

## CHAPTER 3

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### **Cost-effectiveness of protocolized and managed care compared to usual care for patients with type 2 diabetes**

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## ABSTRACT

**Objectives:** To compare the cost-effectiveness of two diabetes management models with usual care for type 2 diabetes patients from the societal perspective.

**Methods:** An economic evaluation was performed alongside a clinical trial. In two distinct regions of the Netherlands, two diabetes management models were implemented: managed and protocolized care, with different levels of centralized organizational structures. The clinical outcome measure was risk of a coronary heart disease (CHD) calculated with the UKDPS risk engine. Cost-effectiveness analysis was performed from the societal perspective comparing patients receiving managed (n=313) and protocolized (n=293) care with patients receiving usual diabetes care (n=485) during one year of follow-up. Missing costs and effects data were imputed using multiple imputation. Differences in costs, effects and cost-effectiveness between the diabetes management groups and usual care were analysed using bootstrapping techniques.

**Results:** Differences in changes in CHD risk over 12 months of follow-up between the three groups were statistically insignificant and clinically irrelevant. Compared to usual care, health care costs during the follow-up period were lower in protocolized (-960 (95% CI: -1890 to -100)) and managed care (-1300 (95% CI: -2300 to -570)). Costs from the societal perspective showed the same trend, although not statistically significant.

**Conclusions:** Clinical outcomes did not differ between the different types of care. Lower health care costs were observed in protocolized and managed care compared to usual care, mainly due to substitution of secondary health care use by primary health care use. This suggests that protocolized or managed care result in equal outcomes at lower health care costs.

## INTRODUCTION

Diabetes is a highly prevalent disease<sup>1, 2</sup> and is associated with both micro- and macrovascular complications<sup>3-7</sup> affecting quality of life and mortality, high health care use and costs.<sup>8</sup>

Innovations to improve the quality of diabetes care to better prevent micro- and macrovascular complications in patients with type 2 diabetes and to control the increasing demand for health care and growth of health care costs are needed.<sup>9</sup> During recent years there has been a strong focus on improvement of diabetes care resulting in the implementation of disease management programs for diabetes care.<sup>10</sup> Disease management programs are assumed to increase the quality of care resulting in improved health outcomes and to decrease costs. Results of studies evaluating the costs or (cost-) effectiveness of diabetes management programs are heterogeneous, some finding no difference or no improvement in clinical guideline adherence<sup>11</sup> or clinical outcomes<sup>11, 12</sup> while others find improved guideline adherence<sup>12, 13</sup> or clinical outcomes.<sup>14</sup> Some studies showed no difference or no improvement in costs,<sup>11, 12, 15</sup> while other studies showed short-term costs savings.<sup>13, 16</sup> Studies evaluating both effects and costs showed positive long-term cost-effectiveness with quality adjusted life years<sup>15, 17</sup> or self-management<sup>17</sup> as outcome. In these studies information on costs from a societal perspective was unavailable.<sup>18</sup>

The current paper presents the results of an economic evaluation from the societal perspective, performed alongside a pragmatic controlled clinical trial comparing two different diabetes management models with usual diabetes care in the Netherlands.

## MATERIALS AND METHODS

### Usual care

Usual diabetes care has a decentralized organisation structure and patients' own general practitioner (GP) is responsible for the diabetes care. The Dutch guidelines for type 2 diabetes<sup>19</sup> specifies that patients should visit their GP four times a year for a diabetes assessment. For the usual care group, all diabetes patients of a representative sample of 17 GPs throughout the Netherlands were invited for participation in our study. The GPs in the usual care group are affiliated to the Continuous Morbidity Registration (CMR) Sentinel GP Network of NIVEL (Netherlands Institute for Health Services).<sup>20</sup> This network of general practices represents 0.8% of the Dutch population and is representative at a national level for age, sex, geographic distribution and population density.

