and restitution policy</td>
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<td>•</td>
<td>Insurers expected to contract selectively with competing hospitals and hospitals are reimbursed by Diagnosis-Related Groups (DTCs)</td>
</tr>
<tr>
<td>•</td>
<td>Government requires hospitals to release quality information</td>
</tr>
</tbody>
</table>
Under the HIA, hospitals remained not-for-profit institutions. Also, private clinics were allowed to provide outpatient and day clinical care. At the same time, transparency was stimulated by developing performance indicators for hospital health care.[13]

**Payment by Diagnosis Related Groups**

The HIA introduced payment by a form of Diagnosis Related Groups (named Diagnosis Treatment Combinations (DTCs) instead of DRGs) for hospitals. Dutch DTCs do not fully equate with DRGs used in other countries. A DTC covers the entire hospital treatment episode over a whole year; there are separate DTCs for outpatient care. In addition, more than one DTC may be billed. Hospital management and specialists are separately reimbursed; in every DTC a (non-negotiable) portion of the price is reserved for the involved medical specialists.

DTCs were split up in two types: A-segment DTCs and B-segment DTCs. For B-DTCs, prices, quality, and volume are freely negotiable between hospital management and insurers. Insurers can purchase extra care in order to reduce waiting times. Hospital management remains under cost-containment policies for A-DTCs, but specialists get ‘open-ended’ reimbursement for A-DTCs as for B-DTCs. This means that for B-DTCs both hospital management and specialists have the incentive to maximize revenue.[14] For A-segment DTCs, only specialists have the incentive to maximize revenue, as hospital management is still paid by block grants for this part of DTCs.

The system started in 2006 with 10% B-DTCs (‘B-2006’), which was increased step-by-step towards 20% in 2008 (‘B-2008’) and 34% in 2009 (‘B-2009’). To include a DTC into the B-segment, the most important criteria are: sufficient revenue to justify serious negotiations, cost homogeneity per DTC and elective care (no life-threatening conditions).[15]

The introductions of DRG systems in both fee-for-service or block grants systems show an increased efficiency of providers mostly by decreasing the average length of stay. Potential undesirable effects of DRGs are ‘upcoding’ and the potential neglect of necessary patient care in order to save money.[16-20]

**Hypotheses of effects of 2006 reform**

In this study we examine how the introduction of a DTC system into the formerly budgeted system affects the performance of hospitals in terms of efficiency, accessibility, and volume of care. We used the national DTC registry, reports of the health care authority, and waiting list registration in the consecutive years 2006-2009. In line with prior studies and policy objectives, we hypothesized that hospitals – especially those facing severe competition – would become more efficient with the introduction of the HIA and that waiting lists would decrease.[18] We expected that efficiency and accessibility gains would be greater in the B-DTCs as there was no volume maximum in this segment of hospital care.

**Methods**

**Database: DTCs**

To test our hypotheses regarding efficiency we used the national DTC registration, which is normally used for billing purposes. For every patient visiting a hospital or private clinic a DTC is opened and DTCs are categorized by medical specialty. The maximum time a DTC can be open is one year; after one year DTCs are processed. For the year 2009 we only analyzed DTCs that were already processed on 31 December 2009. We excluded outpatient DTCs from our analysis for the parameter ‘inputs per DTC’ (see below), as in 2008 the category ‘Urgent care DTCs’ (that were previously registered as outpatient DTCs) were abolished from the Dutch DTC system, leading to incomparable years for outpatient DTCs.[21]
DTC groups
As described in the introduction, each year different DTCs were transferred to the B-segment; the other DTCs remained in the A-segment. To test whether different financing forms for the two DTCs affect efficiency we conducted our analyses for the following four different groups separately:

- A-segment: all DTCs not included in the B-segment during the period 2006-2009 (66% of hospital care).
- B-2006 (10% of hospital care): B-DTCs in the period 2006-2009 - Top three diagnoses (price times quantity): hip and knee replacement (35%), cataract (17%), and lumbar hernia (7%).
- B-2008 (10% hospital care): B-DTCs in the period 2008-2009 - Top three diagnoses: baby delivery (33%), knee surgery for meniscus and distortion (9%), and pacemakers (9%).
- B-2009 (14% of hospital care): B-DTCs in the period 2009 - Top three diagnoses: heart failure (45%), cerebral vascular accident (18%), and breast cancer (6%).[22]

Database: accessibility
To test our hypotheses regarding hospital accessibility we used the national waiting list registry over the period 2006-2009. This registry records the number of weeks for access to a first visit at an outpatient clinic, per specialty, for both hospitals and private clinics. These results were delivered once a month by hospitals and clinics themselves using uniform definitions and were published on websites available to the public.

In addition, the national waiting list registry holds waiting time information for five B-2006 diagnoses: hip and knee replacement, tonsillectomy, varices, and inguinal hernia over the period 2007-2009.[23]

Primary analyses
Inputs per DTC
Every DTC is coupled with medical activities (operative, diagnostic, clinical, laboratory, etc.) that were conducted during the hospital stay. These medical activities are automatically generated or recorded by support staff when one conducts a procedure, diagnostic test or when a patient is enrolled in a planning scheme for e.g. surgery. The information out of the registry of medical activities is used mostly for internal purposes such as calculating cost prices and analyzing hospital logistics. As the reimbursement is solely based on DTCs, hospitals and medical specialists do not have incentives to manipulate the registry of medical activities as the registration of medical activities does not influence the height of the reimbursement.

We weighted each of these 4,029 procedures by multiplying the number of activities times the price per activity. The prices were calculated by the predecessor of the Dutch Healthcare Authority for reimbursement purposes based on costs of representative set of hospitals. We used the same weighting during the period 2006-2009 and did not adjust for inflation. That way, we calculated the total value of medical activities per DTC, which is a detailed proxy for the resources used per DTC and thereby an indicator of hospital efficiency.[14]

Age
We calculated the mean age per DTC group.
Price
The Dutch health care authority calculated the price index per DTC group per year, based on the national DTC registration, unadjusted for inflation, using actual negotiated prices for the B-DTCs and the list prices for A-DTCs. We used these numbers in our study.[15]

Volume
To estimate the volume per DTC group we divided the indexed costs by the indexed prices.

Costs
To estimate total costs per DTC group we used the total costs per year as issued by the Dutch health care authority.[15] As the health care authority only publishes costs for the total A-segment and the total B-DTCs, costs within the different B-segments (2006/2008/2009) had to be allocated. To allocate the total costs of the B-segment as published by the health care authority over these B-DTC groups, we used the total value of medical activities per B-DTC group per year. As the total value of B-segment 2006 was known (as this was the only B-segment in 2006), we used this approach only for the B-segments 2008 and 2009 in the years 2008 and 2009.

Secondary statistical analyses
In Table 4 we used a difference in difference approach using an ordinary least squares (OLS) regression to see whether there are additional efficiency gains when DTCs are transferred from the A to the B groups, correcting for time effects and using dummy variables for the DTC groups as control groups for the baseline trend to allow for the difference in difference approach. In Table 5 we relate hospital efficiency to the level of competition. In order to identify hospitals that faced more competition from neighboring hospitals we used the Herfindahl-Hirschman Index (HHI) of hospitals, which was calculated in 2004.² This HHI was used as an explanatory variable in an OLS regression, correcting for time effects, ages, and socio-economic status of patients.[24]

Results
Table 2 (on the next page) shows the trends in age and accessibility.

In the period 2006-2009 the average age rose between 2.7% and 2.9% in the A-segment and B-2006 group and stayed fairly stable in the B-2008 and B-2009 groups.

Total accessibility (all medical specialties together) stayed stable, where accessibility improved 7.2% in the B-2006 group, as waiting time for the first outpatient visit declined from 6.5 weeks to 6.0 weeks in the years 2007-2009. An OLS regression, where waiting time was the independent variable and the years 2007-2009 were explanatory variables, showed that this reduction in the B-2006 group is significant (p<0.001).

² The Herfindahl-Hirschman Index is a commonly accepted measure of market concentration. It is calculated by squaring the market share of each firm competing in the market and then summing the resulting numbers. For example, for a market consisting of four firms with shares of thirty, thirty, twenty and twenty percent, the HHI is 2600 ((30*30) + (30*30) + (20*20) + (20*20) = 2600).
Table 2  Average age, quality, and accessibility, per DTC group, indexed (2006=100); mean of original values in brackets

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n=2,528,928)</td>
<td>(n=2,738,427)</td>
<td>(n=3,015,113)</td>
<td>(n=1,816,702)</td>
</tr>
<tr>
<td>A-segment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (in years)</td>
<td>100.0 (50.2)</td>
<td>101.4 (50.9)</td>
<td>102.7 (51.5)</td>
<td>102.9 (51.6)</td>
</tr>
<tr>
<td>Accessibility</td>
<td>Unknown for this particular DTC group (see below for total)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B-2006</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (in years)</td>
<td>100.0 (55.7)</td>
<td>100.6 (56.1)</td>
<td>102.1 (56.9)</td>
<td>102.7 (57.2)</td>
</tr>
<tr>
<td>Accessibility</td>
<td>Unknown (6.5)</td>
<td>93.5 (6.1)</td>
<td>92.8 (6.0)</td>
<td></td>
</tr>
<tr>
<td>B-2008</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (in years)</td>
<td>100.0 (39.3)</td>
<td>101.0 (39.7)</td>
<td>102.3 (40.2)</td>
<td>100.8 (39.6)</td>
</tr>
<tr>
<td>Accessibility</td>
<td>Unknown for this particular DTC group (see below for total)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B-2009</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (in years)</td>
<td>100.0 (65.2)</td>
<td>100.3 (65.5)</td>
<td>100.3 (65.4)</td>
<td>100.0 (65.3)</td>
</tr>
<tr>
<td>Accessibility</td>
<td>Unknown for this particular DTC group (see below for total)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total accessibility (in weeks to first outpatient visit)**</td>
<td>100 (3.60)</td>
<td>101.1 (3.64)</td>
<td>99.2 (3.57)</td>
<td>98.9 (3.56)</td>
</tr>
</tbody>
</table>

* 2009 data are incomplete as only DTCs processed by December 31st 2009 are included.
** n= 17,738
*** n= 131,731

Table 3 shows the trends in inputs per DTC, and in volume and total costs per DTC group.

**A-segment DTC**

Within the A-segment efficiency increased; an average DTC in 2009 contains only 83.8% of the medical activities compared to 2006, indicating an average annual productivity growth of 5.1%. Prices rose 9.5% by 2009 and total costs rose 24.1%, mainly due to a volume increase of 13.4%.

**B-2006**

In the B-2006 group efficiency also increased; in 2009 87.3% of resources are used per DTC compared to 2006, indicating an average annual productivity growth of 4.1%. Prices rose 4.8% in the period 2006-2009 and total costs grew to € 1.08 billion, a total rise of 23.1%, largely due to a volume growth of 17.5%.
Table 3  Average inputs, price, volume, and total costs per DTC group, indexed (2006=100), mean of original values in brackets

<table>
<thead>
<tr>
<th></th>
<th>2006 (n = 2,528,928)</th>
<th>2007 (n = 2,738,427)</th>
<th>2008 (n = 3,015,113)</th>
<th>2009* (n = 1,816,702)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A-segment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inputs per DTC</td>
<td>100.0 (2,431)</td>
<td>96.3 (2,342)</td>
<td>88.4 (2,148)</td>
<td>83.8 (2,037)</td>
</tr>
<tr>
<td>Price per DTC**</td>
<td>100.0</td>
<td>102.5</td>
<td>106.4</td>
<td>109.5</td>
</tr>
<tr>
<td>Volume (indexed</td>
<td>100.00</td>
<td>103.89</td>
<td>106.53</td>
<td>113.37</td>
</tr>
<tr>
<td>costs/indexed price</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total costs</td>
<td>100.0 (€ 8.40)</td>
<td>106.5 (€ 8.94)</td>
<td>113.3 (€ 9.52)</td>
<td>124.1 (€ 10.42)</td>
</tr>
<tr>
<td><strong>B-2006</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inputs per DTC</td>
<td>100.0 (1,917)</td>
<td>96.8 (1,855)</td>
<td>91.2 (1,748)</td>
<td>873 (1,673)</td>
</tr>
<tr>
<td>Price per DTC**</td>
<td>100.0</td>
<td>102.1</td>
<td>103.2</td>
<td>104.8</td>
</tr>
<tr>
<td>Volume (indexed</td>
<td>100.00</td>
<td>104.62</td>
<td>115.76</td>
<td>117.46</td>
</tr>
<tr>
<td>costs/indexed price</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total costs</td>
<td>100.0 (€0.88)</td>
<td>106.8 (€ 0.94)</td>
<td>119.5 (€ 1.05)</td>
<td>123.1 (€ 1.08)</td>
</tr>
<tr>
<td><strong>B-2008</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inputs per DTC</td>
<td>100.0 (1,720)</td>
<td>98.0 (1,685)</td>
<td>95.2 (1,637)</td>
<td>92.4 (1,589)</td>
</tr>
<tr>
<td>Price per DTC**</td>
<td>unknown</td>
<td>unknown</td>
<td>100.0</td>
<td>101.4</td>
</tr>
<tr>
<td>Volume (indexed</td>
<td>unknown</td>
<td>unknown</td>
<td>unknown</td>
<td>97.62</td>
</tr>
<tr>
<td>costs/indexed price</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total costs</td>
<td>100.00 (€ 1.22)</td>
<td>113.74 (€ 1.38)</td>
<td>124.96 (€ 1.52)</td>
<td>123.69 (€ 1.50)</td>
</tr>
<tr>
<td><strong>B-2009</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inputs per DTC</td>
<td>100.0 (2,124)</td>
<td>96.1 (2,042)</td>
<td>88.0 (1,869)</td>
<td>86.4 (1,836)</td>
</tr>
<tr>
<td>Price per DTC**</td>
<td>unknown</td>
<td>unknown</td>
<td>100.0</td>
<td>101.2</td>
</tr>
<tr>
<td>Volume (indexed</td>
<td>unknown</td>
<td>unknown</td>
<td>unknown</td>
<td>98.8</td>
</tr>
<tr>
<td>costs/indexed price</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Costs (in billion</td>
<td>100.0 (€ 0.93)</td>
<td>104.1 (€ 0.97)</td>
<td>110.2 (€ 1.02)</td>
<td>110.2 (€ 1.02)</td>
</tr>
<tr>
<td>Euros)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total inputs per DTC</td>
<td>100.0 (2,156)</td>
<td>98.0 (2,111)</td>
<td>91.6 (1,975)</td>
<td>873 (1,882)</td>
</tr>
<tr>
<td>(value of medical</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>activities)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total costs all</td>
<td>100.0 (€ 11.42)</td>
<td>107.1 (€ 12.23)</td>
<td>114.8 (€ 13.11)</td>
<td>122.9 (€ 14.03)</td>
</tr>
<tr>
<td>DTC groups***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*2009 data are incomplete as only DTCs processed by December 31st 2009 are included. As B-group DTCs tend to be declared later than A DTCs, A DTCs may be overrepresented in 2009, leading to an overestimation of the volume growth of A DTCs in 2009 and an underestimation for B DTCs.[22]

**Only indexed prices are known. Prices are only available for B DRGs.

*** Total costs other than DTC costs (subsidies, research grants) are: € 3.01 billion in 2006, € 3.28 billion in 2007, € 3.41 billion in 2008 and € 3.60 billion in 2009.[25]
B-2008
In 2009 an average DTC of the B-2008 group contained 12.7% fewer resources, indicating an annual productivity growth of 2.5% per year. Total costs grew 23.7%.

B-2009
In the B-2009 group efficiency increased 13.6% in the period 2006-2009, indicating an annual productivity growth of 4.3%, where total costs grew 10.2%.

All groups
Total inputs per DTC decreased from 2,156 to 1,882, indicating an average annual productivity growth of 4.6%. Total costs for all DTC groups increased from €11.42 billion in 2006 to €14.03 billion in 2009, an average annual growth of 7.1%.

Effects of transferring DTCs to open-ended reimbursement
We conducted a difference in difference approach where the variable ‘inputs per DTC’ was the independent variable, and years, different groups of DTCs, age, and socio-economic status were dependent variables. In addition, we added a variable for the years that DTCs were transferred from budgeted DTCs into the open-ended system (2008 for the B-2008 group and 2009 for the B-2009 group). The analyses in Table 4 show that the transfer leads to a decreasing efficiency: the B-2008 group shows a decelerating effect on the inputs per DTC of 83.27 in 2008 (5.1% relative to average inputs per B-2008 DTC of 1,637 in 2008, p<0.001). The B-2009 group shows a decelerating effect of 39.71 on the inputs per DTC (2.2% relative to average inputs per DTC B-2009 of 1,836 in 2009, p<0.001).

Table 4  Effects of transferring DTCs to open-ended reimbursement on inputs per DTC

<table>
<thead>
<tr>
<th>Independent variable: inputs per DTC</th>
<th>Coefficient</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effects of transfer in 2008 in group B-2008</td>
<td>83.27</td>
<td>p &lt;0.001</td>
</tr>
<tr>
<td>Effects of transfer in 2008 in group B-2009</td>
<td>39.71</td>
<td>p &lt;0.001</td>
</tr>
<tr>
<td>Year 2007 (compared to 2006)</td>
<td>-58.19</td>
<td>p &lt;0.001</td>
</tr>
<tr>
<td>Year 2008 (compared to 2006)</td>
<td>-226.72</td>
<td>p &lt;0.001</td>
</tr>
<tr>
<td>Year 2009 (compared to 2006)</td>
<td>-325.73</td>
<td>p &lt;0.001</td>
</tr>
<tr>
<td>Group B-2006 (compared to A-segment)</td>
<td>-573.36</td>
<td>p &lt;0.001</td>
</tr>
<tr>
<td>Group B-2008 (compared to A-segment)</td>
<td>-377.48</td>
<td>p &lt;0.001</td>
</tr>
<tr>
<td>Group B-2009 (compared to A-segment)</td>
<td>-588.49</td>
<td>p &lt;0.001</td>
</tr>
<tr>
<td>Age</td>
<td>20.82</td>
<td>p &lt;0.001</td>
</tr>
<tr>
<td>Socio-Economic Status</td>
<td>33.64</td>
<td>p &lt;0.001</td>
</tr>
</tbody>
</table>

Effect of the level of competition on efficiency per DTC
In Table 5 on the next page we analyzed the effect of competition on hospital efficiency via an OLS regression. We use ‘inputs per DTC’ as the dependent variable and years, age, socio-economic status, and the HHI as independent variables. The HHI is negatively related to the inputs per DTC for hospitals, meaning that a higher HHI, which stands for a lower level of competition, is associated with a more efficient production of DTCs. The HHI coefficient is −0.0043 and the values of the HHI in our dataset ranges from 807 to 9,133. Therefore, the effect of the HHI on the total value of the inputs per DTC ranges from 3.5 to 39.8, or approximately 0.15% to 2%.
Discussion

In this study we discuss the effects of payment by DTCs on the efficiency, accessibility, and volume of Dutch hospital care in concordance with each other. In the years 2006-2009 Dutch hospitals improved their productivity annually by 4.6%. In comparison with studies of productivity growth before 2006, it seems that payment by DRGs has spurred productivity growth.[11,14] The growth in productivity in the period 2006-2009 found in this study is in line with previous studies regarding productivity growth of Dutch hospitals in the period 2006-2009.[11,14,26]

Accessibility across all medical specialties has remained stable, but modestly improved within the B-2006 group. Our finding that the 2006 health care reform did not substantially decrease waiting lists is in line with another recent study.[27]

We find that a higher level of competition is associated with a less efficient production of DTCs. This may seem contradictory to conventional economic theory, but is in line with previous studies that empirically relate the level of competition and efficiency of hospitals.[28,29]

Prices rose by 4.8% in the B-2006 group in the period 2006-2009, which is more slowly than the 9.5% in the A-segment. The more moderate price development in the B group may be caused by the negotiating efforts of health insurers. In addition, private clinics were founded (that mostly treat conditions out of the B-2006 group), which tend to have 10-15% lower prices than general hospitals, probably due to more efficient processes and a less severe case mix of patients.[15] This also may have attributed to the relative lower prices in the B-segment. As efficiency growth in the A-segment is highest and prices rose fastest within that group, this suggests that margins increased within the A-segment compared to other DTC groups, assuming equal cost increases for labor, material, and capital across DTC groups.

Remarkably – and contrary to our hypotheses – the fastest productivity growth of 5.1% occurs in the A-segment, where volume and prices are regulated by the health authority and not freely negotiable between insurer and hospitals. The transfer of budgeted DTC groups to open-ended reimbursement had a significant decelerating effect on efficiency. We believe this may be caused by three factors. First, to produce more DTCs in the open-ended reimbursement, additional capacity (beds, diagnostics, etc.) is needed. A part of this capacity is probably created by higher productivity in the budgeted part of care. Second, since the 2006 reform, hospital management is incentivized to minimize costs for the budgeted DTCs as their total budgets are fixed. By using fewer resources per DTC they can save on average costs per DTC, thereby improving operating margins. Lastly, for hospital management and specialists to maximize revenue for DTCs with open-ended reimbursement, it may be easier to produce additional volume in the B-segment than to produce these DTCs more efficiently.

