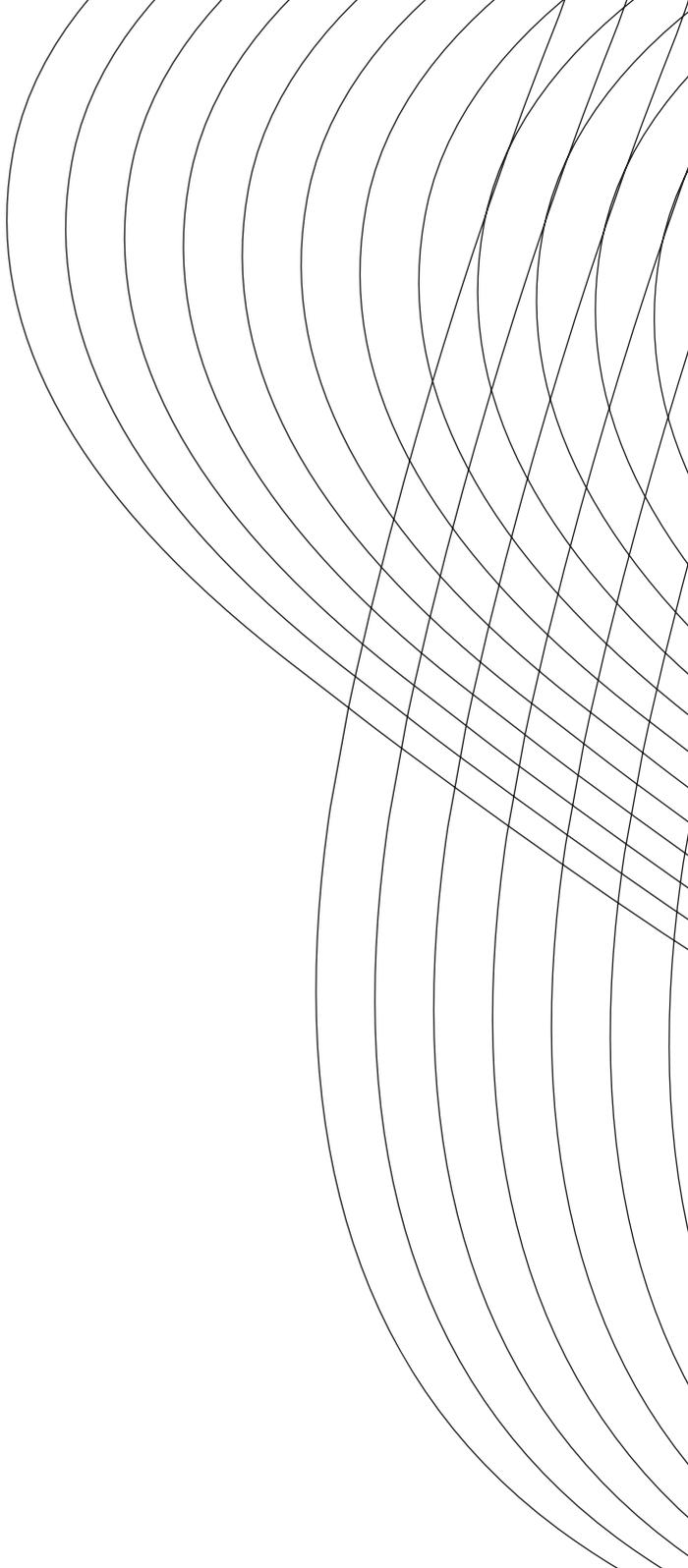
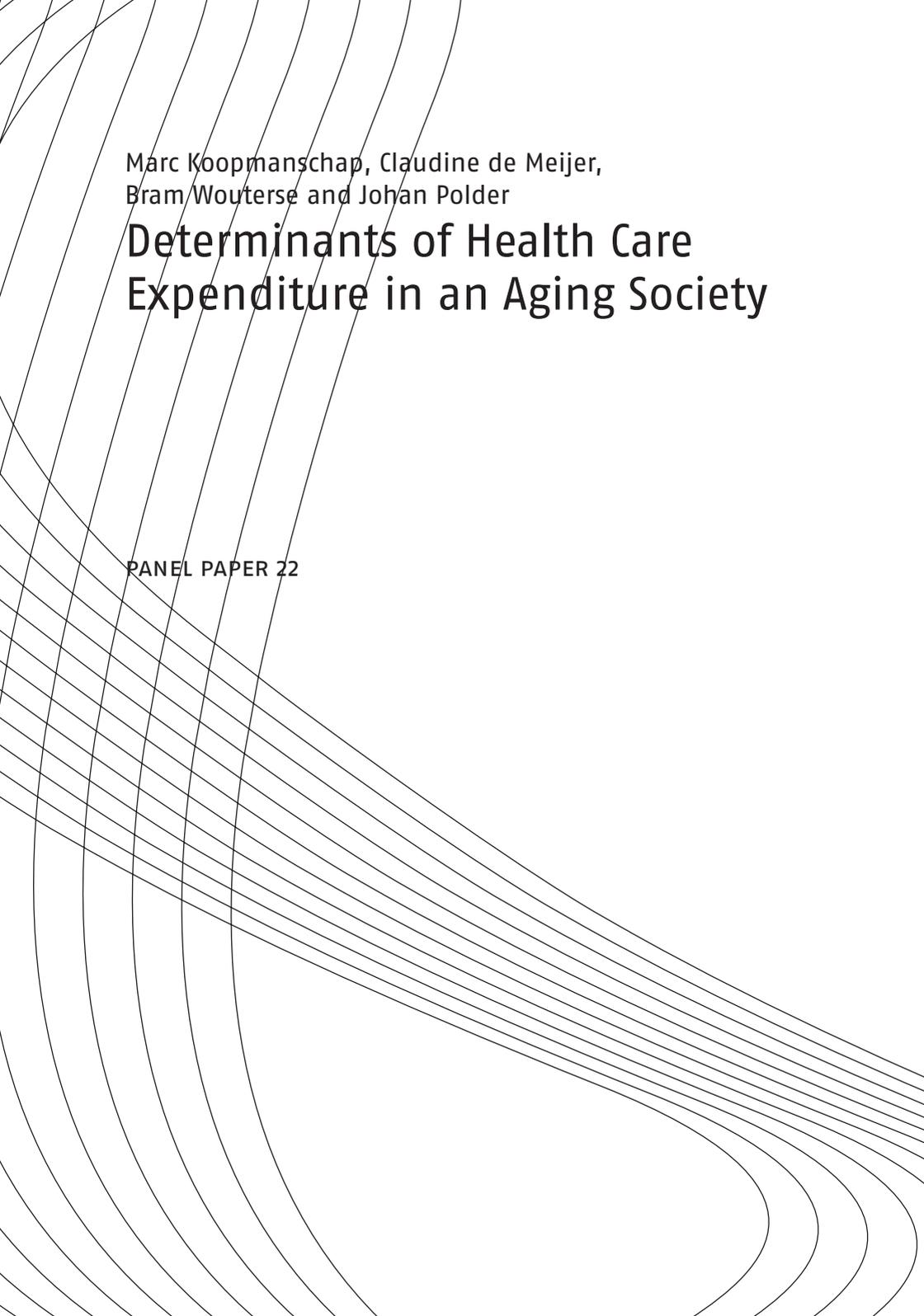


Netspar  
PANEL PAPERS

*Marc Koopmanschap, Claudine de Meijer,  
Bram Wouterse and Johan Polder*

Determinants of Health  
Care Expenditure in an  
Aging Society





Marc Koopmanschap, Claudine de Meijer,  
Bram Wouterse and Johan Polder

# Determinants of Health Care Expenditure in an Aging Society

PANEL PAPER 22



**Netspar**

Network for Studies on Pensions, Aging and Retirement

## **Colophon**

Panel Papers is a publication of Netspar  
December 2010

### **Editorial Board**

Henk Don (Chairman) – Netherlands Competition Authority  
Fieke van der Lecq – Erasmus University Rotterdam  
Erik Jan van Kempen – Ministry of Finance  
Jan Koeman – Ministry of Social Affairs and Employability  
Niels Kortleve – PGGM  
Albert Mentink – AEGON  
Joos Nijtmans – Syntrus Achmea  
Alwin Oerlemans – APG  
Jan Potters – Tilburg University  
Joeri Potters – Cardano Risk Management  
Peter Schotman – Maastricht University  
Hein Stam – Mn Services  
Hens Steehouwer – ORTEC Finance BV  
Marno Verbeek – Erasmus University Rotterdam  
Peter Wijn – APG  
Sjoerd van der Zee – Nationale Nederlanden

### **Design**

B-more Design  
Bladvulling, Tilburg

### **Printing**

Printing Office Tilburg University

### **Editorial address**

Netspar, Tilburg University  
PO Box 90153, 5000 LE Tilburg  
info@netspar.nl

No reproduction of any part of this publication may take place without permission of the authors.

# CONTENTS

<i>Preface</i>	7
<i>Executive Summary</i>	11
1. <i>Introduction</i>	16
2. <i>Conceptual model</i>	20
3. <i>Current international evidence on determinants of HCE in aging populations</i>	26
4. <i>Dynamics in the relationships between HCE and its determinants</i>	62
5. <i>Population aging and future HCE</i>	66
6. <i>New Evidence from the Netherlands</i>	74
7. <i>Conclusion and an agenda for the future</i>	85
<i>References</i>	96
<i>Summary of discussion</i>	104



## PREFACE

Netspar stimulates debate and fundamental research in the field of pensions, aging and retirement. The aging of the population is front-page news, as many baby boomers are now moving into retirement. More generally, people live longer and in better health while at the same time families choose to have fewer children. Although the aging of the population often gets negative attention, with bleak pictures painted of the doubling of the ratio of the number of people aged 65 and older to the number of the working population during the next decades, it must, at the same time, be a boon to society that so many people are living longer and healthier lives. Can the falling number of working young afford to pay the pensions for a growing number of pensioners? Do people have to work a longer working week and postpone retirement? Or should the pensions be cut or the premiums paid by the working population be raised to afford social security for a growing group of pensioners? Should people be encouraged to take more responsibility for their own pension? What is the changing role of employers associations and trade unions in the organization of pensions? Can and are people prepared to undertake investment for their own pension, or are they happy to leave this to the pension funds? Who takes responsibility for the pension funds? How can a transparent and level playing field for pension funds and insurance companies be ensured? How should an acceptable trade-off be struck between social goals such as solidarity between young and old, or rich and poor, and

individual freedom? But most important of all: how can the benefits of living longer and healthier be harnessed for a happier and more prosperous society?

The Netspar Panel Papers aim to meet the demand for understanding the ever-expanding academic literature on the consequences of aging populations. They also aim to help give a better scientific underpinning of policy advice. They attempt to provide a survey of the latest and most relevant research, try to explain this in a non-technical manner and outline the implications for policy questions faced by Netspar's partners. Let there be no mistake. In many ways, formulating such a position paper is a tougher task than writing an academic paper or an op-ed piece. The authors have benefitted from the comments of the Editorial Board on various drafts and also from the discussions during the presentation of their paper at a Netspar Panel Meeting.

I hope the result helps reaching Netspar's aim to stimulate social innovation in addressing the challenges and opportunities raised by aging in an efficient and equitable manner and in an international setting.

*Henk Don*

Chairman of the Netspar Editorial Board



## **Affiliations**

Marc Koopmanschap: institute of Health Policy and Management,  
Erasmus University Rotterdam, Rotterdam, The Netherlands

Claudine de Meijer: institute of Health Policy and Management,  
Erasmus University Rotterdam, Rotterdam, The Netherlands

Johan Polder: National Institute of Public Health and the  
Environment (RIVM), Bilthoven, The Netherlands and Tranzo,  
Tilburg University, Tilburg, The Netherlands

Bram Wouterse: Academic research centre for health and social  
care (Tranzo), Tilburg University, Tilburg, The Netherlands and  
Centre for public health forecasting, National Institute for Public  
Health and the Environment (RIVM), Bilthoven, The Netherlands

# DETERMINANTS OF HEALTH CARE EXPENDITURE IN AN AGING SOCIETY

## **Executive Summary**

Due to lower fertility rates and increases in life-expectancy in recent decades, the age composition of populations in developed countries has changed dramatically. The average proportion of the population aged 65 and over in OECD countries is projected to nearly double between 2010 and 2050 with an average of 25.7% of the population aged 65+ in 2050 (OECD 2009a). At the same time, health care expenditure (HCE) in western countries has risen sharply as a percentage of GDP.

Given that HCE generally rises with age, health policymakers expressed serious concerns about the pressure that population aging will exert not only on the fundability of the health care system but also on the availability of sufficient numbers of health care workers.

None dispute the fact that the recent growth in HCE can to some extent be attributed to population aging (Yang *et al.* 2003; Pezzin *et al.* 1996; Comas-Herrera *et al.* 2007; OECD 2006). The extent to which it does so, however, is still unclear and has to be studied within a broader context of all individual and societal factors determining HCE. It is important to improve our understanding of all possible determinants (and their interactions) of HCE in an aging society in order to be able to rightly inform health policymakers about the future consequences of population aging and to direct them adequately towards the right interventions. This paper provides an overview of the current knowledge on the aging-related determinants of per capita HCE, and provides

various projections of future acute health- and long-term care expenditures based on different specifications of HCE models.

### *Determinants of HCE*

The conceptual model of determinants of HCE as outlined in this paper distinguishes both societal and individual determinants; see the scheme below.

Determinants	Individual	Societal
Predisposing	Age Gender Household composition Socioeconomic status	
Enabling	Informal care supply Individual income Consumer preferences	National income
Illness/need	Health (incl. mortality) Disability	
Societal		Medical technology Organization of health care Wages/prices

When summarizing the international scientific literature, it's clear that health and disability are crucial determinants of HCE. Health status appears to affect acute HCE, whereas disability and household composition largely determine costs of long-term care (LTC.)

Regarding the societal determinants, medical technology plays a major role in boosting HCE in acute care, but advances in technology might also limit disability and lower subsequent demand for LTC. Evidence on the importance of the health care system is mixed: while copayments and deductibles tend to limit

cost increases, the overall effect of managed competition is as yet far from clear.

Aging, narrowly defined as changes in the age composition of the population, has a limited impact on HCE (growth rate less than 1% per year). The role of medical technology is probably much more important (growth rate 2–3%). Hence, Häkkinen *et al.* (2008) conclude: “future expenditure is more likely to be determined by health policy actions than inevitable trends in the demographic composition of the population.” However, when further advances in medical technology are allowed to be introduced swiftly for the elderly, and growing expectations of the future elderly regarding service levels are accommodated, all researchers expect that HCE as a proportion of GDP will increase considerably, probably together with healthy life expectancy. Hence, in a broader perspective, age and aging are unmistakably relevant in the dynamics of HCE.

#### *Projections of future HCE*

Simple projections estimate the impact of population aging on HCE as around 1% per year. Taking account of the fact that HCE is concentrated at the end of life lowers annual HCE growth to 0.8–0.9%. As a consequence, postponing the last expensive year of life might provide some relief with respect to HCE. It should be noted, however, that compression of disease is probably not for free, as it likely will result from progress in medical technology.

Expected trends in household composition and disability are also crucial in projecting future HCE. Setting per capita LTC expenditure in the Netherlands (which is comprised of nursing homes, homes for the elderly and home care) to an index of 100 for the year 2004, naïve projections for the Netherlands indicate that per capita LTC expenditure in 2040 will be indexed at 150,

implying an annual growth rate 1.1%. Taking additionally into account the growing share of single living elderly, per capita LTC expenditure will be indexed at 153 in 2040. Taking into account that HCE concentrates at the end of life results in a per capita index of 128 for total LTC expenditure and 124 for home care expenditure. A model controlling additionally for disability estimates the per capita index for home care expenditure as 117 in 2040.

With respect to trends in health and disability, further analyses should also address underlying epidemiological trends that might affect health, disability – and subsequently – HCE. An example is the relationship between cause of death and the effect of time-to-death on HCE. Insight into epidemiological trends as well as the contribution of specific chronic conditions to the burden of disability is required in order to further improve prediction of future need for health care services.

Projecting the number of singles and disabled persons is difficult. The number of singles is, among other things, dependent on the difference in life expectancy between men and women. If the gap in life expectancy is closing, the number of elderly women with a male partner will increase, limiting the demand for LTC. Regarding disability, it remains to be seen whether the US trend of less disability for a given level of morbidity will also prevail in Europe.

Recent projections based on current health policy indicate that, for the Netherlands, HCE will increase from about 9% of GDP now to at least 14% in 2045, when population aging has completed its impact. This increase in HCE is expected to prevail alongside a growth in (healthy) life expectancy, and is predominantly driven by advances in medical technology.

### *Conclusion*

Aging, narrowly defined, has a limited impact on HCE. However, the effect of aging, from a broader perspective, might have a higher impact when further advances in medical technology are allowed to be introduced swiftly for the elderly and as growing expectations of the future elderly regarding service levels are accommodated. Under this possibility, researchers expect HCE as proportion of GDP to increase considerably, probably together with healthy life expectancy.

Hence, policymakers should be encouraged to use information on cost-effectiveness of new medical technology more systematically, in order to get value for money. More investment in prevention of disease will probably not result in controlling the growth in HCE. On the other hand, policies that are able to limit the prevalence of severe disability and to postpone institutionalization in long-term care facilities are probably the most powerful instruments to attenuate the increase in long-term care expenditure.

A relevant policy question can, then, be formulated as follows: are we willing to pay substantially more for health care as a fraction of GDP in 2040 for further improvement in our health? Should the answer prove to be affirmative, thereby allowing health insurance premiums to rise accordingly, then the opportunity costs probably include more pressure on funds for other government tasks, such as education and safety, or a reduction in private disposable income. Should the answer prove negative, then policy options will have to be developed that are more effective in curbing HCE than all of the measures to date – all the while preserving solidarity.

## 1. Introduction

The age composition of populations in developed countries has changed dramatically. From 1970, the proportion of the population aged above 65 years in OECD countries has steadily increased, from 11.7% in 1970 to 14.7% in 2007 (OECD 2009b). With the most rapid growth in the proportion of the elderly still yet to come (by 2050, this proportion is expected to nearly double to an OECD average of 25.7%), the impact of population aging on health care expenditure (HCE) has become a topic of growing interest (OECD 2009a).

Simultaneously with the increase of the proportion of elderly, HCE as a percentage of GDP has also risen sharply; it has increased, on average, from approximately 5% in 1970 to 9% in 2007 in developed countries (OECD 2009b). Given also the fact that HCE generally rises with age, serious concerns have been expressed regarding the possible pressure that population aging will exert on the fundability and sustainability of health care systems. As most developed countries have built their health care system on the principle of solidarity, the affordability of these systems will be challenged by population aging because the financial basis of the system shrinks, while expenditures increase. Besides its impact on the fundability of health care systems, aging will also affect the availability of health care workers, which might not meet the need.

The future level of health care use and its associated costs need to be determined in advance, in order to ensure adequate and affordable health care services for all citizens. The level of HCE primarily depends on the number of people in need of health services, the duration of service use, the availability of services and the cost of these services. The high-use category contains relatively many elderly, as the majority of national HCE outlays

are concentrated among the elderly, a finding firmly established in evidence from developed countries. Because aging increases the share of the elderly in the population, it's hardly controversial that the recent growth in HCE can to some extent be attributed to population aging (Yang *et al.* 2003; Pezzin *et al.* 1996; Comas-Herrera *et al.* 2007; OECD 2006). Some disagreement remains, however, as to the extent to which aging contributes to rising HCE.

Most of the studies investigating the consequences of aging on the level of HCE focus primarily on the impact of aging, thereby isolating its impact from other simultaneous – but often related – trends that also influence the level of HCE. Up to this point, most of the studies have only considered the associations between age and the remaining lifetime to quantify the impact of population aging on the level of HCE. By considering also the fact that HCE is concentrated at the end of life, one additionally accounts for the effect of changes in longevity on age-specific HCE curves. Still, conclusions drawn from these studies give a rather incomplete impression of the consequences of aging on HCE. Among other things, these consequences depend largely on the number of years lived with morbidity and disability (i.e. whether there will be a compression or expansion of morbidity/disability). As such, the future trend in morbidity and disability will play a major role in determining the impact of aging on HCE. Next to trends in morbidity, the level of national and individual income or progress in medical technology should not be ignored when analyzing the impact of aging on HCE. The impact of aging examined in such a narrow approach (which is employed in most previous studies) might therefore provide quite different results. It is therefore worthwhile to study the impact of trends in all possible determinants – and their interactions – of HCE in an aging society. This acquired knowledge may serve as a basis

for better projections of future HCE by reflecting expected trends in the determinants. This in turn will better equip us to more effectively inform policymakers about the future consequences of population aging, and to direct them adequately towards the right interventions.