At the baseline measurement of our study, one of the GP practices in this usual care group participated in a disease management program. This program was based on bundled payments aimed to improve the quality of care and encourage task delegation.

**Protocolized care**

In 2007, in 12 GPs in the Amstelland region of the Netherlands protocolized care was implemented. Protocolized care mainly focuses on the adherence to guideline for type 2 diabetes. Additionally to usual care, an online database is used for the registration of diabetes-related data, which is applied to monitor mean values of risk factors and to monitor whether patients received diabetes care in line with the guideline. Education is offered to all health care professionals to increase their expertise in the field of type 2 diabetes. In contrast to managed diabetes care, all assessments were performed in patient's own GP practice; there was no centrally organized assessment.

**Managed care**

In 1996, the DCS was started in the West-Friesland region of the Netherlands, in which during the years more and more elements of the CCM were introduced.<sup>21, 22</sup> In contrast with usual care, in which the GP is responsible for the diabetes care, the DCS is responsible for the performance and quality of the diabetes care and organizes the diabetes care centrally and coordinates the care between all care providers. Clinical information of patients is accessible to involved health care providers, using a centrally organized database. Patients treated by the DCS receive an annual extended diabetes assessment at the specialized Diabetes Care Centre, in addition to the diabetes care by patients' GP. During this assessment diabetes-related risk factors are measured. Screening for cardiovascular diseases, retinopathy and complications of the foot is performed at the centre. Patients have a central role in their care and self-management is stimulated by providing education and information programs. Moreover, individual care plans are discussed with the patient and patients were stimulated to make their own choices with respect to treatment options and lifestyle behaviour. Diabetes nurses visit participating GPs twice a year to provide feedback about their performance. Individual patients are evaluated and mean values of risk factors of the diabetes population of the GP are compared to the diabetes populations of other participating GPs.

A detailed comparison of the three types of diabetes care is presented in Appendix A.

**Patient selection**

Type 2 diabetes patients, aged between 40 and 75 years and capable of understanding the Dutch language were eligible for this study. From July 2007 to May 2009, diabetes patients were invited to participate by their GP. The study population consisted of patients with type 2 diabetes receiving protocolized, managed or usual diabetes care.

A random sample of 802 patients receiving protocolized care was invited of which 293 (37%) patients were included. A random sample of 643 patients receiving managed care was invited for this study and 313 (49%) patients were included. For the usual

care group, a random sample of 1098 patients was invited and 485 (44%) patients were included. Patients with type 1 diabetes were excluded, which was defined as diabetes with onset before the age of 40 in combination with insulin treatment (protocolized care: n=4; managed care: n=3; usual care: n=13). Of the included patients, 28 % were lost to follow-up after one year.

All participants provided written informed consent. Ethical approval for the study was obtained from the Ethical Review Committee of the VU University Medical Center Amsterdam.

### Clinical outcome measure

The outcome measure was difference in 10 year coronary risk. Risk of CHD at t0 and after 12 months (t1) was estimated for each patient using the UKPDS function for cardiovascular risk estimation.<sup>23</sup> The UKPDS risk score measures 10 year risk of CHD, based on age sex, systolic blood pressure, smoking status, lipid ratio, HbA<sub>1c</sub>, age at diagnosis of diabetes and ethnicity and was validated in the Dutch population.<sup>24</sup> The change between t1 and t0 for each type of care was computed and compared (difference-in-difference method).

### Cost measures

The cost-effectiveness analysis was performed from a societal perspective. All participants were asked to complete a prospective cost diary during three months starting at baseline and during three months one year after baseline.<sup>25</sup> Items measured included resource use for health care, direct non health-care resource use, that is, use of complimentary care and productivity losses (absence from paid and unpaid work). Using these diaries resource use was estimated over 12 months by linear interpolation. In Appendix B, unit costs, based on the Dutch Manual for Costing are presented <sup>26</sup>. These were multiplied with resource use from the diaries to calculate annual direct health care and direct non-health care costs. Costs due to productivity losses were calculated based on mean income of the Dutch population (Appendix B) and productivity losses from the diaries. No discounting was applied, since the time horizon was only 1 year. Price level was 2008.