<table>
<thead>
<tr>
<th>Table 5</th>
<th>Effects of competition on inputs per DTC, corrected for time effects, age, and socio-economic status of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Independent variable:</strong> inputs per DTC n= 10,099,170</td>
<td><strong>Coefficient</strong></td>
</tr>
<tr>
<td>HHI</td>
<td>-0.0043</td>
</tr>
<tr>
<td>Year 2007 (compared to 2006)</td>
<td>-44.59</td>
</tr>
<tr>
<td>Year 2008 (compared to 2006)</td>
<td>-183.57</td>
</tr>
<tr>
<td>Year 2009 (compared to 2006)</td>
<td>-279.14</td>
</tr>
<tr>
<td>Age</td>
<td>20.65</td>
</tr>
<tr>
<td>Socio-Economic Status</td>
<td>33.08</td>
</tr>
</tbody>
</table>
Although efficiency increased in all DTC groups, total hospital costs grew annually by 7.1%, largely due to volume growth. As that data for 2009 are incomplete, we use 2008 data to determine which DTC group shows the fastest volume growth. These data show that—in line with our hypotheses—volume grew fastest in the B-2006 group (with open-ended reimbursement), by 15.6% in the period 2006-2008, compared to 6.5% in the A-segment. We do not find evidence for more aggressive treatment styles after the DTC introduction, as the average age of patients being treated is fairly stable across all groups. Nonetheless other studies have found substantial practice variation across all DTC groups in the Netherlands, suggesting that not all volume growth is necessary.[30,31] Therefore, it seems wise to introduce policy tools that decrease practice variation and thereby tame volume and cost growth. An important remark is that volume growth may have caused an overestimation of the found efficiency gains, especially in the B-segment.

Although the findings of our study largely support both our hypotheses and prior studies, our study may have limitations. First, we use the HHI to indicate the level of competition that is calculated in 2004. Although some mergers took place in the Dutch hospital market since 2004, changes in market share over time are fairly modest. In addition, most mergers took place on a board level, while merging the medical specialties over multiple locations often lagged several years behind. This implies the same pre-merger level of competition between medical specialists. Therefore, adjusting the HHI over the course of years would not have altered our conclusions. Second, it is likely that the national DTC registry improves in quality over the years as hospitals have better validation tools in place. Although we have no indication that this effect has affected DTC groups to different degrees, we cannot rule out that this may have had a minor effect on the indexed trends. In addition it may be possible that B-segment DTCs are overrepresented in the DTC registry as the hospital management has the incentive to better register B-segment DTCs as they are reimbursed open ended for this part of hospital care. Last, we did not study the quality of hospital care during the period 2006-2009.

Conclusion

In conclusion, the introduction of managed completion including a DTC reimbursement system seems to have stimulated productivity growth in Dutch hospitals. As efficiency gains are largest for the DTCs with block grants, this study provides evidence that hospital management and medical specialists try to free up capacity within the budgeted part of care to be able to produce more DTCs in the open-ended reimbursement part of care. Probably due to negotiation potential for health insurers, prices rise more slowly in the open-ended reimbursement part of hospital care.

Although productivity was stimulated under the new DTC reimbursement system, total costs rose substantially, mainly through volume growth mostly in DTCs with open-ended reimbursement. Presumably this volume growth has hindered the substantial decline of waiting lists.

All in all, the introduction of DTCs and negotiable prices between hospitals and insurers in the Netherlands seems to have stimulated the efficiency and, to some extent, the accessibility of hospitals. Nonetheless, mainly due to growth in volume, hospital costs keep rising at a fast pace.

Competing interests

The author declares to have no competing interests.
The first effects of Dutch healthcare reform on hospitals
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The use of quality information by general practitioners: does it alter choices?

A randomized clustered study

Authors
Ikkersheim DE, Koolman X. Submitted.
Abstract

Introduction
Following the introduction of elements of managed competition in the Netherlands in 2006, General Practitioners (GPs) and patients were given the role to select treatment hospital using public quality information. In this study we investigate to what extent hospital preferences of GP's are affected by performance indicators on medical effectiveness and patient experiences. We selected three conditions: breast cancer, cataract surgery, and hip and knee replacement.

Methods
After an inquiry, 26 out of 226 GPs in the region signed up to participate in our study. After a 2:1 randomization, we analyzed the referral patterns in the region using three groups of GPs: GPs (n=17) who used the report cards and received personal clarification (n=17), GPs that signed up for the study but were assigned to the control group (n=9), and the GPs outside the study (n=200).

We conducted a difference in differences analysis where the choice for a particular hospital was the dependent variable and time (2009 or 2010), the sum score of the CQI, the sum score of the PI's, and dummy variables for the individual hospitals were used as independent variables.

Results
The analysis of the conditions together, and cataract surgery and hip and knee replacement separately, showed no significant relationships between the scores on the report cards and the referral patterns of the GPs. For breast cancer our analysis revealed that GPs in the intervention group refer 4.6% (p=0.014) more to hospitals that score one percent point better on the indicators for medical effectiveness.

Conclusion
Our study provides empirical evidence that GP referral patterns were largely unaffected by the available quality information. This finding was surprising since our study was designed to identify changes in hospital preference 1) amongst the most motivated GP’s, 2) who received personal clarification of the performance indicators, and 3) with selected indicators/conditions from a large set of indicators that they believed were most important. This finding may differ when quality information is based on outcome indicators with a clinically relevant difference, as shown by our indicators for breast cancer treatment. We believe that the current set of (largely process) hospital quality indicators do not serve the GP’s information needs and consequently quality plays little role in the selection of hospitals for treatment.
Introduction

Health care reform is widespread among Western countries in search of more efficient health care provision.[1] While countries with private payers like the Netherlands introduced a form of managed competition, other countries with a public payer system like the United Kingdom (UK) introduced elements of provider competition.[2-4] Regardless of health care system, recent health care reforms stimulate providers to compete for the favour of the patients.[3,5] To achieve this goal, provider quality needs to be transparent.[6,7] Public reporting of provider quality can enable quality improvement at the provider and system level. Providers may use the information to improve processes and results.[8] Patients, payers, and referring professionals such as general practitioners (GPs) may use the information to select providers, and thus shifting capacity towards the high quality providers.[8]

Much is expected from GPs, who are familiar with their patients’ conditions and circumstances, are able to evaluate quality information and are aware of the fact that their patients place great trust in their advice.[7] Consequently, policy makers in different countries are strengthening the position of GPs to allow them to guide the patient to the appropriate hospital.[5,9] For instance, within proposed NHS reform the GP consortia will commission the majority of care for their patients.[10] Also in the US initiatives such as ‘Medical Homes’ are introduced, where primary care physicians are expected to take on the responsibility for coordination of care, which includes referring people to the right provider.[11,12] In the Netherlands, quality information about hospitals became public, to allow patients and GPs to choose hospitals based on objective indicators.[5,13]

Previous studies show that patients may experience difficulties interpreting quality information on report cards.[14] This may be one of the factors why providers that perform well on report card metrics do not attract more patients, even if they outperform other providers on public metrics for consecutive years.[15] In contrast to patients, GPs know which outcomes are important for patients and what processes may lead to these outcomes. Consequently, they are well equipped for judging the meaning and relevance of quality information. In addition, research shows that in the Dutch context, GPs have significant influence in directing patients: 68% of patients who searched for information to select a hospital, state that they determined their choice for a hospital based on the advice of their GP.[16] This percentage is likely to be higher for patients that do not seek information. This puts GPs in the driving seat, and the success or failure of competition on quality depends largely upon the extend to which GPs use quality information to refer patients.

In this study we investigate to what extent GPs are influenced in their hospital choice by using report cards with quality indicators on medical effectiveness and patient experiences for the conditions: breast cancer, cataract surgery, hip and knee replacement when referring patients to hospitals.

Methods

Recruitment, randomization and report cards

To recruit GPs for our study, in September 2009 we sent all 226 GPs in the region Eindhoven a letter, followed-up by phone calls. Based on this enquiry 26 GPs signed up for our study. Based on publicly available quality indicators we drafted report cards with both patient experience and medical effectiveness indicators. For patient experiences we used the Customer Quality Indexes (CQI), which is partly based on the Consumer Assessment of Healthcare Providers and Systems. [13,17-19] In the medical effectiveness domain we selected a shortlist of indicators from the institute ‘Transparent Care’. This institute followed from a nationwide initiative to develop, measure, and publish process and outcome indicators that mostly originated from scientific literature.[20]
We randomly assigned GPs in the intervention group and the control group in a 2:1 proportion. 17 GPs worked with report cards and 9 GPs continued working without report cards and functioned as control group. In addition we used the data of the non-participation GPs (n=200) as a control group outside our study. By doing so we set up a randomized clustered trial in the south of the Netherlands around the city of Eindhoven; the city has around 217,000 inhabitants, the metropolitan area nearly 750,000.[21] Within this area four general hospitals are located within a diameter of 15 kilometers, which all provide treatment of breast cancer, cataract surgery, and hip and knee replacement.

**Figure 1: Study recruitment and randomization diagram**

![Study recruitment and randomization diagram](image)

We then discussed the drafts of the report cards with the GPs of the intervention group to identify the most relevant indicators from the GPs’ perspective. These indicators were selected for this study. During this discussion, it turned out that the quality information presented for each hospital was new for the GPs and did not match their informed opinion. GPs selected only outcome and process indicators (rather than structure indicators) and preferred an equal distribution between indicators for patient experience and medical effectiveness on the report cards. The final paper report cards were sent to the intervention group accompanied by background information and scientific references. All 17 GPs in the intervention group received a one hour instruction on how to interpret the report cards. The report cards were presented as plasticized papers for convenience. The actual use and value of the report cards was determined by the individual GP; the only request was that the report card be discussed with the patient prior to the referral to the hospital. The used report cards are shown in Table 1, 2 and 3.
### Table 1  Breast cancer report card

<table>
<thead>
<tr>
<th></th>
<th>Queens Hospital*</th>
<th>Essex Hospital*</th>
<th>Violett Hill Hospital*</th>
<th>Flower Hospital*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication with surgeon</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>Communication with nurse</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>Would you recommend the hospital to friends and relatives (5-point scale)?</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>Volume of patients undergoing surgery in 2009</td>
<td>182</td>
<td>118</td>
<td>187</td>
<td>140</td>
</tr>
<tr>
<td>Number of surgeons in hospital who conduct breast cancer surgery</td>
<td>3 of 10</td>
<td>3 of 8</td>
<td>7 of 13</td>
<td>2 of 7</td>
</tr>
<tr>
<td>Percentage of breast cancer operations where radical surgery is achieved during first surgery in breast saving therapy</td>
<td>95.2%</td>
<td>87.2%</td>
<td>86.3%</td>
<td>94.4%</td>
</tr>
</tbody>
</table>

### Table 2  Cataract surgery report card

<table>
<thead>
<tr>
<th></th>
<th>Queens Hospital*</th>
<th>Essex Hospital*</th>
<th>Violett Hill Hospital*</th>
<th>Flower Hospital*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication with ophthalmologist</td>
<td>★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★</td>
</tr>
<tr>
<td>Communication with nurse</td>
<td>★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>Communication about medicine</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>Would you recommend the hospital to friends and relatives (5-point scale)?</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>Percentage patients who have a complication following eye surgery leading to vitrectomy</td>
<td>0.41% of 1,937 operations</td>
<td>0.79% of 1,270 operations</td>
<td>0.44% of 2,516 operations</td>
<td>0.44% of 1,127 operations</td>
</tr>
<tr>
<td>Percentage patients who have at least 28 days interval between cataract surgery first and second eye</td>
<td>98.4% of 423 operations</td>
<td>100% of 276 operations</td>
<td>90.1% of 943 operations</td>
<td>100% of 756 operations</td>
</tr>
</tbody>
</table>

### Table 3  Hip and knee replacement report card

<table>
<thead>
<tr>
<th></th>
<th>Queens Hospital*</th>
<th>Essex Hospital*</th>
<th>Violett Hill Hospital*</th>
<th>Flower Hospital*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication with orthopedic surgeon</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>Communication with nurse</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>Would you recommend the hospital to friends and relatives (5-point scale)?</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★½</td>
<td>★★★★★</td>
</tr>
<tr>
<td>Percentage decubitus with patients undergoing hip replacements</td>
<td>2.6% of 332 operations</td>
<td>2.8% of 144 operations</td>
<td>1% of 398 operations</td>
<td>0% of 413 operations</td>
</tr>
<tr>
<td>Percentage deep wound infections hip replacement</td>
<td>0% of 332 operations</td>
<td>0.7% of 144 operations</td>
<td>2.8% of 398 operations</td>
<td>0% of 413 operations</td>
</tr>
<tr>
<td>Percentage deep wound infections knee replacement</td>
<td>0.5% of 194 operations</td>
<td>1.0% of 104 operations</td>
<td>0.9% of 230 operations</td>
<td>0.3% of 293 operations</td>
</tr>
</tbody>
</table>

*names of hospitals are feigned (original hospital names were shown at report cards)

★ stands for statistical significantly lower patient average than national average meaning

★★★ stands for average patient experience

★★★★ stands for statistical significantly higher than national average
Data collection and statistical analyses referral patterns

Nearly all GPs in the region Eindhoven use the digital application ‘Health Domain’ to electronically refer patients to hospitals. [22] To monitor referral patterns of GPs we used data of Health Domain of participating (n=26) and non-participating GPs (n=200) for the 12 month period of the study (year 2010) and the 12 months prior to the study (year 2009).

Our database consists of all individual referrals from GPs to hospitals, where every individual referral is a record in our database. We linked the sum score of the indicators of patient experience (CQI) and medical effectiveness (performance indicators (PI’s)) as separate categories per condition with the hospital per referral in the database, such that a higher sum score relates to better performance of a hospital.[23] In addition, we related waiting times (in number of days to the first outpatient visit) per condition per hospital per week to the unique referrals using the waiting list registry that is available in the application ‘Health Domain’, which is weekly updated by the hospitals themselves.

To analyze the effects of our intervention we used a difference in difference analysis. We used this technique to estimate changes in the referral patterns due to the introduction of the report cards in 2010 in the intervention group. While the differences between the intervention group and the control group within the study may be confounded (due to chance), we expect the difference in changes in referral patterns over time to be comparable. This means that our statistical method corrects for potentially unobserved confounding differences and cluster effects of practices in the control and treatment groups that are fixed over time.[24]

For the difference in difference approach we used a logistic regression. In our database every individual referral is a row and we quadrupled every referral, simulating the choice each patient/GP have had between the four hospitals in the region. We then labeled the actual choice for the hospital of referral with a ‘1’ and the three hospitals that were not chosen with a ‘0’. These variables 0 and 1 were the dependent variable in our regression.

We used the following variables as independent variables in our regression:

- The sum score of the CQI and PI’s per hospital per condition;
- The interaction terms between the group (intervention, control group within study) and the sum score of the CQI and PI’s per hospital per condition, each for the years 2009 and 2010, so in total eight terms:
  - one term for the general effect (in years 2009 and 2010) of the CQ in the intervention group;
  - one term for the general effect (in years 2009 and 2010) of the CQ in the control group within the study;
  - one term for the general effect (in years 2009 and 2010) of the PI’s in the intervention group;
  - one term for the general effect (in years 2009 and 2010) of the PI’s in the control group within the study;
  - one term for the specific effect in 2010 (year with report cards) of the CQ in the intervention group (displayed in Table 6);
  - one term for the specific effect in 2010 (year with report cards) of the CQ in the control group within the study (displayed in Table 6);
  - one term for the specific effect in 2010 (year with report cards) of the PI’s in the intervention group (displayed in Table 6);
  - one term for the specific effect in 2010 (year with report cards) of the PI’s in the control group within the study (displayed in Table 6).

1 Estimations of the local GP association are that 95% of GPs use Health Domain.
• The waiting time per condition per hospital per week of the referral;
• We corrected for cluster effects of hospitals using dummy variables per individual hospital.

**Interviews with GPs in intervention group**
After the study period we held semi-structured 30 minute interview with all 17 GPs in the intervention group to qualitatively assess:
• The ease of the use of report cards
• How GPs interpreted the report cards (where some hospitals delivering better quality of care in their view?)
• To discuss the expected impact of the GPs on their referrals (did they alter their referral patterns based on the report cards?).

After these interviews a short report per interview was made and sent for review to the GPs (interviews were not recorded). We read all these reports and summarized our findings in the result section of this study.

**Ethical approval**
Ethical approval for this study was given by the nationwide ethics committee (Centrale Commissie Mensgebonden Onderzoek (CCMO)) as part of receiving the funding by ZonMw, the Dutch organization for health research and development.

**Results**

**Baseline data**
In Table 4 the characteristics of the GPs who participated in the study are given.

<table>
<thead>
<tr>
<th></th>
<th>Intervention group</th>
<th>Control group within study</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>17</td>
<td>9</td>
</tr>
<tr>
<td>% male</td>
<td>41%</td>
<td>44%</td>
</tr>
<tr>
<td>% in urban area (in city Eindhoven)</td>
<td>35%</td>
<td>33%</td>
</tr>
</tbody>
</table>

In Table 5 the total number of referrals to hospitals per GP group are displayed, per condition per year. The percentages shown are percentages based on the total number of referrals for that specific condition, group, and year (number in cell divided by number in column ‘Total’ on the right side of Table 5).

**Impact report cards on choices**
In Table 6 on page 72 the outcome of the logistic regression on the referral patterns are shown. For breast cancer specifically our analysis shows that GPs in the intervention group refer 4.6% (p=0.014) more to hospitals that score one point better on indicators for medical effectiveness. In addition, also for breast cancer specifically, GPs refer 6.9% (p=0.015) less to hospitals that score one point higher on the CQI. The analysis of all conditions together, and cataract surgery and hip and knee replacement separately, show no significant relationships between the scores on the report cards and the referrals of the GPs.
Table 5  Baseline characteristics referral patterns

<table>
<thead>
<tr>
<th></th>
<th>Queens Hospital*</th>
<th>Essex Hospital*</th>
<th>Violet Hill Hospital*</th>
<th>Flower Hospital*</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Breast cancer</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control group outside study (n=200 GPs) – 2009</td>
<td>348 (24%)</td>
<td>406 (28%)</td>
<td>475 (33%)</td>
<td>229 (16%)</td>
<td>1,458</td>
</tr>
<tr>
<td>Control group outside study (n=200 GPs) – 2010</td>
<td>440 (25%)</td>
<td>494 (28%)</td>
<td>513 (29%)</td>
<td>296 (17%)</td>
<td>1,743</td>
</tr>
<tr>
<td>Intervention group (n=17 GPs) – 2009</td>
<td>13 (19%)</td>
<td>18 (27%)</td>
<td>13 (19%)</td>
<td>23 (34%)</td>
<td>67</td>
</tr>
<tr>
<td>Intervention group (n=17 GPs) – 2010</td>
<td>24 (32%)</td>
<td>13 (17%)</td>
<td>25 (33%)</td>
<td>14 (18%)</td>
<td>76</td>
</tr>
<tr>
<td>Control group within study (n=9 GPs) – 2009</td>
<td>4 (27%)</td>
<td>6 (40%)</td>
<td>2 (13%)</td>
<td>3 (20%)</td>
<td>15</td>
</tr>
<tr>
<td>Control group within study (n=9 GPs) – 2010</td>
<td>2 (17%)</td>
<td>3 (25%)</td>
<td>5 (42%)</td>
<td>2 (17%)</td>
<td>12</td>
</tr>
<tr>
<td><strong>Cataract Surgery</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control group outside study (n=200 GPs) – 2009</td>
<td>249 (27%)</td>
<td>225 (24%)</td>
<td>250 (27%)</td>
<td>209 (22%)</td>
<td>933</td>
</tr>
<tr>
<td>Control group outside study (n=200 GPs) – 2010</td>
<td>341 (28%)</td>
<td>328 (27%)</td>
<td>307 (25%)</td>
<td>242 (20%)</td>
<td>1,218</td>
</tr>
<tr>
<td>Intervention group (n=17 GPs) – 2009</td>
<td>29 (55%)</td>
<td>2 (4%)</td>
<td>9 (17%)</td>
<td>13 (25%)</td>
<td>53</td>
</tr>
<tr>
<td>Intervention group (n=17 GPs) – 2010</td>
<td>28 (41%)</td>
<td>7 (10%)</td>
<td>11 (16%)</td>
<td>22 (32%)</td>
<td>68</td>
</tr>
<tr>
<td>Control group within study (n=9 GPs) – 2009</td>
<td>3 (21%)</td>
<td>0 (0%)</td>
<td>2 (14%)</td>
<td>9 (64%)</td>
<td>14</td>
</tr>
<tr>
<td>Control group within study (n=9 GPs) – 2010</td>
<td>2 (14%)</td>
<td>0 (0%)</td>
<td>7 (50%)</td>
<td>5 (36%)</td>
<td>14</td>
</tr>
<tr>
<td><strong>Hip and knee replacement</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control group outside study (n=200 GPs) – 2009</td>
<td>1,443 (22%)</td>
<td>1,752 (26%)</td>
<td>2,121 (32%)</td>
<td>1,387 (21%)</td>
<td>6,703</td>
</tr>
<tr>
<td>Control group outside study (n=200 GPs) – 2010</td>
<td>1,598 (22%)</td>
<td>2,040 (28%)</td>
<td>1,921 (26%)</td>
<td>1,764 (24%)</td>
<td>7,323</td>
</tr>
<tr>
<td>Intervention group (n=17 GPs) – 2009</td>
<td>85 (30%)</td>
<td>41 (14%)</td>
<td>82 (29%)</td>
<td>75 (27%)</td>
<td>283</td>
</tr>
<tr>
<td>Intervention group (n=17 GPs) – 2010</td>
<td>83 (28%)</td>
<td>61 (20%)</td>
<td>74 (25%)</td>
<td>82 (27%)</td>
<td>300</td>
</tr>
<tr>
<td>Control group within study (n=9 GPs) – 2009</td>
<td>36 (32%)</td>
<td>26 (23%)</td>
<td>33 (29%)</td>
<td>17 (15%)</td>
<td>112</td>
</tr>
<tr>
<td>Control group within study (n=9 GPs) – 2010</td>
<td>47 (38%)</td>
<td>18 (15%)</td>
<td>26 (21%)</td>
<td>33 (27%)</td>
<td>124</td>
</tr>
<tr>
<td><strong>Total all referrals, all years, all groups</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20,516</td>
</tr>
</tbody>
</table>
Interviews with GPs
The GPs unanimously stated that - in general- there was a lack of differentiation between the scores on the report cards, or that the scores were contradictory. For instance for the report card regarding cataract surgery the Essex hospital performs well on the patient experiences, but it performs rather poor on the domain of medical effectiveness.