This paper aims to provide a complete overview of the current knowledge concerning the consequences of population aging on future and past growth in HCE. Instead of isolating the impact of population aging from other important drivers of HCE, we study its impact within a broader context of all factors determining HCE. Studies aimed at examining the consequences of aging for future HCE can be distinguished as follows: (1) macro studies that use cross-sectional aggregate national spending over a certain time period and (2) micro studies that analyze individual spending. Although this paper centers in on findings from studies using micro level data, it also briefly explains the distinct effects of aging found in macro versus micro studies, in which aging has only marginally contributed to the growth in per capita HCE, or did not contribute to it at all in the former studies.

The paper is organized as follows. Section 2 introduces a conceptual model – based mainly on the Health Behavior Model of Andersen and Newman (2005) – that describes and relates the determinants of HCE. Section 3 summarizes and discusses the international literature on the relationship between HCE and its individual and societal determinants in aging populations. Attention is paid to the effect of its determinants on acute HCE versus long-term care (LTC) expenditure, as many studies have indicated that these two subsectors differ in important aspects. Section 4 discusses possible time trends in the relationship of HCE and its determinants, and focuses only on the determinants directly affected by aging. It is important to consider that

projections based on current models might give biased forecasts – as the relationship between HCE and its determinants has been proven to be a dynamic one. Section 5 provides various projections of future acute health and LTC expenditures based on different specifications of HCE models. This section illustrates the improvements in projections when richer models, with a higher explanatory power, are used – although we still have to conclude that even richer models are needed to explain and project HCE. The final topic of this section puts the debate into a wider perspective by discussing the relative contribution of aging in HCE growth. This section distinguishes the effects of aging narrowly defined from its broader definition, including also the impact of factors related to aging. Section 6 presents new evidence obtained from Dutch data that contributes to the understanding of HCE and its determinants in aging populations that is provided by the NETSPAR theme 'Living Longer in Good Health', and the research projects 'Healthy aging and Health care Expenditures' and 'Solidarity in the health care sector and the costs of aging.' Finally, section 7 summarizes the evidence, reflects on its consequences and proposes an agenda for future policy and for research.

## 2. Conceptual model

In order to improve our understanding of the importance of aging for future health care use and costs, we first need an overview of all determinants of health care expenditure (HCE). More knowledge on the nature of these determinants (and their interactions) of HCE in an aging society may serve as basis for better projections of future HCE, for scenarios reflecting expected trends in the determinants as well as various health policy scenarios.

Our conceptual model is partly inspired by the behavioral model of health service use developed by Andersen and Newman (2005). They distinguish both societal and individual determinants of health care utilization. The individual determinants are predisposing-, enabling- and illness/need determinants. *Predisposing determinants* reflect the individual's 'propensity toward use'. This concept has three dimensions: the demographic dimension, the social structure dimension and beliefs about health care. *Enabling determinants* concern the resources available to satisfy a need regarding health service use. Important enabling determinants in this context are the level of individual health insurance coverage and income. *Illness/need-level determinants* measure the illness and disability levels of the respondent. As societal determinants of health service use, medical technology and characteristics of the health care system were proposed by Andersen and Newman.

Our conceptual model (see figure 1) contains elements of both individual and societal determinants because both can affect HCE differently.

Our model incorporates additional elements, however, since we want to explain not only behavior but also HCE. Furthermore, we

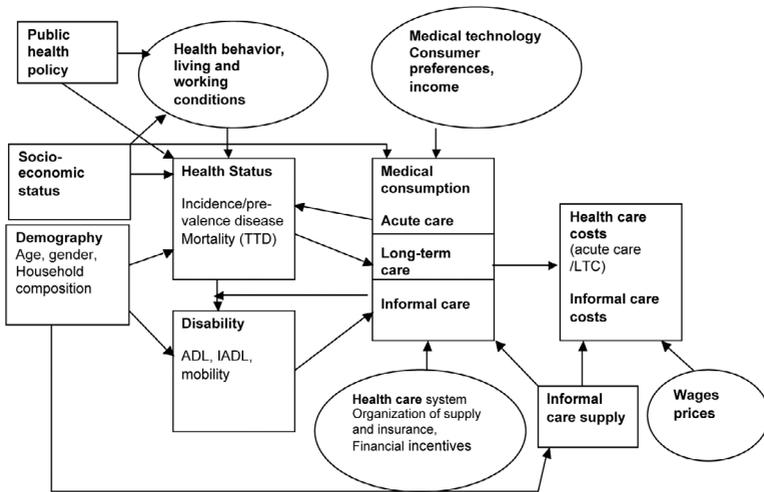


Figure 1 Conceptual model of demand for health care services

have included public health policy, the health insurance system and (financial) incentives for professionals and patients, which also might affect HCE on an aggregated level. Not all determinants included in figure 1 are directly related to aging (such as wages in the health care sector), but are included in the model for a complete impression of the possible interplay of determinants. The model incorporates elements of demography, epidemiology, public health and health economics, as we believe that aging and HCE is a multi-causal and multidisciplinary topic. Many health economists who attempted to explain the trend in HCE indicate the need for more complete explanatory models (Payne 2007; 2009).

The conceptual model shows possible relationships between HCE and its determinants. We distinguish acute health care and LTC, as determinants have been proved to act differently on the level of use in the two subsectors of health care.

## **Predisposing determinants**

The model starts with demographic determinants. Age and gender of individuals affect the incidence and prevalence of diseases and self-reported health. Whether calendar age (and life expectancy) still explains HCE, when controlling for such relevant determinants as health, disability and household composition, will be discussed later in this paper.

Regarding household composition, it has been demonstrated that marital status and household composition affect health. In general, individuals living alone appear to have a lower health status and a higher level of HCE (Kunst *et al.* 2007). Having a partner and/or children also affects the availability of informal care, which subsequently influences the amount of care consumed when falling ill (Weaver 2008; Bonsang 2009).

The socioeconomic status (SES) of individuals clearly affects their health and medical expenditure. Those with a low SES have poorer health than the rest of the population and consequently consume more health care, involving higher HCE (Kunst *et al.* 2007; Marmot *et al.* 2008). Partially related to SES, are factors as living and working conditions, as well as life style and health behavior related to specific risk factors (smoking, exercise etc.). Evidence clearly show that these are very important determinants of population health (Dahlgren and Whitehead 2007; Marmot *et al.* 2008).

## **Illness/need determinants**

Health, as a major determinant of illness and need, can be conceptualized in many ways. In our model it is summarized as self-assessed health, including a physical and mental component, the incidence and prevalence of diseases, time to death and mortality. Obviously, health status is one of the most important

determinants of health care utilization and expenditure. There is an extensive literature on the relationship between mortality/ final year(s) of life and HCE (e.g. Zweifel 1999, 2003; Werblow *et al.* 2007); see section 3.

Disability, next to health, is also crucial as determinant of the need for health care, The concept of disability is here operationalized as the ability to perform (instrumental) activities of daily living ((i)ADL), and mobility. The degree of disability will be affected foremost by health status. The greater the disability, the greater the need is for health care consumption. Thus, the trend in disability among the elderly is crucial for HCE, as Manton (2007) showed for the United States. On the other hand, given the presence of a disease, effective health care and informal care (for example, by medication or appliances) might limit disability, which underlines the dynamic relationship between health status and disability. Whether disability has the same impact on HCE in acute care as in LTC is also a relevant research topic that will be discussed in this paper. Surprisingly, research explaining HCE that combines data on all aspects of health (and disability) is very scarce. This might be due to limited availability of adequate data.

### **Enabling determinants**

The availability and supply of informal care is important for HCE, as it can serve both as a condition and as substitute for formal care. Informal care supply depends in part on demography and household composition, as many informal caregivers are partners. Thus far, the increased participation of (middle-aged) women in paid labor in the Netherlands has not significantly limited the supply of informal care (De Boer and Timmermans 2007). However, it has been shown that when substantially more women work full time (which is the case in Sweden), the number of informal

caregivers aged 30–64 years could fall by as much as 25% in 2030 (Sadiraj *et al.* 2009). Taking this into consideration, the future supply of informal care might not meet its demand. The more informal care that is available in a society, the greater the chances are for the sick elderly to stay at home, which in turn might decrease (formal) HCE.

Income influences HCE on two different levels: the macro level (national income) and the micro level (personal or household income). While national income has been proven to be strongly associated with the growth of aggregated national HCE (OECD 2006; Gerdtham *et al.* 1992), reflecting both willingness and ability to pay for health and health care, its effect on individual HCE is far less pronounced. According to Getzen, health care is neither “a necessity” nor “a luxury”; it is both, since the income elasticity varies with the level of analysis. With insurance, individual income elasticities are typically near zero, while national health expenditure elasticity is commonly greater than 1.0 (Getzen 2000). The large income effect on HCE as found in many macro studies might decrease when account is taken of important individual determinants, such as health status.

The role of consumer preferences as a determinant of HCE is potentially an important one. The shifting consumer preferences in more wealthy and well-educated post-baby-boom cohorts, which include such behaviors as asking for more second opinions, requesting more (early) diagnostic procedures and medication, may also increase medical consumption and HCE.

### **Societal determinants**

The development in available medical technology provides health care with a growing array of possibly effective interventions to lengthen life or improve or restore health. Although technological

progress might sometimes substitute expensive care and reduce costs (Cutler and McClellan 2001; Cutler 2007), it generally tends to increase health care consumption and expenditure (Newhouse 1992). Many studies mention the impact of technology on HCE, but only a few analyze this relationship explicitly; see section 3. A second social determinant concerns the organization of the health care system. An abundant literature explores the various ways of organizing the supply of health care services as well as the array of existing models of health insurance (Card *et al.* 2008; Lichtenberg 2002; Hullegie and Klein 2009; Gerdtham and Jönsson 2000; Miller 2009; Van der Zee and Kroneman 2007). Several elements of these systems might affect HCE. Section 3 of this paper discusses the (possible) effect of the following organizational features of the health care systems: co-payments, the benefit package, budgeting, competition in health care and the different institutional arrangements that affect the financial incentives of health care providers to enhance quality or to reduce service use, or the institutions that restrict the access to care.

As health care is a very labor-intensive sector, wages are the main driver of health care prices and –costs. Since the development of labor productivity in health care tends to be slower than in the entire economy, health care prices tend to increase faster than general inflation – the well-known Baumol effect. Health care prices transform medical consumption into HCE.

Demography, health, disability, medical technology, consumer preferences and wages/prices, as well as the effects of institutional arrangements, will be discussed extensively in this paper.

### **3. Current international evidence on determinants of HCE in aging populations**

This section reviews the literature exploring the way in which the determinants included in the conceptual model affect HCE. The determinants directly related to population aging will be discussed in more detail. Focusing in on these determinants, we detail their distinct impact on acute care and LTC expenditure because population aging is proved to affect the expenditure of both subsectors differently. Before turning to the actual reviews of the determinants of HCE, we highlight briefly the differences between these two subsectors. Next, we summarize the evidence on the impact of the determinants, starting with those directly associated with population aging, thereby following the debate as much as possible in the original chronological order. Finally, we discuss briefly the impact of the remaining determinants of HCE. Note that most studies only analyze the influence of determinants on the level of publicly financed HCE.

#### **Acute health care versus long-term care**

The goal of the acute health care sector is to treat and prevent illnesses, and to preserve health through *medical* service use. In the remainder of the paper, *HCE* refers to the sum of acute HCE and LTC expenditures, and *acute HCE* consists of both acute and preventive health care services. The bulk of acute health care is provided by general practitioners, hospitals, dentists and paramedics, and includes use of medication.

LTC assists individuals who cannot take care of themselves (for a longer period) with daily activities. Unlike acute care, LTC consists of both medical and non-medical services. LTC can be provided at home, by a relative or acquaintance, or by a professional, in an

assisted living or nursing home. Acute care includes informal and formal homecare, whereas LTC consists of care in residential and nursing homes (OECD 2005). Compared to acute care systems, the organization of LTC systems varies widely across countries. These two subsectors of the health care sector differ in three respects. First, the primary aim of the acute sector is to cure and prevent the emergence of (more advanced stages of) diseases, whereas the aim of the LTC sector is to assist people in the management of a chronic condition/disability rather than cure this condition. As a consequence, acute health care services require highly skilled medical professionals, whereas LTC services are often provided by less skilled medical professionals and non-medical workers, and may often be provided by unskilled (informal) caregivers. The second difference can be found in the target population of both sectors. The disabled population (i.e. the chronically ill and frail elderly) relies most on the LTC sector, while the "ill health" population is the target group of the acute health care sector. Third, LTC is mainly provided for a longer period of time – or provided until the end of life, while acute health care is often provided for a much shorter period. Given these major differences between both subsectors, the roles played by individual determinants are likely to depend on the type of expenditure under consideration.

### **International evidence on HCE and its determinants**

In recent decades, per capita HCE in developed countries has risen dramatically.

Figure 2 illustrates that this trend is evident in OECD countries, irrespective of the way in which a country has organized its health care (insurance) system. HCE has increased in countries with National Health Systems (such as the UK) and Social Security Health

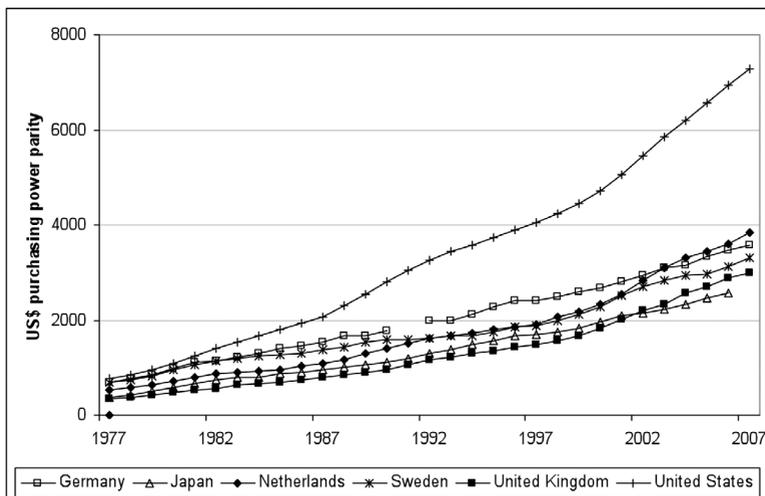


Figure 2 Trend in per capita HCE in developed countries (source: OECD Health Data 2009)

Systems (such as Germany and the Netherlands), and in countries without universal health insurance coverage (the US). Per capita HCE rose from below 1000\$ in 1977 to over 2000\$ (but for most developed countries to over 3000\$ – and for the US even over 7000\$) in 2007. Figure 3 presents the trends of HCE as a percentage of GDP, stratified by type of health service.

Figure 3 shows that acute HCE – consisting here of curative and rehabilitative care – represents the largest part of total HCE. Clearly, all types of expenditure have risen in recent decades.

Until the end of the 1980s, the simultaneous increase in the proportion of the 65+ population and per capita HCE, had led most researchers conclude that population aging was responsible for much of the rise in per capita HCE (Longman 1987; OECD 1988; Börs *et al.* 1989; Gerdtham 1993). At that time, per capita HCE was explained primarily by differences in age and sex. HCE expenditure

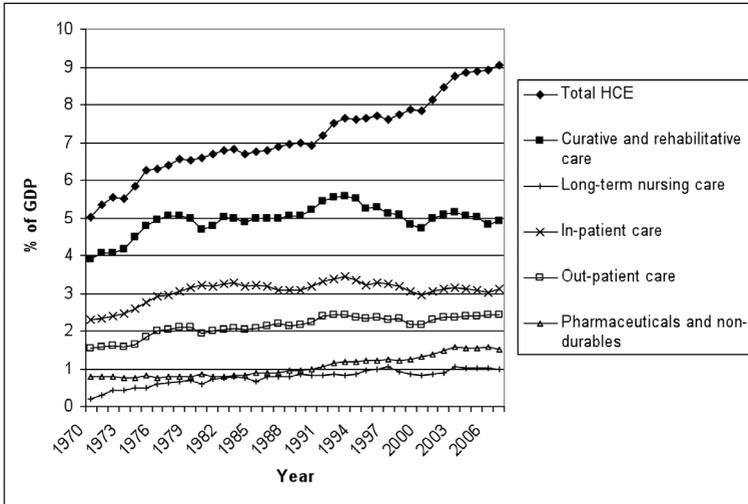


Figure 3 Trends in expenditure disaggregated by type of service in OECD-30 countries

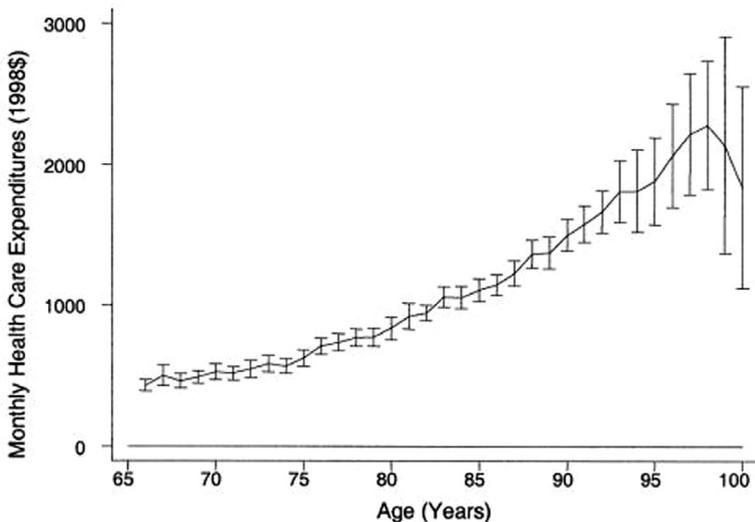


Figure 4 HCE by age (in US 1998 dollars; source: Yang et al. 2003)

was simply plotted against age for both genders, and the resulting age-HCE curves quantified the relationship between HCE and age. Not surprisingly, these models have found that HCE increases dramatically with age (figure 4).

Consequently, it was expected that future population aging would definitely continue to increase per capita HCE. This view has, however, changed dramatically with the publication of the first cost-of-dying (COD) studies (see Payne *et al.* 2007, for a review).

### **Evidence on the impact of predisposing determinants on HCE**

#### *Cost-of-Dying studies: the impact of age and the last year(s) of life on HCE*

Figure 5 illustrates the associations between HCE, mortality and age. Not only HCE but also mortality increases with age. Consequently, mortality rather than age might be a better explanation for the higher HCE among the elderly. This new insight has resulted in a reconsideration of the consequences of population aging for rising HCE. The COD studies all *descriptively* analyze the HCE of decedents by age, or compared age-specific HCE between survivors and decedents. By hypothesizing that mortality instead of age drives HCE, these curves should not increase with age among decedents, while the expenditure of decedents should exceed that of survivors considerably.

#### *Cost-of-dying studies on total and acute HCE*

Indeed, total and acute HCE for decedents were consistently found to decrease with age at death in most countries (see Hoover *et al.* 2002; Yang *et al.* 2003; McGrail *et al.* 2000; Madsen *et al.* 2002; Polder *et al.* 2006). Individuals aged 85+ were found to require

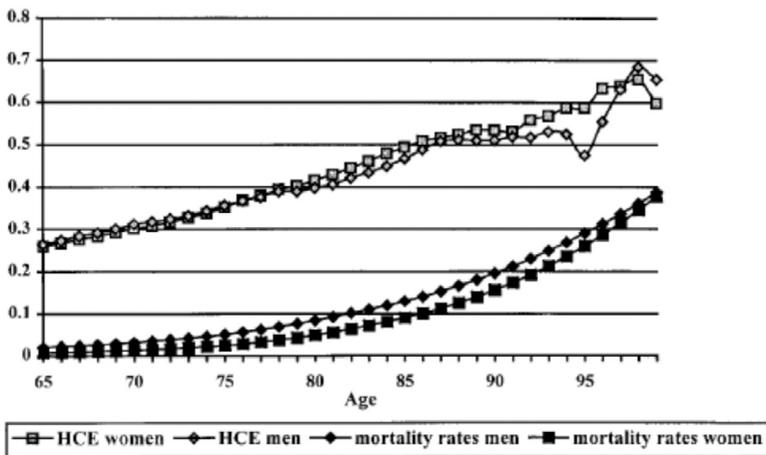


Figure 5 Total HCE (in Swiss franc 10,000) and mortality by age and gender (source: Zweifel *et al.* 1999)

significantly less Medicare expenditure in their last years of life than individuals aged 65–75 years (see Hoover *et al.* 2002; Yang *et al.* 2003). The costs of dying by age were even found to decrease at a higher rate for hospital expenditure (Yang *et al.* 2003). An exception is McGrail *et al.* (2000), who found that Canadian decedents' costs increased with age.