### Statistical analysis

To avoid loss of power caused by partially missing data, multiple imputation techniques were used to replace missing values for costs and effects. Data was missing at random. Covariates related to missing cost data and cost outcomes were included in the Multiple Imputation model. Multiple imputation was performed in SPSS 18.0, in which 10 complete data sets were generated. The results of the 10 analyses were pooled using Rubin's rules.<sup>27</sup>

R1 Because of the skewed distribution of cost data, bootstrapping methods with 5000  
R2 replicates were used to estimate “approximate bootstrap confidence” (ABC) intervals  
R3 around cost differences.<sup>28, 29</sup>

R4 Incremental cost-effectiveness ratios (ICERs) were calculated by dividing the  
R5 difference in total costs by the difference in clinical effects between protocolized, managed  
R6 and usual care. The 95% confidence intervals around the mean cost differences and the  
R7 uncertainty around the ICERs were estimated using non-parametric bootstrapping (5000  
R8 replicates). P-values < 0.05 were considered as statistically significant. The uncertainty  
R9 around the ICERs was graphically illustrated by plotting the bootstrapped cost-effect  
R10 pairs on a cost-effectiveness plane (CE plane). In a CE plane, incremental costs between  
R11 protocolized, managed and usual care are plotted on the y axis and incremental effects on  
R12 the x axis resulting in four quadrants. The northeast quadrant indicates that this form of  
R13 care is more expensive and more effective than usual care. In the southeast quadrant the  
R14 new care model dominates usual care, i.e. is less expensive and more effective than usual  
R15 care. In the southwest quadrant the new care model is less expensive and less effective  
R16 than usual care. Finally, in the northwest quadrant the new care model is dominated  
R17 by usual care (more expensive and less effective). The cost-effectiveness analysis was  
R18 performed in R Statistical Software (version 2.13.1).

## R19 RESULTS

R20 Baseline characteristics of type 2 diabetes patients treated by protocolized care, managed  
R21 care or usual care are shown in Table 1. Compared to patients receiving protocolized  
R22 care or usual care, patients in the managed care group had lower education. In the  
R23 managed care group more patients were treated with glucose lowering medication  
R24 (90.1%) compared to protocolized care (75.9%) or usual care (81.7%). Besides comparable  
R25 HbA<sub>1c</sub>, total and HDL cholesterol levels between the three groups, LDL cholesterol was  
R26 lowest in the protocolized care group. BMI and systolic blood pressure was highest in the  
R27 managed care group while diastolic blood pressure was lowest in this group compared  
R28 to protocolized and usual care. Risk of a CHD during a ten year-period calculated at  
R29 baseline using the UKPDS risk engine was comparable between the three groups  
R30 (protocolized care: 0.17 ± se: 0.01, managed care: 0.19 ± se 0.01, usual care: 0.18 ± se:  
R31 0.01). Risk of CHD increased in the usual care and protocolized care groups with 0.008%  
R32 and with 0.003% in managed care. The changes during follow-up were not significantly  
R33 different between groups (Table 2). Health care costs were lower in protocolized and  
R34 managed care compared to usual care. This was mainly due to substitution of secondary  
R35 health care use by primary health care use. Costs from the societal perspective showed  
R36 the same trend, although not statistically significant (Table 2). Because of the lower costs  
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of protocolized care and very small differences in effects, large negative ICERS were found for protocolized care compared to usual care. The lower costs of managed care compared to usual care and a marginally lower deterioration of the outcome measure, resulted in an ICER of €260,000 for direct costs per unit decrease 10 years CHD risk from a health care perspective, that is including only direct costs and €207,600 per unit decrease in CHD risk from a societal perspective, that is, for total costs. Of the cost-effect pairs, 78% were located in the southeast quadrant, representing lower costs and improved effectiveness. This indicates a 78% chance of managed care being cost-saving and more effective compared to care as usual. For protocolized care, the chance of being cost-saving and more effective than care as usual was 46%. Compared to protocolized care, there is a 75% change that managed care is more cost-saving and effective considering direct costs. From a societal perspective, change of being more cost-saving and effective was 35% (Figure).