For the report card regarding hip and knee replacements, there is a lack of differentiation for the patient experiences and GPs stated that the differences in the indicators for medical effectiveness are rather small and some scores are unlikely to be so good (Flower hospital). In addition, they mentioned the fact that indicators on the report cards give process rather than outcome information, which limits the potential impact of the report cards even more so. In contrast, the majority of GPs said that the report card for breast cancer was an exception, with more differentiating and also more relevant indicators as the indicator “% breast cancer operations where radical surgery is achieved during first surgery” was considered a rather meaningful measure, where confounding was unlikely. In addition, the scores on this indicator per hospital were supported by the other indicator on the report card: the volume of breast cancer patients per surgeon per year, where many studies have shown a positive volume outcome relationship for this condition.[25]

During the interviews it became clear that other aspects than quality information on report cards had impact on the GPs’ referral to a hospital. These aspects include: personal preferences of the GP, communication of specialists after discharge with the GP, consultation options of medical specialists and whether the GPs knows the medical specialist who he is referring to in person.

GPs stated that they were unsure whether the report cards altered their referral patterns and also mentioned that taken the time to thoroughly discuss the report cards with patients was about 5 minutes, which is fairly long as a standard consult takes about 10 minutes in a Dutch GP practice.
Discussion

In many countries policy reforms are implemented that rely on GPs to guide patients to the ‘best’ hospitals using publicly available quality information. If a success, these reforms enhance the medical quality and patient centeredness of these health care systems. In this study we show the effect of report card use by GPs in referring their patients to the hospital under optimal conditions. In contrast to prior studies we do not use surveys of patients or GPs, but use actual referral data. [26,27] Given the training and experience of GPs, GPs should be well equipped to understand, interpret, and use the quality information wisely. In addition, patients rely on their GP for their hospital choice. Given these circumstances we expect that if the current quality information would have the potential to alter choices of patients for hospitals, our study should bring this to light.

Our analyses show mixed results regarding the impact of report cards. The overall analyses did not show significant alteration in referral patterns of GPs in the intervention group compared to the control group within and outside the study, which is in line with previous studies.[27-29] Nonetheless, for the condition breast cancer this study shows that a one point higher score on indicators for medical effectiveness results in a 4.6% (p=0.016) increase in the likeliness of referring a patient to that hospital. This finding is in line with the qualitative statements of the GPs, where they mentioned that the breast cancer indicators for medical effectiveness appeared to be the most valid, reliable and differentiating indicators.

The finding that GPs rely for their referrals on other aspects than quality information is in line with previous survey studies, that show that GPs usually refer patients to hospitals based on their (informed) opinion about a particular hospital rather than quality information.[26,27]

While our experimental design is robust in many ways, our study may have suffered from possible limitations. First, the number of GPs included in our study is limited, therefore minor changes in referral patterns might not result in statistically significant changes. Second, the period of our study is only one year. Therefore results in this study should be interpreted as short term results.

Conclusion

Our study provides empirical evidence that GP referral patterns were largely unaffected by the available quality information. This finding was surprising since our study was designed to identify changes in hospital preference 1) amongst the most motivated GP’s, 2) who received personal clarification of the performance indicators, and 3) who selected indicators/conditions from a large set of indicators that they believed were most important. This finding may differ when quality information is based on outcome indicators with a clinically relevant difference, as shown by our indicators for breast cancer treatment. We believe that the current set of (largely process) hospital quality indicators do not serve the GP’s information needs and consequently quality plays little role in the selection of hospitals for treatment.

Competing interests
The authors declare to have no competing interests.

Funding
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References


10. Wise J: GPs are handed sweeping powers in major shake up of NHS. BMJ 2010, 341:c3796.


22. For more information on Health Domain see: www.zorgdomein.nl

23. We ensured that the higher the score the more positive the score was. For e.g. the indicator percentage infections we subtracted this score from 100%.


Does value-based competition improve value?

Evidence from the Dutch health care reform

Abstract

Objective
How to structure competition in health care remains subject of debate. Over the last decade significant reform has taken place in different sectors of the Dutch health care system where managed competition and value-based competition (VBC) principles were applied into a varying extent.

Methods
We examined trends in costs and quality for different health care sectors over the period 2000-2008. We related the costs and quality trends per health care sector to what policy principles were applied.

Results
The two health care sectors where VBC principles were applied (hospitals and intramural elderly care) showed heightened efficiency of care and at the same time quality indicators showed an improvement. Nonetheless on a sector level, the operational efficiency gains were not translated in declining total costs due to volume growth.

Conclusion
Our analyses show that an introduction of VBC principles seems to be related with a better costs/quality ratio of care on a product level, although these gains are not translated in lower costs on a sector level. At this point in time health plans have been unsuccessful in channeling customers to preferred providers. Therefore the effect of managed competition seems to be limited, although this may change in the future.
Introduction

Since decades health care costs have outpaced gross domestic product (GDP) growth in Western countries.[1] At the same time, studies toward adverse outcomes show that health outcomes are less than could be expected.[2] Scholars and policy makers continue to search for ways to create a cost-effective, demand-driven system that addresses both of these challenges. As described by Cutler, health care reform typically follows three waves.[3] At first, universal coverage and access are pursued. Countries are willing to accept spending above efficient levels to meet distributional goals, but finding it hard to afford because the growing health care costs outpace the growth of GDP. In order to slow down cost growth, cost-containment policy measures are issued in the second wave of reform. Enthusiasm for the rationed model then gradually fades; inefficiencies occur under cost-containment policies as providers have limited incentives to work efficiently, and many of the of the cost-containment measures yield one time savings, while the long term rise in health care costs continues. This brings us at the third wave of health care reform: the wave of incentives and competition in which most Western countries are today. Many studies have analyzed the effect of competition on the quality of care. Evidence from the US suggests that under fixed prices, quality improves in areas with higher competition.[4] Studies conducted in the UK show similar outcomes.[5-8] Studies looking into the effect of competition in the context of free prices show that competition leads to lower prices of care.[9-11] Two approaches within this third wave of health reform have been widely discussed over the last years: ‘managed competition’ as described by Enthoven and ‘value-based competition’ as described by Porter.[12,13]

Within the concept of managed competition, preconditions for regulated competition are created by risk-compensation for payers, product classification, and measuring quality of these products.[12,14] Payers are then expected to selectively contract competing system of integrated care providers based on their costs/quality ratio.[12] Evidence suggest that systems of managed competition (such as Health Maintenance Organizations (HMOs) in the US), manage to drive down the costs of health care, but produce rather similar outcomes in terms of quality of care, compared to other types of health insurance systems.[15,16] Nonetheless, critics of managed care state that these cost savings of HMOs may be (partly) attributable to purchase advantages rather than operational efficiencies of providers.[15]

Porter and Teisberg proposed to structure the health care market based on their value-based competition (VBC) theory, that has both similarities and differences with the concept of managed competition.[13] Like the concept of managed competition, VBC includes a focus on transparency of costs and outcomes of care. Compared to the concept of managed competition, the VBC theory has a significant difference and that is the role of payers and customers the VBC theory envisions. Where the concept of managed competition advocates health care systems where payers contract integrated delivery systems (IDSs), the VBC theory stipulates that informed customers should choose the best integrated provider units (IPUs) based on outcomes of care. IPUs should be reimbursed via bundled payments that are aligned with value for patients around the full cycle of care per condition.[13,17] Porter and Teisberg argue that IPUs face competition from all other IPUs treating the same condition and are therefore motivated to excel and lower costs, whereas it is unlikely that a vertically integrated systems will contain the highest value providers in every single service area.[18,19]

Until now, there has been limited empirical evidence regarding the results of application of VBC at the health care system level. To gain insight into the systemic effects of VBC, this study analyzes the effects of the Dutch health reform, that combines elements of both managed competition as well as the VBC theory, in varying degrees per health care sector.
Payer reform

After more than a decade of debate, the Ministry of Health concluded in 2000 that the performance of the Dutch health care system was insufficient to meet the demands of the citizens. Due to top-down supply containment policies, there were waiting lists, patients had limited choices in terms of providers, and provider productivity was lagging. This led to the reform of the Dutch health care system.

Hospital care, outpatient mental health care, and primary health care (coined the ‘cure’ system), underwent reform. In 2006, the ‘Health Insurance Act (HIA)’ came into effect. This law reformed the payment system by initiating a system of managed competition inspired by Enthoven. The distinction between private health plans and public sickness funds was abolished: all health plans became private, but both for-profit and not-for-profit plans were available. Health insurance became obligatory, and health plans were obliged to accept every citizen for a standardized package at the same premium.

Every health plan can set its own premium, but plans cannot differentiate between patients within the plan. A risk-equalization fund compensates health plans for differences in risk loads, and premiums are subsidized for low-income households. There is a mandatory deductible of € 150 per person, which can be voluntary increased to € 650 per person per year to reduce premiums. Employers play a limited role but can negotiate collective insurance deals for their employees. The standardized package is defined by the government and is rather comprehensive; health plans are free to offer additional packages. Providers and health plans remain separate entities, and there are no concepts such as ‘integrated delivery systems’ (IDSs) in the reformed Dutch health care system as pre-set ties between health plans and providers are seen as potentially limiting the benefits such competition can bring.

Health plans are expected to contract selectively based on price and quality on behalf of their subscribers. Health plans are allowed to offer subscribers both refundable or in-kind insurance. They are able to differ the amount of deductible per provider per treatment, to stimulate patients to go to preferred suppliers. Nonetheless, full freedom of choice between providers for customers exists as health plans companies cannot commit their subscribers to providers. Health plans are expected to play a directing role in coordinating care across providers, to stimulate an integrated delivery of care.

Long term care, inpatient mental health care, and home care (coined the ‘care’ system in the Netherlands) are financed mostly by taxes through the ‘Exceptional Medical Expenses Act (AWBZ)”; approximately 10% is funded by co-payments. Non-competing regional ‘health agencies’ administer the AWBZ. Before 2003, every provider was assigned a budget regardless of the value the provider delivered or the number of patients treated by the provider. After the 2003 reform, reimbursement became better connected to value for patients as the products became functionally described instead of the previous input parameters, although the budget per provider remained. Regional health agencies started with pay-for-performance schemes for providers based on structure and process quality indicators. In 2007, domestic home care was transferred from the AWBZ to the ‘Social Support Act (WMO)’. Within the WMO, municipalities are responsible for purchasing domestic health care through public tenders.

Product reform

In the earlier system, top-down limited budgets existed for providers. If the annual budget was exceeded, providers were reduced proportionally for the following year. This was known as ‘input’ reimbursement. In 2006 a product-based reimbursement system was introduced for hospitals, so called ‘diagnosis treatment combinations’ (DTCs; a form of ‘diagnosis-related groups’ (DRGs)).
In 2009, ‘care intensity packages’ were introduced in the intramural elderly care sector, reimbursing the whole cycle of care during the period of intramural stay. The amount of money tied to a care intensity package is based on an assessment of an individual patient by an independent indication agency.[28] These types of products that reimburse multiple aspects of care are therefore a form of bundled payments as defined by the VBC theory.[13]

**Transparency of quality**

The notion that standardization of quality reporting at the level of health care products is a prerequisite for transparency led to the founding of the institute ‘Transparent Care’ (Zichtbare Zorg). This institute works together with providers and professionals in all health care sectors to create a nationwide, standard set of quality indicators for each sector for all relevant conditions.[29]

**A natural experiment**

Since the start of the reform, the principles of Enthoven and VBC have been implemented in the different health care sectors in the Netherlands to a varying extent. The reform started in hospital and primary care sector as preconditions for regulated competition were met; a product structure was developed based on the international DRG system, and quality measurement became possible via available quality indicators.[14,20,30] Also there was already a risk-adjustment scheme in place that created a level playing field for health plans to compete and contract care on behalf of their subscribers.[20] In addition, long waiting lists in the hospital sector existed, and because the hospital sector is the largest sector in the cure system, policy makers felt the need to reform this sector.[31]

The care system reform was initially planned at the same speed as the cure sector, but this process was delayed and reform is now carried out in a stepwise process.[20,32] Nonetheless, especially in the elderly care sector reforms took place, as two of the three preconditions for regulated competition were met. First, quality measurement in the elderly care sector was more advanced than in the other care sectors.[29,33] Second, regional health agencies were able to categorize intramural elderly care in standard products, using functionally described input parameters. In addition, policy makers felt the need to reform the intramural elderly care sector as it is the largest sector in the care system (approximately 50% of the funds) and given the fact that the graying society would result in increasing demand for this type of care.[20,25]

As the presence or absence of the preconditions for regulated competition themselves may not influence the costs of care nor the quality of care, these circumstances led to a natural experiment of sectors that were faced with the application of VBC principles in varying degrees.

In the next sections we briefly describe the situation of product definition, reimbursement, and quality measurement per sector.

**Care by general practitioners**

Until 2005, general practitioners (GPs) were reimbursed with a yearly subscription payment for each patient enrolled in a sickness fund, regardless how often the patient visited the GP. For patients enrolled in a private health plan, GPs received a per-visit fee, and there was often a patient co-payment as part of the fee. Under the HIA, GPs are reimbursed in part by a yearly tariff of € 52 per subscribed patient, and, in addition, they receive a fixed fee of € 9 for each visit. As the outcomes in this sector are not transparent at this point in time, insurers do not selectively contract GPs yet.[34]
Care by physiotherapists

Until 2004, physiotherapists were reimbursed by both sickness funds and private health plans as part of the collective basic health care package. From 2004 on, reimbursement was provided on a per-visit basis, and prices became freely negotiable between health plans and physiotherapists. The outcomes in this sector are not transparent at this point in time.[29,34]

Mental health care

A DRG system based on DSM-IV diagnosis was developed for extramural mental health care, although every DRG has multiple categories, depending on the number of minutes spent with patients. The more minutes spent with the patient, the higher the reimbursed fee, resulting in a fee-for-service system concealed within the DRG system. In addition, mental health care institutions receive additional funds per intramural bed in the period 2000-2008. Process outcomes are becoming transparent in this sector, but trends are not yet apparent, and measurements are often incomplete.[29,34]

Hospital care

To enable provider competition, in 2006 products were defined in terms DTCs, which are rather comparable to diagnosis related groups (DRGs). In 2006, 10% of the prices of DTCs were freely negotiable between hospitals and health plans, and this was heightened to 20% in 2008. A number of initiatives were aimed at making provider quality transparent, starting to enable health plans to contract selectively.[29,30,34,35]

Intramural elderly care

Since 2003 products in the intramural elderly care products were functionally described, meaning that providers were paid once clients had a indication for e.g. nursing rather than the number of inpatient days produced. In the period 2003-2008 bundled payments were designed based on the amount of care needed based on the condition of a patient, which was effectively introduced in 2009. In addition, there is information about health care quality for an increasing number of conditions. Regional health agencies increasingly set up pay-for-performance schemes for intramural elderly care providers.[29,34]

Nursing and domestic home care

The nursing and domestic home care sectors got reimbursed based on the set of activities within a service performed (e.g. nursing, nourishing, cooking, cleaning, etc.) since 2005. Outcomes for nursing home care are starting to become transparent.[29,34]

In this study, we examined the cost and quality development in health care sectors during the 2000–2008 period. We relate the trends in costs and quality in each health care sector to the extent to which the principles VBC were implemented during the study period.

Methods

Study data

In this study we conducted a trend analysis on a population level, as we analyzed year on year differences in costs and quality at a national level per health care sector in the period 2000–2008. The used data came from previously published reports by authorities and nationwide databases and therefore we were not able to apply secondary statistic tests. Demographics over the study period show a trend toward a graying society; in 2000 there were 10.4% people over 65 years old, in 2008 11 % of the population was over 65 years.[36]
**Costs**
As costs are caused by prices per individual case times quantity, we included the following domains: price, operational efficiency, volume, and total costs as share of GDP. We calculated the compound annual growth rate (CAGR) as share of GDP per health care sector for the relevant period based on the policy interventions per health care sector in the period 2000–2008, and compared the data - if possible - with OECD data. For hospitals, for example, we calculated the CAGR for the period 2006–2008, as the HIA became effective in 2006. In parts of the Dutch health care system, prices are still regulated and therefore are not a valid indicator for trends in efficiency within health care sectors. We chose to include operational efficiency, such as average length of stay, consultations per patient, etc., as a proxy for efficiency per individual case. We used databases and annual reports from the College of Health Plans, the Central Bureau of Statistics, and the Dutch Healthcare Authority.[34,36,37]

**Quality**
The selected domains regarding quality were as follows: medical quality (effectiveness and patient safety), patient experiences, and timeliness (waiting lists). To collect data, we used the national registry from the Transparent Care Institute, complication registries, and annual reports of sector associations and reports from the Dutch Healthcare Authority.[29,33,34] To determine trends in patient experiences, we used the Customer Quality Index (CQI), which is partly a transformation of the CAHPS hospital questionnaire but which is also used in most other Dutch health care sectors. Lastly, we used national registries and sector reports to gauge waiting list trends for each sector.[38]

**Characteristics per health care sector**
As described in the introduction, health care reform took place at various speed in various health care sectors. To relate the trends in costs and quality to the used policies we describe the characteristics per health care sector in Figure 1, based on the description per health care sector in the introduction. For every health care sector we describe three factors: 1) the nature of the reimbursement: whether or not it is aligned with value for patients), 2) the level of quality measurement: whether or not outcome or process measures are transparent for health plans and customers, and 3) the possibility for health plans to contract providers selectively.

We judged every health care sector to see whether these factors were applied or not, using Harvey balls. If a sector did not apply a factor, we marked the Harvey ball white. If a part of the sector (e.g. some products) used the factor, the Harvey ball is marked black by a quarter. If the factor is applied to the majority of the products of the sector, the Harvey ball is marked black by half. If the factor is applied in (almost) all sector products’, the Harvey ball is marked black three quarters. None of the Harvey balls are fully black, as thus at this point of time none of the sectors ‘perfectly’ applies these factors.

**Results**

**Care by physiotherapists**
Cost growth (CAGR: 3.1 %) outpaces GDP growth due to volume growth as the price per visit is stable. As quality is not systematically measured it is not possible to say whether outcomes are improving or not. Patients rate their experiences as good, with an average of 8.4/10 for physiotherapists.

**Care by general practitioners**
Cost growth (CAGR: 8.6%) outpaces GDP growth, due to volume growth of consultations. Patients
rate their experiences as good, with average scores of 8.0/10 for GPs. Other quality measurements are not available.