Studies comparing average HCE by age between decedents and survivors found that – regardless of the health service under consideration – the average costs of decedents exceeded considerably the average costs of survivors. Polder *et al.* (2006) reported for the Netherlands that care for individuals in their last year of life cost on average 13.5 times more than that for survivors. Hogan *et al.* (2001) and Lubitz *et al.* (2003) reported that Medicare expenditure was, respectively, 6 and 7 times larger for decedents than for survivors.

The ratio of decedents' to survivors' costs was found to fall with age as a consequence of increasing HCE for survivors. McGrail *et al.* found the relative costs of dying to decrease from 16.6 at age 65 to 2.5 at age 90 to 93 in Canada. Polder *et al.* reported that the relative costs of dying decreased from 30 at ages below 45 to around 5 for ages above 75. The spending differences between decedents and survivors concerning pharmaceuticals and primary care were also found to diminish with age, but less apparently than the differences regarding hospital expenditure (Madsen *et al.* 2002; Kildemoes *et al.* 2006). Worth noting is that, due to censoring, the remaining lifetime of survivors is measured with some error, as the date of death is unknown. As older people are more likely to be close to death, a larger proportion of the survivors in the older age groups might be misclassified, leading to higher HCE of survivors at the older ages.

#### *The impact of the last years of life on acute HCE versus LTC*

A number of studies examine the costs of dying for acute and LTC expenditure separately. In contrast to total and acute HCE for decedents, LTC expenditure for decedents was found to rise steadily with age in different countries (Canada: McGrail *et al.* 2000; US: Spillman and Lubitz 2000 and Yang *et al.* 2003; The Netherlands: Polder *et al.* 2006) McGrail *et al.* found over 30 times higher annual nursing home costs of individuals aged over 85, compared to those aged 65, in Canada. Similar findings are reported for the US. Spillman and Lubitz modeled lifetime HCE of individuals aged 65+ to estimate the impact of longevity on US national health care spending. Unsurprisingly, cumulative HCE from the age 65 until death increases considerably with longevity.

Figure 6 demonstrates their finding. The impact of aging on HCE differs greatly by type of service. As shown, the rise in total

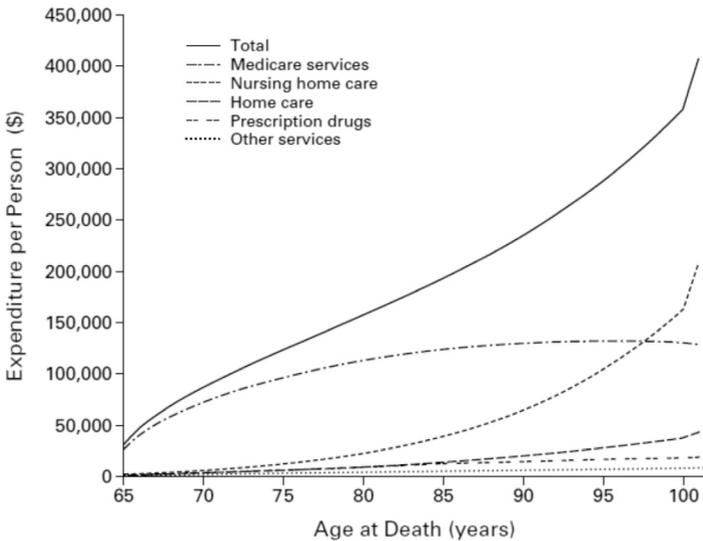


Figure 6 Lifetime HCE from the age of 65 by type of service and age at death (source: Spillman and Lubitz 2000)

HCE can be largely attributed to the accelerated increases in nursing home expenditure by age at death. Conversely, the rate of increase in Medicare expenditure (primarily acute HCE) decreases. Yang *et al.* confirmed the conclusion of Spillman and Lubitz. Monthly expenditures on acute care were found to decrease with age for decedents, but to increase slightly for survivors, while LTC expenditures for both decedents and survivors increased substantially with age – but more so for nursing care than for home care. As such, aging will have a relative larger impact on the LTC sector.

*Results of COD studies that also account for need determinants*

While separating the HCE curves of decedents from those of survivors further clarifies the consequences of population aging

on future HCE, it still does not adequately represent the real cause of spending, as it is not death itself that is expensive, but the morbidity/disability that precedes it (and which may eventually lead to death). A number of COD studies indeed considered the health differences within decedents or between survivors and decedents.

Bird *et al.* (2002) distinguished decedents by their cause of death. Stroke and cardiovascular disease were associated with the lowest end-of-life spending, while cancer and chronic obstructive pulmonary disorder accounted for the highest end-of-life spending. Using aggregated Medicare claim data in combination with the Medical Current Beneficiaries Survey, Hogan *et al.* (2001) noted that decedents have almost four times more diseases per year than survivors do. The high costs of dying should therefore be associated with this high burden of disease. They concluded that acute HCE on decedents was on average six times higher than it was on survivors, but it was only slightly less than 50% higher compared to survivors, when controlling for chronic conditions. Lubitz *et al.* (2003) used micro simulation and multistage life tables to quantify the relation between health status and cumulative HCE from the age of 70 until death. Elderly persons with better self-reported health had a longer life expectancy but similar cumulative HCE until death than those reporting poor health. There were, however, notable differences in spending between institutionalized and non-institutionalized persons at the age of 70. Furthermore, persons without disability lived on average 2.7 years longer than those with at least one limitation in their *activities of daily living* (ADL): their cumulative HCE was on average \$9,000 lower. Important implications are that longevity per se will not increase HCE, as life extension due to better health does not seem to be very costly. The morbidity and disability in

the life years gained are therefore important in determining the impact of longevity on future HCE.

Summing up, the COD studies proved that a significant part of higher annual/monthly expenditure at older ages can be attributed to higher expenditure at the end of life, as decedent expenditure exceeded survivor expenditure at all ages. These higher expenditures for decedents can, to a large extent, be explained by the presence of chronic conditions at the end of life. As acute and LTC expenditure for survivors and LTC expenditure for decedents increase with age, according to COD studies, population aging is still expected to increase future HCE, but more so for LTC than for acute care.

### **Time-to-Death studies:**

#### **the impact of age and time-to-death on HCE**

Instead of comparing aggregated costs of decedents and survivors by age, Roos *et al.* (1987) were the first to use individual level data of decedents to econometrically model HCE as a function of the time away from death. This new methodology offered new insights concerning the effect of approaching death on expenditure over time (that is, at what point in life the unhealthy end-of-life period, on average, starts). Furthermore, these models that analyze HCE as a function of time-to-death (TTD) enabled a much more flexible relationship between mortality and HCE. This new approach of Roos *et al.* laid the foundation for an emerging literature on HCE models including TTD. The literature on TTD models can be divided into those including only decedents (Zweifel *et al.* 1999; Seshamani and Gray 2004a; 2004b; O'Neill *et al.* 2000) and those including both decedents and survivors (Roos *et al.* 1987; Zweifel *et al.* 2004; Stearns and Norton 2004; Weaver

*et al.* 2008; Werblow *et al.* 2007; Felder *et al.*, in press). The follow-up period of TTD varies from 16 years to two years preceding death. These studies indeed proved that HCE rises long before the actual year of death.

#### *Time-to-death studies on total and acute HCE*

Roos *et al.* (1989) were the first to conclude that not age but TTD seemed to be the main demographic determinant of HCE. It took, however, over ten years before this conclusion got the full attention it deserved. Only when Zweifel *et al.* (1999) concluded that the proclaimed effect of age on HCE is a red herring – a distraction away from the true drivers of expenditure – did tempers flare high. Their conclusion had far-reaching consequences for HCE projections, which were traditionally based on age-related per capita expenditure. Zweifel *et al.* used two Swiss longitudinal data sets from deceased individuals in their final two years of life. Using a Heckman selection model<sup>1</sup> (Heckman 1979), they analyzed quarterly HCE as a function of age, sex, age\*sex, and TTD dummies for the number of quarters before death. Although age was found to be significant in one of the two samples, it had no influence on quarterly HCE in either subsample of individuals aged 65+ at death. The dummies for TTD, however, explained most of the variation in total HCE. Individuals within the range of one to six quarters before death incurred significantly higher quarterly HCE than individuals eight quarters away from death. Over 42% of HCE in the final year of

1 To correct for the high proportion of zero expenditures, models analyzing HCE are usually split up in two parts: (1) a part analyzing the probability of having any expenditures and (2) the level of expenditures among users only. As this second part is not representative for the total population, the Heckman selection model corrects for this selection by including the inverse Mill's ratio of the first part as a regressor in the second part.

life amounted to the last quarter of life for individuals aged 65+ at death. As in the COD studies, Zweifel *et al.* found the effect of TTD to decrease with age, a finding confirmed by subsequent TTD studies (including Seshamani and Gray 2004a; Stearns and Norton 2004; Werblow *et al.* 2007; Häkkinen *et al.* 2008). Given that age does not significantly increase total HCE *among users* (at least in the 65+ population), Zweifel *et al.* concluded that per capita HCE is independent of population aging.

Using similar data, Felder *et al.* (2000) found the TTD effect to be stronger in females. However, this gap between males and females decreases with age, a finding that is consistent with the theory that those who expect to live longer spend more. The gender gap in life expectancy also decreases at higher ages. Although the study of Zweifel *et al.* was quite influential, important methodological comments (questioning the red-herring hypothesis) were directed toward a possible presence of multicollinearity<sup>2</sup> and endogeneity (Salas and Raftery 2001; Dow and Norton 2002; Seshamani and Gray 2004). Regarding endogeneity, the amount of care consumed was recently found to reduce mortality and increase longevity, making TTD endogenous to HCE (Hall and Jones 2007; Becker *et al.* 2005). If TTD is indeed not exogenous, then the coefficients and standard errors of TTD estimated by Zweifel *et al.* are biased.

- 2 Multicollinearity increases type-II error (wrongly omitting an influential variable). The presence of multicollinearity originated from their model selection: Zweifel *et al.* first analyze selection (i.e. the probability of having any HCE) using a probit. The second part of the model analyzed the level of expenditures conditional on having any. To correct for selection in the second part, the inverse Mill's ratio of the probit is included as a regressor in part II of the model. As both parts of the models consist of exactly the same regressors, multicollinearity is indeed very likely to occur. For a Heckman model to work, it requires exclusion restrictions – regressors that enter the selection part, but not the second part of the model.

Taking into account these methodological comments, Seshamani and Gray (2004a) found both age and TTD to be important determinants of the level of quarterly hospital expenditure in Oxfordshire (UK)<sup>3</sup>. They found that individuals up to three years prior to death incurred significantly higher hospital expenditures compared to those five years prior to death. The importance of age was driven by its effect on the probability of being in a hospital, which might explain why their results diverge from those of Zweifel *et al.*, who center their debate on the importance of age and TTD on the conditional level of HCE. Seshamani and Gray (2004b) further conclude, when exploiting the panel structure of the data, that the event of death affects hospital costs up to 15 years prior to death. This stronger effect of TTD in panel models is due to the incorporation of hospitalization history. Although age was an important determinant as well, the 30% increase in hospital expenditures from age 65 to 85 is only marginal compared to the tenfold increase in expenditures from five years prior to death to the last year of life.

In response to the methodological comments raised, Zweifel and his colleagues (Zweifel *et al.* 2004; Felder *et al.* in press) investigated the potential endogeneity using two different approaches. First, Zweifel *et al.* (2004) claim that examining yearly HCE (instead of using panel data) – thereby measuring TTD from that year as a continuous variable – mitigates the endogeneity problem because HCE in the current year cannot influence TTD in a preceding period – as a cause should precede its effect. The results found partly confirm earlier findings:<sup>4</sup> age still does not

3 Seshamani and Gray (2004a) used a two-part model (see Jones 2000) to mitigate multicollinearity.

4 Due to heavy skewness of its residuals, HCE is usually modeled by (1) ordinary least squares (OLS) on log HCE or (2) a generalized linear model with log link to approach a normality of the error term. To avoid problems of retransforming

significantly determine the HCE of decedents, once account is taken of TTD.

In a subsequent paper, Felder *et al.* (in press) further investigated the potential endogeneity of TTD. They used longitudinal data on monthly HCE, socioeconomic characteristics and survival status – first predicting TTD and then using it as an instrument in the HCE model. TTD is indeed found to be endogenous. This proves once again that removing endogeneity entirely from the model presents a challenge when data on illness/need determinants is lacking (as these unobserved determinants are correlated with the error terms).

Zweifel *et al.* (2004) further aimed to strengthen their “red-herring” argument by expanding their model to survivors as well. Unlike in the case of decedents, both age and TTD are important determinants of HCE in survivors. Due to censoring, TTD of survivors could only be measured with substantial error. This censoring has probably resulted in a downward bias of the true effect of TTD, and an upward bias of the effect of age on the level of HCE. While their conclusion centers on age being an insignificant determinant of the conditional level of HCE, age still significantly determines the probability of use. This finding is confirmed by other TTD studies as well (Stearns and Norton 2004; Seshamani and Gray 2004a). Expected expenditure of survivors (and to a lesser extent of decedents) is therefore still associated with age – although its effect dropped substantially once account was taken of TTD.

log HCE back to its raw scale (Manning and Mullahy 2001), Zweifel *et al.* (2004) use OLS on raw scale HCE. Consequently, their results might be biased, as a few extreme observations might disproportionately influence the parameters to be estimated.

*The impact of time-to-death on acute HCE versus LTC expenditure*

As the effect of population aging in COD studies was found to depend on the sector under consideration, the relationship between age and TTD and expenditure found for hospital care or total HCE might not necessarily hold for other subsectors of the health care sector. A number of TTD studies have examined the scope of the red-herring argument by decomposing HCE into expenditure on various health care services (Werblow *et al.* 2007; Häkkinen *et al.* 2008).

Both Werblow *et al.* and Häkkinen *et al.* analyze expenditure on several health service components separately for users and non-users of LTC services. Werblow *et al.* used the Swiss insurance data previously explored by Zweifel *et al.* (2004), whereas Häkkinen *et al.* used a large sample of Finnish 65+ individuals. Werblow *et al.* distinguished ambulatory care, nursing home care, home care, hospital/inpatient care, hospital/outpatient care, and prescription drugs. They report that the combination of service use greatly differs between survivors and decedents. Acute inpatient care and nursing care comprise the largest part of decedent's costs, while ambulatory care and prescription drugs rank first among survivors. Both studies show that controlling for TTD importantly attenuates the effect of age on expenditure for all types of services. Age, however, remains an important determinant of total HCE. As total HCE is strongly dependent on the probability to use LTC, the significance of age is driven mainly by the dramatic increase in LTC expenditure with age. The effect of TTD on nursing home expenditure is even found to decrease with age, indicating that the higher LTC expenditure at older ages can to a lesser extent be attributed to the higher likelihood of being close to death. For expenditure on acute care services by non-LTC users, Werblow *et al.* (2007) found age to have a significant

positive relationship with inpatient care expenditure only, once account was taken of TTD. Other acute expenditures were found to decrease with age for decedents. A slight increase with age was found for expenditures on ambulatory and inpatient care among survivors. In contrast, Häkkinen *et al.* found that inpatient care expenditures were increasing with age only for inpatient care provided at specialized health centers and psychiatric inpatient care, but not for inpatient care provided at hospitals. Expenditure on hospital care and prescribed drugs decreased with age, but only for decedents (Häkkinen *et al.* 2008).

Weaver *et al.* (2009) analyzed the effect of TTD on the probability of using two types of LTC services – nursing home care and formal home care – among the US elderly aged 70+. Home care (and to a larger extent, nursing home care) was found to heavily depend on age and TTD. Overall, being in the final two years of life increases the probability of nursing home use and formal home care use by 50% and 12.4%, respectively.

#### *Results of TTD studies that account for need determinants*

Several studies have examined the age effect on HCE by (additionally) controlling for morbidity and/or disability. Seshamani and Gray (2004a) further examined the variation in hospital costs of dying by including cause-of-death information. The level of hospital expenditure was significantly higher among individuals deceased from cancer, a respiratory disease or stroke – compared to those deceased from heart disease.

A number of studies use morbidity information on both decedents and survivors. Using a French dataset including various morbidity measures as well as death risk, Dormont *et al.* (2006) aimed to decompose the causes of the upward drift in the age-specific curves of expenditure on ambulatory, pharmaceutical

and hospital care between 1992 and 2000 (see also section 4). Morbidity was found to be the only factor explaining the increasing pattern of HCE by age. Once it is controlled for, HCE is no longer increasing with age. Hypertension, diabetes, metabolism disorders or depression increase the level of pharmaceutical expenditure by 40%, 48%, 26% and 37%, respectively. The level of ambulatory care expenditure, however, is positively influenced by depression (27%) and the number of diseases. Finally, the likelihood of using hospital care is positively influenced by diabetes, death risk and cataracts, while conditional expenditures are significantly determined by hypertension (37%) and the level of disability.

Using predicted life expectancy estimated by hazard models rather than observed TTD, Shang and Goldman (2008) overcame the problem of censoring of death under the assumption that they have rightly modeled life expectancy. They evaluate the effect of age on Medicare expenditure when controlling further for remaining life expectancy and morbidity, measured by certain chronic conditions and disability in ADL. They confirmed previously reported findings of an attenuating role of age in explaining HCE, once account was taken of the remaining life expectancy. However, the effect of the remaining life expectancy itself diminished considerably, but remained significant, once account was taken of morbidity. It is hard to rightly interpret their results, as some exogenous variables are used twice: in modeling life expectancy and in measuring its effect on HCE (once account is taken of life expectancy). The coefficients of the morbidity measures are not reported.

Häkkinen *et al.* (2008) present information on the presence of certain chronic conditions in their non-institutionalized sample. With regard to the majority of these conditions, merely

the presence of the condition greatly increases expenditure on hospital care, health centers and psychiatric care and prescription drugs. Only those having glaucoma, breast- or prostatic cancer have significantly less conditional hospital expenditure, while suffering from asthma or coronary heart disease significantly reduces expenditure on health centers, psychiatric care and prescription drugs. As it was not their aim to study the effect of morbidity on HCE and to examine to what extent its inclusion mitigates the impact of TTD on HCE, hardly anything can be concluded regarding these points. However, the highly significant influence of TTD, even after controlling for an extensive range of chronic conditions, points towards an important independent role of TTD in determining HCE. The same is found with regard to nursing-home and formal home care use by Weaver *et al.* (2009). Although disability is found to greatly influence both the probability to be institutionalized and the use of formal home care, controlling for it does not omit the influence of age and TTD – as both are still found to be significant drivers of LTC use. In addition, cognitive functioning only influences institutional LTC use (thus not homecare use). Weaver *et al.* further found that TTD does not significantly impact LTC use in individuals who have sufficient informal care sources available, as TTD has no effect on nursing-home use among married couples.

Summing up, although still significant for the probability of using health care in most TTD studies, the effect of age is attenuated considerably when account is taken of TTD, and is only marginal compared to the effect of TTD. The impact of TTD is, however, found to diminish with age. This is true for total and acute HCE only – as LTC expenditure is still found to depend heavily on age. However, when controlling for morbidity and disability, the effect of both

age and TTD decreases substantially. Consequently, although TTD and age often approximate morbidity and/or disability, they still importantly explain some of the remaining variation in acute HCE and (to a larger extent) LTC expenditure.

### **Evidence on the impact of other predisposing determinants on HCE**

#### *Demographic determinants: gender, household composition and ethnicity*

As discussed in the second section of this paper, far more determinants of HCE that are not directly affected by population aging exist. The importance of gender as a determinant of HCE is mixed. If the gender determinant is present, most studies (e.g. Zweifel *et al.* 1999; Häkkinen *et al.* 2008; Dormont *et al.* 2006) reported higher spending among females – but often no gender effect is found (Seshamani and Gray 2004b). The effect of gender is found to decrease with age. The majority of studies that have found a role of gender included LTC expenditure. Females depend more on LTC services than males do because they live longer. However, females spend relatively more of their lifetime with morbidity – and therefore often rely on formal LTC sources because they lack sufficient informal care sources, especially at higher ages. The higher total HCE of females is therefore often caused by their higher likelihood of using LTC services.