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**Table 1.** Baseline characteristics of patients treated by managed care, protocolized care or usual care.

	<b>Protocolized care</b>	<b>Managed care</b>	<b>Usual care</b>
	N=289	N=310	N=471
Men	154 (53.3)	157 (50.8)	247 (52.4)
Age (years)	65.1 (7.6)*	64.4 (7.7)	63.9 (7.5)
Diabetes duration	5 (3-9)	6 (3-11)	6 (3-10)
Married/living together	218 (75.4)	239 (78.4)	373 (79.4)
Educational level (%) - low	149 (51.6)	155 (50.8)*	280 (59.8)
- medium	71 (24.6)	121 (39.7)*	98 (20.9)
- high	69 (23.9)	29 (9.5)*	90 (19.2)
Paid job (%)	77 (26.6)	65 (21.2)	91 (19.4)
Retired (%)	128 (44.3)	140 (45.8)	200 (42.6)
Disabled (%)	10. (3.5)	25 (8.2)	3.4 (7.2)
Smoking status - current	39 (13.6)	52 (18.1)	86 (18.3)
(%) - former	156 (54.5)	147 (52.3)	242 (51.6)
- never	91 (31.8)	88 (30.7)	141 (30.1)
Treatment - diet only	68 (24.1)*	30 (9.9)	85 (18.3)
(%) - oral medication	182 (64.6)	207 (68.6)	272 (58.4)
- insulin (+/- oral medication)	32 (11.3)*	65 (21.5)	109 (23.4)
HbA <sub>1c</sub>	6.80 (0.05)	6.86 (0.06)	6.84 (0.05)
Total cholesterol	4.46 (0.06)	4.50 (0.06)	4.55 (0.06)
HDL cholesterol	1.34 (0.03)	1.15 (0.02)	1.30 (0.03)
LDL cholesterol	2.43 (0.05)*	2.54 (0.05)	2.60 (0.05)
Systolic blood pressure	140.28 (1.07)	145.26 (1.22)*	139.64 (0.95)
Diastolic blood pressure	80.10 (0.06)	77.80 (0.57)*	80.42 (0.49)
BMI	29.98 (0.32)	30.33 (0.31)*	29.06 (0.28)
UKPDS score (%)	0.17 (0.01)	0.19 (0.01)	0.18 (0.01)

Data are presented as mean (SD) or proportions

\* Statistically different from usual care (p<0.05)



**Table 2.** Mean differences in costs (Euros) and effects (%) and effects (%) (and 95% confidence intervals (CI) between managed care, protocolized care and usual care, incremental cost-effect ratios (ICERs), and cost-effectiveness (CE) plane distributions

PC	MC	UC	Group	Δ Costs (95% CI) (Euros)	Δ effects (95% CI) (difference in annual change of ten years CHD risk (%)) <sup>7</sup>	ICER	Distribution CE plane (%)			
							NE <sup>1</sup>	SE <sup>2</sup>	SW <sup>3</sup>	NW <sup>4</sup>
289		471 <sup>5</sup>		Direct costs -960 (-1890 to -100)	0.0003 (-0.010 to 0.010)	N.A.	1	47	51	1
289		471 <sup>5</sup>		Total costs -1200 (-2300 to 40)	0.0003 (-0.010 to 0.010)	N.A.	1	46	51	2
	310	471 <sup>5</sup>		Direct costs -1300 (-2300 to -570)	-0.005 (-0.016 to 0.006)	260000	0.0	83	17	0
	310	471 <sup>5</sup>		Total costs -1040 (-2370 to 390)	-0.005 (-0.016 to 0.006)	207600	6	78	15	1
289 <sup>6</sup>	310			Direct costs -340 (-950 to 270)	-0.006 (-0.017 to 0.006)	64800	9	75	14	2
289 <sup>6</sup>	310			Total costs <sup>5</sup> 140 (-1130 to 1400)	-0.006 (-0.017 to 0.006)	N.A.	49	35	6	10