**Mental health care**

In this sector, the CAGR was 3.2% over the period 2000–2008 and operational efficiencies gains over the cycle of care were not present. Patients rated their experiences with an average score of 7.5/10.

**Hospital care**

Costs were stable at a 2.9% share of GDP in the hospital sector in the 2006-2008 period (CAGR 0.2%). Prices grew with 1.2% and volume by 6.5%. Comparing these figures to OECD health data for the relevant years showed that the hospital had a low CAGR compared to EU-15 countries, which had an average CAGR of 1.4% for hospitals.[39] There were operational efficiency gains in the hospital sector: the medical services per DRG decreased by 10% after the introduction of DRGs. Waiting lists declined for first outpatient visits from 13 to 8 weeks on average. Quality indicators showed an upward trend, while adverse outcomes, such as pressure ulcer rates, continue to fall. Patients rated their experiences with average scores of 8.0/10 for hospital care; this increases over time, and is positively related to the level of competition a hospital faces and whether or not the hospital publicly reports its results.[40] In addition, it seems that patients are starting to travel to further located hospitals if they perform well on quality indicators.[41]

**Intramural elderly care**

Costs were declining as share of GDP as the CAGR was -1.8% in the 2003-2008 period for intramural elderly care. Comparing these figures to OECD health data for the relevant years showed that the Dutch intramural elderly care sector had a low CAGR compared to EU-15 countries, which had an average CAGR of 3.1% for intramural elderly care.[42] There were operational efficiency gains in intramural elderly care: extramural care replaced some intramural care. There was also a positive trend in quality: quality indicators showed an upward trend, while adverse outcomes, such as pressure ulcer rates, continue to fall. Patients rated their experiences with average scores of 7.5/10 for intramural care.

**Nursing and domestic home care**

Costs for nursing home care were stable around 0.73% of the GDP, but costs were falling both in relative terms (-4.4% CAGR) and in absolute terms for domestic home care. Patient experiences became more transparent in the nursing home and domestic care sectors, but information is lacking about outcomes for this type of care. Adverse outcomes declined, such as pressure ulcer rates, indicating a positive trend in quality. Patients rated their experiences with average scores of 8.0/10 for nursing home care and 8.3/10 for domestic home care.
The costs and quality findings are summarized in Tables 1 and 2 for the examined health care sectors. The entries in the costs, quality, and value columns in Figure 1 are based on the findings presented in Tables 1 and 2.

As shown in Figure 1, the intramural elderly care, nursing home care, domestic care, and hospital care showed a stable or declining trend for costs of care on a product level and quality of care seemed to improve, whereas other health care sectors (care by general practitioners, and physiotherapists, and mental health care) showed increases in costs and none or limited quality increases.

### Table 1 Costs per health care sector in the relevant period

<table>
<thead>
<tr>
<th></th>
<th>Operational efficiency</th>
<th>Prices</th>
<th>Volume</th>
<th>CAGR share of GDP</th>
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<td>(CAGR; relevant</td>
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<td>policy period;</td>
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<tr>
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<td></td>
<td></td>
<td>€ Billion in 2008 per sector)</td>
</tr>
<tr>
<td>Care by general practitioners 2005-2008</td>
<td>Unknown</td>
<td>Regulated</td>
<td>Number of consultations per patient increased 8.3% in 2005–2007</td>
<td>6.7% (2005-2008; € 2.5 B – 0.35% of GDP in 2008)</td>
</tr>
<tr>
<td>Physiotherapy care 2004-2008</td>
<td>Number of consultations per patient is stable</td>
<td>Stable around € 27 euro per consult</td>
<td>3.0% more patients per year since 2005</td>
<td>3.1% (2004–2008; € 0.47 B 0.078% of GDP in 2008)</td>
</tr>
<tr>
<td>Mental health care 2000-2008</td>
<td>159 beds per 100,000 inhabitants Average treatment cycle increased from 290 days in 2003 to 320 days in 2007</td>
<td>Regulated</td>
<td>9.6% increase per year in period 2001-2007</td>
<td>3.2% (2000–2008; € 4.8 B – 0.80% of GDP in 2008)</td>
</tr>
<tr>
<td>Intramural elderly care 2003-2008</td>
<td>Length of stay declined from 251 days in 2004 to 236 days in 2008, indicating longer extramural care</td>
<td>Regulated</td>
<td>0.8% increase 240,000 in 2004, 250,000 in 2008</td>
<td>-1.8% (2003–2008; 78 B – 1.3% of GDP in 2008)</td>
</tr>
<tr>
<td>Nursing home care 2005-2008</td>
<td>4.1% increase in hours per patient in 2004–2007</td>
<td>Regulated</td>
<td>Declined 11.5% from 580,000 persons in 2004 to 520,000 in 2007</td>
<td>0.0% (2005–2008; 4.3 B – 0.73% of GDP)</td>
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<tr>
<td>Domestic home care 2005-2008</td>
<td>8.5% increase in hours per patient in 2005–2008</td>
<td>Prices fell an average of 2.1% per year in 2005–2008</td>
<td>Stable at 400,000 persons</td>
<td>-4.4% (2005–2008; 13B 0.215% of GDP in 2008)</td>
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<tr>
<td>Hospital care 2006-2008</td>
<td>Increased, with value of medical services (operations, length of stay, diagnostics etc.) 10.0% less per DRG in 2008 than 2006</td>
<td>1.4% increase per DRG per year in 2006–2008</td>
<td>Volume of DTCs per patient increased 6.5% per year in 2006–2008*</td>
<td>0.2% (2006–2008; 17.4 B – 2.9% of GDP in 2008)</td>
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</table>

* A-segment DTCs
Table 2  Quality per health care sector in the relevant period

<table>
<thead>
<tr>
<th>Health care sectors</th>
<th>Medical quality (effectiveness)</th>
<th>Patient experience</th>
<th>Waiting lists</th>
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<tbody>
<tr>
<td>Care by general practitioners 2005-2008</td>
<td>Unknown</td>
<td>CQI: 8.0/10, no trend available</td>
<td>A couple of days at the most, stable</td>
</tr>
<tr>
<td>Physiotherapy care 2005-2008</td>
<td>Unknown</td>
<td>CQI: 8.4/10, no trend available</td>
<td>A couple of days at the most, stable</td>
</tr>
<tr>
<td>Mental health care 2000-2008</td>
<td>No trends available. Strong variation across providers: 55%–95% of patients report improvement in 2008</td>
<td>79% positive about effect of treatment, no trend and CQI available</td>
<td>Stable around 10 weeks</td>
</tr>
<tr>
<td>Intramural elderly care 2003-2008</td>
<td>Increasing: e.g. pressure ulcer rates fell from 12% in 2004 to 6% in 2008. Other indicators (maldnourishment, fall incidents, etc.) show improvement as well</td>
<td>CQI: stable around 7.5/10, variation is declining, indicating that the worst performers are improving</td>
<td>Stable around 8 weeks</td>
</tr>
<tr>
<td>Nursing home care 2005-2008</td>
<td>Increasing: e.g. pressure ulcer rates fell from 6% in 2004 to 2% in 2008. Other indicators (maldnourishment, fall incidents, etc.) show improvement as well</td>
<td>CQI: stable around 8.0/10</td>
<td>Unknown</td>
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<tr>
<td>Domestic home care 2005-2008</td>
<td>Not applicable</td>
<td>CQI: 8.3/10, no trend available, some providers have insufficient scores</td>
<td>Unknown</td>
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<tr>
<td>Hospital care 2006-2008</td>
<td>Improving: performance indicators at the diagnosis level, Hospital Standardized Mortality Ratio, and complication registries (such as pressure ulcers, maldnourishment, fall prevention) show improvement</td>
<td>CQI: 8.0/10, trend slightly improving</td>
<td>Declined from 13 weeks to 8 weeks for non-urgent first outpatient visit</td>
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Figure 1  Value creation in the different health care sectors

<table>
<thead>
<tr>
<th>Health care sectors</th>
<th>Reimbursement aligned with value</th>
<th>Outcomes transparent</th>
<th>Selective contracting by payers possible</th>
<th>Costs</th>
<th>Quality</th>
<th>Value</th>
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<td>Care by general practitioners</td>
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<td>Care by physiotherapists</td>
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<tr>
<td>Mental health care</td>
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<td>Intramural elderly care</td>
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<td>Nursing home care</td>
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<tr>
<td>Hospital care</td>
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Factor applied

Factor not applied
Discussion

In this study we studied the first effects of the Dutch health reform inspired by the concept of managed competition and we analyzed per health care sector whether or not VBC principles were applied, and related this to the results in costs and quality per health care sector. In the discussion section we first discuss what effect managed competition may have on the results we found. Then we will continue to discuss the potential effects of the application of VBC principles.

The relationship between managed competition and costs/quality trends

Within the Dutch system managed competition was implemented in the hospital, GP, and physiotherapy sector from 2006 on. The outcomes in terms of trends in costs/quality ratios of these sectors differ. Where the hospital sector shows a fairly favorable trend, the GP and physiotherapy sector show a less favorable trend. This may have been caused by the fact that outcomes in the last two sectors are not systemically measured yet, leading to the inability for payers and customers of making informed choices between providers.

On the other hand, evidence suggests that also in the hospital sector, where outcomes are starting to become transparent, health plans are not very successful yet in channeling subscribers to the ‘right’ hospital. When health plans introduced variable deductibles per provider, subscribers did not respond and they stopped using this incentive.[43] Also, selective contracting of providers turned out to be less prevalent than expected; within the study period, all health plans had contracts with all hospitals and GPs, although from 2009 on the first selective contracting occurred in the hospital sector for the diagnosis breast cancer as one health plan excluded five hospitals.[44]

Dutch health care sectors which were ran by regional health agencies (intramural elderly care, mental care, nursing home care), which use pay-for-performance schemes but do not act as agents that selectively contract care according to the principles of managed competition, show varying results. For instance, a contrast can be found between intramural elderly care that shows favorable outcomes in terms of the trend in costs and quality, where in mental health care a less favorable trend is found.

At this point in time health plans have shown limited ability to channel subscribers nor have they been able to selectively contracting providers. In fact, the mode of operation between health plans and regional health agencies has been fairly similar within our study period. Therefore we cannot attribute the found differences in performance of health care sectors to the potential effect of managed competition, although this may change in the future if health plans become more successful in selectively contracting providers.

The relationship between VBC principles and costs and quality trends

A shared theme in sectors that show favorable trends in the costs/quality ratio (hospitals, intramural elderly care, home nursing care, and domestic care) is that the VBC principle of reimbursement aligned with value for patients is (starting to be) applied. The bundled payments for hospital care seemed to have led to a higher operational efficiency, and the upcoming introduction of bundled payment in the intramural elderly sector may have also stimulated operational efficiency in this sector. These findings are in line with previous studies toward forms of bundled payment, mostly in the form of DRGs in various countries.[45,46] In addition, in areas of higher competition, hospitals’ prices of DTCs are lower,[47] and patient experiences are better.[40] Also there is some evidence that patients are travelling to further located hospitals if they perform well on quality indicators.[41] Our findings on a health care sector level are in line with the evidence about the application of VBC principles on a case level.[48,49]
Nonetheless, in the hospital sector where the application of bundled payments via DTCs is most advanced, we see a discrepancy between the substantial operational efficiency gains on a product level, compared to a (modest) cost growth on a sector level stemming from volume growth. This suggests that although the application of VBC principles may have improved the costs/quality ratio on a product level, the application of VBC principles is not, or to a lesser extent, associated with the improvement of the costs/quality ratio on a sector level. This finding is in line with recent studies that show that in the Dutch hospital sector unwarranted practice variation is apparent.[50] This suggests that outcome measurements focused on the appropriateness of care are needed to enhance value creation in this sector.

In the domestic home care sector, competition between providers was most intense due to public tenders between providers. In these sectors, costs decreased in both absolute and relative terms, while quality of care was maintained or enhanced. At the same time, we see that outcome measurement is most advanced in sectors that show favorable trends. In our study, all quality indicators measured over multiple years improved.

Health care sectors that showed less favorable outcomes in terms of costs and quality shared two characteristics. The first was that the reimbursement system was not designed around value for patients and had ‘fee-for-service’ elements. GPs, physiotherapists, and mental health care institutions are currently reimbursed on a per-visit basis or according to minutes spent with the patient. This leads to strong volume growth, and it cannot be measured whether this creates value for patients. Second, outcomes were not transparent, and therefore providers cannot be rewarded for good performance as the value delivered per provider is rather unclear.

Another finding of this study is that particular sites where value is lost are the intersections of payment and reimbursement systems, since these systems are still mostly organized separately for each health care sector. This prevents value creation beyond different sectors, while patient demand often spans multiple sectors. This finding is in line with the critique that Enthoven and Tollen issued regarding the VBC theory, in which they state that VBC may lead to fragmentation of health care systems due to a lack of coordination.[17,23] How value beyond sectors should be created is currently the subject of debate in the Netherlands. Recently, so-called ‘integrated care DTCs’ have been developed, which reimburse the full cycle of services (diagnostics, treatment, education, coaching, etc.) of primary and secondary care professionals (GPs, physiotherapists, pharmacists, medical specialists, etc.) for chronic conditions such as diabetes and COPD.[51] Health plans purchase these integrated DRGs from the party (GPs or physiotherapists, e.g.) with the best bid regarding costs and quality of care. This subcontracts other primary care professions to deliver an integrated value proposition, thereby realizing virtual or actual multidisciplinary integrated practice units (IPUs) across sectors.[19] Whether and/or how these IPUs of e.g. Diabetics and COPD, which partly deliver care to the same chronically ill patients, should integrate and/or cooperate is still an unsolved issue in the Dutch debate.

This study may have suffered from several potential limitations. First, the underlying assumption in this study was that health care sectors could function as benchmarks for each other, although we compared international data for the hospital and intramural elderly sectors, which are comparable by OECD definitions. Technological issues, demographic trends, and minor policy issues might have affected some of the sectors in this study more than others. Second, we used the best available data to gauge cost and quality development in each sector, but some of the sectors omit data for costs and/or quality domains. In addition, quality measures are still mostly process measures, and this limits the ability to identify ‘true’ quality trends. Last, although the presence of preconditions for regulated competition themselves do not influence the actual delivery of care and the presence of these preconditions were used to chose sectors for reform, the sectors that were targeted for
reforms may have been more eligible for achieving improvements by other reasons or coincidence, thereby jeopardizing our conditions for a natural experiment.

In conclusion, our analyses show that an introduction of VBC principles seems to be related with a better costs/quality ratio of care on a product level. The application of VBC principles is not, or to a lesser extent, associated with the improvement of the costs/quality ratio on a health care sector level. At his point in time - a couple years after the introduction of managed competition - health plans have been unsuccessful in channeling customers to preferred providers. Therefore the effect of managed competition in improving value seems to be limited, but this may change in the future.

**Competing interests**

The authors declare to have no competing interests.
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38. OECD, OECD Health data 2010. We compared with EU-15 countries over which figures are present in relevant periods (2003-2008 and 2006-2008 respectively). Benchmark countries for hospitals: Belgium, Finland, France, Germany, Spain and Sweden. Benchmark countries for intramural elderly care (Nursing & resident care in OECD data): Belgium, Finland, France, Germany, Portugal and Spain.


41. For other health care sectors no realliable cross-country comparision is possible due to different defintions per health care sector within OECD countries

42. Boonen LH SF, Donkers B, Koolman X. Which preferred providers are really preferred? Effectiveness of insurers’ channeling incentives on pharmacy choice. Int J Health Care Finance Econ 2009


A new approach to the trade-off between quality and accessibility of health care

Abstract

Introduction
Quality of care is associated with patient volume. Regionalization of care is therefore one of the approaches that is suited to improve quality of care. A disadvantage of regionalization is that the accessibility of the facilities can decrease. By investigating the trade-off between quality and accessibility it is possible to determine the optimal amount of treatment locations in a health care system. In this article we present a new model to quantitatively ‘solve’ this trade-off. We use the condition breast cancer in the Netherlands as an example.

Materials & Methods
We calculated the expected quality gains in Quality Adjusted Lifetime Years (QALY’s) due to stepwise regionalization using ‘volume-outcome’ literature for breast cancer. Decreased accessibility was operationalized as increased (travel) costs due to regionalization by using demographic data, drive-time information, and the national median income. The total sum of the quality and accessibility function determines the optimum range of treatment locations for this particular condition, given the ‘volume-quality’ relationship and Dutch demographics and geography.

Results
Currently, 94 locations offer breast cancer treatment in the Netherlands. Our model estimates that the optimum range of treatment locations for this particular condition in the Netherlands varies from 15 locations to 44 locations.

Conclusion
Our study shows that the Dutch society would benefit from regionalization of breast cancer care as possible quality gains outweigh heightened travel costs. In addition, this model can be used for other medical conditions and in other countries.
Introduction

Ever since the report ‘Crossing the Quality Chasm’, quality improvement of hospital care has been a high priority for both policymakers and professionals. One of the approaches that is suited for quality improvement is regionalization of health care.[1] Within the concept of regionalization, hospitals and physicians focus on the treatment of a selection of specific conditions, thereby treating a substantial volume of patients annually.[2] Many studies have shown that hospitals that treat a high volume of patients achieve superior outcomes in terms of quality of care, both in surgical and non-surgical procedures (e.g. [3-6]). However, the magnitude of the volume–outcome relation varies between conditions and the outcome is not only dependent on hospital volume, but also on surgeon volume and the level of specialization.[7-10]

Recently, a number of studies have shown that outcomes indeed can improve after regionalization, indicating a causal effect between hospital volume and outcomes.[11-13] For instance in the Netherlands, hospital mortality rates dropped from 24.4% to 2.6% after the regionalization of pancreatic cancer surgery. The percentage of re-operations decreased from 37.8% to 18.4%.[13]

Within systems of managed competition, such as the Dutch system, hospitals often autonomously decide what services they provide.[14] On the other hand, government run health care systems (such as the National Health Service in the UK) often use centralistic planning models in order to attempt to regionalize care with certain district hospitals (e.g. cancer treatment).[15,16]

In July 2011 the Dutch Ministry of Health, the associations of hospitals, and health insurers signed an agreement which states the ambition to create hospitals that focus on certain conditions, instead of the current situation where most hospitals provide the full range of care.[17] Nonetheless regionalization may lead to decreased accessibility of care as the distance to the nearest hospital location may increase. Therefore, even with the current agreement it remains hard for insurers and hospitals to determine what the optimal number of providers for a certain condition is from a societal perspective, as the arguments for accessibility and quality of care point in the opposite direction when discussing regionalization.

In this article we present a new model to quantitatively ‘solve’ the trade-off between quality and accessibility of care. As an example we use the condition breast cancer in the Netherlands. The expected quality gains in Quality Adjusted Lifetime Years (QALY’s) due to stepwise regionalization (from the current 94 hospitals to a fictive 1 hospital) are calculated based on volume-outcome literature available for breast cancer. QALY’s are translated into monetary units based on previously described concepts.[18] To assess the costs of decreasing accessibility of care, we calculate the increased (travel) costs for patients that stem from the regionalization.

Subsequently we compare the quality and accessibility function to determine what the optimum range of locations for this particular condition is, given the volume-outcome relationship and the Dutch demographics and geography. Based on our findings we believe that the methodology we present is applicable for conditions other than breast cancer and is also suitable for countries other than the Netherlands.

Material & Methods

Patients and current hospital landscape

The total number of breast cancer patients, the average age at diagnosis, and the current breast cancer survival were derived from the Dutch National Public Health Compass (‘Zorgkompas’).[19]
The current volume of surgical breast cancer treatments per hospital in the Netherlands was obtained from the Dutch registration system for hospital declarations in the year 2008 (database DBC information system, DBC-Onderhoud, Utrecht, the Netherlands).

**Calculation of quality gains (euros)**

**Study selection and synthesis of the literature**

One of the authors (MT) performed a systematic search to identify relevant studies that describe the association between hospital volume and clinical outcomes.


In addition, reference lists of relevant articles were hand-searched to identify additional articles which could have been missed in the search. We also used the “related articles” function in PubMed. Last, experts in the field were asked whether relevant publications were missing.

Studies were selected using the following inclusion criteria:

- The subject of the study is the surgical treatment of breast cancer.
- Hospital volume is an independent variable.
- The outcome parameter is survival.
- The study does not describe a single hospital.
- The study uses primary data (e.g. editorials, systematic reviews are excluded).
- A multivariate analysis is performed with adjustment for at least age and gender.
- Volume is defined as a distinct number or a cut-off value and is reported in the article (e.g. studies that defined volume as ‘specialization’, as well as studies that only report “high or low volume” are excluded).
- The relation between volume and quality is reported as Odd’s ratio, hazard ratio or risk-adjusted mortality.
- Studies were published in the last 15 years.

Our search retrieved eight articles that met our selection criteria.[20-26] All studies that were included had an observational design. All studies had an endpoint of 5-year survival with the exception of 1 study that had a 3-year survival endpoint. All studies showed a beneficial effect of higher hospital volume on survival.

