Scandinavian Journal of Primary Health Care

ISSN: 0281-3432 (Print) 1502-7724 (Online) Journal homepage: http://www.tandfonline.com/loi/ipri20

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To cite this article: Arna L. van Doorn-Klomberg, Jozé C. C. Braspenning, René J. Wolters, Margriet Bouma, Wim J. C. de Grauw & Michel Wensing (2014) Organizational determinants of high-quality routine diabetes care, Scandinavian Journal of Primary Health Care, 32:3, 124-131, DOI: 10.3109/02813432.2014.960252

To link to this article: http://dx.doi.org/10.3109/02813432.2014.960252

Scandinavian Journal of Primary Health Care, 2014; 32: 124–131

ORIGINAL ARTICLE

Organizational determinants of high-quality routine diabetes care

ARNA L. VAN DOORN-KLOMBERG[1], JOZÉ C. C. BRASPENNING[1], RENÉ J. WOLTERS[1], MARGRIET BOUMA[2], WIM J. C. DE GRAUW[3] & MICHEL WENSING[1]

[1]*Radboud University Medical Center, Scientific Institute for Quality of Healthcare, Nijmegen, The Netherlands,* [2]*Dutch College of General Practitioners (NHG), The Netherlands, and* [3]*Radboud University Medical Center, Department of Primary and Community Care, Nijmegen, The Netherlands*

Abstract

Objective. Randomized trials showed that changes in healthcare organization improved diabetes care. This study aimed to identify which organizational determinants were associated with patient outcomes in routine diabetes care. *Design*. Observational study, in which multilevel regression analyses were applied to examine the impact of 12 organizational determinants on diabetes care as separate measures and as a composite score. *Setting*. Primary care practices in the Netherlands. *Subjects*. 11,751 patients with diabetes in 354 practices. *Main outcome measures*. Patients' recorded glycated hemoglobin (HbA1c), systolic blood pressure, and serum cholesterol levels. *Results*. A higher score on the composite measure of organizational determinants was associated with better control of systolic blood pressure ($p = 0.017$). No effects on HbA1C or cholesterol levels were found. Exploration of specific organizational factors found significant impact of use of an electronic patient registry on HbA1c (OR = 1.80, 95% CI 1.12–2.88), availability of patient leaflets on systolic blood pressure control (OR = 2.59, 95% CI 1.06–6.35), and number of hours' nurse education on cholesterol control (OR = 2.51, 95% CI 1.02–6.15). *Conclusion*. In routine primary care, it was found that favorable healthcare organization was associated with a number of intermediate outcomes in diabetes care. This finding lends support to the findings of trials on organizational changes in diabetes care. Notably, the composite measure of organizational determinants had most impact.

Key Words: *Chronic disease, diabetes mellitus, general practice, observational study, practice management, primary health care, quality improvement, the Netherlands*

Introduction

Improving diabetes care has been on the agenda for several decades in many countries. In their systematic review of 142 trials, Tricco et al. examined the effects of various organizational changes on glycated hemoglobin (HbA1c), blood pressure, and serum cholesterol levels [1]. They identified 12 target areas (Box 1) in three domains: the local healthcare system, the healthcare providers, and the patients. The results suggested that in particular the combination of intervention components targeting the health system and patient-mediated interventions contributed to better outcomes. Since the amount of different intervention components varied among the studies and the relationship between components was often not investigated, considerable uncertainty remained associated with these findings. Similar results were found in a recent review by Stellefson et al. [2]. This study showed that interventions related to each of the six Chronic Care Model (CCM) components [3], "community resources and policies", "healthcare organization", "self-management support", "delivery system design", "decision support", and "clinical information systems" [4], contributed to quality improvement. However, there was not one particular component that proved to be a key component to achieve improvements. They also suggest that a multifaceted program could facilitate better implementation. Most evaluative studies are randomized controlled trials, which involve optimized support for achieving change. Although this offers obvious advantages regarding risk of bias, there is inconclusive evidence on whether effects can be replicated in daily practice [5,6].

Correspondence: Arna L. van Doorn-Klomberg, MSc, Radboud University Medical Center, Scientific Institute for Quality of Healthcare, PO Box 9101, 6500 HB, Nijmegen, The Netherlands. Tel: 0031-243615305. Fax: 0031-243540166. E-mail: Arna.vanDoorn-Klomberg@radboudumc.nl

(Received 7 May 2014; accepted 23 August 2014)

ISSN 0281-3432 print/ISSN 1502-7724 online © 2014 The Author(s)
DOI: 10.3109/02813432.2014.960252

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Several organizational determinants of high-quality diabetes care could be associated with improved intermediate outcomes in routine diabetes care.