When there is a lack of data on informal care availability, co-residence and marital status are often used to approximate informal care availability (Dormont *et al.* 2006; Weaver *et al.* 2009). These studies confirm that informal care availability reduces the amount of formal LTC consumed, but to a much larger extent for the lower skilled types of LTC, such as domestic help (Bonsang

2009). Weaver *et al.* (2009) reported that non-married elderly are five times less likely to be institutionalized than married elderly. Furthermore, the extent to which informal care substitutes formal LTC depends on the source of informal care provision. Informal care provided by a spouse is a more likely substitute for formal care than care provided by others (Weaver *et al.* 2009; Freedman 1996). Marital status was found to significantly determine hospital expenditure of decedents (Seshamani and Gray 2004a). Married couples spend less on hospital care than unmarried individuals. Finally, HCE is found to differ by ethnic group. While African Americans and other minority groups were usually found to use less health care, their spending at the end of life was found to be significantly higher than that of Caucasians (Hogan *et al.* 2001; Shugarman *et al.* 2009).

### *Socioeconomic status*

Socioeconomic differences in the level of use and costs are found for nearly all types of health services (Kunst *et al.* 2007). Individuals belonging to the lower socioeconomic classes use significantly more health care resources. For the Netherlands, Kunst *et al.* estimate that individuals with a university or higher vocational degree incurred costs averaging 11% less per year than the national average, while those who only completed primary school incurred costs averaging 21% more than the national average. This spending difference could be explained mainly by differences in health status. However, once accounting for differences in health status, the less educated tend to under-use some specific health care services: specialist care, for instance, is under-used by 30%. This finding is confirmed by evidence from other developed countries. Overall, given a certain level of health, the less educated and low-income individuals in both the US and

Europe have higher use of primary care services, but lower use of secondary care services (Morris *et al.* 2005; Weaver *et al.* 2009).

### **Evidence on the impact of enabling determinants on HCE**

#### *Income*

Although national income has been proven to be strongly associated with the growth of aggregated national HCE (OECD 2006; Gerdtham *et al.* 1992, Van Elk *et al.* 2009), its effect on individual HCE is far less pronounced. The majority of macro studies concluded that health care is a luxury good, as growth in health care spending is increasing at a greater rate than growth in national income. This finding – that health care is a luxury good – could be explained by the fact that decisions regarding investments in new technologies and the coverage of medical technologies by insurance schemes are made at the governmental level, and do not therefore depend on the individual budget constraint. However, (medical) decision-making on the individual level rarely depends on an individual's income, as the price of health care services is typically near zero in the presence of insurance (Getzen 2000). This is confirmed by Häkkinen *et al.* (2008), who found an important role of income only for expenditure on prescription drugs, as cost-sharing for this expenditure is relatively high in Finland. Furthermore, the seeming contradiction that institutional LTC expenditure in Finland and the US is concentrated among low-income patients can be clarified by the publicly financed LTC service for low-income individuals in the US or the income-related copayments in Finland (Häkkinen *et al.* 2008; Weaver *et al.* 2009). Richer patients may pay up to around 80% of their income as user charges for use of LTC institutions. Home care, on the other hand, is concentrated

among higher income individuals (Weaver *et al.* 2009). Recent studies on equity in access to medical care in developed countries have found that primary care services are often pro-poor distributed, while secondary care services are more intensively used by the rich (Van Doorslaer *et al.* 2006).

Regarding cost in the final years of life, results are mixed, as Hogan *et al.* (2001) found that individuals living in high poverty areas incurred more Medicare costs in their final year of life, while Felder *et al.* (2000) and Seshamani and Gray (2004a) found the opposite in Switzerland and the UK, respectively.

### **Evidence on the impact of societal determinants on HCE**

#### *Organization of the health care system*

Next to the effect of demographic, socioeconomic and health-related determinants, as discussed previously, HCE is influenced by the organization of health care, the health insurance system and the incentives hidden in health system policies.

The relationship between elements of the health care system and the level of HCE is very complex. The OECD (2009c) recently tried to map the quartile ranking of OECD countries on various indicators such as demand for care, price, capacity, volume, remuneration and administrative costs to health spending across countries, but could not observe a clear pattern, precluding firm conclusions.

Two examples may illustrate this complex relationship. First is the US, which has high HCE – unequaled around the world, accompanied by about 40 million uninsured persons, huge variations in quality and an average overall performance. Second is Japan, one of the world's most aged countries, with only a moderate level of HCE, although the hospital length of stay is

very long (on average, 36 days), as compared to other countries. Consider that in Japan the number of physicians and nursing personnel per capita is relatively low. These examples illustrate that relationships between aging and HCE depend on the institutional context of the health care system. In the remainder of this section we therefore do not summarize all of the literature, but mainly focus on some relevant issues for the Netherlands.

### *Bismarck versus Beveridge*

Health systems can be divided into two broad categories: National Health Services (NHS), based on the ideas of Beveridge, on the one hand, and Social Security Health care systems (SSH), inspired by Bismarck, on the other hand (Van der Zee & Kroneman 2007). The UK and the Scandinavian countries are the most prominent examples of NHS systems. The Dutch and German health care systems belong to the category of SSH systems.

The existing literature on which system performs best has found relatively small differences in performance indicators. SSH systems, however, are significantly more expensive than NHS systems. In a recent study, focusing on transitions between NHS and SSH systems, Wagstaff (2009) concluded that SSH systems are about 3–4% more expensive, but found no evidence that SSH systems achieve lower rates of amenable mortality. Nevertheless, the efficiency of NHS systems comes at the price of waiting lists and the coexistence of a private health care sector that is accessible only for those who can afford it.

Compared to the US, which is the only developed country where health care is delivered by the market, both NHS and SSH systems perform better on nearly all indicators regarding quality, availability and efficiency. At the macro level, the NHS and SSH

systems combine universal access to achieve a comprehensive set of health services with a modest development in HCE.

#### *Cost containment strategies in a Bismarck system*

In a Bismarck system, there are, in principle, two strategies to influence HCE. First, some elements of NHS systems can be introduced – such as planning and budgeting mechanisms, or measures that regulate the accessibility of care. In the Netherlands, planning instruments were tried in the 1970s, without success. Conversely, a budget system, introduced in 1983, was quite successful in terms of cost containment for about two decades. However, although a sudden relaxation of budgetary constraints was found to increase HCE in the Netherlands, the benefits of the budget system should not be overlooked. Mackenbach *et al.* (2010), who analyzed the sudden decline in mortality and increases in longevity in the Netherlands in 2002/2003, conclude that the rapid increase in HCE and hospital admissions since 2001/2002, which was facilitated by the sudden relaxation of budgetary restraints, most likely caused these declines in mortality.

A second strategy to influence HCE in a Bismarck system is to introduce market forces and managed competition in order to influence health care delivery and HCE. Below, some examples of both strategies are described in more detail.

#### *Mechanisms to regulate the accessibility of care*

Access to publicly financed care is often limited by institutional regulations. Gatekeepers are established to restrict access to specific types of services. Gatekeeping is a key feature of a number of health care systems, among them the Dutch system. Gatekeeping means that specialized care is accessible only

after referral by a general practitioner. Two examples of this gatekeeping function are the general practitioner who is expected to reduce unnecessary use of hospital services and the Indication Committee LTC (CIZ), which regulates access to publicly financed LTC in the Netherlands.

It is often assumed that gatekeeper systems have lower HCE. Delnoij *et al.* (2000) performed a study to test this hypothesis for 18 OECD countries. Their analysis demonstrated an effect only for ambulatory (outpatient) care, for which the expenditure increased more slowly than in non-gatekeeping health systems. For other health care facilities, such as inpatient hospital care, no significant effects of gatekeeping were found.

The CIZ restricts access to publicly financed LTC to those who are objectively in need of this care. Criteria developed to guide this eligibility process adequately measure which type and amount of LTC care sufficiently meets the need for care. However, before the CIZ decides on the eligibility of an individual to publicly financed LTC, his or her social context and the availability of informal care are taken into account. Notice that policymakers can easily modify the access to and expenditure on publicly financed LTC by adjusting the eligibility guidelines: for example, by changing the definition for the amount of informal care that is within reasonable limits.

### *Managed competition*

In 2006, the Netherlands became the first country in the world to introduce a system of managed competition. The old system consisted of a public mutuality for low-income groups and a compulsory private insurance for high-income groups. In the new system, all citizens are obliged to purchase private health insurance. However, the insurance market is regulated

to ensure basic coverage for all citizens at an affordable price. Insurers are obliged to accept all clients for their basic package, and price discrimination is not allowed. An extensive ex ante risk-equalization scheme between insurers has been established to compensate for differences in population characteristics. The idea behind managed competition is that risk-bearing insurers compete to be able to offer patients qualitatively good care for a low premium, and health care providers compete for contracts with these insurers. Consequently, managed competition should lead to quality and accessibility of care at reasonable costs.

The overall impact of managed competition on HCE in the Netherlands is a complicated matter to analyze, as it consists of many modifications of the health care system (for example, the introduction of a no-claim, which was replaced by copayments in 2008; the introduction of the Diagnostic Treatment Combinations (DBC) system to facilitate better negotiations on prices of hospital procedures; changes in payment of physicians; and more financial risks for health insurers) (Van de Ven and Schut 2008). Notwithstanding this complexity, a few of these elements allow provisional conclusions.

Thus far, the introduction of the new system does not seem to have led to lower HCE growth. Some prices declined, but since the budget system was removed, the volume of care increased sharply, especially in hospitals. The combination of both developments resulted in a substantial expenditure growth.

In their evaluation of the new insurance system, Van de Ven *et al.* (2009) conclude that insurers are becoming more effective in contractually enforcing more efficiency in health care. However, partly due to institutional limitations, insurers have thus far used selective contracting only on a very limited basis.

By comparing health survey data of 2001–2005 and 2006, Van Herten (2007) found that the introduction of the new insurance system has led to an increase in medical specialist contacts and use of (non)prescription drugs.

Despite the higher use of pharmaceuticals, the introduction of managed competition does seem to have resulted in lower prices of pharmaceuticals. Several health insurers have managed collectively to lower the reimbursed price of frequently used generic drugs to lower cholesterol and to treat ulcers, thereby managing to save between 170 and 348 million Euro on HCE ([www.gipdatabank.nl](http://www.gipdatabank.nl); Boonen *et al.* 2010) in 2008.

The general conclusion on the effect of the new system seems to be that, although in some areas lower prices have been realized, managed competition has not led to lower HCE growth. This result is mainly due to volume growth. Whether insurers are able and willing to control this volume growth in the future is still unclear. It should be noted, however, that the major goal of competition is to enhance microeconomic efficiency rather than macroeconomic cost containment.

### *Benefit package and cost-sharing*

One of the most potentially successful instruments to limit *public* HCE is to limit the benefit package of health insurance. Although Public HCE is lowered by definition, it might (partly) shift expenditure to the private sector. Another weakness is that while it has the potential to be effective in limiting expenditure, given that governments succeed in limiting the package, it seems to be quite difficult to remove beneficial interventions that belong to the common practice of medical professionals from the benefit package. Cost-sharing, therefore, would seem to be a much more promising strategy to influence health expenditure.

The majority of evidence confirms that being insured increases the demand for health care, as the price of care is considerably less than it was, or is even zero. Individuals with more complete coverage spend on average more, while (voluntary) high deductibles reduce the amount of health care consumed. A related finding is the higher use of health care by publicly insured individuals compared to privately insured individuals (Manning *et al.* 1987; Card *et al.* 2008; Lichtenberg 2002; Hulleger and Klein 2009; Zweifel and Manning 2000; 2004; Häkkinen *et al.* 2008). Van Vliet (2004) estimated the effectiveness of deductibles in decreasing yearly individual HCE, and found a price elasticity of  $-0.14$ . It should be noted that a part of the savings in HCE might actually have shifted to the insured's own payments. In contrast, Van de Ven *et al.* (2009) reported that the obligatory copayment, introduced in 2008 in the Netherlands, has not been successful in limiting HCE and in making people more price-aware. They state that the size of the copayment (€155 in 2009) is too low to induce changes in the behavior of the elderly and chronically ill, because their expenditure exceeds this amount, anyway.

Unlike the above-described cost-sharing initiatives, the recently introduced value-based insurance designs (VBIDs) link cost-sharing for health services with the expected clinical benefit (often stratified by specific patient populations). Patients are driven to use high-value health services because this lowers or cancels their copayments. Preliminary results suggest that VBIDs lead to lower HCE and better health outcomes (Fendrick *et al.* 2009).

### *Provider remuneration*

A variety of provider payment systems exist. These systems can be adopted in quite different health systems, either by the

government or by health insurance and health care organizations. The extent to which these systems could contribute to lower HCE growth depends on the financial incentives addressed in these systems. The following types of remuneration schemes can be distinguished: fee-for-service (FFS), episode-of-care payment, traditional capitation and comprehensive care payment. Under the FFS system, a predetermined amount is paid for each service provided. Because the provider's payments depend on the number of services, providers might tend to over-provide (unnecessary) services. This phenomenon is called supplier-induced demand. The episode-of-care payment, on the other hand, pays providers a single price per patient for an entire episode of care, independent of the number of services provided to this patient. Hence, it stimulates providers to provide only necessary services. However, incentives exist to under-provide services within an episode and to increase the number of episodes (Miller 2009). The diagnostic-related groups (DRG) system, often established to finance hospitals, is an example of episode-of-care payment.

Pomp (2009) analyzed for the period 2006–2007 whether supplier-induced demand prevailed in the Dutch DBC system. The Dutch DBC system, established to reimburse hospitals, can be seen as a mixture of FFS and DRG elements. Pomp concluded that for most DBCs, self-employed hospital physicians (participating in a partnership) seemed to produce significantly more health care services than employed physicians. Hence, the system still has strong incentives to increase the number of services. However, the elasticities found were modest (between 0.05 and 0.25), and the resulting impact on total HCE will be very limited.

The traditional capitation system enables a further control of the provision of services, as payments are independent of the

number of episodes. Instead, providers receive a single payment to cover all services provided to one patient during a specific time period. Gerdtham and Jönsson (2000) conclude that capitation systems in primary care tend to lead to lower HCE than FFS systems do. However, this remuneration system gives incentives to cream-skim patients, and puts providers with a relatively large population of chronic patients at risk of bankruptcy. Therefore, in the comprehensive care payment system, such capitation payments are further adjusted to the health status and other factors affecting the level-of-service need of the patient population (Miller 2009). An example is the care intensity package (ZZP) system recently established in the Dutch LTC sector. LTC institutions are remunerated a daily fee, which is a function of the (mental and physical) disabilities of their residential population. Pay for performance (PFP) initiatives are increasingly being used alongside the above-mentioned payment systems to improve efficiency or resource use by motivating providers to simultaneously eliminate waste, improve quality of care and contain costs. Providers are given financial incentives to enhance the quality of care. PFP initiatives link the payment of providers to a performance benchmark, thereby rewarding providers that perform well. However, ambiguity exists concerning the impact of PFP initiatives on the level of HCE because quality improvement might yield more intensive service provision for some providers, while eliminating unnecessary service use for others (Garcia-Caban 2010).

### *Medical technology*

Although many studies mention technological progress as an important determinant of HCE, the vast majority of publications considering aging and growth in HCE mentioned technological

progress only qualitatively as a determinant of HCE in the introduction or discussion section (e.g. Polder 2006; Zweifel 1999; Stearns and Norton 2004; Serup-Hansen 2002; Payne 2007, 2009; Manton 2007). Only a limited number of papers attempted to analyze the role of technological progress more explicitly (Cutler 2006, 2007; Lichtenberg 2007; Jones 2002; Breyer and Ulrich 2000; Goldman 2005; Westerhout 2006; Dormont 2006).

In an influential study, Newhouse (1992) considered many possible explanations for the rise in HCE as a share of GDP. After his review of possible explanations, a large residual is left for which he had no satisfactory explanation. He argued: "I believe the bulk of the residual increase is attributable to technological change, or what might loosely be called the march of science and the increased capabilities of medicine" (p 11) (as cited by Jones 2002). Still, technological progress is a challenge for health economists.

Two basic questions are interesting here. First, does medical technology offer value for money, and second, can we estimate the separate impact of medical technology on HCE? In other words, can we disentangle it from the other determinants? We will discuss the first question briefly, and focus more on the second.

### *Value for money*

It is important to know whether medical technology offers value for money, because if so, it might (partially) legitimate rising HCE resulting from medical technology. Furthermore, such information provides insight into the contribution of health care for improvements in health and disability (see the conceptual model in section 2).

Cutler has contributed to several papers on medical technology, focusing on the balance between its health gains and costs. Overall, Cutler showed that the value of medical spending in the

US between 1960 and 2000 was less than \$40,000 per life year gained. However, for the elderly (65+) it rose up to about \$145,000 per life year gained between 1990 and 2000. Lichtenberg (2007) and Civan and Köksal (2009) are even more optimistic on the efficiency of drugs as an example of medical technology. They found for the US that using new drugs more often increases drug expenses somewhat, but yields larger net savings on hospital and physician expenditures. It should be noted that these favorable conclusions for new drugs do not automatically apply for all health care technologies.

Goldman *et al.* (2005) attempted to quantify health trends and medical innovation for the elderly. They estimated the expected increase in HCE and the cost per additional life year as a result of nine key technologies. Both the budgetary impact and the cost per additional life year vary enormously between technologies, showing that value for money differs substantially between new medical interventions. The latter conclusion is confirmed by many studies producing so-called cost per QALY (= Quality Adjusted Life Year) leagues tables, which show an enormous range in incremental costs per QALY gained for various health interventions (Drummond *et al.* 2005).

### *Technology and HCE*

Referring to Newhouse, Jones (2002) stated that "the march of sciences leads to the discovery of costly treatments for health problems that could previously not be cured, but it also reduces the cost of those treatments over time." Jones remarked that the sickest persons in a population become more costly over time, because technological progress constantly shifts out the frontier medical condition that can be treated. Based on an analysis of US life expectancy and HCE over time, he concluded that HCE for

people shortly before they die had been rising at 4.7% per year. Consequently, he concluded that the life expectancy of a society is the result of its willingness to pay for large expenses near death. Breyer and Ulrich (2000) estimated for Western Germany during 1970–1995 that technological change increased per capita HCE by 0.8–1.4% annually. In five regression models the impact of medical technology on average HCE per capita was estimated as a time trend, next to income and the share of elderly (65+) in the population. A linear trend produced 0.8% for technology, and an exponential trend 1.0%. Controlling for the German health care reform of 1989 increased the impact of the latter trend to 1.4%. The share of decedents was not significant in explaining HCE.

Suen (2005) hypothesized that the persistent rising trend in HCE and the significant increase in life expectancy can be explained by the combination of technological improvements in medical treatment and rising incomes. Using a multi-period generational model, he showed that improvements in medical treatment and rising incomes can explain the increase in HCE during the second half of the 20th century. He suggested that the rapid growth in HCE reflects optimal responses to changes underlying the production and accumulation of health.

Westerhout (2006) stated that only a crude estimate of the medical technology effect is feasible. He combined the elasticity between the growth rate of new drugs and the size of their potential market (Acemoglu and Linn 2004) with the expected increase in the number of elderly, and estimated an additional 0.6% annual growth in HCE due to medical progress.

Dormont *et al.* (2006) decomposed the relative contributions of changes in demography, morbidity and health care practices on the upward shift of age-specific HCE in France between 1992 and 2000. Changes in practices could be further divided into changes

in practices for a given level of morbidity and other changes in practices (e.g. institutional and behavioral changes and changes in individual characteristics). Changes in practices, given a certain level of morbidity, reflect the impact of medical technology. Medical technology explains more than 70% of the growth in prescription drugs expenditure, suggesting a large innovation component, as the drift is only observed on the conditional level of HCE. In contrast, medical technology could only explain 10% of the upward drift in hospital expenditure. The growth in hospital expenditure – primarily caused by a higher participation rate – is instead driven strongly by changes in behavior and individual characteristics.

Wong *et al.* (work in progress; see also Luijben & Kommer 2010) use macro data to estimate the influence of technology on the trend in hospital use in the Netherlands by approximating medical innovation with lagged patents related to medical innovation. Next to technology, they additionally controlled for age, gender and GDP. Their findings demonstrate that medical innovation is a major driver of hospital use. Moreover, the influence of innovations on hospital use is found to be largest for the age groups that rely most on hospital care.

Summing up, although technological progress has not been analyzed in a very sophisticated manner, many studies indicate that progress in medical technology is responsible for a substantial part (perhaps more than half) of the annual increase in HCE in past decades. Some studies conclude that technological progress often provides value for money, which partly legitimizes its upward pressure on HCE.