The studies used different volume categories to define high or low volume, and the reference categories differed between studies. In order to compare the studies we converted the effect-sizes. This was done by using the hazard ratio’s mentioned in the studies for the different volume-categories and by scaling them to a reference category of 90 operations per year.

None of the studies included a volume category of more than 300 treatments a year. Therefore, we present two scenarios in our study: a conservative scenario in which there is no effect of a higher volume on quality of the treatment, and a scenario in which we conservatively extrapolated the data. This extrapolation was based on the following data: there is maximal possible survival gain of 5% based on the current 5-year survival rate in the Netherlands (85%) [19], and the best practice internationally reported (90%).[27]
Translating quality gains to monetary units
We calculated the possible quality benefit of regionalization of breast cancer care in the Netherlands in terms of monetary units in four steps: First, we determined the current volume of surgical breast cancer treatment per hospital in the Netherlands based on reimbursement figures. Second, we determined the potential survival benefit under a regionalized scenario. Hereby we simulated the transfer of patients from lower-volume hospitals to a fictive hospital with a given volume. Starting point of the simulation was that no patients were transferred to a hospital with less volume than the current volume. This procedure was repeated for the current 94 locations to a fictive 1 locations.

Third, we translated the allocated survival gain into QALY’s (for the assumptions, see: supplementary data).

The last step was to convert the QALY’s into monetary units, in our case euros, based on earlier described concepts, using € 50,000 per QALY which is a relative low number as previous studies often use $100,000 per QALY.[18]

Calculation of costs of decreased accessibility of care
To assess the costs of decreasing accessibility of care, we calculated the increase in costs for patients that stem from the regionalization of breast cancer care patients compared to the current situation.

Travel expenses per patient
Total travel expenses per patient are based on total amount of time travelling and the travel expenses per time unit, based on using drive-time information, the Dutch national median income, population density per zip code area, and current breast cancer guidelines in which the number of (outpatient) clinic visits and average admission days are specified. Details about this calculation can be found in the supplementary data.

Simulation of the effect of regionalization on accessibility of care
The regionalization of breast cancer treatment from the current 94 locations to a fictive single location was simulated stepwise. We then calculated the average difference in travel expenses between the current 94 locations and the simulations. Hereby, we assumed that the hospital locations are optimally distributed in the Netherlands. This means that the sum of the individual driving times for all inhabitants are as short as possible. The density of the population per zip code area was used to calculate the optimal localization of the hospitals.[28]

The total driving time per simulation (e.g. per number of hospital locations) was calculated by multiplying the average driving time per inhabitant with the number of patients travelling, in this case all patients that are treated for breast cancer in the Netherlands in one year.[19,29]

Analysis of the trade-off between quality and accessibility
Finally, we summed the quality and accessibility function to determine what the optimum range of locations for this particular condition is, given the volume-outcome relationship and the Dutch demographics and geography. The result of this trade-off is the optimum range of locations for breast cancer treatment in the Netherlands.

To determine whether these results are robust, we performed sensitivity-analyses, in which we adjusted the value of a QALY from € 10,000 to € 100,000 per QALY and the amount of QALY’s gained per patient from one tenth (0.5 % gains in 5-year survival) to two times (10 % gains in 5-year survival) the values found from our literature search.
Results

Patients and current hospital landscape
In the Netherlands there are about 13,000 patients with newly diagnosed breast cancer per year. The average age at diagnosis is 60. The survival from breast cancer in the Netherlands in 2008 was respectively 85% and 70% for 5 and 10 year survival.[19] In 2008, there were 94 hospitals in the Netherlands that performed at least one breast cancer treatment. The volume of patients per hospital varied from less than 50 to over 500 treatments a year (mean=139, SD=80, median=118).

Quality gains
Literature search shows a volume-outcome relationship for breast cancer
The relationship between volume and converted hazard ratios of mortality of the included studies is shown in Figure 1A. In Figure 1B two scenarios are included: the conservative scenario and the ‘extrapolation scenario’.

Results of the simulation
Based on our assumptions, patients who are diagnosed with breast cancer currently live with about 13 QALY’s after diagnosis. After regionalization, this could increase with 0.3 to 0.7 QALY’s per patient, depending on whether it is based on the conservative scenario or the extrapolation scenario. The quality gain in euros due to regionalization is shown in Figure 2 (dashed lines). In the most extreme scenario all 13,000 breast cancer patients are treated in 1 center.

Accessibility
On average, a patient (and her visitors) visits the hospital 67.5 times. The average travel time to a location increases from 11.6 minutes with 96 locations to 28.6 minutes with 10 locations. The increase in travel expenses per simulation (number of hospital locations) compared to the current number of hospitals is presented in Figure 2 (dotted line).

Optimum range of locations for breast cancer treatment in the Netherlands
Figure 2 shows the quality gains, travel expenses, and the difference (‘sum’) between these components for the stepwise simulation of regionalizing treatment for breast cancer. The optimum range of locations for this particular condition in the Netherlands ranges from 15 locations (based on the extrapolation) to 44 locations (based on the conservative scenario).
Figure 1: Converted hazard ratios of mortality of the included studies (A) and the conservative and extrapolated scenario (B). The thick black line in Figure 1B represents the average association between volume per hospital and mortality and is the conservative scenario, meaning that there are no additional quality gains if a hospital treats more than 300 patients a year. The thick grey line represents the ‘extrapolation scenario’ in which hospitals do achieve minor quality gains when they treat more than 300 patients per year, up to a maximum of 90% 5-year survival rate.

(A) Publications show a negative correlation between hospital volume and long-term mortality

(B) Extrapolation and conservative scenario based on Figure A
Sensitivity analysis

Adjusting the value of a QALY or adjusting the gains in QALY’s per treatment that stem from regionalization does not substantially change the optimum range of locations for treatment of breast cancer patients in the Netherlands (see supplementary data). The reappraisal of the value of a QALY from € 50,000 to € 10,000 leads to an optimum range of locations of 22 in the extrapolation scenario and 44 in the conservative scenario, in comparison to 15 and 44 in the original simulation (Figure 2).

Discussion

In this study we present a new model to quantitatively solve the quality versus accessibility trade-off that health care systems encounter. The main contribution in comparison with previous studies is that we include both travel costs and quality gains that stem from regionalization of care.[30, 31] The model allows to calculate the number of locations that gives optimum value for society for a certain condition within a specific geographical area. These insights can be useful for policy makers that have to make decisions regarding infrastructure allocation, and for health care professionals that are drafting strategies on what scale they would provide optimal value of care for their patients. This model could well be used for other conditions and/or other geographical areas as long as there is information available regarding the volume-outcome relationship. For more acute conditions or facilities (such as Intensive Care Units or Percutaneous Coronary Interventions (PCI’s)), where fast access to facilities is important, the possible decrease in quality due to heightened travel time for patients may be included in the model.
Based on our specific findings for breast cancer patients in the Netherlands we conclude that the current landscape of treatment for this condition in the Netherlands is too dispersed. Given the relative small size of the country and the subsequently limited travel costs, optimal value for patients would be provided by regionalization of breast cancer care, leading to significant lower number of providers. Indeed, breast cancer patients are willing to travel up to 230 kilometers knowing that they will receive better quality of care (where the surface area of the Netherlands is roughly 300 kilometers by 200 kilometers). Transparency of outcomes of breast cancer care will be essential to actually get patients to visit hospitals located further away.[32] As the studies in our model only focus on the breast cancer surgery, one could debate if only the surgical part of breast cancer care should be regionalized, or the entire integrated care cycle (such as diagnostics, chemotherapy, radiotherapy). Given the coordination costs and possible quality losses that come with fragmented care we would propose regionalization over the full cycle of care, combined with protocolled outreach where possible.[1] It should be noticed, however, that regionalization as a means to improve quality of care should not distract hospitals’ focus on continuous quality improvement activities. In addition, a higher volume of care for a certain condition is no guarantee for high quality care and hospitals with a lower volume can also provide high quality care. Besides, regionalization may lead to a restriction of patients’ choice.

In this study, we used published (international) data regarding the volume-outcome relationship of breast cancer care as input for our model. A limitation with this approach is the dependency on the availability and quality of the literature. The model can be made even more powerful when using only national data.

Another limitation of our study is that we did not include possible efficiency and price effects of regionalization. One could expect efficiency gains due to a higher quality of care as costly complications may be avoided in centers that have superior expertise. In addition, economies of scale can lead to additional cost reductions.[2] On the other hand prices may rise due to decreasing competition. Studies about mergers of whole hospitals (rather than regionalization of sole conditions) suggest that substantial price spikes may occur in low competition areas.[33] Nonetheless we think that price rises may not occur as studies show that the willingness to travel is substantial.[32] Moreover, we did not take into account the potential start-up costs of regionalization, such as building new capacities or hiring new personnel. Another minor limitation is that we assume that the locations are optimally distributed.

In conclusion, this study presents a new model to solve the trade-off between quality versus accessibility of care quantitatively. This model can be used in various countries for various conditions. Our example of breast cancer treatment in the Netherlands shows that the Dutch society would benefit from regionalization of breast cancer care as possible quality gains outweigh heightened travel costs.
References


Assumptions to translate the allocated survival gain into QALY’s

We made three assumptions to make this conversion: 1) A patient who survives 10 years after the diagnosis lives on for another 10 years on average. This is based on the average age of diagnosis in the Netherlands (60 years) [19], and the average life expectancy at age 60 (about 23 years).[34] 2) The quality of life of breast cancer patients is between 80-90% when surviving 5 to 10 years, and 50% at most when dying within 5 to 10 years.[35-37] 3) The quality of life is equal for all patients that survived the diagnosis, regardless whether they are treated in high-volume or low-volume hospitals.

Assumptions to calculate the travel expenses

Total amount of time travelling

The total number of visits was taken from current breast cancer guidelines in which the number of outpatient clinic visits (including radiotherapy/chemotherapy and follow-up visits) and average admission days are specified.[29] On average, a patient (and her visitors) visits the hospital 67.5 times. This includes one pre-operative visit, a three day admission for surgery, six visits for visitors, chemotherapy (30 visits) for 75% of the patients, radiotherapy (30 visits) for 50% of the patients and 21 follow-up visits. We assumed that all treatments take place at one location, including follow-up visits. The driving time to the hospital locations was calculated with the use of the Dutch Drive Time Matrix (Postcode.nl B.V., Haarlem, the Netherlands).

Travel expenses per hour

The travel expenses per hour are derived from the costs of travelling by taxi (€ 2.20 per kilometer)[38] and the loss of income by travelling, using the national median income of € 32,000 a year for 1,600 working hours.[28] We assumed that apart from the patient, a second person always accompanies the patient to outpatient visits. When admitted to the hospital, we assume that the patient is visited twice a day.

Sensitivity analysis

Table 1  Sensitivity analysis

<table>
<thead>
<tr>
<th>Value per QALY</th>
<th>Gain in QALY’s per treatment</th>
<th>Extrapolation</th>
<th>Conservative scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>€ 50,000</td>
<td>0,6</td>
<td>15</td>
<td>44</td>
</tr>
<tr>
<td>€ 10,000</td>
<td>0,6</td>
<td>22</td>
<td>44</td>
</tr>
<tr>
<td>€ 30,000</td>
<td>0,6</td>
<td>15</td>
<td>44</td>
</tr>
<tr>
<td>€ 100,000</td>
<td>0,6</td>
<td>11</td>
<td>44</td>
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<tr>
<td>€ 50,000</td>
<td>0,31</td>
<td>15</td>
<td>44</td>
</tr>
<tr>
<td>€ 50,000</td>
<td>1,23</td>
<td>11</td>
<td>44</td>
</tr>
</tbody>
</table>
Chapter 8

Modeling hospital infrastructure by optimizing quality, accessibility and efficiency via a Mixed Integer Programming model

**Abstract**

**Introduction**
In many countries the majority of curative health care is organized in hospitals. As in most other countries, the current 94 hospital locations in the Netherlands offer almost all treatments, ranging from rather basic to very complex care. Recent studies show that concentration of care can lead to substantial quality improvements for complex conditions and that dispersion of care for chronic conditions may increase quality of care. In previous studies on allocation of hospital infrastructure, the allocation is usually only based on accessibility and/or efficiency of hospital care. In this paper, we explore the possibilities to include a quality function in the objective function, to be able to give global directions to how the ‘optimal’ hospital infrastructure would be in the Dutch context.

**Methods**
To create optimal societal value we have used a mathematical mixed integer programming (MIP) model that balances quality, efficiency and accessibility of care for 30 ICD-9 diagnosis groups. Typical aspects that are taken into account are the volume-outcome relationship, the maximum accepted travel times for diagnosis groups that may need emergency treatment and the minimum use of facilities.

**Results**
The optimal number of hospital locations per diagnosis group varies from 12-14 locations for diagnosis groups which have a strong volume-outcome relationship, such as neoplasms, to 150 locations for chronic diagnosis groups such as diabetes and chronic obstructive pulmonary disease (COPD).

**Conclusions**
In conclusion, our study shows a new approach for allocating hospital infrastructure over a country or certain region that includes quality of care in relation to volume per provider that can be used in various countries or regions. In addition, our model shows that within the Dutch context chronic care may be too concentrated and complex and/or acute care may be too dispersed. Our approach can relatively easily be adopted in other countries and is very suitable to perform ‘what-if’ analysis.
Introduction

In the Netherlands, just as in most other countries, the majority of curative health care is organized in hospitals. Currently, there are 94 hospital locations in the Netherlands, almost all of them offering the whole range of treatments, varying from placing ear tubes to cancer treatment and long-term support of patients with COPD.

Recent studies show that quality of care can be improved by concentration of care.[1,2] Within the concept of concentration, hospitals and physicians focus on the treatment of a selection of specific conditions, treating a substantial volume of patients annually. Thereby they achieve superior outcomes in terms of quality of care.[1,2] In the literature this so-called ‘volume-outcome’ association is widely established; hospitals that treat a larger volume of patients annually achieve better outcomes for conditions ranging from AIDS to cholecystectomies.[3] Moreover, increased hospital specialization - meaning a hospital that only treats certain diagnoses such as cancer or cardiovascular diseases - is associated with improved patient outcomes after adjusting for hospital procedural volume.[4,5]

Concentration and specialization may also increase the efficiency of hospitals. One could expect efficiency gains due to a higher quality of care as costly complications may be avoided in centers that have superior expertise.[6] Economies of scale within a certain (group of) condition(s) can lead to additional cost reductions, i.e. by better procurement rates and higher turnover rates of tools and capacity usage.[7,8] On the other hand a decrease in the number of providers may result in a lower level of competition possibly leading to higher prices of care.[9]

In contrast to the gain in quality of care and efficiency, concentration of care may lead to decreased accessibility of care as the distance to the nearest hospital location may increase. Therefore gains in quality of concentration of care should outweigh the heightened travel costs for patients. Studies show that patients are willing to travel distances for higher quality of care [10,11], a better patient experience [12] or shorter waiting times.[13,14] Considering that more complex conditions have a more profound volume-outcome association and that for other, mostly chronic diseases, care should be provided as close to home as possible. Therefore, the ‘ideal’ hospital landscape would accommodate the quality versus accessibility trade-off with a different number of providers per (group of) condition(s). In addition, to ensure an efficient delivery of care these providers should be large enough to operate efficiently.

To create optimal society value in our health care system, one should therefore optimize three dimensions: quality, efficiency, and accessibility of care.[15] In previous studies on allocation hospital infrastructure, the allocation is usually based on only one or two of these dimensions: accessibility and/or efficiency of hospital care.[16-18] In this paper, we explore the possibilities to include a quality function in the objective of a MIP model, to give global directions how the ‘optimal’ hospital infrastructure would be in the Dutch context. To our knowledge, this is the first attempt to include the recent literature regarding volume-outcome relationship together with accessibility and efficiency characteristics to model a new optimal hospital infrastructure from a societal perspective.

Methods

Mathematical models are very suitable to make complex trade-offs. Location models have been studied for a long time in science and industry. An excellent overview of the various forms of location models can be found in Revelle et al. and Melo et al.; they describe the use of location models in supply chain management.[19,20] In our study we use a mixed integer linear (MIP) programming approach in an AIMMS software environment with the CPLEX solver to solve the
Dutch hospital infrastructure problem.[21] Objective, relations, and constraints will be explained in the following sections.

Models are very suitable for; not only to find the optimal allocation of infrastructure, but also to perform sensitivity and ‘what-if’ analysis. This should be kept in mind since this is an explorative study in which estimations of the volume-outcome relations based on expert opinions are used.

**Conditions and hospital locations**

To create the ‘ideal’ hospital landscape from the trade-off between quality, accessibility, and operational efficiency, we first identified the possible hospital locations in the Netherlands and conditions that should be allocated. In the new hospital landscape, 150 possible hospital locations are defined. This number was chosen taken into account that: 1) there are enough locations to provide health care close to home (the average travel time currently with 95 hospital locations is 14.9 minutes to the closest located hospital[22], 2) the number of possible locations would not become a serious constraint in the model, and 3) the model does not become too complex. From the total of 150 locations, 88 of these locations are based on the 3-digit distinct zip code of the 95 current hospitals in the Netherlands. The other locations are chosen in such a way that the total amount of 150 locations are optimally distributed in the Netherlands. This means that the sum of the individual driving times for all inhabitants is as small as possible. The density of the population per zip code area was used to calculate the optimal location of the hospitals.[23]

**Allocated diagnosis groups based on ICD-9-CM codes**

The total health care delivered in hospitals in the Netherlands was assigned to one of 30 diagnosis groups. These diagnosis groups are slightly modified from the diagnosis groups of the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM, WHO), in such a way that the groups are as homogeneous as possible with regard to:

**Volume-outcome relationship**

The diagnosis group ‘Signs, Symptoms, and Ill-defined Conditions’, was excluded because of a lack of information. The ICD-9-CM codes and corresponding 30 diagnosis groups are described in Table 1 on the next page. We formulated one obligatory relationship between ICD-9 groups in the model: between gynecology and pediatric care (groups 21 and 23, see Table 1). In the current model, all other diagnosis groups can operate on their own or be combined with other diagnosis groups if the efficiency constraint is not met. Details of the criteria of the volume-outcome relationship, the use of resources, and the accessibility are described in the paragraphs below.

**Data: volume-outcome relationship**

In this study we estimated per diagnosis group the volume-outcome relationship compared to the diagnosis group neoplasms. This diagnosis group was chosen as a reference group, because the volume-outcome relationship is well studied for the condition breast cancer in the diagnosis group neoplasms and the angle of inclination of outcomes expressed as Quality Adjusted Lifetime Years (QALY’s) per volume step has been established in previous studies.[22,24-31] The study shows, in short, that on average 0.5 QALY for an individual may be gained per breast cancer treatment, when breast cancer care is concentrated from the current 94 hospitals (that each treat 138 cases per year) to 15 specialized breast cancer centers (that each treat 866 cases per year). With this concentration of care the current Dutch 5-year survival for breast cancer could improve from 85% to 90% according to international literature and best practices. [22,24-32]

Although numerous studies have documented a volume-outcome relationship, literature to quantify the strength of this relationship is not available for all diagnosis groups. It is presumed that the association depends on the level of complexity of the intervention and the level of co-
<table>
<thead>
<tr>
<th>Main category ICD-9-CM classification</th>
<th>The 30 diagnosis groups</th>
</tr>
</thead>
</table>
| Infectious and Parasitic Diseases    | 1. Acute infectious and parasitic diseases and poisoning  
                                         2. Chronic infectious and parasitic diseases  
                                           (tuberculosis, HIV, hepatitis) |
| Neoplasms                            | 3. Neoplasms             |
| Endocrine, Nutritional, and Metabolic Diseases and Immunity Disorders | 4. Diabetes  
                                         5. Endocrine, metabolic, and immunity disorders |
| Diseases of Blood and Bloodforming Organs | 6. Haematology |
| Mental Disorders                     | 7. Acute mental disorders (i.e. psychosis)  
                                         8. Chronic mental disorders (i.e. rehabilitation programs, personality disorders) |
| Diseases of the Nervous System and Sense Organs | 9. Diseases of the nervous system  
                                         10. Eyecare  
                                         11. Earcare |
| Diseases of the Circulatory System   | 12. Cerebral hemorrhage and ischemia  
                                         13. Chronic cardiovascular disease  
                                           (including congestive heart failure)  
                                         14. Cardiovascular disease with intervention (PCI/CABG) |
| Diseases of the Respiratory System   | 15. Acute diseases of the respiratory system (i.e. pneumonia and influenza)  
                                         16. Complex pulmonary surgery  
                                         17. Common surgery of the respiratory system (i.e. tonsillitis)  
                                         18. Chronic obstructive pulmonary disease and allied conditions |
| Diseases of the Digestive System     | 19. Surgery of diseases of the digestive system  
                                         20. Diseases of oral cavity, salivary glands, and jaws |
| Diseases of the Genitourinary System | 21. Gynaecology  
                                         22. Urinary system |
| Complications of Pregnancy, Childbirth, and the Puerperium | 23. Complications of pregnancy, childbirth, and the puerperium |
| Diseases of the Skin and Subcutaneous Tissue | 24. Dermatology |
| Diseases of the Musculoskeletal and Connective Tissue | 25. Rheumatism and arthropathies (non surgical)  
                                         26. Diseases of the musculoskeletal system that require surgical treatment |
| Congenital Anomalies                 | 27. Congenital disorders |
| Newborn (Perinatal)                 | 28. Certain conditions originating in the perinatal period |
| Injury and Poisoning                | 29. Emergency care (distortion, luxation, common fractures)  
                                         30. Specialized trauma care (injuries of organs, complex fractures) |

operation between different specialties.[31,33] Therefore, based on the complexity of the diagnosis groups, we divided the diagnosis groups in four categories and (somewhat arbitrarily) gauged volume-outcome relationship in QALYs relative to the diagnosis group neoplasms: high (the same relationship as the group neoplasms), intermediate (50% of neoplasms), low (5% of neoplasms), or no volume-outcome relationship.
To calculate the gain in QAL Ys, three figures were used, information from national statistics and literature:
1) A patient who survives 10 years after the diagnosis lives on for another 10 years on average. This is based on the average age of diagnosis in the Netherlands (60 years), and the average life expectancy at age 60 (about 23 years). The quality of life of breast cancer patients is between 80-90% when surviving 5 to 10 years, and 50% at most when dying within 5 to 10 years.
2) The quality of life is equal for all patients that survived the diagnosis, regardless whether they are treated in high-volume or low-volume hospitals.