PC= protocolized care; MC= managed care; UC= usual care

<sup>1</sup>Refers to the northeast quadrant of the CE plane, which indicates that PC or MC is more effective and more costly than UC.

<sup>2</sup>Refers to the southeast quadrant of the CE plane, which indicates that PC or MC is more effective and less costly than UC.

<sup>3</sup>Refers to the southwest quadrant of the CE plane, which indicates that PC or MC is less effective and less costly than UC.

<sup>4</sup>Refers to the northwest quadrant of the CE plane, which indicates that PC or MC is less effective and more costly than UC.

<sup>5</sup>Usual care is reference category.

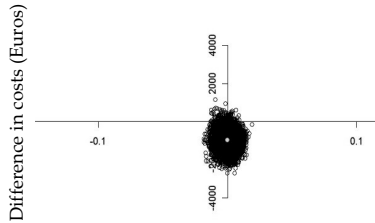
<sup>6</sup> Protocolized care is reference category.

<sup>7</sup> % risk of coronary heart disease during a ten-year period, calculated with the UKPDS risk engine.

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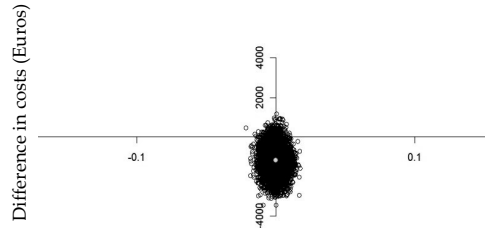
Protocolized care vs. usual care

Direct costs



Difference in risk of coronary heart disease (UKPDS)

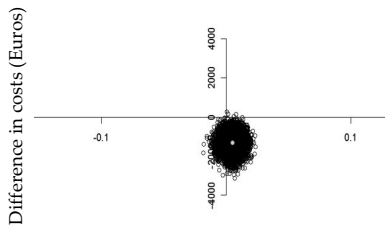
Total costs



Difference in risk of coronary heart disease (UKPDS)

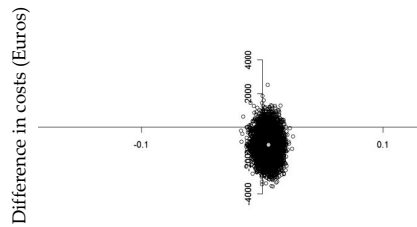
Managed care vs. usual care

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Difference in risk of coronary heart disease (UKPDS)

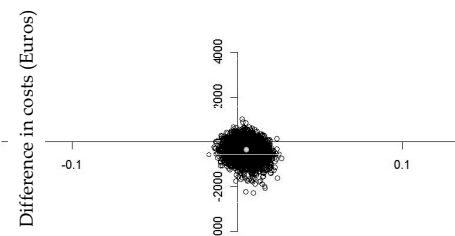
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Difference in risk of coronary heart disease (UKPDS)

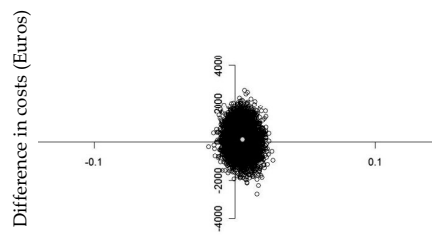
Managed care vs. protocolized care

Direct costs



Difference in risk of coronary heart disease (UKPDS)

Total costs



Difference in risk of coronary heart disease (UKPDS)

**Figures:** Cost-effectiveness planes for the uncertainty around the mean incremental direct and total costs and the mean difference in risk of coronary heart disease calculated with the UKPDS risk function during one year of follow-up between managed, protocolized and usual diabetes care.

