



SUMMARY

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R2
R3
R4
R5
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R10
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R12
R13
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R26
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R32
R33
R34
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R36
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R38
R39

Type 2 diabetes is a highly prevalent disease with a high burden on patients, health care and society. Therefore, ways to optimize diabetes care for patients, to manage the increasing demand on the health care system and control health care costs, should be explored.

During recent decades, it has become clear that tackling the growing societal and economic burden of diabetes will require nothing less than a transformation of health care, from a system that reacts to acute episodes of illness to one that pro-actively maintains health. Targeted programs have become important means for improving the quality of diabetes care and overcoming existing deficiencies. A wide array of approaches exists such as the Chronic Care Model, and managed care. A common aspect of these care models is the central role of the patient and the proactive interaction between patient and care provider.

In this thesis, two different diabetes care models are compared with usual diabetes care with regard to costs, effects and cost-effectiveness. Furthermore, a model to estimate long-term (cost-)effectiveness of diabetes related interventions was developed. Finally, to enable a more efficient targeting of diabetes care, methods to facilitate personalized diabetes care were investigated.

Diabetes management programs

Managed diabetes care was delivered by the Diabetes Care System (DCS), which started in 1996, in the West-Friesland region of the Netherlands. The DCS is a centrally guided diabetes care organization. The DCS coordinates the diabetes care between primary and secondary care. Using a centrally organized database, clinical information of patients is accessible to involved health care providers. Patients treated by the DCS receive an annual extended diabetes check-up at the specialized Diabetes Care Center, in addition to the diabetes care by patients' general practitioner (GP). Patients have a central role in their care and self-management is stimulated. Diabetes nurses visit participating GPs twice a year for feedback about their performance by comparing mean levels of risk factors of diabetes patients between GP practices.

In the Amstelland region of the Netherlands, a diabetes care program was implemented which was less centrally organized compared to the diabetes care implemented in the DCS. This form of diabetes care, *protocolized diabetes care*, mainly focuses on the adherence to type 2 diabetes guidelines. In addition to usual care, a web-based database was used for the registration of diabetes-related data, which was applied to monitor mean values of risk factors and whether patients received diabetes care in line with the Dutch guideline for type 2 diabetes. Education was offered to all involved 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.

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Chapter 2: Process and costs of diabetes care

Performance of assessments and screenings was obtained by self-administered questionnaires.

Information on health care use and loss of productivity (absenteeism of paid and unpaid work) was obtained using prospective cost diaries.

Compared to protocolized and usual care, in managed care more patients were treated according to diabetes guidelines. Managed diabetes care was statistically significantly associated with a better process of the diabetes care and lower direct costs compared to usual diabetes care. This persisted after adjustment for differences in patient characteristics at baseline. To a lesser extent, protocolized diabetes care was also associated with lower direct costs compared to usual diabetes care. This difference disappeared after adjustment for differences in patient characteristics between groups.

Chapter 3: Cost-effectiveness of diabetes care

We related the difference in costs between the groups to the difference in coronary heart disease (CHD) risk. Risk of CHD was calculated using the UKPDS model. This model estimates an individual's risk of CHD during ten years of follow-up based on patients' risk profile (e.g. blood pressure, HbA1c, diabetes duration).

No statistically significant differences were seen in change in CHD risk according to the UKPDS risk function in managed and protocolized care during follow-up compared to usual diabetes care. Thus, lower health care costs were observed in managed and protocolized care compared to usual diabetes care, without affecting clinical outcomes. Similar trends were seen when considering costs from the societal perspective, however not statistically significant.

Chapter 4: Quality of care according to patients

Patient experience is an important aspect of diabetes care. By means of a questionnaire patients were asked to rate the importance of and their experience with aspects of the diabetes care.

Patients' experience with managed care and protocolized care were compared with usual diabetes care. Patients treated by managed diabetes care reported a better experience with the continuity of the diabetes care compared to patients receiving protocolized or usual care. This difference between groups decreased during follow-up, most likely because of improvements in protocolized and usual care. Patients in the managed care group had a lower risk of a negative experience with the dietician compared to the other two groups.

Chapter 5: The MICADO model

Simulation models can assist in diabetes policy by evaluating preventive and curative interventions and projecting trial results over time. Most models concentrate on known diabetes patients. We developed the MICADO model to estimate long term effects of diabetes-related interventions in persons with and without diabetes.

The MICADO model includes micro- and macrovascular diseases and risk factors and the possibility to assess parameter uncertainty by ways of probabilistic sensitivity analyses. Outcomes are prevalence of complications, quality of life, costs and cost-effectiveness. Validation by comparison with independent empirical data showed that the MICADO model simulates the incidence and natural course of diabetes and its microvascular and macrovascular complications well. It can be applied for projections as well as scenario analyses to evaluate the long-term (cost-) effectiveness of diabetes-related interventions.

Chapter 6: Validation of coronary heart disease risk functions

For effective targeting of interventions to reduce the incidence of complications, prediction models can be used to assess an individual's absolute risk of developing coronary heart disease within a defined time period. Several models exist that combine risk factors (e.g. blood pressure, HbA_{1c}, diabetes duration) for the estimation of an absolute CHD risk.

We tested calibration and discrimination of three often used prediction models (UKPDS, Framingham, SCORE) using prospective data of the Hoorn Study. The Hoorn Study is large prospective cohortstudy on diabetes and diabetes complications, which started in 1989.

Overall, the predictive accuracy of the models was low to moderate. In CHD prevention, application of the SCORE and UKPDS functions might be useful in the absence of a more valid tool.

Chapter 7: Risk of a recurrent cardiovascular event

Because of the increase in obesity and diabetes prevalence worldwide, and improved care after a first cardiovascular event, the number of people at risk for a recurrent cardiovascular event is rising. To be able to identify persons who are at increased risk for a recurrent cardiovascular event, we investigated the association between potential risk factors and a recurrent cardiovascular event in participants of the Hoorn Study.

Risk of a recurrent cardiovascular event can be identified based on patients' risk profile before the first event. Male sex, age, systolic blood pressure, HbA_{1c} and family history of a myocardial infarction predicted a recurrent cardiovascular event in the general population.

Chapter 8: Discussion and conclusions

In this thesis, we investigated the effectiveness and cost-effectiveness of managed and protocolized diabetes care compared to usual diabetes care. A model to estimate long-term (cost-)effectiveness of diabetes related interventions was developed. Finally, methods to facilitate personalized diabetes care were explored.

The results of this thesis indicate that managed or protocolized care result in equal clinical outcomes at lower health care costs compared to usual care. Managed care is associated with a better process of diabetes care and better continuity of care according to patients' opinion.

Models to identify high-risk patients based on patients' risk profile might be a useful tool to facilitate personalized care but should be further explored.

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