The categories high, intermediate and low are established using the following criteria:
- High: multi medical specialty treatment, low volume, and high risk of complication, according to previous reports (e.g.[34]) and current volume norms per condition of professionals associations.[35]
- Intermediate: a high complication risk but a single medical specialty approach.[34]
- Low: groups with a high volume and a low risk of complication.[34]

Since there is consensus in the literature that it is desirable that health care for chronic conditions is within close reach, chronic care was not included in this classification. As it requires frequent visits for relatively complex care, often accompanied with lifestyle change, chronic care was labeled as having no volume-outcome relationship.[34]

After estimating the volume-outcome association per diagnosis group we calculated the angle of inclination of quality of care (expressed in QALYs) per diagnosis group, by simulating a concentration of care per diagnosis group from the current 94 locations to a virtual single centre (for the model formulation see below).

**Data: accessibility**
For acute diagnosis groups, the travel time is in the Netherlands by law maximized on 45 minutes. Therefore we also used this as the maximum travel time in the acute diagnosis groups.[36] The maximum travel time for other diagnosis groups were set at 120 minutes. This amount is derived from Discrete Choice Experiments in which patients state they are willing to travel up to 230 kilometers (approximately 2 hours by car) for better quality of care.[46]

**Data: use of resources**
The average length of stay in the hospital is based on the national medical registry.[37] For the average lengths of stay in an Intensive Care Unit and the average duration of an operation we used the KPMG Plexus benchmark analysis of 70 hospitals in the Netherlands.[38] The minimum utilizations were estimated using benchmarking results from Dutch hospitals. For an OR the minimum utilization was estimated as being 65% of the total time available for operations (48 weeks a year, 5 days a week, 8 hours a day). For an ICU the minimum was estimated as having 6 beds occupied during 365 days a year. For a ward it was estimated as 80% utilization of 12 beds during 365 days a year.

**Data: costs per diagnosis group**
The total costs per diagnosis group are estimated by the National Institute for Public Health and the Environment Cost of Illness in 2005.[39] The abovementioned characteristics per diagnosis group are summarized in Table 2.

---
1 To calculate the gain in QALYs, three figures were used, information from national statistics and literature 1) A patient who survives 10 years after the diagnosis lives on for another 10 years on average. This is based on the average age of diagnosis in the Netherlands (60 years), and the average life expectancy at age 60 (about 23 years). The quality of life of breast cancer patients is between 80-90% when surviving 5 to 10 years, and 50% at most when dying within 5 to 10 years. 2) The quality of life is equal for all patients that survived the diagnosis, regardless whether they are treated in high-volume or low-volume hospitals.
## Table 2  The characteristics of the 30 diagnosis groups

<table>
<thead>
<tr>
<th>Diagnosis groups</th>
<th>Category</th>
<th>Costs (mln euro)</th>
<th>Number of Admissions</th>
<th>Volume-outcome relation</th>
<th>Maximum travel time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Source:</strong></td>
<td></td>
<td>Poos et al. [39]</td>
<td>LMR registry [37]</td>
<td>Expert opinion</td>
<td>Expert opinion</td>
</tr>
<tr>
<td>1. Acute infectious and parasitic diseases and poisoning</td>
<td>Acute</td>
<td>€ 95.8</td>
<td>93,193</td>
<td>Intermediate</td>
<td>45</td>
</tr>
<tr>
<td>2. Chronic infectious and parasitic diseases</td>
<td>Chronic</td>
<td>€ 184.4</td>
<td>3,885</td>
<td>High</td>
<td>120</td>
</tr>
<tr>
<td>3. Neoplasms</td>
<td>Chronic</td>
<td>€ 1,845.1</td>
<td>405,124</td>
<td>High</td>
<td>120</td>
</tr>
<tr>
<td>4. Diabetes</td>
<td>Chronic</td>
<td>€ 197.6</td>
<td>17,445</td>
<td>Non existent</td>
<td>45</td>
</tr>
<tr>
<td>5. Endocrine, metabolic, and immunity disorders</td>
<td>Chronic</td>
<td>€ 220</td>
<td>46,837</td>
<td>Intermediate</td>
<td>45</td>
</tr>
<tr>
<td>6. Haematology</td>
<td>Elective/Chr.</td>
<td>€ 146.1</td>
<td>51,064</td>
<td>High</td>
<td>45</td>
</tr>
<tr>
<td>7. Acute mental disorders</td>
<td>Acute</td>
<td>€ 85.7</td>
<td>12,000</td>
<td>High</td>
<td>45</td>
</tr>
<tr>
<td>8. Chronic mental disorders</td>
<td>Chronic</td>
<td>€ 306.6</td>
<td>22,134</td>
<td>Non existent</td>
<td>45</td>
</tr>
<tr>
<td>9. Diseases of the nervous system</td>
<td>Chronic</td>
<td>€ 522.2</td>
<td>89,335</td>
<td>Low</td>
<td>45</td>
</tr>
<tr>
<td>10. Eyecare</td>
<td>Elective</td>
<td>€ 586.9</td>
<td>207,327</td>
<td>Low</td>
<td>45</td>
</tr>
<tr>
<td>11. Earcare</td>
<td>Elective</td>
<td>€ 230.4</td>
<td>61,090</td>
<td>Intermediate</td>
<td>45</td>
</tr>
<tr>
<td>12. Cerebral hemorrhage/ischemia</td>
<td>Acute</td>
<td>€ 436.3</td>
<td>47,925</td>
<td>High</td>
<td>45</td>
</tr>
<tr>
<td>13. Chronic cardiovascular disease (including congestive heart failure)</td>
<td>Chronic</td>
<td>€ 938.5</td>
<td>180,186</td>
<td>Non existent</td>
<td>45</td>
</tr>
<tr>
<td>14. Cardiovascular disease with intervention (PCI/CABG)</td>
<td>Acute</td>
<td>€ 1047.7</td>
<td>163,275</td>
<td>High</td>
<td>45</td>
</tr>
<tr>
<td>15. Acute diseases of the respiratory system</td>
<td>Acute</td>
<td>€ 246.7</td>
<td>64,310</td>
<td>Low</td>
<td>45</td>
</tr>
<tr>
<td>16. Complex pulmonary surgery</td>
<td>Elective</td>
<td>€ 305.6</td>
<td>20,502</td>
<td>High</td>
<td>45</td>
</tr>
<tr>
<td>17. Common surgery of the respiratory system</td>
<td>Elective</td>
<td>€ 122.1</td>
<td>74,168</td>
<td>Low</td>
<td>45</td>
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<tr>
<td>18. Chronic obstructive pulmonary disease and allied conditions</td>
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<td>€ 305.5</td>
<td>48,236</td>
<td>Non existent</td>
<td>120</td>
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<tr>
<td>19. Surgery of diseases of the digestive system</td>
<td>Elective</td>
<td>€ 422.7</td>
<td>215,757</td>
<td>Intermediate</td>
<td>45</td>
</tr>
<tr>
<td>20. Diseases of oral cavity, salivary glands, and jaws</td>
<td>Chronic</td>
<td>€ 1,108.9</td>
<td>26,366</td>
<td>Low</td>
<td>45</td>
</tr>
<tr>
<td>21. Gynaecology</td>
<td>Elective</td>
<td>€ 481.6</td>
<td>82,053</td>
<td>Low</td>
<td>45</td>
</tr>
<tr>
<td>22. Urinary system</td>
<td>Elective</td>
<td>€ 497.1</td>
<td>151,334</td>
<td>Low</td>
<td>45</td>
</tr>
<tr>
<td>23. Complications of pregnancy, childbirth and the puerperium</td>
<td>Elective</td>
<td>€ 739.3</td>
<td>296,513</td>
<td>Intermediate</td>
<td>45</td>
</tr>
<tr>
<td>24. Dermatology</td>
<td>Chronic</td>
<td>€ 412.3</td>
<td>68,625</td>
<td>Low</td>
<td>45</td>
</tr>
<tr>
<td>Diagnosis groups</td>
<td>Category</td>
<td>Costs (mln euro)</td>
<td>Number of Admissions</td>
<td>Volume-outcome relation</td>
<td>Maximum travel time (min)</td>
</tr>
<tr>
<td>----------------------------------------------------------------</td>
<td>--------------</td>
<td>------------------</td>
<td>----------------------</td>
<td>-------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Source:</td>
<td>Poos et al. [39]</td>
<td>LMR registry [37]</td>
<td>Expert opinion</td>
<td>Expert opinion</td>
<td></td>
</tr>
<tr>
<td>25. Rheumatism and arthropathies (non surgical)</td>
<td>Chronic</td>
<td>€ 961.2</td>
<td>157,265</td>
<td>Low</td>
<td>45</td>
</tr>
<tr>
<td>26. Diseases of the musculoskeletal system that require surgical treatment</td>
<td>Elective</td>
<td>€ 857.3</td>
<td>238,155</td>
<td>Intermediate</td>
<td>45</td>
</tr>
<tr>
<td>27. Congenital disorders</td>
<td>Chronic</td>
<td>€ 216.1</td>
<td>25,669</td>
<td>High</td>
<td>120</td>
</tr>
<tr>
<td>28. Conditions originating in the perinatal period</td>
<td>Elective</td>
<td>€ 331.2</td>
<td>75,980</td>
<td>High</td>
<td>120</td>
</tr>
<tr>
<td>29. Signs, symptoms, and ill-defined conditions</td>
<td>-</td>
<td>€ 2,746.3</td>
<td>346,106</td>
<td>Intermediate</td>
<td>45</td>
</tr>
<tr>
<td>30. Emergency care</td>
<td>Acute</td>
<td>€ 604.1</td>
<td>52,605</td>
<td>Non existent</td>
<td>45</td>
</tr>
<tr>
<td>31. Specialized trauma care</td>
<td>Acute</td>
<td>€ 475.6</td>
<td>77,330</td>
<td>High</td>
<td>120</td>
</tr>
</tbody>
</table>

### The MIP model

The problem is formulated using a mixed integer linear programming model, whereby accessibility and quality are translated to euros. This will be further explained in this section. We solve the instances by using the CPLEX solver within the AIMMS development environment.

**Objective function:**

\[
\max \sum_d (\text{Quality}_d - \text{Travel}_d)
\]

\[
\text{Quality}_d = EQ \cdot NP_q \cdot (a_d \cdot NL_d + b_d) \quad \text{for all } d,
\]

\[
\text{Travel}_d = 2 \cdot ET \cdot NV_d \cdot \sum_{p,q} NP_{p,d} \cdot Y_{p,q,d} \cdot TT_{p,q} \quad \text{for all } d,
\]

\[
X_p = 1
\]

\[
\sum_p Y_{p,q,d} \leq Z_{q,d} \cdot M \quad \text{for all } q,d,
\]

\[
\sum_q Z_{q,d} \leq X_d \cdot M \quad \text{for all } q,
\]

\[
\sum_q Z_{q,d} = NL_d \quad \text{for all } d,
\]

\[
Y_{p,q,d} \cdot TT_{p,q} \leq \max_t \quad \text{for all } p,q,d,
\]

\[
\sum_{p,d} NP_{p,d} \cdot Y_{p,q,d} \cdot U_{f,d} \geq \min_t \cdot X_p \quad \text{for all } f,p.
\]

See Table 3 on the next page for the description of the indices, parameters, and decision variables.
Table 3 Description of indices, parameters and variables

<table>
<thead>
<tr>
<th>Notation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indices</strong></td>
<td></td>
</tr>
<tr>
<td>$d$</td>
<td>Diagnosis group</td>
</tr>
<tr>
<td>$f$</td>
<td>Facility</td>
</tr>
<tr>
<td>$p$</td>
<td>Zip code area</td>
</tr>
<tr>
<td>$q$</td>
<td>Zip code area</td>
</tr>
<tr>
<td><strong>Parameters</strong></td>
<td></td>
</tr>
<tr>
<td>$a_d$</td>
<td>The slope of the (linear) volume-outcome relationship of diagnosis group $d$</td>
</tr>
<tr>
<td>$b_d$</td>
<td>The constant term of the (linear) volume-outcome relationship of diagnosis group $d$</td>
</tr>
<tr>
<td>$EQ$</td>
<td>Euros per QALY</td>
</tr>
<tr>
<td>$ET$</td>
<td>Travel expenses per time unit</td>
</tr>
<tr>
<td>$M$</td>
<td>Big number {1,000,000}</td>
</tr>
<tr>
<td>$max_t_d$</td>
<td>The maximum acceptable travel time for diagnosis group $d$</td>
</tr>
<tr>
<td>$min_u_f$</td>
<td>Minimum utilization per facility $f$</td>
</tr>
<tr>
<td>$NP_d$</td>
<td>The number of patients per diagnosis group $d$</td>
</tr>
<tr>
<td>$NP_{p,d}$</td>
<td>The number of patients per diagnosis group $d$ and zip code $p$</td>
</tr>
<tr>
<td>$NV_d$</td>
<td>The total number of visits per patient having diagnosis $d$</td>
</tr>
<tr>
<td>$TT_{p,q}$</td>
<td>The driving time from zip code $p$ to zip code $q$</td>
</tr>
<tr>
<td>$U_{f,d}$</td>
<td>The amount of resources each patient within diagnosis group $d$ makes use of facility $f$</td>
</tr>
<tr>
<td><strong>Dependent variables</strong></td>
<td></td>
</tr>
<tr>
<td>$Quality_d$</td>
<td>Total quality achieved for diagnosis group $d$ [euros]</td>
</tr>
<tr>
<td>$Travel_d$</td>
<td>Total travel costs made for diagnosis group $d$ [euros]</td>
</tr>
<tr>
<td>$NL_d$</td>
<td>The number of locations treating diagnosis group $d$</td>
</tr>
<tr>
<td><strong>Decision variables</strong></td>
<td></td>
</tr>
<tr>
<td>$X_p$</td>
<td>Whether a health care location is established in zip code $p$</td>
</tr>
<tr>
<td>$Z_{q,d}$</td>
<td>Whether diagnosis group $d$ is treated at potential hospital location with zip code $q$</td>
</tr>
<tr>
<td>$Y_{p,q,d}$</td>
<td>Whether for diagnosis group $d$ patients from zip code $p$ are assigned to potential hospital location with zip code $q$</td>
</tr>
</tbody>
</table>

Model formulation

The objective of our model is the trade-off between quality and accessibility of care (traveling time) in concentration and specialization of hospital care. This leads to the following objective function:

$$\max_d (Quality_d - Travel_d)$$

More accurate would be to regard the relationship as a continuous convex function. For modeling purposes a linear function is chosen that approaches the convex function in the interval of the expected number of optimal locations.
Quality: volume-outcome relationship

It is assumed that the volume-outcome relationships are linear functions \((ax + b)\) depending on the number of locations \((NL_d)\) treating a diagnosis group \(d\) \((a_dNL_d + b_d)\). After solving the problem the optimal number of locations is compared with the interval and if necessary another interval (with another linear function) is chosen.²

QALY’s are converted into monetary units (euros), based on earlier described concepts, using € 50,000 per QALY \((EQ)\) which is a relative low number as previous studies often use $100,000 per QALY.⁴⁰ To test the robustness of our results we also ran the model using € 20,000 per QALY and € 100,000 per QALY. Implicitly, this is also a sensitivity analysis for the assumptions we made for the volume-outcome relationship.

The volume-outcome relationship for a disease group \(d\) is now as follows:

\[
Quality_d = EQ \cdot NP_d \cdot (a_d \cdot NL_d + b_d) \quad \text{for all } d.
\]

Accessibility

The second element in the objective is travel time. The travel time of patients is calculated based on the demographics per zip code, using similar approaches as previous studies measuring accessibility of care.⁴¹ The Netherlands are divided in 794 zip code areas (the Dutch Frisian Islands are excluded). The percentage wise distribution of patients for every diagnosis group is assumed identical for these 794 zip code areas.

Total travel expenses per diagnosis group are based on the number of patients \((NP_{p,d}^D)\) per diagnosis group \(d\) and zip code \(p\), the total amount of time traveling \((\text{number of visits times travel time})\), and the travel expenses per time unit \((ET)\).

The total number of visits per patient having diagnosis \(d\) \((NV_d)\) was taken from current guidelines in which the number of outpatient clinic visits (including possible radiotherapy/chemotherapy and follow-up visits). It is assumed that all treatments take place at one location, including follow-up visits. For the driving time to the hospital locations \((TT_{p,q})\) the Dutch Drive Time Matrix was used.⁴²

The travel expenses per hour \((ET)\) are derived from the costs of traveling by taxi (€ 2.20 per kilometer)⁴³ and the loss of income by traveling, using the national median income of € 32,000 a year for 1,600 working hours.⁴³ We assumed that apart from the patient, a second person always accompanies the patient. Based on the literature regarding patient preferences – as mentioned in the introduction – we assumed that all patients are willing to travel as these travel costs are compensated by a higher quality of care. As we know that individual patient preferences regarding willingness to travel may differ, this is a limitation of our used data and approach.

For all diagnosis groups \(d\) a maximum is set – based on expert opinions – on the acceptable travel time \((\text{maxt}_d)\) for patients. The decision variable \(Y_{p,q,d}\), which assigns zip code areas to potential hospitals for a diagnosis group, is restricted to the domain \((p,q,d)\) with:

\[
Y_{p,q,d} \cdot TT_{p,q} \leq \text{maxt}_d \quad \text{for all } p, q, d.
\]

The costs for traveling for a diagnosis group \(d\) is as follows:

\[
Travel_d = 2 \cdot ET \cdot NV_d \cdot \sum_{p,q} NP_{p,d}^D \cdot Y_{p,q,d} \cdot TT_{p,q} \quad \text{for all } d.
\]
**Constraint: efficient use of resources**

Efficiency is regarded as operational efficiency concerning three facilities $f$:

- Operating room (OR)
- Ward
- Intensive care unit (ICU)

It is assumed that there are no capacity limitations for these facilities and that the same facility can be used for different diagnosis groups.

A health care location is considered efficient when a minimum utilization ($\text{min}_{u,f}$) is reached. How much a facility is used depends on the number of patients coming to this specific health care location $p$ ($\sum_{p,d} N_{p,d} \cdot Y_{p,q,d}$ where $N_{p,d}$ is the number of patients with diagnosis $d$ living in zipcode $q$ and $Y_{p,q,d}$ indicates to which health care location $p$ these patients go for care) and how much each patient makes use of this facility ($U_{f,d}$).

This leads to the following constraint:

$$\sum_{p,d} N_{p,d} \cdot Y_{p,q,d} \cdot U_{f,d} \geq \text{min}_{u,f} \cdot X_p \quad \text{for all } f, p.$$

**Results**

The above model has been run with the data as discussed. Figure 1 shows per diagnosis group the number of locations that ideally provides care for patients with a disease from that diagnosis group. The number of locations vary from 12 locations for diagnosis groups like congenital anomalies and 14 locations for neoplasms, which have a high volume-outcome relationship, to 150 locations for chronic diagnosis groups such as diabetes and chronic obstructive pulmonary disease (COPD). Also the figure displays the results from the model using € 20,000 per QALY and € 100,000 per QALY.