### *Consumer preferences*

As trends in consumer preferences are difficult to disentangle from health care supply factors, the number of relevant studies is rather low. Dormont *et al.* (2006) tried to detect shifts in consumer preferences by studying trends in participation in health care. The data did not indicate a clear shift in consumer preferences for France during the period 1992–2000.

### *Wages/prices*

Generally, the Baumol effect indicates that health care prices tend to increase faster than general inflation. Douven (2006) estimated that this effect resulted in an additional 0.8% increase in price per year for the Netherlands. Van Elk *et al.* (2009) discussed empirical studies that include the effect of relative prices on HCE. They concluded that “The available evidence for OECD–countries seems to suggest that an increase in the relative price of health care causes larger real health care expenditures and a lower volume of health care”. On top of the Baumol effect, developed countries expect serious workforce shortages in health care in the coming decades. In 2008, 11% of the Dutch workforce was employed in health care. Without any change in policy, this proportion will increase to 19–22% in 2040 (RvZ 2008). This might result in upward pressure on wages in the health care sector.

### *Societal determinants: conclusion*

In addition to demographic and epidemiological determinants, societal factors have a major influence on HCE. Technological progress is a driving force behind the diffusion of new treatments and the steady expansion of the health care sector. Baumol’s disease comprises a structural factor causing prices in health care to outpace general inflation. The size of this effect is

considerable, and comes close to the influence of pure aging. The health care system can be seen as the institutional context that moderates price and volume developments. This context is mainly important for the relative level of HCE compared to other systems. Time trends in HCE are more or less the same in all developed countries, except for the United States, which particularly lacks the governance of any health care system.

To the best of our knowledge, nothing is known about the interaction of aging and institutional factors. Only Seshamani and Gray (2002) reported that in England and Wales the proportion of health expenditure allocated to the elderly population decreased, in contrast with other countries (such as Canada and Australia, where this proportion increased). This could have been caused by institutional differences in patient management and access to care for older patients. The authors, however, did not analyze the interaction itself.

Given the evidence in this chapter, a major policy issue is to develop institutional arrangements that will bend downwards the growth rate in HCE, rather than lowering its level.

#### **4. Dynamics in the relationships between HCE and its determinants**

This section discusses possible time trends in the relationship between HCE and its determinants. Use of current models to project future HCE assumes a stable relationship between HCE and its determinants. When these relationships are in fact dynamic, use of these models might result in biased forecasts of HCE. This section indeed demonstrates that the influence of determinants on HCE is not constant over time. It centers primarily on dynamics in the relationships of the determinants directly related to aging. The section does not forecast HCE, which is the topic of the next section.

##### *Effect of age on HCE over time*

Studies analyzing trends in US HCE by age have found that average HCE outlays during the period 1963–1987 have disproportionately grown for children below six years and elderly people aged 65 years and older. This trend is, however, reversed from 1987–1999, as HCE among the middle-aged population has increased to a larger extent compared to that of the elderly (Meara *et al.* 2004). In contrast, Hartman *et al.* (2008) found that during 1987–2004, relative spending profiles by age hardly changed, except for the 85+ age group, whose HCE increased substantially. Using Dutch macro data, Polder *et al.* (2002) analyzed separately the time trend in the effect of age on acute and LTC expenditure. They found an increasing growth rate of per capita expenditure for acute care, but a decreasing growth rate for LTC. Combining both trends showed an average annual growth rate of 4.6%, nearly constant with age.

*Effect of TTD on HCE over time*

Although Hogan *et al.* (2001) found that the share of Medicare spending for persons in their last year of life was stable over a period of 20 years, the relative costs of dying have decreased between 1979 and 1995. This decrease is due to more rapid increases in survivor HCE than decedent HCE between 1989 and 1996 (Spillman and Lubitz 2000). Zweifel *et al.* (1999) confirm these results for Switzerland, as HCE of survivors increased more than that of decedents. The relative costs of dying in the total population dropped from 10.6 to 5.3 over a ten-year period (Zweifel *et al.* 1999). In the period 1989–1993, the relative costs of dying were also found to decline in Canada because acute HCE fell – but more among decedents than survivors. Furthermore, LTC expenditure only declined among decedents and increased among survivors (McGrail *et al.* 2000). Payne *et al.* (2009), however, reported contradictory results for Canada. From 1991 to 2000, the combination of stable or rising decedent's HCE and dropping survivor's HCE has resulted in a rising decedent/survivor ratio – but more so for hospital care and LTC than for prescription drugs and physician care. Generally, the downward-sloping curve of the relative costs of dying with age is found to persist over time (McGrail *et al.* 2000; Spillman and Lubitz 2000; Lubitz *et al.* 1993). Some TTD studies have included dummies representing the calendar year to examine trends in HCE over time. These studies generally found an increase in per capita HCE over time, which is most likely caused by technological changes (Zweifel *et al.* 1999; Seshamani and Gray 2004a). Unfortunately, none of these studies included interactions between these calendar years and TTD to examine the trend in the effect of TTD on HCE over time. Zweifel *et al.* provided some evidence of a decreasing effect of TTD on HCE over time. They found that in 1981–1992, TTD significantly

determined HCE up to six quarters preceding death, while in 1991–1994 only significantly more was spent in the last three quarters preceding death (reference group: 8th quarter). Their finding could support the compression of morbidity theory, as the duration of the end-of-life morbidity measured by TTD is shrinking. However, it is more likely that HCE in the 8th quarter of life increased, because this is confirmed by the larger increase in survivor's costs compared to that of decedent's (Zweifel *et al.* 1999; Seshamani and Gray 2004b).

#### *Effect of illness/need determinants on HCE over time*

Changes in the relationship between morbidity and health care use can be caused by a variety of factors. First, changes in the underlying aspects of morbidity contribute to dynamics in the relationship between morbidity and health care use. Morbidity is a complex concept with a number of distinct aspects (including disability, perceived health and chronic conditions). Trends in these underlying aspects are not necessarily the same, and the relationships between these aspects can change over time. These changes are partly caused by factors that also affect HCE, but they can also have an additional effect on the relationship between HCE and morbidity. For example, the apparent decline in the disabling effect of chronic diseases has consequences for the relationship between chronic diseases and HCE. As suggested by De Hollander *et al.* (2007), the introduction of new medical devices could partly explain the less-disabling effect of diseases. This implies that the relationship between chronic diseases and utilization of different types of health care changes: the higher use of medical devices reduces LTC use.

Secondly, changes in practices or treatments, given a morbidity level, could also explain dynamics in the relationship between

morbidity and HCE. Due to medical innovation, and other factors affecting the availability and accessibility of health care (like institutional changes), practices for a given level of morbidity can change. For example, the introduction of a new drug to treat a certain kind of disease obviously changes the relationship between the disease and HCE. Dormont *et al.* (2006) concluded that the growth in drug expenditure in France between 1992 and 2000 could almost entirely be attributed to changes in practices, given morbidity. In contrast, this effect is found to be much weaker for hospital care (only 10%).

Finally, changes on the demand side (e.g. consumer preferences) might have an impact on the relationship between morbidity and HCE. Dormont *et al.* (2006) found that changes in other practices – including changes in physician behavior, the institutional context, patient preferences and unmeasured morbidity – contributed to 46% of the growth in total HCE in France between 1992 and 2000.

In conclusion, the effect of age is either found to increase or to remain stable over time. Evidence from the Netherlands indicates that population aging will shift costs from the LTC sector to the acute care sector because age-adjusted growth rates are decreasing with age for LTC and increasing for acute care. However, the dynamic relationship between age and HCE largely depends on changes in the underlying morbidity. Most studies found a decreasing effect of TTD over time, mainly caused by a higher growth rate of survivor HCE, which is probably caused by the changing influence of morbidity/disability on HCE over time. Dynamics in the relationship between morbidity/disability and HCE mainly result from progress in medical technology, changes on the demand side and changes in the underlying aspects of morbidity.

## 5. Population aging and future HCE

In the previous sections we established that the inclusion of TTD and morbidity improves model fit and largely decreases the role of age as a determinant of HCE. This section assesses the consequences of including TTD and morbidity on predictions of future HCE. First, we provide an overview of predictions of HCE based on TTD, and compare them to naïve models, based solely on age. We then discuss predictions based on trends in morbidity. Finally, we discuss the relevance of age, TTD and morbidity on future HCE in relation to other factors that influence HCE, especially technological development (see the next section for new evidence for the Netherlands).

### *Projections based on naïve versus TTD models*

Naïve models, based solely on age, apply the current age-specific HCE curves to the demographic composition of the population over time to calculate the impact of population aging on future HCE. Thus, these models ignore the possibility that improvements in longevity will change age-specific HCE curves. By ignoring this possible change, naïve models assume that extra life years gained comprise only years with high HCE. Consensus has emerged that this is not a valid assumption, and that TTD should therefore consistently be included in prediction models (Stearns and Norton 2004).

Many international scholars have compared forecasts of HCE based on naïve and TTD models. A general and strong result, regardless of country or model specification, is that population aging has a significantly lower impact on future HCE in TTD models than in naïve models. The gap in differences between naïve and TTD models widens when the expected increase in life expectancy

is larger and when the projection period is longer. Comparison of the exact impact of the inclusion of TTD on predictions between studies is complicated by the fact that demographical changes differ by country, and not all studies report the same type of outcome. In particular, not all reported results can be interpreted as the impact of aging on annual growth rates in HCE.

The studies that do include annual growth rates roughly find around 1% annual growth of HCE due to aging when TTD is not included, which is lowered by around 0.2 percentage points when TTD is included. In Switzerland, Steinmann *et al.* (2007) found an increase of 0.7% annually between 2005 and 2030 for the naïve projection and 0.55% annually when TTD and increasing life expectancy are taken into account. Although the effect of aging on predicted HCE is thus significantly smaller when TTD is included, over a period of 25 years a growth rate of 0.7% would still imply an increase of total HCE of around 15% due purely to aging. Miller (2001), using US Medicare data, employed a relatively long prediction period (1997–2070) and found somewhat higher average annual growth rates: 1.3% for a naïve model and 1.1% for a TTD model<sup>5</sup>. Shang and Goldman (2007) also found that Medicare expenditure will rise from roughly \$300 billion in 2000 to about \$1175 billion or \$950 billion in 2080, based on either a naïve or a TTD model. This implies an annual growth rate due to demographic change of 1.7% and 1.5%, respectively. For the Netherlands, Polder *et al.* predicted 0.7% and 0.61% annual growth between 2000 and 2020 due to aging in a naïve model and a TTD model, respectively.

As discussed previously, the influence of TTD on HCE differs between health care services. Serup–Hansen *et al.* (2002)

5 We calculated the implied annual growth rate based on the total growth between 1997 and 2070 in Figure 6 (Miller 2001).

projected future costs of hospital inpatient care and primary health care in Denmark for the period 1995–2020. The naïve model predicts an annual growth rate of 0.78% for hospital care, whereas the TTD model projects a growth rate of 0.63%. Over 25 years, this amounts to 25.7% lower predicted hospital expenditures for the TTD model. For primary care, the differences are considerably smaller: 0.33% annual growth in the naïve model and 0.32 in the TTD model, resulting in 1.4% lower predicted expenditures in 2020 for the TTD model. Häkkinen *et al.* (2009) make projections of HCE in 2036 for Finland for different sectors. For total HCE, they predict annual growth of 2.3% using a naïve model, and 1.7% using a TTD model. The difference in predicted annual growth rates between the two models is large for expenditures on inpatient care in health centers and psychiatry (1.7% instead of 2.2% per annum) and somatic specialized care (1.5% instead of 1.9%), but small for expenditures on prescription drugs (1.6% instead of 1.7%). Kildemoes *et al.* (2006) also found a relatively weak effect of controlling for TTD in projecting Danish drug expenditure for 2030; controlling for TTD resulted in 5.5% lower projected costs in 2030. Seshamani and Gray (2002) predicted hospital expenditure for the UK in 2026, finding that the annual growth rate due to aging drops by 50%, from 0.8% per annum to 0.4%, when TTD is included. Summing up, using TTD models instead of naïve models leads to lower projections of HCE – particularly for hospital expenditure, and to a smaller extent for expenditure on primary care and prescription drugs.

#### *Predictions of HCE using trends in illness/need determinants*

Although the inclusion of TTD in models to project future HCE yields substantial improvement (as trends in life expectancy are taken into account), these models still do not control for trends

in morbidity. Whereas naïve models assume that increases in life expectancy do not influence the age profile of HCE, likewise TTD models implicitly assume a postponement of morbidity, as the period of morbidity preceding death only shifts to higher ages (i.e. the period of morbidity preceding death remains stable). It is therefore believed that the additional life years gained are all lived in full health (i.e. the increase in life expectancy equals the increase in healthy life expectancy). TTD models therefore do not sufficiently incorporate possible dynamics in the relationship between mortality and morbidity at the end of life.

In comparison to the extensive TTD literature, few projections of future HCE based on morbidity have been made. This lack of morbidity-based projections may be due to the fact that trends in morbidity are much more uncertain than trends in mortality. Due to the complex nature of morbidity, evidence on time trends in morbidity tends to differ between countries, and sometimes even between studies within the same country (Mackenbach *et al.* 2008; Parker and Thorslund 2007, Lafortune and Balestat 2007). Despite the widely divergent results, the general tendency seems to be that elderly populations simultaneously report more diseases and health problems but possess a greater ability to perform many of the activities necessary for independent living (Parker and Thorslund 2007). Concerning the Netherlands – although this is not confirmed by all studies – severe disability seems to have declined, while mild disability seems to have increased. This decline in disability coincided with an increase in chronic diseases (De Hollander *et al.* 2006). As most evidence concerning recent trends in morbidity favors the compression-of-morbidity theory (Payne *et al.* 2007), which holds that the period lived in morbidity at the end of life is shrinking, use of TTD models to estimate future HCE might still overestimate it.

Manton *et al.* (2006, 2007) extensively investigated how the decline in disability (found between 1982 and 1999) among the US elderly affects future Medicare cost projections. Their study, which used the National Long Term Care Surveys 1982–1999 to describe disability trends, found a decline in the prevalence of severe and mild age-adjusted disability rates of the elderly. This decline accelerated after 1989. Based on these disability trends, Manton *et al.* (2007) predicted Medicare costs for 2009 using four different scenarios on disability trends. First, using prevalence of disability in 1982, projected costs for 2009 were \$300.32 billion. Second, using the improved disability rates in 1989, costs were projected to be \$286.96 billion. Third, assuming that the average decline in disability observed between 1982 and 1999 would continue at the same pace, the cost projection came to \$256.7 billion. Finally, using the accelerated decline between 1989 and 1999, the projected costs in 2009 were \$252.6 billion. They concluded that continuation of the declining disability trend (1.52% annually) would be sufficient to keep the Medicare system financially sustainable.

Whereas Manton *et al.* (2007) only looked at disability trends in the elderly, Bhattacharya *et al.* (2004) argued that current developments in disability of the young have to be taken into account when projecting HCE for the future elderly. Because the trend among the young declines at a lower rate than that of the elderly, they argued that the future elderly will be more disabled than projections suggest from an extrapolation of the recent disability trend among the elderly. Data from the Medicare Current Beneficiary Survey and the National Health Interview Study were used to project that per capita Medicare costs decline for the next 15–20 years – which is in line with recent projections that used declining disability among the elderly. However, due to rising disability rates among the younger elderly, they forecast that per

capita HCE will begin to rise after 2020. Therefore, they concluded that cost forecasts for the elderly depend on the incorporation of information regarding disability among the younger generations; including these trends as well yields more pessimistic scenarios for future Medicare expenditure.

Whereas projections based on disability trends show that the possible impact of these trends on HCE growth is large, more research is needed to provide reliable forecasts of morbidity and disability trends, as well as resulting changes in HCE growth. An especially relevant issue is that most studies that project HCE based on morbidity trends assume that these trends are exogenous. The observed trends in disability, however, may be partly due HCE growth. Also, HCE (given a certain level of morbidity) is highly dependent on the accepted methods of treatment and technologies set at that time, and is not constant over time.

#### *The relative contribution of aging*

Thus far, we have discussed the role of aging in projections of future HCE. Aging is only one of the important factors, however, in forecasting HCE. In explaining the growth in aggregate national HCE, most studies only find a relatively small role for the age composition of the population (OECD 2006). Of the total annual growth rate (which can reach around 8.5%), only between 0.5% and 1% can be attributed to aging (Richardson and Robertson 1999; Reinhardt 2003; Burner *et al.* 1992). The major factor determining the growth rate seems to be technological change. In their literature review of macro studies on HCE growth, Van Elk *et al.* (2009) concluded that the age composition is often a significant variable in explaining HCE growth, but technological change and income growth are the main drivers. However, macro studies can introduce aging only as an explanatory variable in

some approximate way (e.g. the percentage of the population aged 65+).

A number of studies have assessed more directly the impact of demographic changes next to that of other determinants. Dormont *et al.* (2006) estimated the relative contributions of changes in demography, morbidity, health practices (given a level of morbidity), and other changes in practices (e.g. institutional and behavioral changes, and changes in individual characteristics) to the recent growth of French HCE. Of the 53.9% growth of HCE between 1992 and 2000, changes in practices (given a level of morbidity) – mainly caused by the introduction of medical technologies – contributed to 12.9%, while changes in the age structure contributed to only 3.4% of the growth. Other changes in practices contributed to 46.0% of the growth, and changes in morbidity decreased HCE by 9.7%.

Breyer and Felder (2006) factored the estimated annual growth rate of 1% caused by technology (Breyer and Ulrich 2000) into their demographic expenditure model and concluded that the impact of medical progress on HCE is much larger than the impact of aging, which was found to be only 0.37% annually. Extrapolating this 1% external growth per year to projections for HCE in 2050, amounts to an increase of per capita HCE of 77%. The large role of medical technology is confirmed by a Finnish study, which concludes that most of the growth is a result of the introduction of new, often more expensive, drugs (Häkkinen *et al.* 2008). Of the 7% annual expenditure growth in Finland during 1993–2004, only 10% can be attributed to changes in the population age composition. Dormont *et al.* confirmed the large role of technology in the growth of drug expenditure because 70% of its growth between 1992 and 2000 can be contributed to the development of new drugs.

Steinmann *et al.* (2007) argued that, although the influence of pure population aging may be small compared to other factors, population aging is still very relevant for future HCE. First, on the aggregate level, population aging might have a considerable influence, as the younger will have to bear a substantial part of the HCE induced by aging. Steinmann *et al.* estimated a 50% increase in the contribution of the younger population, indicating a significant distributional effect. Second, recently some steepening HCE curves by age were found, suggesting either an expansion of morbidity or a compression of morbidity reached by a non-proportional growth rate of HCE that favors the elderly. Either way, the effect of aging seems to be underestimated. Finally, an additional influence of aging might be caused by the so-called Sisyphus syndrome. This concept claims that aging shifts voting power to the elderly, who in turn raise their voice to have more resources allocated to health care.

This section demonstrated that reductions in disability and ill health have been shown to decrease future HCE. This finding indicates a role for prevention policies to reduce the pressure that population aging asserts on the health care sector. Although this direction seems like an attractive route to take, it might be a naïve route as well. Several scholars and policymakers argue that increases in longevity reached by prevention might result in controlling the growth in HCE, as expenditure in the final year of life decreases with age. Unfortunately, this argument has been falsified by other scholars, who have found that HCE in the additional life years lived is not compensated by the savings from postponing the last expensive life year (Van Baal *et al.* 2008; Gandjour 2009). Thus, the question concerning the effect of prevention policies on the growth of HCE remains largely unanswered.

## 6. New Evidence from the Netherlands

This section summarizes new evidence that sheds light on the effect of aging on HCE in the Netherlands. The findings summarized in this section originate from three main research projects. Before turning to this new evidence, we briefly describe the main goals of these three projects, and then sketch the Dutch institutional context. As in previous sections, we discuss separately the new evidence concerning the acute care and LTC sectors.

### **Aims and contributions of the projects**

The research projects, “Solidarity in the health care sector and the costs of aging”<sup>6</sup>, “Healthy aging and health care expenditures”<sup>7</sup> and “Living Longer in Good Health,”<sup>8</sup> aim to gain more insight into the determinants of HCE and to develop scenarios of future HCE in the Netherlands, based on demographic and epidemiological trends.