## DISCUSSION

In this study, we evaluated the cost-effectiveness of protocolized care and managed care for type 2 diabetes patients in primary care. Health care cost savings were seen in both protocolized and managed care compared to usual care, mainly due to substitution of secondary health care use by primary health care use. From a societal perspective, the same trend was seen with on average €1,100 difference in annual costs, however results were not statistically significant. Protocolized and managed care were clinically not superior to usual diabetes care-regarding the annual change in ten years CHD risk. No significant differences were seen between protocolized and managed care in either costs or effects. From a societal perspective, we found a 78% chance of managed care being cost-saving and more effective compared to care as usual.

Outcomes of studies investigating clinical effects of diabetes management models are inconsistent.<sup>30</sup> Our findings are comparable to other studies showing no effect of diabetes management on clinical outcomes.<sup>11, 12</sup> A suggested reason for no effect on clinical outcome might be a non-optimal implementation during the first year of implementation.<sup>12</sup>

Despite different baseline years of implementation (managed care: 1996, protocolized care: 2007), we didn't observe significant differences between protocolized and managed care in costs and effects which could confirm this suggestion. Another explanation is that one year of follow-up might be too short to detect significant differences in our clinical outcome measure, estimated risk of CHD. Long-term follow-up might be needed to investigate whether the marginal difference in effects in favour of managed care compared to usual care is maintained.

Costs were significantly lower in protocolized and managed care when considering health care costs only-, mainly due to substitution of secondary health care use by primary health care use. The results of our study confirm the findings of the study of Sidorov et al and Littenberg et al, in which the diabetes management program was associated with lower health care use and health care costs compared to usual diabetes care.<sup>13, 16</sup> Considering costs from a societal perspective, the difference in costs between protocolized or managed care and usual care decreased and lost significance. This decrease in difference in costs might be caused by differences in severity of the disease between the care groups.

In the interpretation of the results of our study, some limitations have to be taken into account. A weakness of this study is the low participation rate which might have resulted in a relatively healthy cohort, decreasing differences in effects between the three groups. Of all participants included in this study, 28 % did not return the cost diary after one year of follow-up. The high effort required from patients to fill in the cost diary might explain the loss to follow-up. Loss to follow-up was associated with younger age,

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R1 living alone, former smoking, and higher BMI. We used multiple imputation methods  
R2 to impute missing cost data. Variables that were found to be related to missing cost data  
R3 en cost outcomes were included in the multiple imputation model. Nonetheless, missing  
R4 data on costs might have affected the internal validity of our study.

R5 A randomized controlled trial is considered the gold standard to test the effectiveness  
R6 of an intervention. In clinical studies, comparing effects of different disease management  
R7 models, randomization is not always feasible. Therefore, we performed a pragmatic  
R8 controlled study, evaluating implemented diabetes care models. Strength of this  
R9 pragmatic controlled study is that it reflects actual clinical practice rather than an ideal  
R10 trial setting and provides useful information for policymakers. We were able to estimate  
R11 the cost-effectiveness of two different diabetes care models implemented in primary  
R12 care. The wide inclusion criteria that we used for the selection of type 2 diabetes patients,  
R13 resulted in a high external validity of this study.<sup>31</sup> During recent years, there has been  
R14 increasing focus on improvement of diabetes care in primary care. Changes in the process  
R15 of diabetes care in our usual care group might have decreased the difference between the  
R16 two diabetes care models and usual care, however only one participating GP in the usual  
R17 care group was part of a diabetes management program during the study period.

R18 The results of our study suggest that protocolized or managed care result in equal  
R19 outcomes compared to usual care at lower health care costs.  
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