In the new hospital landscape, care for acute diagnosis groups and diagnosis groups with a strong volume-outcome relationship is provided on less locations than in the current situation. Patients with a chronic disease have less travel time than they have nowadays. Figure 2 shows the travel time for patients with acute, chronic or other diseases in the new hospital landscape. In the current landscape of 94 hospitals the average travel time is 14.9 minutes, whereas, given the number of locations per diagnosis group in Figure 1 with the scenario of € 50,000 per QALY the travel time will be 28.9 minutes.
Figure 1  Number of locations per diagnosis group, including sensitivity analyses with different values per QALY³

<table>
<thead>
<tr>
<th>Diagnosis Group</th>
<th>#locations € 20,000 per QALY</th>
<th>#locations € 50,000 per QALY</th>
<th>#locations € 100,000 per QALY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute infectious and parasitic diseases and poisoning</td>
<td><img src="image" alt="Graph of Acute infectious and parasitic diseases and poisoning" /></td>
<td><img src="image" alt="Graph of Acute infectious and parasitic diseases and poisoning" /></td>
<td><img src="image" alt="Graph of Acute infectious and parasitic diseases and poisoning" /></td>
</tr>
<tr>
<td>Chronic infectious and parasitic diseases</td>
<td><img src="image" alt="Graph of Chronic infectious and parasitic diseases" /></td>
<td><img src="image" alt="Graph of Chronic infectious and parasitic diseases" /></td>
<td><img src="image" alt="Graph of Chronic infectious and parasitic diseases" /></td>
</tr>
<tr>
<td>Endocrine, metabolic and immunity disorders</td>
<td><img src="image" alt="Graph of Endocrine, metabolic and immunity disorders" /></td>
<td><img src="image" alt="Graph of Endocrine, metabolic and immunity disorders" /></td>
<td><img src="image" alt="Graph of Endocrine, metabolic and immunity disorders" /></td>
</tr>
<tr>
<td>Haematology</td>
<td><img src="image" alt="Graph of Haematology" /></td>
<td><img src="image" alt="Graph of Haematology" /></td>
<td><img src="image" alt="Graph of Haematology" /></td>
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<tr>
<td>Acute mental disorders</td>
<td><img src="image" alt="Graph of Acute mental disorders" /></td>
<td><img src="image" alt="Graph of Acute mental disorders" /></td>
<td><img src="image" alt="Graph of Acute mental disorders" /></td>
</tr>
<tr>
<td>Chronic mental disorders</td>
<td><img src="image" alt="Graph of Chronic mental disorders" /></td>
<td><img src="image" alt="Graph of Chronic mental disorders" /></td>
<td><img src="image" alt="Graph of Chronic mental disorders" /></td>
</tr>
<tr>
<td>Diseases of the nervous system</td>
<td><img src="image" alt="Graph of Diseases of the nervous system" /></td>
<td><img src="image" alt="Graph of Diseases of the nervous system" /></td>
<td><img src="image" alt="Graph of Diseases of the nervous system" /></td>
</tr>
<tr>
<td>Eyecare</td>
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<td><img src="image" alt="Graph of Eyecare" /></td>
<td><img src="image" alt="Graph of Eyecare" /></td>
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<tr>
<td>Earcare</td>
<td><img src="image" alt="Graph of Earcare" /></td>
<td><img src="image" alt="Graph of Earcare" /></td>
<td><img src="image" alt="Graph of Earcare" /></td>
</tr>
<tr>
<td>Cerebral hemorrhage / ischemia</td>
<td><img src="image" alt="Graph of Cerebral hemorrhage / ischemia" /></td>
<td><img src="image" alt="Graph of Cerebral hemorrhage / ischemia" /></td>
<td><img src="image" alt="Graph of Cerebral hemorrhage / ischemia" /></td>
</tr>
<tr>
<td>Chronic cardiovascular disease (including congestive heart failure)</td>
<td><img src="image" alt="Graph of Chronic cardiovascular disease (including congestive heart failure)" /></td>
<td><img src="image" alt="Graph of Chronic cardiovascular disease (including congestive heart failure)" /></td>
<td><img src="image" alt="Graph of Chronic cardiovascular disease (including congestive heart failure)" /></td>
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<tr>
<td>Cardiovascular disease with intervention (PCI/CABG)</td>
<td><img src="image" alt="Graph of Cardiovascular disease with intervention (PCI/CABG)" /></td>
<td><img src="image" alt="Graph of Cardiovascular disease with intervention (PCI/CABG)" /></td>
<td><img src="image" alt="Graph of Cardiovascular disease with intervention (PCI/CABG)" /></td>
</tr>
<tr>
<td>Acute diseases of the respiratory system</td>
<td><img src="image" alt="Graph of Acute diseases of the respiratory system" /></td>
<td><img src="image" alt="Graph of Acute diseases of the respiratory system" /></td>
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<tr>
<td>Complex pulmonary surgery</td>
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<td><img src="image" alt="Graph of Complex pulmonary surgery" /></td>
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<td>Common surgery of the respiratory system</td>
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<td><img src="image" alt="Graph of Common surgery of the respiratory system" /></td>
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<tr>
<td>Chronic obstructive pulmonary disease and allied conditions</td>
<td><img src="image" alt="Graph of Chronic obstructive pulmonary disease and allied conditions" /></td>
<td><img src="image" alt="Graph of Chronic obstructive pulmonary disease and allied conditions" /></td>
<td><img src="image" alt="Graph of Chronic obstructive pulmonary disease and allied conditions" /></td>
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<tr>
<td>Surgery of diseases of the digestive system</td>
<td><img src="image" alt="Graph of Surgery of diseases of the digestive system" /></td>
<td><img src="image" alt="Graph of Surgery of diseases of the digestive system" /></td>
<td><img src="image" alt="Graph of Surgery of diseases of the digestive system" /></td>
</tr>
<tr>
<td>Diseases of the genitourinary system</td>
<td><img src="image" alt="Graph of Diseases of the genitourinary system" /></td>
<td><img src="image" alt="Graph of Diseases of the genitourinary system" /></td>
<td><img src="image" alt="Graph of Diseases of the genitourinary system" /></td>
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<tr>
<td>General surgery</td>
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<td><img src="image" alt="Graph of General surgery" /></td>
<td><img src="image" alt="Graph of General surgery" /></td>
</tr>
<tr>
<td>Gynaecology</td>
<td><img src="image" alt="Graph of Gynaecology" /></td>
<td><img src="image" alt="Graph of Gynaecology" /></td>
<td><img src="image" alt="Graph of Gynaecology" /></td>
</tr>
<tr>
<td>Obstetrics</td>
<td><img src="image" alt="Graph of Obstetrics" /></td>
<td><img src="image" alt="Graph of Obstetrics" /></td>
<td><img src="image" alt="Graph of Obstetrics" /></td>
</tr>
<tr>
<td>Urinary system</td>
<td><img src="image" alt="Graph of Urinary system" /></td>
<td><img src="image" alt="Graph of Urinary system" /></td>
<td><img src="image" alt="Graph of Urinary system" /></td>
</tr>
<tr>
<td>Complications of pregnancy, childbirth and the puerperium</td>
<td><img src="image" alt="Graph of Complications of pregnancy, childbirth and the puerperium" /></td>
<td><img src="image" alt="Graph of Complications of pregnancy, childbirth and the puerperium" /></td>
<td><img src="image" alt="Graph of Complications of pregnancy, childbirth and the puerperium" /></td>
</tr>
<tr>
<td>Dermatology</td>
<td><img src="image" alt="Graph of Dermatology" /></td>
<td><img src="image" alt="Graph of Dermatology" /></td>
<td><img src="image" alt="Graph of Dermatology" /></td>
</tr>
<tr>
<td>Rheumatism and arthropathies (non surgical)</td>
<td><img src="image" alt="Graph of Rheumatism and arthropathies (non surgical)" /></td>
<td><img src="image" alt="Graph of Rheumatism and arthropathies (non surgical)" /></td>
<td><img src="image" alt="Graph of Rheumatism and arthropathies (non surgical)" /></td>
</tr>
<tr>
<td>Diseases of the musculoskeletal system that require surgical treatment</td>
<td><img src="image" alt="Graph of Diseases of the musculoskeletal system that require surgical treatment" /></td>
<td><img src="image" alt="Graph of Diseases of the musculoskeletal system that require surgical treatment" /></td>
<td><img src="image" alt="Graph of Diseases of the musculoskeletal system that require surgical treatment" /></td>
</tr>
<tr>
<td>Congenital disorders</td>
<td><img src="image" alt="Graph of Congenital disorders" /></td>
<td><img src="image" alt="Graph of Congenital disorders" /></td>
<td><img src="image" alt="Graph of Congenital disorders" /></td>
</tr>
<tr>
<td>Conditions originating in the perinatal period</td>
<td><img src="image" alt="Graph of Conditions originating in the perinatal period" /></td>
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</tr>
<tr>
<td>Emergency care</td>
<td><img src="image" alt="Graph of Emergency care" /></td>
<td><img src="image" alt="Graph of Emergency care" /></td>
<td><img src="image" alt="Graph of Emergency care" /></td>
</tr>
<tr>
<td>Renal and other diseases requiring end stage renal care</td>
<td><img src="image" alt="Graph of Renal and other diseases requiring end stage renal care" /></td>
<td><img src="image" alt="Graph of Renal and other diseases requiring end stage renal care" /></td>
<td><img src="image" alt="Graph of Renal and other diseases requiring end stage renal care" /></td>
</tr>
<tr>
<td>Diabetes</td>
<td><img src="image" alt="Graph of Diabetes" /></td>
<td><img src="image" alt="Graph of Diabetes" /></td>
<td><img src="image" alt="Graph of Diabetes" /></td>
</tr>
<tr>
<td>Neoplasms</td>
<td><img src="image" alt="Graph of Neoplasms" /></td>
<td><img src="image" alt="Graph of Neoplasms" /></td>
<td><img src="image" alt="Graph of Neoplasms" /></td>
</tr>
</tbody>
</table>

³ For some diagnosis groups the number of locations did not alter with adjusting the monetary value per QALY to € 20,000 and € 100,000 (such as earcare). In such cases only the thick horizontal line is displayed.

Figure 2  Travel time by car to nearest hospital per type of diagnosis group

<table>
<thead>
<tr>
<th>Travel time (minutes)</th>
<th>% of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-15</td>
<td>30%</td>
</tr>
<tr>
<td>15-30</td>
<td>40%</td>
</tr>
<tr>
<td>30-45</td>
<td>20%</td>
</tr>
<tr>
<td>45-60</td>
<td>10%</td>
</tr>
<tr>
<td>60-75</td>
<td>5%</td>
</tr>
<tr>
<td>75-90</td>
<td>2%</td>
</tr>
</tbody>
</table>

Legend
- Acute
- Elective
- Chronic
Discussion

In this study we explored how the optimal hospital landscape may look like based on a MIP model that trade-offs the dimensions efficiency, quality, and accessibility of hospital care in the Dutch context.

Our findings – given the assumptions we made - suggest that the current Dutch hospital landscape is too dispersed and too concentrated at the same time. For the more complex diagnosis groups such as neoplasms, patients would benefit from more concentration of care, where for chronic diagnosis groups such as COPD and diabetes, optimal value may be created by making care more accessible to patients by providing chronic care at more locations throughout the country. These findings are in line with previous non-empirical but rather conceptual studies regarding the Dutch hospital landscape that also advocates more dispersion for chronic care and more concentration for acute and/or complex diagnosis groups.[44]

Based on our findings we believe that other countries or regions can apply our model as well.

Moreover we see that this development of concentration of care is actually happening in the Dutch hospital market; associations of medical specialists are formulating minimum volume norms for a range of conditions, resulting in fewer hospitals providing treatments for complex care.[45] In addition, there is a trend of merging of (smaller) hospitals, probably caused by efficiency pressures, concentration of care to enhance quality, as well as market power considerations.[46] This latter development is not necessarily in line with the findings of our model as hospitals tend to merge as a whole, making no differentiation between characteristics of individual (groups of) diagnosis.

The main contribution of this study compared to previous hospital allocation studies is that it systemically includes the quality of care dimension.[16-18] It is this dimension that is very highly rated by patients in multiple studies, showing patients’ willingness to travel substantial distances for higher quality of care.[11,47,48] Therefore, including the quality of care dimensions in hospital allocation models that are used by policy makers may improve the alignment of the hospital infrastructure with the preferences of society as a whole and of individual patients.

It is important to state that this study has an explorative character, especially because the volume-outcome relationship is not established yet for all different diagnosis groups, let alone all the individual diagnoses. Future research regarding the volume-outcome relationship may alter the used input data and thereby alter the optimal number of locations per diagnosis group. In addition we did not include specialization effects of hospitals in our model; we only ensured a minimal scale of hospitals, but did not fully model economies of scale nor economies of scope effects. Also we did not include potential price effects due to a potentially lower level of competition between providers. However, most of these effects, like other constraints or functions, could be added to this approach as well: nearly the only aspect that needs to be taken into account is the size of the mathematical model (otherwise it cannot be solved within a reasonable time frame). Last, it is important to state that our model does not include individual preferences of patients, this implies that our findings of a different hospital landscape do not necessarily match with (all) individual preferences.

In conclusion, our study shows a new approach for determining the allocation of diagnosis groups in a hospital blueprint in a country or certain region. This approach, considering quality of care in relation to volume per provider, can be used in various countries or regions. In addition, our model shows that within the Dutch context chronic care may be too concentrated while complex and acute care may be too dispersed.

Competing interests

The authors declare to have no competing interests.
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Discussion

In this chapter we start with summarizing the content and main findings of the three parts of this thesis. We then continue with reflection on our findings and analyzing the validity and reliability of these findings. We conclude with the policy relevance of our findings.

Findings part I: quality of care

In part I of this thesis we examined the quality and safety of care via a literature study (chapter 1), conducted a cross-sectional survey accompanied with interviews at emergency departments (chapter 2), and we analyzed the trend of the Customer Quality Index of Dutch hospitals in the period 2006 – 2009 (chapter 3). Based on the findings in these chapters we conclude that there is substantial potential for improving quality of care. Chapter 1 shows that processes (care pathways) in health care in comparison with other industries are relative unreliable and that most hospitals are still in the early development (phase 0 to phase 1) of assuring quality and safety of care. This finding is confirmed in chapter 2, which shows that none of the 27 emergency departments that were sampled complied to minimum quality standards. A first step in improving the reliability of high risk processes may be complying to the quality requirement framework in chapter 2, but actual measurement of outcomes and process reliability and steering by professionals and management to improve these outcomes will be essential to really improve the quality of care. In chapter 3 we show that the introduction of transparency and competition as part of the health reform in 2006 seems to have improved patient experiences in Dutch hospitals. If one combines the findings of chapter 1, 2 and 3 one may conclude that focusing on the measurement of outcomes of care and publishing these outcomes in concordance with the development of quality requirement frameworks may be a fruitful route to further improve the quality of care in the Dutch health care system.

Findings part II: system performance

In part II of this thesis we analyzed the costs, efficiency, and accessibility of the hospital system by examining all (day)clinical DTCs in the period 2006-2009 (chapter 4). In chapter 5 we provide the results of a regional study around the city of Eindhoven were GPs worked with report cards. Based on the findings in chapter 4 we conclude that the introduction of standardized ‘products’ (DTCs), transparency of quality, and negotiable prices and volumes for DTCs have led to improvement of efficiency, lower prices, and marginally improved accessibility of care on a product level. Nonetheless substantial volume increases within the so called ‘B-segment’ outweigh the gains in efficiency of care and therefore total costs in the period 2006 to 2009 rose at an unsustainable fast rate. In addition, we see that once DTCs enter the B-segment without volume caps, efficiency gains compared to previous years of these DTCs and other DTCs within the same year decrease, probably due to a focus on volume growth of providers rather than focusing on realizing additional efficiency improvements for these DTCs. In chapter 5 we show that the current level of transparency in the hospital market is too limited to result in substantial volumes of patients and/or GPs that choose for the ‘best’ hospital. For patients (and GPs) to act in the role of envisioned ‘change agent’, easily accessible, risk-adjusted outcomes of quality of care are needed.

Findings part III: value of care

In third part of this thesis we described potential strategies to improve value of care. In chapter 6 we measure the developments in costs and quality of care in the different health care sectors using the VBC theory. In chapter 7 we present a new method to make the trade-off between accessibility and quality of care for one specific diagnosis (breast cancer). In chapter 8 we use the methodology of chapter 7 to gauge how the hospital landscape in the Netherlands would look like if one would optimize the value of care.
Based on the findings in chapter 6 we conclude that in the first years after the health reform it seems that primarily the principles of the VBC theory (outcome measurement, bundled payments, competition between providers) improve the efficiency and quality at a product level rather than health plans that selectively purchase care products. The main finding of chapter 7 is that via concentration of breast cancer care in the Netherlands in 15 to 44 centers, the quality of care can be improved and that this outweighs the lessened accessibility of care according to patient preferences. Therefore, by concentrating breast cancer care in fewer centers, the total value of breast cancer can be optimized. In chapter 8 we gauge how the Dutch hospital landscape would look like if one would optimize the societal value of hospital care using the methodology of chapter 7. We come to the conclusion that there seems to be a mismatch between the current hospital landscape and patient preferences; the current hospital landscape for complex care may be too dispersed, while for basic care it may be concentrated and care could be provided in non-hospital settings in the proximity of patients.

Findings of this thesis in the perspective of the literature

The conclusion of part I of this thesis that quality can be improved within the Dutch health care system is congruent with the international literature, where other studies also find substantial room for improvement of quality of care e.g.[1-4] In chapter 3 we are able to use a rather comprehensive longitudinal dataset of Customer Quality Indices and have the ability to compare a group of hospitals that have been divided by a health plan in two groups: a group that is confronted with early publication of results and a group that is later confronted with these results. Due to this situation we were able to confirm foreign studies that transparency and competition lead to better quality of care, also within the specific Dutch setting.[5-7]

In chapter 5 in the second part of this thesis we conclude that the introduction of DTCs, transparency of quality of care, and competition between providers has led to increased productivity and lower prices, similar to what is reported in the international literature.[8-10] The increased volume growth in the B-segment is not literally reported in international studies, because as far as the author is aware no comparable health systems are available internationally, but the phenomenon of supply induced demand or practice variation (what is the an underlying cause of volume growth) is well-known and widely studied issue in the health services literature.[11-16] In comparison with other Dutch studies regarding the 2006 health reform and the effects on volume, price, accessibly, and/or productivity trends within the hospital market [17-19], our dataset has the advantage of including four consecutive years (compared to three years in the study of Krabbe et al.[19]) and is able to combine trends in volume, prices, accessibility and productivity of hospital care by using multiple sources of data. Chapter 6 is – as far as the author knows – the first empirical study towards choice behavior of patients (‘revealed preferences’) where GPs use report cards within the Dutch setting. In line with international studies we find that – with the current state of quality information - report cards do not or only for some indicators have limited influence in the actual choices that patients make.[20-22]

In the third part of the thesis we conclude that value of the health care can be improved by concentrating (complex) care in fewer centers (chapter 7 and 8). This finding is in line with studies regarding the volume-outcome relationship in multiple areas of medicine, e.g. [23-27] and also congruent with the value-based competition framework of Porter.[28]

Validity and reliability of the findings in this thesis

In this section we reflect on the validity and reliability of the main findings in the different parts of this thesis. Per part of the thesis we will discuss whether or not selection bias, measurement bias, confounding, and/or reliability issues may be applicable on the main findings.
In part 1 we use different methods that may have been subject to different types of biases. In chapter 1 we conduct a systematic literature review that should not suffer from selection or measurement bias as the review was conducted in a systematic way. Given the fact that the findings of this review are in line with a significant number of previous studies we expect that there are no reliability issues with the findings of chapter 1. In chapter 2 we assess whether or not emergency department comply with (minimum) quality requirements. Within this study selection bias may have occurred as we sampled 27 out of 104 nationwide emergency departments by choosing three out of eleven acute care regions (‘ROAZ’ regions). Nonetheless we checked for the representativeness of the emergency departments by comparing the sampled emergency departments with the national average on the following parameters: location (urban/rural), and type of hospital (general hospital, teaching hospital, academic center). This comparison showed that in our study rural emergency departments are overrepresented (60% in the sample versus 50% in the national average), but the results of our study show no difference between urban and rural emergency departments (all emergency departments did not comply). Therefore we think that this potential bias did not affect our findings. Secondly, our study may have suffered from measurement bias due to the fact that different emergency departments may have interpreted the survey in different ways. As within this study all sampled emergency departments were visited and all answers were checked with the interviewee and no emergency departments stated after publication of the results that they in fact did comply with the minimal quality requirements, we do not think that this has influenced our results. In chapter 3 the findings may have been affected by selection bias as one group of hospitals was selected to be publicly confronted with their results. Nonetheless, as the health plan made the decision to confront these hospitals (rather than hospitals’ themselves), we do not expect significant effects on our findings. In addition one may be worried about confounding issues due to the absence of correction for all relevant case mix variables, albeit we adjusted for five available (and relevant) case mix parameters and cluster effects. We think that this potential bias has not significantly affected our results, because we show that hospitals improve their performance over consecutive years and we know that case mix within hospitals seems to be fairly stable.[29] Nonetheless, the potential absence of correction for all case mix factors still may be a source of confounding for this study, especially for the results regarding the effects of transparency and competition on the improvement of the Customer Quality Index.