### **New evidence concerning the acute health care sector**

#### *Extending the TTD approach*

The TTD approach used by previous studies to estimate the consequences of aging for (future) HCE provides no insight into the underlying relationship between morbidity and disability, TTD

- 6 This project – carried out at Tilburg University and the National Institute for Public Health and the Environment (RIVM) – focuses on extending the TTD approach to specific diseases and comorbidity. Also the relationship between hospital use and subsequent use of LTC for specific diseases is analyzed.
- 7 This project – carried out at Tilburg University and the RIVM – investigates the influence of healthy aging and differences between age cohorts on the development of HCE
- 8 This project – carried out at Erasmus University and funded by NETSPAR – aims to translate past/expected changes in demography, morbidity, disability and practices into changes in the levels of acute and LTC expenditures.

### **The Dutch institutional context**

The financing of acute care and LTC in the Dutch health care system are organized separately. All Dutch citizens are covered for acute HCE by the Health Insurance Act (ZVW). According to this act, citizens are obliged to purchase an insurance covering the services included in the basic benefit package – a package consisting of necessary, effective and efficient health care services. A variety of institutional arrangements are made to ensure that all citizens can purchase such an insurance against a fair non-discriminative price. In addition to this social security health care system, there is the ability to purchase supplementary insurance for services not covered by the basic benefit package. Supplementary insurances are subject to price discrimination. In 2009, the vast majority of Dutch citizens had purchased additional insurance. In 2008, mandatory copayments were established.

Next to universal access to acute health care services, universal access to long-term care facilities and other exceptional medical expenses are covered by the Exceptional Medical Expenses Act (AWBZ) and the Social Support Act (mainly domestic care). AWBZ premiums are collected by general taxes and are earmarked. To reach a desired allocation of publicly financed LTC (i.e. one according to 'need'), an assessment agency has been established to regulate access to these LTC services by performing objective, independent and comprehensive assessments (Peeters and Francke, 2007; Van Gameren and Woittiez 2005). Publicly financed LTC services are not entirely free of charge. Users are charged an income-related copayment.

and HCE. As it is the morbidity and disability preceding death that causes (much of) the demand for health care, it is important to better understand this – until now – epidemiological blind spot. Using longitudinal data on hospital use, Wong *et al.* (2009c) extended the TTD approach by looking at the predictive value of TTD for disease-specific HCE and by analyzing the effects of comorbidity. The differential effect of TTD for specific diseases might partially explain changes in the relationship between TTD and HCE over time. For the majority of diseases, the ratio between the hospital costs of decedents and survivors is found to be significantly greater than one. Therefore, it could be

concluded that strong lethality of a disease is not a prerequisite for the presence of a TTD effect on costs. However, Wong *et al.* did find that the ratio between deceased and survivors is largest for the most lethal diseases, including lung cancer, septicemia, heart- and renal failure. Diseases for which a TTD effect is not found include non-life threatening diseases and either chronic or planned non-urgent treatments. The differences in the effect of TTD between diseases indicate that the aggregated relationship between TTD and HCE may change as a consequence of epidemiological trends. For example, in the Netherlands a decline can be observed in the number of individuals dying of heart disease. Wong *et al.* found that the costs associated with TTD due to COPD are relatively low – compared to cancer, for instance. As a result, the decline of COPD as a cause of death will probably lead to an increase in costs associated with TTD on an aggregated level. Wong *et al.* (2008; 2009a) further extended the TTD approach by including comorbidity (i.e. having a specific combination of diseases). Wong *et al.* (2009a) demonstrated that comorbidity generally leads to higher *additional* expenses incurred, next to the costs of each disease separately. Consequently, increasing the prevalence of comorbidity will only lead to additional expenses if the prevalence of those specific combinations increases as well. They also found that expenditure for a specific disease is strongly associated with that disease being the cause of death, and that the expenditures of individuals who die of another disease are in many cases not significantly different from those of the survivors.

*The longitudinal relationship between health and hospital use*

Concerning the relationship between health status, life expectancy and mortality, in their projections of the consequences of trends in life expectancy and health, most studies do not account for

the fact that the developments in life expectancy and health are not independent: some determinants of life expectancy also influence health, and better health itself can also lead to longer life expectancy. Moreover, developments that influence health and life expectancy can simultaneously change the relationship between health, life expectancy and HCE. Therefore, insight into the inter-determinant relationship between these three factors is required.

Building on the work of Lubitz *et al.* (2003), Wouterse *et al.* (2009a) analyzed the long-term relationship between health, survival and costs of hospital use. They estimated the relationship between initial health status and costs of hospital use over an eight-year period in the Netherlands. Cross-sectional health survey data from 1997 to 2005 were linked to the national hospital register. Four different indicators of health and disability (self-perceived health, long-term impairments, ADL limitations and comorbidity) were considered. The study used discrete survival analysis to relate initial health status to costs of hospital use in the following yearly periods. The model consists of three parts. Part one models the probability of survival up to a certain period. Part two models the probability of hospital use in a certain period conditional on survival, and part three models the costs of hospital use conditional on using hospital care. In all three parts of the model, the effect of initial health on hospital costs is assumed to be linearly time dependent.

The findings are as follows. For those aged between 50 and 70, differences in hospital costs between initial good health and poor health are substantial and persistent over the entire eight-year period. For these age groups, severe ADL limitations are associated with considerably higher costs than other indicators of health. For the higher ages, differences in long-term costs of hospital

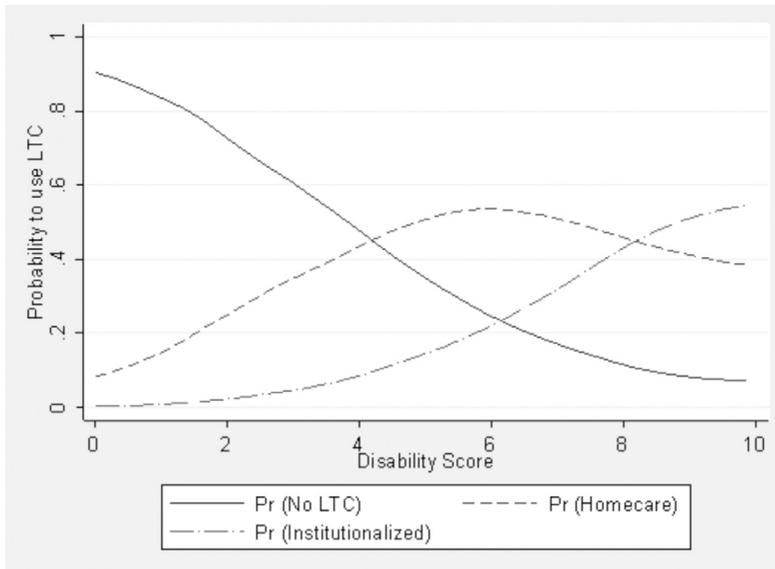
use between good and poor health are much less substantial. Expected hospital costs for individuals in poor health decline rapidly and become lower than those for people in good health after about six to seven years. This is primarily due to the higher mortality rate among people in poor health. The results are confirmed for all four health indicators. The results demonstrate that differences in life expectancy play an important role in determining the long-term relationship between health and hospital costs. Therefore, the relationship between health, life expectancy and costs should be taken into account when making predictions of health care expenditure.

### **New evidence concerning the LTC sector**

#### *Predictors of long-term care use*

Exploiting LTC use data on a sample of the Dutch 55+ population, De Meijer *et al.* (2009a) investigated the likelihood of using two different LTC services (home care and institutional LTC) simultaneously, and centered on the degree of disability. Disability was measured by impairments in (i)ADL and mobility. In addition, a disability index was constructed including all of these disability items. Consistency with the Dutch public LTC eligibility criteria used by the assessment agency resulted in the selection of an ordered response model to analyze LTC use.

Results demonstrate that even after extensive control for disability, age remained an important driver of LTC use. Next to age, disability – but not self-reported health, nor the presence of a chronic disease – was found to be the main determinant of home care and institutional LTC use. Moreover, the presence of at least one disability displayed a greater effect on utilization than any additional disabilities.



*Figure 7 Relationship between disability and LTC use stratified by type of service – all other determinants at their mean*

Figure 7 demonstrates the probability of home care and institutional LTC use as a function of disability (measured by the disability index) – holding everything else constant. The likelihood of using institutional LTC care (or not using LTC care) increases (decreases) with the degree of disability. The probability of using home care first increases and finally decreases with the level of disability. For the severely disabled, the probability of using home care decreases as their probability of using institutional LTC increases. Those having a disability score over 8.5 are more likely to be institutionalized than to use home care. These individuals could be described as being disabled in all iADL items, and in four out of ten ADL/mobility items. Apart from those who are more disabled and older in age, also females, those living

alone, those having psychological problems and those with a previous hospitalization were more likely to use LTC.

Using mixed logit models, Bakx (2009) took a slightly different approach than De Meijer *et al.* (2009) by examining the determinants of informal LTC use and professional LTC (including home care and institutional care) use among the Dutch 50+ population included in the Survey of Health Aging and Retirement in Europe (SHARE). Concerning the main determinants of LTC use, Bakx found similar results as De Meijer *et al.* (2009). However, next to disability, co-residence status and age, physical and mental health increased the probability to use informal and professional LTC as well. Being female and not having children only increased the likelihood of using professional LTC.

Moreover, Bakx exploited the panel structure of the data by modeling transitions from no care or informal care to professional LTC. The probability of starting to use professional LTC was greater for individuals initially living alone or starting to live alone, due to a change in co-residence status, experiences that decreased mobility or deteriorating mental or physical health, and those who previously used informal care.

In line with De Meijer *et al.* (2009a) and Bakx (2009), Wong *et al.* (2009b) also analyzed the predictors of LTC utilization. However, Wong *et al.* were primarily interested in the predictors of LTC use in a cohort of discharged hospital patients aged 65+. Using discharge registrations, they modeled LTC use as a function of demographic characteristics and several medical diagnoses. The outcome variables are the following: discharge to home with no formal care (reference category), discharge to home with formal home care, admission to a residential home and admission to a nursing home. The findings of De Meijer *et al.* are confirmed for this specific population: higher age and the absence of a spouse

are found to be associated with a higher risk of all three types of LTC use. Furthermore, the probability of using formal LTC is found to be higher for those with a longer stay in the hospital. Individuals with a child had a lower risk of requiring institutional LTC. Stroke is the strongest disease predictor of nursing home admission, and fractures of the ankle or lower leg are strong determinants of admission to a residential home. Lung cancer is the strongest determinant of discharge to the home with formal home care.

The three studies mentioned above demonstrated that LTC use is to an important extent driven by disability and by specific diseases, probably the diseases that have a high disabling impact. Unfortunately, De Meijer *et al.* (2009) lacked information on specific chronic conditions, while Wong *et al.* (2009b) lacked data on disability. Therefore, insight into epidemiological trends as well as the contribution of specific chronic conditions to the burden of disability is required in order to further improve prediction of future need for LTC. Given that LTC expenditure contributes to roughly 18.5% of total health spending (Poos *et al.* 2008), the diseases that were found to be associated with the utilization of LTC should also be the center of focus in disease-prevention policies. Worth noting is that – unless controlling extensively for disability or morbidity – age is still found to importantly determine LTC use. Finally, the influence of co-residence status (a proxy for informal care availability) should not be overlooked. Both studies confirm what the eligibility guidelines already confirmed: an individual's lack of access to informal care sources upon which he or she can rely substantially increases eligibility to – and therefore use of – publicly financed LTC.

### *Predictors of LTC expenditure*

Using registrations for the amount of LTC use, De Meijer *et al.* (2009b) extended the TTD approach by analyzing home care and institutional LTC expenditure for the entire Dutch 55+ population – conditioning not only on age, gender and TTD, but also on cause of death and co-residence status.

The results are as follows. The effect of cause of death and co-residence status on both home care and institutional LTC expenditure is profound. Those living alone, as well as those who died of diabetes, mental illness, CVA, diseases of the respiratory or digestive system, have higher LTC expenditure, while a neoplasm (tumor)-related death resulted in lower expenditure. In contrast, Wong *et al.* (2009c) found substantially higher hospital expenditure for those who died from a neoplasm. This probably explains the lower LTC expenditure, as the health care use by cancer patients is relatively concentrated at the hospital sector. De Meijer *et al.* (2009b) further examined home care expenditure among a sample of non-institutionalized individuals conditioning, additionally, on morbidity and disability. Findings of this extended model demonstrate that TTD does not drive home care expenditure (once account is taken of disability), while age and co-residence status do. Consequently, it could be concluded that once account is taken of disability, TTD itself is a “red herring”, while age, disability and informal care availability are important determinants of LTC expenditure. The fact that TTD acts merely as a proxy for disability suggests that it is time to drop TTD in modeling LTC expenditure and replace it with more appropriate indicators of care needs, like disability.

Finally, De Meijer *et al.* (2009b) demonstrated the importance of omitting important determinants by projecting LTC expenditure using various models. Per capita LTC expenditure in 2004 is

indexed at 100. This index is projected to increase to 150 in 2040, which is an annual increase of 1.14%, based on a naïve projection method. Using a model that controls for co-residence status as well – and therefore takes into account the growing number of single living elderly – reveals that forecasts per capita LTC expenditure in 2040 are indexed at 153. Using a TTD model resulted in the forecast of a per capita index of 128 for total LTC expenditure (124 for home care expenditure), while a model controlling additionally for disability estimated the per capita index for home care expenditure as 117 in 2040.

Concluding, three research projects carried out recently on the consequences of aging on HCE in the Netherlands show that there is more to aging than age or TTD alone. Results from these studies show that the consequences of aging depend on underlying dynamics in diseases and measures of morbidity, and are different for cure and care.

For acute care, it is shown that the relationship between expenditure and TTD depends on the type of disease, and that the aggregated relationship between TTD and costs is likely to change due to changes in morbidity. The results also show that the relationship between health and expenditure has to be considered in combination with mortality – and that at higher ages differences in health have a relatively small effect on long-term costs of hospital use.

For care, it is found that the effect of TTD on expenditure becomes redundant when controlling for disability. TTD therefore approximates disability. Disability is further found to explain most of the variation in LTC expenditure, while general health only contributes marginally to this. Projections of future need for LTC based on the current relationship between morbidity (chronic

conditions) and LTC use might therefore overestimate the need for LTC, as the disabling impact of chronic conditions is expected to further decrease.

## 7. Conclusion and an agenda for the future

### Conclusion

For each group of determinants of HCE in our conceptual model (figure 1) we draw some conclusions, based on the available evidence. Our focus subsequently turns to projections of future HCE related to these determinants. The section concludes with a proposal for a future agenda, for both health policy and research.

#### *Predisposing determinants*

The age composition of the population has a limited (less than 1% growth per year) role in explaining the growth in aggregate national HCE. For LTC expenditure, age has explanatory value, but here age might be a proxy for frailty, which is not measured by disability and health measures. Females depend more on LTC services than males do because they have a longer life expectancy (but live relatively longer in less-than-good health, as compared to men) and therefore often rely on formal LTC sources, as they more often lack informal care, especially at higher ages.

Household composition affects medical consumption, as individuals living alone are substantially more likely to use LTC, especially homecare, and their level of expenditure is much higher than that of co-residing individuals. Co-residence increases the probability that patients will receive informal care, limiting the demand for formal care (see also the section on informal care).

#### *Illness/need determinants*

Many studies on health status and HCE have focused on the cost of dying (COD) or TTD. COD studies have proven that a significant part of higher HCE at older ages can be attributed to the higher HCE of decedents at the end of life, as compared to survivors.

This higher HCE for decedents can to a large extent be explained by the presence of chronic conditions at the end of life. The ratio between HCE of decedents and survivors is largest for the most lethal diseases, like lung cancer, septicemia, heart- and renal failure. Among the deceased, the specific cause of death was also relevant for LTC expenditure in the Netherlands.

When controlling for TTD, the effect of age on HCE considerably decreases in acute care; it is only marginal compared to that of TTD. Differences in the effect of TTD on disease-specific HCE were also found. This indicates that the aggregated relationship between TTD and HCE in acute care may change as a consequence of epidemiological trends. In contrast, LTC expenditure is still found to depend on age.

Because acute care and LTC expenditure for survivors and LTC expenditure for decedents increase with age, population aging is still expected to increase future HCE – but more so for LTC than for acute care. However, once account is taken of health (by means of chronic diseases) and disability, the effect of both age and TTD is substantially attenuated. TTD and age therefore seem to act primarily as proxies for morbidity and disability in determining HCE.

The role of disability in explaining acute HCE has not yet been extensively analyzed. The scarce evidence indicates that more disability raises annual expenditure, whereas lifetime HCE is not seriously influenced, unless one gets institutionalized. With respect to LTC, a number of studies point out that disability (together with age) is crucial and much more important than health status in explaining home care and institutional LTC use and – costs. After controlling for disability, TTD is no longer an important driver of LTC expenditure.

Cross-sectional studies indicate that the more disabled an individual is, the more LTC that person consumes. Panel data indicate that an increase in disability over time clearly heightens the risk of using (more intensive) LTC services.

The dynamic relationship between health status and disability is very important for future HCE. If the degree of disability that individuals experience, given their morbidity, could be limited (partly as a result of health care), then the increase in HCE – and particularly in LTC – would be weakened. Data for the US show this trend, but European data are less conclusive. In forecasting future HCE, trends in health status and disability (probably disease-specific) and their mutual relationship are crucial.

#### *Enabling determinants*

Informal care availability clearly reduces the amount of formal LTC consumed, especially for the lower skilled types of LTC, like domestic help. The supply of informal care depends on household composition and on female labor participation. A so-called Swedish scenario – with substantially more full-time working women – might imply that informal care supply falls short of demand, putting upward pressure on LTC expenditure.

The influence of income on HCE is twofold: on the macroeconomic level, income turns out to be a major determinant of HCE, reflecting both willingness and ability to pay for health and health care. However, in the case of comprehensive health care insurance, individual income has a limited role in determining HCE. With insurance, individual income elasticities are typically near zero, while national income elasticity is commonly greater than 1.0.

Changes in consumer preferences are often purported to be potentially important drivers of rising HCE. However, scientific

evidence of this determinant is very scarce, probably because its influence is difficult to separate from shifts in health care needs and supply.

### *Societal determinants*

The exact contribution of medical technology to the increase in HCE is hard to estimate. Nonetheless, there is broad consensus that the lion's share of growth in HCE in the last decades is the result of technological improvements, which places the aging debate in a wider perspective. The impact of technology on HCE is found to be especially strong for expenditures on prescription drugs, and somewhat less for hospital care. Whether medical technology offers enough value for money, thereby legitimizing its upward pressure on HCE, has yet to be addressed. Thus far, the evidence is mixed: medical technology produces both very cost-effective interventions as well as health services that are extremely expensive in terms of cost per QALY gained. The room for technological progress and related growth in HCE will probably depend on GDP growth and societal willingness to pay for health (care).

The impact of the healthcare system on HCE is hard to measure, as the relationship between elements of the health care system with the level of HCE is very complex. Mapping various indicators such as demand for care, price, capacity, volume, remuneration and administrative costs to health spending across countries, has not yet resulted in any clear conclusions about system determinants of HCE. SSH systems are about 3–4% more expensive than NHS systems, with no better health outcomes. Managed competition in health care could potentially promote quality and accessibility of care at reasonable cost. The overall impact of managed competition on HCE is very complicated to analyze.

For the Netherlands, it was concluded that health insurers play a more active role in promoting efficiency in care, resulting in substantial savings in medication costs. Nevertheless, managed competition tended to increase the number of contacts with medical specialists.

Limiting the basic benefit package could limit *public* HCE, but it is still a controversial option for policymakers, as they should use cost-effectiveness data to exclude parts of the benefit package. There is, however, firm evidence that deductibles reduce the amount of health care consumed, when controlling for health status. Value-based insurance design is a new instrument linking cost-sharing to the value of the health services. The role of budgeting is also clear: tight budgets might control HCE, at the expense of longer waiting lists and potential health loss. Gatekeeping is a key feature of Dutch health care. It can limit access to care and reduce HCE, especially in ambulatory care and LTC. Overall, the organization of health care might clearly affect HCE, but evidence on the link between institutional aspects, aging and HCE is still limited.

With respect to the effect of wages and prices on HCE, the Baumol effect is crucial. It indicates that, in general, health care prices tend to increase faster than general inflation. For the Netherlands, this effect was estimated as an additional 0.8% increase in price per year. On top of this, in all developed countries, serious workforce shortages in health care are expected in the coming decades, resulting in upward pressure on wages in the health care sector. A possible way to dampen this cost-increasing effect could be to raise the retirement age and to stimulate labor-saving technology in acute care – and especially long-term care.