In part II, in chapter 4 we analyze the performance of hospitals using all (day)clinical DTCs. We exclude outpatient DTCs; this may have introduced selection bias, but the majority of resources within a hospital are spent on (day)clinical activities, therefore we do not expect a major impact of this selection bias. Measurement bias may have occurred within this chapter as hospitals may have improved their registry of activity codes over the years. Nonetheless, this may have lead to an underestimation of the found productivity increases as over the years more activities are then coupled to DTCs leading to a lower efficiency. Because the productivity increases and volume growth have also been reported in other studies [18,19] and because of the large sample size we do not expect reliability issues. Although we correct for age and social economic status, the case mix of patients may become less severe over the years due to the observed volume growth, what may have been a confounding factor regarding the results of the productivity growth. Chapter 5 may have suffered from selection bias as probably motivated GPs signed up for the study. Although we randomized the GPs who signed up for this study, GPs in the intervention group may have been more likely to use the information on the report cards than non-participating GPs, leading to a potential overestimation of the effect of report cards. In addition, this study may have suffered from reliability issues as the 26 participating GPs may have not been equally randomized over the control and intervention group, albeit the two groups seemed comparable at two (rough) parameters: location of their practice (urban vs. rural) and division of sexes in both groups and we also compared with 200 GPs non participating with the study but working within the same region as an extra control group.
In part III of this thesis we start out with chapter 6 which has the benefit of analyzing a natural experiment that includes all health care sectors, therefore we do not expect confounding bias. As we use sources that are already several years old, which are periodically updated by authorities, we do not expect measurement bias. Given the fact that we examine all health care sectors we do not expect reliability issues nor selection bias. In chapter 7 and 8 we conduct a systematic literature search as the source for the found volume-outcome relationship; therefore we do not expect selection or bias, nor do we expect reliability issues. A confounding factor that sometimes is discussed in the literature e.g. [30] is the one of reversed causality: that volume does not improve outcomes, but that better outcomes lead to higher volumes due to the fact that patients tend to seek hospitals that provide the best quality of care. We do not expect this to be the case due to a variety of reasons. First, outcomes are usually not publicly available yet and therefore the impact of quality information on patients’ choices is usually limited (see e.g. chapter 5). Second, research shows that after concentration of care the outcomes improve, strongly suggesting a causal relationship between volume and outcome and not the other way around e.g.[31] As the inclination angle of the volume-outcome relationship is not (yet) known for all diagnosis categories, the angle of inclination is gauged based on expert opinions and available literature. Therefore the magnitude of the found need for concentration or dispersion to optimize value of health care in chapter 8 is vulnerable to measurement bias; for this reason we include a sensitivity analysis in chapter 8.

**Policy implications of the findings**

This study examined the performance of Dutch health care system after the 2006 reform. It provides insight what value the reform has brought, but also where improvements are needed and what strategies may work. In this paragraph we discuss the policy implications of this thesis.

**For introducing (and improving) minimum quality, quality frameworks can be useful**

As chapter 2 shows, introducing (minimum) quality requirements for hospitals can be a useful instrument to heighten the chance that patients receive care according to the (international) standards. The same type of instruments have been recently put in place by scientific associations by introducing minimum (volume)norms based on a consensus approach.[32] These instruments – although they only improve the minimum standard – may have a beneficial effect on quality over the course of the years, as long as these norms will be heightened step-by-step. A next step in the quality debate will be defining optimal volumes, infrastructure and outcomes of care.
For optimal quality value measurement (both costs and outcomes) is crucial. To actually achieve optimum quality and thereby also decrease costs, value measurement is needed. Where value measurement once looked like a theoretical perceptive, the latest developments show that value measurement is feasible for the majority of care by using administrative data (from Vektis) within the year 2012 already (see Figure 1).

**Figure 1** Value of CVA care (source: KPMG Plexus and Vektis, 2012)

In addition, for the diagnoses where administrative data may not be the most valid source for value measurement, clinical registries (such as the NICE for ICU care and the National Trauma Care registry for trauma care) and Patient Reported Outcome Measures (PROMs) can provide these insights. The clue is to make these and other clinical registries (such as the National Cancer Registry and clinical registries handled by the Dutch Institute for Clinical Audit (DICA)) transparent for both health insurers and patients.

**Contracting value by health plans is the only way forward**

We come to the conclusion that the current way of contracting hospitals via pay-for-performance systems is not a viable strategy to improve value. To really improve value in health care health plans should purchase integral health care products using three principles that are already routine in other parts of the economy: 1) define a meaningful health care product or service, 2) measure the outcomes (costs and quality) of this product or service, and 3) pay for these outcomes rather than activities.[33] Now that value of care can be measured, over the coming years health plans become able to contract value. Although conceptually sound and the only way forward, the implementation of this new approach may be challenging as purchasing of care by health plans currently still works by contracting entire hospitals rather than specific (groups of) diagnoses. This requires new skills from health plans and may also generate resistance from providers as the amount of risk for providers increases.
Taming cost growth is only feasible by having access to relevant data and decreasing capacity of hospitals

From a macro perspective, having access to relevant data to draft policies and to make meaningful budget forecasts is crucial. Currently, policy makers do not have timely access to all relevant data sources[34], resulting in a fairly rough manner of budget forecasting based on historical cost growth, rather than using demographical, technological, and epidemiological trends that influence demand per type of care (e.g. CVA care or elective care) across different sectors.[35] This results in budget forecasting in separated silos per health care sector, instead of following health care demand of patients that often spans multiple health care sectors. To topple the current budget forecasting cycle from the current silos to meaningful entities following actual demand of care, access to (in principle available) data is needed for the policy makers. With these data at hand it will become easier to make more realistic budget forecasts and to adjust faster when exceeding of budgets tend to occur.

Last, to substantially tame cost growth in health care, apart from contracting value by health plans, decreasing (hospital) capacity will be needed given the phenomenon of supply induced demand. The current agreement by hospitals, insurers and the government to tame growth at a maximum of 2.5% (excluding inflation) is a good first step in cost containment, but will not be enough given the dire growth forecasts of our economy.

Conclusion

This thesis has shown that the 2006 reform has spurred efficiency, lowered price growth, and improved accessibility of care on a product level. On a macro level costs still rise at an unsustainable pace due to volume growth. To complete the 2006 reform, health plans (and policy makers) should focus on measuring value (both costs and quality) and contracting that value rather than activities, and reducing redundant hospital capacity. By doing that, the next step in the health reform can be made; growth of costs can become aligned with demographic changes and cost-effective technological innovations, while at the same time substantially improving quality of care.
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Summary

In part I of this thesis we examined the quality and safety of care via literature study (chapter 1), conducted a cross-sectional survey accompanied with interviews at emergency departments (chapter 2) and we analyzed the trend of the Customer Quality index of Dutch hospitals in the period 2006 – 2009 (chapter 3). Based on the findings in these chapters we conclude that there is substantial potential for improving quality of care. Chapter 1 shows that processes (care pathways) in health care in comparison with other industries are relative unreliable and that most hospitals are still in the early development (phase 0 to phase 1) of assuring quality and safety of care. This finding is confirmed in chapter 2, which shows that none of the 27 emergency departments that were sampled complied to minimum quality standards. A first step in improving the reliability of high risk processes may be complying to the quality requirement framework in chapter 2, but actual measurement of outcomes and process compliance and steering by professionals and management to improve these outcomes, will be essential to substantially improve the quality of care. In chapter 3 we show that the introduction of transparency and competition as part of the health reform in 2006 seems to have improved patient experiences in Dutch hospitals. If one combines the findings of chapter 1, 2 and 3, one may conclude that focusing on the measurement of outcomes of care and publishing these outcomes in concordance with the development of quality requirement frameworks may be a fruitful route to further improve the quality of care in the Dutch health care system.

In part II of this thesis we analyzed the costs, efficiency and accessibility of the hospital system by examining all (day)clinical Diagnosis Treatment Combinations (DTCs) in the period 2006-2009 (chapter 4). In chapter 5 we provide the results of a regional study around the city of Eindhoven were GPs worked with report cards. Based on the findings in chapter 4 we conclude that the introduction of standardized ‘products’ (DTCs), transparency of quality and negotiable prices and volumes for DTCs have led to improvement of efficiency, lower prices and marginally improved accessibility of care on a product level. Nonetheless substantial volume increases within the so called ‘B-segment’ outweigh the gains in efficiency of care and therefore total costs in the period 2006 to 2009 rose at an unsustainable fast rate. In addition, we see that once DTCs enter the B-segment, efficiency gains - compared to previous years of these DTCs and other DTCs within the same year - decrease, probably due to a shift of focus for these DTCs by hospitals towards volume growth instead of realizing additional efficiency improvements for these DTCs. In chapter 5 we show that the current level of transparency in the hospital market is too limited to result in substantial volumes of patients and/or GPs that choose for the ‘best’ hospital. For patients (and GPs) to act in the role of envisioned ‘change agent’, easily accessible, risk-adjusted outcomes of quality of care are needed.

In part III of this thesis we described potential strategies to (further) improve value of care. In chapter 6 we measure the developments in costs and quality of care in the different health care sectors using the value-based competition theory. In chapter 7 we present a new method to make the trade-off between accessibility and quality of care for one specific diagnosis (breast cancer). In chapter 8 we use the methodology of chapter 7 to gauge how the hospital landscape in the Netherlands would look like if one would optimize the value of care. Based on the findings in chapter 6 we conclude that in the first years after the health reform it seems that primarily the principles of the value-based competition theory (outcome measurement, bundled payments, competition between providers - as described by Michael Porter) improved efficiency and quality of care (at a product level) rather than health plans that selectively purchase care products. The main finding of chapter 7 is that via concentration of breast cancer care in the Netherlands in 15 to
44 centers the quality of care can be improved and that this outweighs the lessened accessibility of care according to patient preferences. Therefore by concentrating breast cancer care in fewer centers the total value of breast cancer care can be optimized. In chapter 8 we gauge how the Dutch hospital landscape would look like if one would optimize the societal value of hospital care using the methodology of chapter 7. We come to the conclusion that there seems to be an mismatch between the current hospital landscape and patient preferences; the current hospital landscape for complex care may be too dispersed, while for basic care it may be too concentrated and care could be provided in non-hospital settings in the proximity of patients.

We come to the conclusion that the current way of contracting hospitals via pay-for-performance systems is not a viable strategy to significantly improve value of care. Where value measurement once looked like a theoretical perceptive, the latest developments show that value measurement is feasible for the majority of care by using administrative data within the year 2012 already. In addition, for diagnosis where administrative data may not be the most valid source for value measurement clinical registries (such as the NICE for ICU care and the National Trauma Care registry for trauma care) can provide these insights, together with Patient Reported Outcome Measures (PROMs). To really improve value in health care, health plans should purchase integral health care products using three principles that are already routine in other parts of the economy: 1) define a meaningful health care product 2) measure the outcomes (costs and quality) of this product 3) pay for these outcomes rather than activities. By using this new way of contracting in combination with reducing redundant hospital capacity, it should be possible to make the next step in health care reform: realizing a cost growth that is in line with demographic trends and technological innovations while at the same time improving quality of care.
In het eerste deel van dit proefschrift onderzoeken we de kwaliteit en veiligheid van de Nederlandse zorg via: literatuur studie (hoofdstuk 1), een cross-sectionele survey gecombineerd met interviews bij spoedeisende hulp en analyse van de trend van de Customer Quality Index van Nederlandse ziekenhuizen in de periode 2006 tot 2009 (hoofdstuk 2). Op basis van de bevindingen in deze hoofdstukken concluderen we dat er significant potentieel is voor het verbeteren van de kwaliteit van de Nederlandse zorg. Hoofdstuk 1 laat zien dat zorgprocessen (zorgpaden) in ziekenhuizen, in vergelijking met andere bedrijfstakken, relatief vaak afwijken van de beoogde procesgang en dat de meeste ziekenhuizen nog aan het begin staan van organiseren van betrouwbare (en daarmee veilige) zorgprocessen. Deze bevinding wordt bevestigd in hoofdstuk 2 waar blijkt dat geen van de 27 bezochte spoedeisende hulp anno 2009 voldeden aan minimale kwaliteitsbeveiliging. Follow-up onderzoek van de Inspectie van de Volksgezondheid uit 2011 laat zien dat in 2011 bijna alle onderzochte zorgprocessen verbeteringen hebben geïmplementeerd. In hoofdstuk 3 blijkt dat in de periode 2006 tot 2009 de patiëntervaringen in de Nederlandse ziekenhuizen significant zijn verbeterd. Verder blijkt dat ziekenhuizen die op initiatief van de zorgverzekeraar eerder hun resultaten openbaar moesten maken en ziekenhuizen die meer concurrentie ervaren, hun resultaten sneller verbeterden dan andere ziekenhuizen. Wanneer men de resultaten van hoofdstuk 1, 2 en 3 combineert, kan men concluderen dat het introduceren, handhaven en stapsgewijs verhogen van minimum standaarden een eerste stap kan zijn om de (minimum)kwaliteit te verbeteren. Echter, om de kwaliteit van zorg substantieel te verbeteren is het meten en publiceren van proces compliance en uitkomsten van zorg cruciaal. Op basis van deze uitkomsten kunnen ziekenhuizen dan concurreren om de gunst van verzekeringsmaatschappijen en patiënten, om zo de kwaliteit van de ziekenhuiszorg te verbeteren.

In het tweede deel van dit proefschrift gaan we in op de prestaties van het nieuwe zorgstelsel. In hoofdstuk 4 van dit proefschrift brengen we de trends in kosten, prijzen, doelmatigheid en toegankelijkheid van de ziekenhuiszorg in de periode 2006-2009 in kaart aan de hand van de analyse van alle (dag)klinische DBC’s in deze periode. Uit deze analyse blijkt dat ziekenhuizen in deze periode fors efficiënter zijn gaan werken, dat prijzen in het vrij onderhandelbare B-segment minder snel stijgen dan in het A-segment en dat wachttijden (marginaal) verminderen. Ondanks deze positieve ontwikkelingen stijgen de kosten op een niet duurzaam niveau van zo’n 7% per jaar voornamelijk veroorzaakt door volumestijgingen in het B-segment, waarschijnlijk grotendeels ten gevolge van aanbod geïnduceerde vraag. Verder blijkt dat zodra de DBC’s worden overgeheveld naar het B-segment, de waarborgen doelmatigheidswinst op DBC-niveau vertraagt. Waarschijnlijk is dit ten gevolge van het feit dat bij ziekenhuizen voor deze DBC’s de focus verschuift richting volumegroei, in plaats van het produceren van doelmatiger DBC’s. In hoofdstuk 5 van dit proefschrift analyseren we in de regio Eindhoven een experiment met 26 huisartsen die patiënten met de verdenking op de diagnosen borstkanker, staar, heup- en knievervanging verwijzen naar het ziekenhuis met behulp van zogenaamde kwaliteitskaarten. Op deze kwaliteitskaarten staat de kwaliteit van de ziekenhuizen op basis van openbare kwaliteitsindicatoren voor de betreffende ziektebeelden weergegeven. Uit deze analyse blijkt dat huisartsen en patiënten, op basis van het huidige niveau van transparantie over kwaliteit, zich ten tijde van de studie (anno 2010) niet in grote mate laten beïnvloeden door te kiezen voor het ‘beste’ ziekenhuis. Om patiënten (en huisartsen) de rol van ‘change agent’ in de zorg te laten spelen is transparantie over de risico gecorrigeerde uitkomsten van zorg cruciaal.

In het derde deel van dit proefschrift onderzoeken we hoe de waarde (kosten/kwaliteit verhouding) van de Nederlandse zorg verhoogd kan worden. Uit hoofdstuk 6 blijkt dat in de eerste
jaren na de introductie van het nieuwe zorgstelsel de principes van ‘value-based competition’ (transparantie van kwaliteit, gebundelde bekostiging van activiteiten, en concurrentie tussen zorgaanbieders – zoals beschreven door Michael Porter) de doelmatigheid en kwaliteit van zorg op het zorgproduct niveau hebben verbeterd en niet zozeer zorgverzekeraars die selectief zorg inkopen. In hoofdstuk 7 wegen we de publieke belangen kwaliteit en toegankelijkheid van zorg tegen elkaar af voor de patiënt met borstkanker. Uit deze afweging blijkt dat vanuit het perspectief van de patiënt de optimale waarde gecreëerd wordt wanneer in Nederland borstkanker zorg geconcentreerd zou worden in 15 tot 44 centra en niet meer in ieder ziekenhuis wordt aangeboden zoals dat nu het geval is. In hoofdstuk 8 bouwen we voort op de methodologie uit hoofdstuk 7 en komen we tot de conclusie dat het huidige Nederlandse zorglandschap te geconcentreerd is voor de basiszorg en te verspreid in het geval van de complexe zorg. Om de waarde van de zorg voor de Nederlandse burger te verhogen dient complexe zorg, meer dan nu het geval is, geconcentreerd worden in een beperkt aantal centra, terwijl basiszorg meer in de eigen omgeving in de 1,5e lijn dient te worden geleverd.

Tot slot concluderen we dat de huidige manier van het contracteren van ziekenhuizen door zorgverzekeraars volgens de zogenaamde pay-for-performance benadering niet zal leiden tot de mogelijke waardeverbetering van de zorg. Om daadwerkelijk de waarde van de zorg te verbeteren dienen integrale uitkomsten van zorg gecontracteerd te worden en niet inspanningen die (mogelijk) leiden tot deze uitkomsten. Waar het meten van waarde van zorg lang een theoretisch vergzicht leek, blijkt het anno 2012 door het slim gebruiken van Vektis declaratiedata - waar nodig aangevuld met klinische registraties en Patient Reported Outcome Measures (PROMs) - mogelijk voor het merendeel van de diagnosen de waarde ervan te meten. Dit stelt zorgverzekeraars de komende jaren in staat om te contracteren conform drie principes die in andere delen van de economie reeds standaard zijn: 1) definieer een betekenisvol integraal zorgproduct 2) meet de waarde van dit zorgproduct 3) betaal de aanbieder(s) voor de geleverde waarde en niet voor de gepleegde inspanningen. Door het hanteren van deze drie principes en het afbouwen van overbodige ziekenhuiscapaciteit, zou het mogelijk moeten zijn om de volgende stap te maken in het hervormen van de zorg: het komen tot een duurzame kostengroei die gelijke tred houdt met demografie en technologische innovaties met het tegelijkertijd verbeteren van de kwaliteit van de zorg.
Publicaties

Engelstalige artikelen


Ikkersheim DE. Koolman X. The first effects of Dutch healthcare reform on hospitals. Submitted.


Engelstalige rapporten


Nederlandstalige artikelen

Ikkersheim DE, Putters K. Staak die nivellering via de zorg. NRC, 9 november 2012.


About the author

David Emanuel Ikkersheim (1982) completed his secondary education (Atheneum) at St. Bonifatius College Utrecht in the year 2000. During his secondary education he won the debating contest ‘VARA’s Lagerhuis voor Scholieren’. In 2000 he started studying Medicine at the University of Utrecht. During his medical internships he became interested in improving efficiency and quality of health care and decided to start a second study: Business Administration at the Erasmus University Rotterdam. In 2007 he finished his Medicine study and became a Medical Doctor. In 2008 David participated in the exchange program of the Erasmus University and studied one semester at Brandeis University, International Business School, Boston, United States. In the fall of 2008 he completed his Master in Business Administration. In 2010 David was selected to participate in the course Value Based Health Care Delivery taught by professor Michael Porter at the Harvard Business School.

Since 2008 the author has been working for KPMG Plexus, the company where he already interned in 2007. At KPMG Plexus David works on improving value of care in a variety of assignments for hospitals, health insurers and policy makers. Topics in his recent work at KPMG Plexus include the development of a nationwide quality framework for emergency care, the development of an international hospital benchmark, determining the value of myocardial infarction based on administrative data and supporting health insurers to contract value of care from providers rather than outputs. Apart from his regular assignments at KPMG Plexus he started writing this PhD thesis in the winter of 2008/2009 and he is a guest lecturer at the VU University, at the faculty of health sciences. As an additional function, David is member of the city council of Utrecht; he is member of the Dutch liberal party (VVD) and is spokesman on the portfolios welfare, public health and primary education.

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