### *The role of aging in perspective*

When summarizing the abovementioned determinants of HCE, it can be concluded that health and disability, in interaction with medical innovations and demographic change, are crucial determinants of HCE. Self-assessed health, chronic conditions, comorbidity and causes of death appear to affect acute care costs, whereas disability and household composition largely determine costs of LTC. Medical technology plays a major role in boosting HCE in acute care, but advances in technology might also limit disability and lower subsequent demand for LTC. Evidence on the importance of the health care system is mixed: copayments and deductibles tend to limit cost growth, the overall effect of managed competition is far from clear yet, while limiting the benefit package is still controversial. The institutional context cannot explain clearly the differences in HCE among countries.

As explained above, aging, narrowly defined as changes in the age composition of the population, has a relatively limited impact in HCE. The role of medical technology is much more important. Hence, Häkkinen (2008) concluded rather optimistically: "future expenditure is more likely to be determined by health policy actions than inevitable trends in the demographic composition of the population." Along the same lines, Evans *et al.* (2001) and Richardson and Robertson (1999), analyzing Canada and Australia, respectively, stated that "there is nothing fixed or clinically imperative about currently prevailing age-specific health care use or spending levels, nor do countries need to accept as an unalterable fact that age-specific per capita health care spending in the future must necessarily go up for all groups, and especially for the elderly" (as phrased by Reinhardt 2003).

However, looking at aging from a broader policy perspective, when further advances in medical technology are allowed to be

introduced swiftly for the elderly, and growing expectations of the future elderly regarding service levels are accommodated, all researchers expect that HCE as proportion of GDP will increase considerably, probably together with healthy life expectancy. So age and aging are unmistakably relevant in the dynamics of HCE.

### *Population aging and future HCE*

This section summarizes the relative contribution of specific (combinations of) determinants in projections of future HCE and attempts to draw some more general conclusions.

When taking into account the fact that HCE is concentrated at the end of life (TTD studies), a significantly lower impact (10–20%) of population aging on HCE is reported – compared to naïve projections, which take into account only age and gender.

Studies comparing projections of HCE that also include LTC expenditure found much lower discrepancies between projections based on naïve and TTD models, as age is still found to be an important demographic driver of LTC expenditure. Consequently, postponing the last expensive year of life might provide some relief with respect to HCE. Breyer and Felder (2006) found that taking into account TTD as well as the expected increase in longevity by shifting the age-specific expenditure curves results in 10% lower HCE in 2050.

Compression of disease could postpone institutionalized LTC. Häkkinen (2008) estimated that delaying LTC institutionalization in Finland by three years resulted in an 18% lower projection of total HCE in 2036, compared to a projection based on the TTD method. It should be noted, however, that compression of disease is probably not free of charge, as it might be the result of progress in (expensive) medical technology!

Expected trends in household composition and disability are also crucial in projecting future HCE. Setting per capita LTC expenditure of 2004 to an index of 100, naïve projections for the Netherlands indicate that per capita LTC expenditure in 2040 will be indexed at 150, which is an annual increase of 1.14%. Taking additionally into account the growing share of the elderly living alone, per capita LTC expenditure will be indexed at 153 in 2040. Using a TTD model resulted in a forecast of a per capita index of 128 for total LTC expenditure (124 for home care expenditure), while controlling additionally for disability estimated the per capita index for home care expenditure as 117 in 2040.

With respect to trends in health and disability, further analyses should also address underlying epidemiological trends that might affect health, disability and, subsequently, HCE. An example is the relationship between cause of death and the effect of TTD on HCE. Insight into epidemiological trends as well as the contribution of specific chronic conditions to the burden of disability is required in order to further improve prediction of the future need for health care services.

It should be noted that projecting the number of singles and disabled individuals is difficult. The number of singles is, among other things, dependent on the difference in life expectancy between men and women. If the gap in life expectancy is closing, the number of elderly women with a male partner will increase, limiting demand for LTC. Regarding disability, it remains to be seen whether the US trend of less disability for a given level of morbidity will also prevail in Europe.

The role of aging per se, narrowly defined as the change in the age composition of the population, is rather modest. However, including advances in medical technology for the elderly, more single elderly and satisfying higher expectations about service

levels raises future HCE considerably. Recent projections (CPB 2010, forthcoming) based on current health policy indicate that for the Netherlands HCE will increase from 9% of GDP now until (at least) 13–14% in 2045, when aging has completed its impact. This increase in HCE is expected to prevail alongside a growth in (healthy) life expectancy, and is predominantly driven by advances in medical technology.

Given the autonomous impact of the determinants of HCE, changes in the organization and financing of health care, institutional arrangements, and public health policies probably offer a limited potential for HCE saving. The relevant policy question is then: are we willing to pay substantially more for health care as a fraction of GDP in 2040 for (further) improvement in our health? Relevant to this question are the opportunity costs and utility gains associated with alternative spending goals. The decision to spend a large proportion of GDP on health improvement, allowing health insurance premiums to rise accordingly, would therefore reinforce pressure on funds for other government tasks, such as education and safety, or it would reduce private disposable income.

### **Agenda for the future**

Both health policy and research might contribute to a sustainable health care sector in the future. Therefore we present both a policy and a research agenda.

#### *Policy agenda*

Public health policy to promote living longer in good health might produce additional health, but it would be naive to expect corresponding savings in HCE. Some scholars have argued that increases in longevity that have been reached by prevention

might result in containing the growth in HCE, as expenditures in the last year of life are decreasing with age. Unfortunately, this argument is falsified by others, who found that the HCE in the additional life years are not compensated by the savings from postponing the last expensive life year. It might therefore be worthwhile for policymakers to be more explicit about the link between increasing HCE and the growth in healthy life expectancy. This is relevant in light of encouraging citizens to consider their willingness to pay for their own health and their solidarity regarding the health of their fellow citizens.

As can be concluded from this paper, policies that are able to limit the prevalence of severe disability and to postpone institutionalization in long-term care are probably the most powerful instruments to attenuate the increase in long-term care expenditure. On top of this, policymakers should be encouraged to use information on the cost-effectiveness of new medical technology more systematically, in order to get value for money. In addition, specific incentives for consumers, health care providers and health insurers to use health care resources efficiently could be explored and used more often as policy instruments. Promising examples include pay-for-performance systems, value-based insurance designs and shifted deductibles. Incentives specifically aimed at limiting medical consumption of the elderly (without compromising their health) could be further explored.

Aging will also affect the availability of health care workers, which might not meet its need. Promoting labor-saving technologies (also at home) such as e-health or telemedicine applications might be a sensible track to lower growth in HCE and to limit expected substantial shortage of health care personnel.

Later retirement might alleviate the shortage of health care personnel, but at the expense of less available informal care. Furthermore, because a considerable further increase in female labor participation – important for economic growth – could threaten the availability of informal care, policies to promote the availability of informal care might be considered.

### *Research agenda*

More research is needed on the relationship between aging and HCE. This research should preferably be multidisciplinary, combining epidemiology, public health and (socio)-economic knowledge. Especially the dynamic interaction between disease-specific mortality trends, health status, disability and, respectively, costs of acute care and LTC, should be investigated in more depth. In this respect, the recent progress in linking large databases with information on demography, health, disability, mortality medical consumption, HCE and informal care is promising.

Moreover, more in-depth research is desirable with regard to the contents of progress made in medical technology and the sector-specific impact on HCE in acute care and LTC. Simultaneously, the relative contribution of medical technology to increases in healthy life expectancy should be investigated.

A further challenge for researchers is to analyze the impact of the organization of health care on HCE, especially related to aging. For example: research on incentives for consumers, health care providers, health insurers and manufacturers of drugs and medical devices is still in its infancy and might be intensified.

## References

- Acemoglu, D., Linn J. 2004. Market size in innovation: theory and evidence from the pharmaceutical industry. *Quarterly Journal of Economics* 119: 1049–1090.
- Andersen, R. & Newman, JF. 2005, Societal and individual determinants of medical care utilization in the United States, *Milbank Quarterly*, 84, 4: 1–28.
- Bakx, P. 2009. Micro-level determinants of long-term care use and transitions of the middle-aged and elderly in the Netherlands. Master thesis Health Economics Policy and Law. Rotterdam: Erasmus University.
- Becker, G.S., Philipson T.J., Soares R.S. 2005. The quantity and quality of life and the evolution of world health inequality. *Am Econ Rev.* 95:277–291.
- Bhattacharya, J., Cutler, D.M., Goldman, D.P., Hurd, M.D., Joyce, G.F., Lakdawalla, D.N., Panis, C.W., Shang, B. 2004. Disability forecasts and future Medicare costs. *Frontiers in Health Policy Research* 7:75–94.
- Bird, C., Shugarman, L.R., Lynn, J. 2002. Age and gender differences in health care utilization and spending for Medicare beneficiaries in their last years of life. *J Palliat Med* 5(5):705–712.
- Bonsang E. 2009. Does informal care from children to their elderly parents substitute for formal care in Europe? *J Health Econ.* 28(1):143–54.
- Boonen, L.H.H.M., Van der Geest, S.A., Schut, F.T., Varkevisser, M. 2010. Pharmaceutical policy in the Netherlands: from price regulation towards managed competition. In: Pharmaceutical markets and insurance worldwide', *Advances in Health Economics and Health Services Research*, 22: 53–76.
- Bös, D., von Weizsäcker, R.K. 1989. Economic consequences of an aging population. *European Economic Review* 33: 345–54.
- Breyer F., Felder, S. 2006. Life expectancy and health care expenditures: A new calculation for Germany using the costs of dying. *Health Policy* 75(2):178–86.
- Breyer, F., Ulrich, V. 2000. Gesundheitsausgaben, Alter und medizinischer Fortschritt: eine Regressionsanalyse, *Jahrbücher für Nationalökonomie und Statistik* 220: 1–17.
- Burner, S.T., Waldo, D.R., McKusick, D.R. 1992. National health expenditures projections through 2030. *Health care Financing Review* 14(1):1–29.
- Card, D., Dobkin, C., Maestas, N. 2008. The impact of nearly universal insurance coverage on health care utilization: Evidence from Medicare. *Am Econ Rev.* 98:2242– 2258.
- Civan, A., Köksal, B. 2009. The effect of newer drugs on health spending: Do they really increase the costs? *Health Econ.* [Epub ahead of print].
- Cutler, D.M., McClellan, M. 2001. Is technological change in medicine worth it? *Health Aff* 20(5):11–29.
- Cutler, D.M. 2006. Making sense of medical technology. *Health Aff* 25(2):w48–50. Epub 2006 Feb 7.

- Cutler, D.M. 2007. The lifetime costs and benefits of medical technology. *J Health Econ.* 26(6):1081–100. Epub 2007 Oct 10.
- Dahlgren, G., Whitehead, M. 2007. European strategies for tackling social inequities in health: Levelling up Part 2. *Studies on social and economic determinants of population health*, no. 3. Copenhagen: WHO Regional Office for Europe.
- De Boer, A., Timmermans, J. 2007. An exploration of the future of informal care [In Dutch]. The Netherlands Institute for Social Research (SCP) report. The Hague: SCP.
- De Hollander, A.E.M., Hoeymans, N., Melse, J.M., Van Oers, J.A.M., Polder, J.J. 2006. *Public Health Forecast 2006* [In Dutch]. Bilthoven: RIVM.
- Delnoij, D., Van Merode, G., Paulus, A., Groenewegen, P. 2000. Does general practitioner gatekeeping curb health care expenditure? *J Health Serv Res Policy.* Jan;5(1):22–6.
- De Meijer, C.A.M., Koopmanschap, M.A., Koolman, X.H.E., Van Doorslaer, E.K.A. 2009. The role of disability in explaining long-term care utilization. *Medical Care* 47(11):1156–63.
- De Meijer, C., Koopmanschap, M., Bago d' Uva, T., Van Doorslaer, E. 2009. Time to drop time-to-death? Unraveling the determinants of long-term care spending in the Netherlands. *Netspar DP 11/2009-045*. Tilburg: Netspar.
- Dormont, B., Grignon, M., Huber, H. 2006. Health expenditure growth: Reassessing the threat of aging. *Health Economics* 15:947–963.
- Douven, R., Ligthart, M., Mannaerts, H., Woittiez, I. 2006. A scenario for health spending 2008–2011 [In Dutch]. *CPB Document* No.121. The Hague: CPB.
- Dow, W.H., Noron, E.C. 2002. The red herring that eats cake: Heckit versus two-part model redux. Working Paper 1 Triangle Health Economics Working Paper Series.
- Evans, R.G., McGrail, K.M., Morgan, S.G., Barer, M.L., Hertzman, C. 2001. Apocalypse No: Population aging and the future of health care systems. *Canadian Journal of Aging* 20:5160–5191.
- Felder, S., Meier, M., Schmitt, H. 2000. Health care expenditure in the last months of life. *J Health Econ.*19:679–695.
- Felder, S., Werblow, A., Zweifel, P. 2009. Do red herrings swim in circles? Controlling for the endogeneity of time to death. *J Health Econ.* [Epub ahead of print]
- Fendrich, A.M., Chernew, M., Levi, G.W. 2009. Value-based insurance design: Embracing value over cost alone. *American Journal of Managed Care* 15(10):S277–S283.
- Fernandez, de la Hoz K., Leon, D.A. 1996. Self-perceived health status and inequalities in use of health services in Spain. *Int J Epidemiol* 25:593–603.
- Fries, J.F. 1980. Aging, natural death, and the compression of morbidity. *New England Journal of Medicine* 303(3):130–135.
- Gandjour, A. 2009. Aging diseases – Do they prevent preventive health care from saving costs? *Health Economics* 18:355–362.

- Garcia-Caban, I.A. 2009. Pay-for-Performance: Quality programs at the crossroads. *Journal for Healthcare Quality* 32(1):3-7.
- Gerdtham, U.G., Sogaard, J., Andersson, F., Jonsson, B. 1992. An econometric analysis of health care expenditure: A cross-section study of the OECD countries. *Journal of Health Economics* 11:63-84.
- Gerdtham, U.G., Jönsson, B. 2000. International comparison of health care expenditure. In: Culyer, A.J., Newhouse, J.P., editors. *Handbook of Health Economics*. Amsterdam: Elsevier.
- Gerdtham, U.G. 1993. The impact of aging on health care expenditure in Sweden. *Health Policy* 24:1-8.
- Getzen, T.E. 2000. Health care is an individual necessity and a national luxury: Applying multilevel decision models to the analysis of health care expenditures. *Journal of Health Economics* 19:259-270.
- Getzen, T.E. 2001. Aging and health care expenditures: A comment on Zweifel, Felders and Meier. *Health Economics* 10(2):175-177.
- Goldman, D.P., Shang, B., Bhattacharya, J., Garber, A.M., Hurd, M., Joyce, G.F., Lakdawalla, D.N., Panis, C., Shekelle, P.G. 2005. Consequences of health trends and medical innovation for the future elderly. *Health Aff (Millwood)*. 24 Suppl 2:W5R5-17.
- Häkkinen, U., Martikainen, P., Noro, A., Nihtilä, E., Peltola, M. 2008. Aging, health expenditures, proximity to death, and income in Finland. *Health Economics, Policy and Law* 3:165-195.
- Hall, R.E., Jones, C.I. 2007. The value of life and the rise in health spending. *Quarterly Journal of Economics* 122(1):39-72.
- Hartman, M., Catlin, A., Lassman, D., Cylus, J., Heffler, S. 2008. U.S. Health spending by age, selected years through 2004. *Health Affairs* 27(1):w1-w12.
- Heckman, J.J. 1979. Sample selection bias as a specification error. *Econometrica* 47:153-162.
- Hogan, C., Lunney, J., Gabel, J., Lynn, J. 2001. Medicare beneficiaries' costs of care in the last year of life. *Health Affairs* 20(4):188-195.
- Hullegie, P., Klein, T.J. 2009. The effect of private health insurance on medical care utilization and self assessed health in Germany. *HEDG working paper*, York.
- Jones, A.M. 2000. Health econometrics. In *Handbook of Health Economics*, vol 1, Culyer, A.J., Newhouse, J.P. (eds). Elsevier: Amsterdam.
- Jones, C.I. 2002. Why have health expenditures as a share of GDP risen so much? *NBER working paper* 9325. November.
- Kunst, A.E., Meerding, W.J., Varenik, N., Polder, J.J., Mackenbach, J.P. 2007. Social differences in health care utilisation and costs in the Netherlands 2003 [In Dutch]. Bilthoven: RIVM.
- Leung, S.F., Yu, S. 1996. On the choice between sample selection and two-part models. *Journal of Econometrics* 72:197-229.

- Lichtenberg, F.R. 2002. The effects of Medicare on health care utilization and outcomes. *Forum for Health Economics & Policy* 5 (Frontiers in Health Policy Research): Article 3.
- Lichtenberg, F.R. 2007. Benefits and costs of newer drugs: an update. *Managerial and Decision Economics* 28:485–90.
- Longman, Ph. 1987. *Born to pay: the new politics of aging in America*. Boston MA: Houghton Mifflin.
- Lubitz, J., Liming Cai, M.P.H., Kramarow, E., Lentzner, H. 2003. Health, life expectancy, and health care spending among the elderly. *New England Journal of Medicine* 349(11):1048–1055.
- Luijben, A.H.P., Kommer, G.J. 2010. Time and future – Part of the report VTV 2010 “From healthy to be better” [In Dutch]. RIVM: Bilthoven.
- Mackenbach, J., Garssen, J. 2010 (in press). Renewed progress in life expectancy: the case of the Netherlands. In: *National Academy of Sciences Panel on Divergent Trends in Life Expectancy*. Washington.
- Mackenbach, J., Nusselder, W., Polinder, S., Kunst, A. 2008. Compression of morbidity – a promising approach to alleviate the societal consequences of population aging? *Netspar Panel Paper 7*. Tilburg: Netspar.
- Madsen, J., Serup-Hansen, N., Kragstrup, J., Kristiansen, I.S. 2002. Aging may have limited impact on future costs of primary care providers. *Scandinavian Journal of Primary Health Care* 20:169–73.
- Manning, W.G., Newhouse, J.P., Duan, N., Keeler, E.B., Leibowitz, A., Marquis, M.S. 1987. Health insurance and the demand for medical care: Evidence from a randomized experiment. *Am Econ Rev.* 77(3):251–77.
- Manning, W.G., Mullahy, J. 2001. Estimating log models: to transform or not to transform? *Journal of Health Economics* 20(4):461–94.
- Manton, K.G., Lamb, V.L., Gu, X. 2007. Medicare cost effects of recent U.S. disability trends in the elderly, future implications. *Journal of Aging and Health* 19(3).
- Manton, K.G., Gu, X., Lamb, V.L. 2006. Change in chronic disability from 1982 to 2004/2005 as measured by long-term changes in function and health in the U.S. elderly population. Proceedings of the National Academy of Sciences of the United States of America. 103(48):18374–18379.
- Marmot, M., Friel, S., Bell, R., Houweling, T.A., Taylor, S. 2008. Commission on Social Determinants of Health. Closing the gap in a generation: Health equity through action on the social determinants of health. *Lancet* 372(9650):1661–9.
- McGrail, K., Green, B., Barer, M.L., Evans, R.G., Hertzman, C., Normand, C. 2000. Age, costs of acute and long-term care and proximity to death: Evidence for 1987–88 and 1994–95 in British Columbia. *Age and Aging* 29:249–253.
- Meara, E., White, C., Cutler, D.M. 2004. Trends in medical spending by age, 1963–2000. *Health Affairs* 23(4):176–83.
- Miller, H.D. 2009. From volume to value: Better ways to pay for health care. *Health Affairs* 28(5):1418–1428.

- Miller, T., 2001. Increasing longevity and Medicare expenditures. *Demography* 38(2):215–26.
- Morris, S., Sutton, M., Gravelle, H. 2005. Inequity and inequality in the use of health care in England: An empirical investigation. *Soc Sci Med* 60(6):1251–66.
- Mullahy, J. 1998. Much ado about two: Reconsidering retransformation and the two-part model in health econometrics. *Journal of Health Economics* 17:241–81.
- Newhouse, J.P. 1992. Medical care costs: How much welfare loss? *Journal of Economic Perspectives* 6(3):3–21.
- Olshansky, S.J., Rudberg, B.A., Carnes, B.A., Cassel, C.K., Brody, J.A. 1991. Trading off longer life for worsening health: The expansion of the morbidity hypothesis. *Journal of Aging and Health* 3(2):194–216
- Organization for Economic Co-operation and Development (OECD). 1988. *Aging population: The Social Policy Implications*. Paris: OECD.
- Organization for Economic Co-operation and Development (OECD). 2005. *Long Term Care for Older People*. Paris: OECD
- Organization for Economic Co-operation and Development (OECD). 2005. *Society at a Glance – OECD Social Indicators*. Paris: OECD.
- Organization for Economic Co-operation and Development (OECD). 2006. Projecting OECD Health And Long-Term Care Expenditures: What Are The Main Drivers? *Economics Department Working Papers* No. 477. Paris: OECD.
- Organization for Economic Co-operation and Development (OECD). 2009a. *OECD Fact Book 2009*. Paris: OECD
- Organization for Economic Co-operation and Development (OECD). 2009b. *OECD Health data 2009*. Accessed: 25th January 2010.
- Organization for Economic Co-operation and Development (OECD). 2009c *Achieving Better Value for Money. OECD Health Policy Studies*. Paris: OECD.
- Payne, G., Laporte, A., Deber, R., Coyte, P.C. 2007. Counting backward to health care's future: Using time-to-death modeling to identify changes in end-of-life morbidity and the impact of aging on health expenditures. *Milbank Quarterly* 85(2):213–57.
- Payne, G., Laporte, A., Foot, D.K., Coyte, P.C. 2009. Temporal trends in the relative cost of dying: Evidence from Canada. *Health Policy* 90:370–376.
- Peeters, J.M., Francke, A.L. 2006. The extent of the demand and use of nursing and care, and do they increase or decrease? [In Dutch] In: *Volksgezondheid Toekomst Verkenning, Nationaal Kompas Volksgezondheid*. RIVM: Bilthoven.
- Polder, J.J., Barendregt, J.J., van Oers, H. 2006. Health care costs in the last year of life--the Dutch experience. *Soc Sci Med*. 63(7):1720–31.
- Polder, J.J., Bonneux, L., Meerding, W.J., Van der Maas, P.J. 2002. Age-specific increases in health care costs. *European Journal of Public Health* 12(1):57–63.
- Pomp, M., Hasaart, F. 2009. Supplier induced demand in the hospital care market [In Dutch]. *Economisch Statistische Berichten* 94(4562): 372–374.

- Poos, M.J.J.C, Smit, J.M., Groen, J., Kommer, G.J., Slobbe, L.C.J. 2008. Cost of illness in the Netherlands 2005 – Care for euro's [In Dutch]. RIVM report 270751019. Bilthoven: RIVM.
- Reinhardt, U.E. 2003. Does the aging of the population really drive the demand for health care ? *Health Affairs* 22(6):27-39.
- Richardson, J., Robertson, I. 1999. Aging and the cost of health services. *Centre for Health Program Evaluation Working Paper* no. 90.
- Roos, N.P., Montgomery, P., Roos, L.L. 1987. Health care utilization in the years prior to death. *Milbank Quarterly* 65(2):231-254.
- RvZ (Council for Public Health and Health care) RVZ. 2009. Expenditures management in health care. RVZ Report 08/11. The Hague: RVZ.
- Sadiraj, K., Timmermans, J., Ras, M., De Boer, A. 2009. The future of informal care [In Dutch]. The Netherlands Institute for Social Research (SCP) report. The Hague: SCP.
- Salas, C., Raftery, J.P. 2001. Econometric issues in testing the age neutrality of health care expenditures. *Health Economics Letters* 5:12-15.
- Seshamani, M., Gray, A. 2002. The impact of aging on expenditures in the National Health Service. *Age and Aging* 31(4):287-94.
- Serup-Hansen, N., Wickstrøm, J., Kristiansen, I.S. 2002. Future health care costs – Do health care costs during the last years of life matter? *Health Policy* 62(2):161-172.
- Seshamani, M., Gray, A. 2004a. Aging and health-care expenditure: the red herring argument revisited. *Health Economics* 13:303-314.
- Seshamani, M., Gray, A.M. 2004b. A longitudinal study of the effects of age and time to death on hospital costs. *Journal of Health Economics* 23:217-235.
- Shugarman, L.R., Decker, S.L., Bercovitz, A. 2009. Demographic and social characteristics and spending at the end of life. *Journal of Pain and Symptom Management* 38:15-26.
- Spillman, B.C., Lubitz, J. 2000. The effect of longevity on spending for acute and long-term care. *New England Journal of Medicine* 342(19):1409-1415.
- Steinmann, L., Terser, H., Zweifel, P.S. 2008. Aging and future health care expenditure: A consistent approach. *Forum for Health Economics & Policy* 2(10): article 1.
- Suen, R.M.H. 2005. Technological advance and the growth in health care spending. *Economie d'Avant Garde Research Reports* no. 13.
- Van Baal, P.H.M., Polder, J.J., De Wit, G.A., Hoogenveen, R.T., Feenstra, T.L., Boshuizen, H.C., Engelfriet, P.M., Brouwer, W.B.F. 2008. Lifetime medical costs of obesity: Prevention no cure for increasing health expenditure. *PLOS Medicine* 5(2):242-249.
- Van der Zee, J., Kroneman, M.W. Bismarck or Beveridge: A beauty contest between dinosaurs. *BMC Health Serv Res.* 2007;7:94.

- Van de Ven, W.P.M.M., Schut, F.T. 2008. Universal mandatory health insurance in the Netherlands: A model for the United States? *Health Affairs* 27(1): 771–781.
- Van de Ven, W.P.M.M., Schut, F.T., Hermans, H.E.G.M., De Jong, J.D., Van der Maat, M., Coppen, R., Groenewegen, P.P., Friele, R.D. (2009). Evaluatie Zorgverzekeringswet en Wet op de zorgtoeslag. Den Haag.
- Van Doorslaer, E., Wagstaff, A., van der Burg, T., Christiansen, T., De Graeve, D., Duchesne, I., Gerdtham, U.G., Gerfin, M., Geurts, J., Gross, L., Häkkinen, U., John, J., Klavus, J., Leu, R.E., Nolan, B., O'Donnell, O., Propper, C., Puffer, F., Schellhorn, M., Sundberg, G., Winkelhake, O. 2000. Equity in the delivery of health care in Europe and the US. *Journal of Health Economics* 19:553–583.
- Van Doorslaer, E., Masseria, C., Koolman, X., OECD Health Equity Research Group. 2006. Inequalities in access to medical care by income in developed countries. *CMAJ*. 174(2):177–83.
- Van Elk, R., Mot, E., Franses, P.H. 2009. Modelling health care expenditures – Overview of the literature and evidence from a panel time series model. CPB Netherlands Bureau for Economic Policy Analysis Discussion Paper no. 121. The Hague: CPB.
- Van Gameren, E., Woittiez, I. 2005. Transitions between care provisions demanded by Dutch elderly. *Health Care Management Science* 8(4):299–313.
- Van Herten, M. 2007. Specialistencontact en medicijngebruik nemen toe in eerste jaar nieuwe zorgstelsel. CBS, Voorburg/Heerlen.
- Van Vliet, R.C.J.A. 2004. Deductibles and health care expenditures: Empirical estimates of price sensitivity based on administrative data. *International Journal of Health Care Finance and Economics*. 4(4):283–305.
- Wagstaff, A. 2009. Social health insurance vs tax-financed health systems – Evidence from the OECD. World Bank, *Policy Research Working Paper* 4821.
- Weaver, F., Stearns, S.C., Norton, E.C., Spector, W. 2009. Proximity to death and participation in the long-term care market. *Health Economics* 18:867–883.
- Werblow, A., Felder, S., Zweifel, P. 2007. Population aging and health care expenditure: A school of 'Red Herrings'? *Health Economics* 16:1109–1126.
- Westerhout, E.W.M.T. 2006. Does ageing call for a reform of the health care sector? *CEifo Economic Studies* 52:1–31
- Wong, A., Boshuizen, H.C., Polder, J.J. 2009a. The role of cause of death and comorbidity in death-related health expenditure. LOLAhesg Conference. Maastricht.
- Wong, A., De Bruin, A., Van Hilten, G.J., Kommer, G.J., Polder, J.J. 2006. Large and small users of hospital care [In Dutch]. In: *Health and Health Care in Numbers 2006*. Voorburg: Statistics Netherlands.
- Wong, A., Elderkamp-de Groot, R., Polder, J.J., Van Exel, N.J.A. 2009b. Predictors of long-term care utilization by Dutch hospital patients aged 65+. Submitted.
- Wong, A., Kommer, G.J., Polder, J.J. 2008. Health care utilization in the last years of life [In Dutch]. *RIVM report* 270082001. Bilthoven: RIVM. 7.

- Wong, A., Van Baal, P.H.M., Boshuizen, H.C., Polder, J.J. 2009c. Exploring the influence of proximity to death on disease-specific hospital expenditures: A carpaccio of red herrings. *Health Economics* [early view DOI: 10.1002/hec.1597].
- World Health Organization (WHO). 2000. *Why do Health Systems Matter?* Geneva: WHO.
- Wouterse, B., Koolman, X., Don, H. 2009a. Income redistributions in the Dutch health care system. A lifecycle approach. Work in progress.
- Wouterse, B.B., Meijboom, Polder, J.J. 2009b. The longitudinal relationship between health and costs of hospital use. submitted.
- Yang, Z., Norton, E.C., Stearns, S.C. 2003. Longevity and health care expenditures: The real reasons older people spend more. *Journal of Gerontology: Social Sciences* 58B(1):S2-S10.
- Zweifel, P., Felder, S., Meiers, M. 1999. Ageing of population and health care expenditure: A red herring? *Health Econ.* 8(6):485-96.
- Zweifel, P., Felder, S., Werblow, A. 2004. Population aging and health care expenditure: New evidence on the 'Red Herring'. *Geneva Papers on Risk and Insurance: Issues and Practice* 29(4):652-666.
- Zweifel, P., Manning, W.G. 2000. Moral hazard and consumer incentives in health care. In: *Handbook of Health Economics Volume 1A* (Ed: Culyer and Newhouse). Amsterdam: Elsevier Science BV.

# SUMMARY OF DISCUSSION

By Marike Knoef

## **Determinants of Health Care Expenditures in an Aging Society**

By Marc Koopmanschap, Claudine de Meijer, Bram Wouterse and Johan Polder

Chairman: Henk Don

Discussants: Isolde Woittiez (Netherlands Institute for Social Research) and Eddy van Doorslaer (Erasmus University Rotterdam and Netspar)

**Isolde Woittiez** opened the discussion by affirming the importance of the research questions in this paper. She pointed out that health care expenditures have increased about 70% between 1995 and 2008, which is 15%-points more than the expenditures of the public sector in total.

Woittiez appreciated the large number of determinants that the paper took into account, such as demographics, health, disability, informal care supply, medical technology, the organization of the health care system and prices. The literature that is covered by the paper is very large, however, which, in her opinion, makes it sometimes difficult to grasp the main message. The main message she summed up as follows: "Are we willing to pay substantially more for health care as a fraction of GDP in 2040 for further improvements in our health?" The paper contains many messages, and the question arises what policymakers should learn from them.

It is difficult to reduce health care expenditures, as persons in the Netherlands have, by law, the right to receive care—and it is difficult to reduce health care use. One can either raise prices or reduce accessibility to health care facilities. The paper states that changes in the organization and financing of health care, institutional arrangements, and public health policies probably offer limited potential for health care savings. Woittiez does not agree with this; she believes policies are an important factor. This can also be seen in Figure 2 of the paper, which shows the trends in per capita health care expenditures in several developed countries. Health care expenditures have been growing in various OECD countries with different health care systems. However, the growth in the US has been much higher than in the other countries, and for the Netherlands we find an increasing slope as of the years 2000–2002, when the budgets were relaxed.

Woittiez could agree with the theorem of Hakkinen, that future expenditures are more likely to be determined by health policy actions than by inevitable trends in the demographic composition of the population. If Hakkinen is right, we can ask ourselves how knowledge about determinants of health care expenditures can help us in reducing them.

The paper mainly focuses on volume effects, while price effects are also important. The Netherlands Institute for Social Research found that about 22% of the growth in health care expenditures between 2000 and 2008 was due to price increases. For long-term care, one-third of the increase in health care expenditures were due to price increases.

A substantial part of the paper is about the relation between time to death, cause of death, and health care expenditures. Research has shown that mortality, rather than age, drives health care expenditures. The paper argues that postponing the last

expensive year of life might provide some relief to the growth in health care expenditures, as health care expenditures in the final year of life decrease with the age of dying. Woittiez asked whether we can really reduce health care expenditures by making investments in health, so as to postpone our time of death. Will health care expenditures be lowered or raised by prevention? RIVM finds that healthy people live longer and have the highest number of healthy years. However, their health costs are higher because they live more years (thus, smokers cost less than non-smokers). The projections in the paper are not far from the projections made by the Netherlands Institute for Social Research (SCP) and CPB Netherlands Bureau for Economic Policy Analysis. SCP and CPB projections are slightly higher than those in the paper. According to the paper, postponing institutionalization lowers health care expenditures. SCP found that the benefits from living independently vary between 6,000 and 16,000 euros per person per year.

Woittiez concluded that the paper is an elaborate and solid piece of work. Since she found it sometimes difficult to grasp the main message, she emphasized the importance of making clear what policymakers, who must consider the affordability of the health care expenditures, should learn from this paper.

The second discussant, **Eddy van Doorslaer**, agreed that the paper deals with important research questions. He began the discussion by pointing out important strengths and weaknesses of the study. The first strong point of the paper is that it covers a large literature – which, although difficult to accomplish, does offer the benefit of being comprehensive. Van Doorslaer felt that the paper did a fine job covering the following relations: health status, disability, medical consumption (acute care, long-term care and informal

care) and health care costs. He evaluated the other relations that were mentioned (found in figure 1 of the paper, including medical technology, health care financing and organization) as less adequate, recognizing at the same time that it is impossible to review all of these relations in one paper. Another strong point of the paper is that the authors consider health care expenditures and long-term care jointly.

A weak point of the paper is that there is little or no role for behavioral responses. At the moment, the relationships are rather mechanical. Also, some determinants receive very little attention, such as health care financing and organization. The paper pays a lot of attention to aging and the relation between time to death and health care expenditures – but they only explain a minor part of the growth in health care expenditures. There is little attention for the bulk of the expenditure growth, which is often attributed to the adoption and diffusion of medical technology.

Van Doorslaer then made some suggestions. With regard to health care financing and organization, he argued that recent studies have attempted to establish causal effects by exploiting natural experiments. He mentioned three examples: Wagstaff and Moreno-Serra (2009a and 2009b) and Moreno-Serra and Wagstaff (2010). These kinds of studies deserve more attention in the future.

With regard to medical technology, there are two research questions in the paper that were not answered clearly. (1) Does medical technology offer value for money, and (2) can we isolate its impact? Figure 2 in the paper shows that, by the mid 90s, the Netherlands was an average spender of health care (given the collection of countries in the graph). After 2002, we were one of the biggest spenders. Van Doorslaer questioned to what extent this was due to the adoption of medical technologies. Medical

technologies often appear as cost-increasing, but some of them must be cost-decreasing.

Dormont et al. (2006) convincingly attempt to isolate the impact of medical technology. They found that more than 70% of the spending growth of drugs can be explained by 'changing practices', but only 10% of the spending growth in hospitals can be explained by 'changing practices'. It is unclear how this low proportion (10%) can be reconciled with the bulk of the expenditure growth that is often attributed to medical technology. Van Doorslaer ended his discussion with a remaining question. Due to the aging society, LTC costs (such as like pensions) will grow – but won't LTC health care costs also grow (in excess of incomes)?

**Henk Don** added a question to the remarks of the discussants: namely, whether more intensive use of ICT could help to fight Baumol's cost disease in our health care system.

### **Reply by Marc Koopmanschap**

There are many initiatives to use ICT more intensively in the health care system. A great potential exists to reduce labor intensiveness – hopefully, not at the expense of care and the relation between givers and receivers of care. Perhaps ICT can help us in reducing the expected labor shortage, especially with regard to long-term care.

Inevitably, health care expenditures as a percentage of GDP will grow. About three-quarters of this growth will be due to long-term care costs. If we could reduce severe disabilities, we would win a lot, and could decrease the growth in health care expenditures.

Both discussants mentioned the increase in the growth of health care expenditures as from 2000–2002, which were a result

of the relaxation of the budgets. Koopmanschap believes that this increased growth was not (only) due to medical technology, but that the relaxation of the budgets gave more room to employ the available technologies – especially to apply them to the elderly, for whom Mackenbach finds a jump in life expectancy.

**Bas Werker** wondered about the endogeneity between time to death and health care expenditures. It was stated that health care expenditures increase with time to death; but if health care expenditures improve your health, then also time to death increases when health care expenditures increase. Koopmans answered that this endogeneity puzzle is indeed part of the literature, and that this especially holds for acute care. Long-term care does not lengthen your life that much, in general.

The last comment, made by **Peter Schotman**, had to do with prevention. Koopmanschap stated that preventions often decrease disabilities and increase longevity. They are not always cost effective, and most are costly (e.g. campaigns against smoking). But when preventions increase well-being, it should not always be our first purpose to reduce costs.

Koopmanschap advised policy makers to invest in a longer life expectancy and in fewer disabilities. It might cost a bit more, but people can also work longer when they live longer in good health. If we can delay institutionalization and compress morbidity, then he thinks that there is a fair chance that we can lower health care spending growth.

# PUBLICATIONS IN THE PANEL PAPERS SERIES

1. *Saving and investing over the life cycle and the role of collective pension funds*  
Lans bovenberg , Ralph Koijen, Theo Nijman and Coen Teulings
2. *What does behavioural economics mean for policy? Challenges to savings and health policies in the Netherlands*  
Peter Kooreman and Henriëtte Prast
3. *Housing wealth and household portfolios in an aging society*  
Jan Rouwendal
4. *Birth is the sessenger of death – but policy may help to postpone the bad news*  
Gerard van den Berg and Maarten Lindeboom
5. *Phased and partial retirement: preferences and limitations*  
Arthur van Soest and Tunga Kantarci
6. *Retirement Patterns in Europe and the U.S.* (2008)  
Arie Kapteyn and Tatiana Andreyeva
7. *Compression of morbidity: A promising approach to alleviate the societal consequences of population aging?* (2008)  
Johan Mackenbach, Wilma Nusselder, Suzanne Polinder and Anton Kunst
8. *Strategic asset allocation* (2008)  
Frank de Jong, Peter Schotman and Bas Werker
9. *Pension Systems, Aging and the Stability and Growth Pact* (2008) Revised version  
Roel Beetsma and Heikki Oksanen
10. *Life course changes in income: An exploration of age- and stage effects in a 15-year panel in the Netherlands* (2008)  
Matthijs Kalmijn and Rob Alessie
11. *Market-Consistent Valuation of Pension Liabilities* (2009)  
Antoon Pelsser and Peter Vlaar
12. *Socioeconomic Differences in Health over the Life Cycle: Evidence and Explanations* (2009)  
Eddy van Doorslaer, Hans van Kippersluis, Owen O'Donnell and Tom Van Ourti
13. *Computable Stochastic Equilibrium Models and their Use in Pension- and Ageing Research* (2009)  
Hans Fehr
14. *Longevity risk* (2009)  
Anja De Waegenaere, Bertrand Melenberg and Ralph Stevens

15. *Population ageing and the international capital market* (2009)  
Yvonne Adema, Bas van Groezen and Lex Meijdam
16. *Financial Literacy: Evidence and Implications for Consumer Education* (2009)  
Annamaria Lusardi and Maarten van Rooij
17. *Health, Disability and Work: Patterns for the Working-age Population* (2009)  
Pilar García-Gómez, Hans-Martin von Gaudecker and Maarten Lindeboom
18. *Retirement Expectations, Preferences, and Decisions* (2010)  
Luc Bissonnette, Arthur van Soest
19. *Interactive Online Decision Aids for Complex Consumer Decisions: Opportunities and Challenges for Pension Decision Support* (2010)  
Benedict Dellaert
20. *Preferences for Redistribution and Pensions. What Can We Learn from Experiments?* (2010)  
Jan Potters, Arno Riedl and Franziska Tausch
21. *Risk Factors in Pension Returns* (2010)  
Peter Broer, Thijs Knaap and Ed Westerhout
22. *Determinants of Health Care Expenditure in an Aging Society* (2010)  
Marc Koopmanschap, Claudine de Meijer, Bram Wouterse and Johan Polder

## Determinants of Health Care Expenditure in an Aging Society

Marc Koopmanschap (EUR), Claudine de Meijer (Erasmus MC), Bram Wouterse (Tranzo/UvT) and Johan Polder (Tranzo/UvT) provide in this paper an overview of the current knowledge on the aging related determinants of per capita health care expenditure (HCE). Next to that, the paper offers various projections of future acute health and long-term care expenditures based on different specifications of HCE models.