- In this study, findings from trials of organizational change strategies could partly be replicated in routine daily practice.
- A composite measure composed of several organizational determinants had more impact than organizational items separately.

In this contribution, we focus on the impact of organizational determinants on (intermediate) patient outcomes in routine diabetes care for type 2 diabetic patients. In the Netherlands, this is largely provided in primary care. We aimed to identify organizational determinants of the following outcomes: HbA1c, blood pressure, and cholesterol levels. As the quality of diabetes care generally has improved over the last decades [7–11], we wondered whether organizational determinants identified in trials had been implemented and whether they contributed to increased control in routine diabetes care in the Netherlands.

Box 1. Measures included in the study related to the target areas for improvement strategies.

Tricco taxonomy		Variable included
Health systems		
Team changes	**1**	Nurse practitioner volume: the amount of FTE (full-time equivalent) NP (nurse practitioners) per 1000 patients
Continuous QI		*Continuous quality improvement in the form of written plans with plan–do–study–act cycles was present in all practices since this was required in the Dutch accreditation program*
	2	Annual report: dichotomous measure of whether the practice evaluates quality in a written report (for internal use) at least once a year
	3	Complaints procedure: percentage of patients aware of the complaints procedure in the practice
Electronic Patient Registry	**4**	Use of Electronic Patient Registry (EPR), sum score of seven dichotomous items: (a) General practitioners (GPs) always use the EPR to create prescriptions (b) Incoming lab results are processed automatically (c) Hospital referrals are completely created in EPR (d) Referrals to other disciplines (e.g. physiotherapy) are completely created in EPR (e) Application forms for diagnostic procedures are generated in the EPR (f) Contraindications and intolerances are systematically recorded in the EPR (g) GPs have the support of an electronic referral system during visiting hours
Case management	**5**	Diabetic clinic available in the practice (dichotomous)
Facilitated relay of information to clinicians	**6**	Consultation with partners, sum score of five dichotomous items: (a) Practice has regular consultations with local district nurses (b) Practice has regular consultations with local physiotherapists (c) Practice has regular consultations with local dietitians (d) Practice has regular consultations with local pharmacists (e) Practice has regular consultations with local social workers
	7	Collaboration with partners, sum score of two dichotomous items: (a) Practice collaborates with local physiotherapists (b) Practice collaborates with local social workers
Health care providers		
Financial incentives		–
Clinician education	**8**	GP education: dichotomous measure, amount of accredited education less than 50 hours per year or exactly/more than 50 hours. The cut-off point was based on the approximate median score in our dataset
	9	Nurse education: dichotomous measure, amount of education less than 15 hours per year or exactly/more than 15 hours. The cut-off point was based on the approximate median score in our dataset
	10	Electronic guidelines are available in every treatment room (dichotomous)
Clinician reminders		–
Audit and feedback		*The Dutch accreditation program was an audit and feedback system in itself, in which all practices participated*
Patients		
Education of patients	**11**	Patient leaflets, composite score of two dichotomous items: (a) Patient leaflets regarding cardiovascular diseases are available in the practice (b) All patient leaflets are kept in an area that is clearly visible and accessible for patients
Promotion of self-management		–
Reminder systems	**12**	Patient reminder system available in the practice (dichotomous)

Since several studies suggested that a combination of determinants rather than individual determinants contribute most to quality improvement [1,2], we also examined the impact of a composite measure of organizational factors.

Material and methods

Research design and population

We analyzed electronic patient record data from 362 primary care practices that participated for the first time in a Dutch Accreditation program between 2006 and 2009 (Box 2). These practices manually extracted information from a random sample of 40 medical records, using a structured protocol and data-extraction tool to ensure the selected sample was unbiased. Data were collected retrospectively during the preparatory phase of the accreditation process. The practice was instructed to select records on only those patients that were diagnosed with diabetes and had a general practitioner (GP) as main diabetes care provider. In effect, practices mainly included diabetes type 2 patients.

Box 2. Dutch practice accreditation program for primary care practices.

Since 2005, primary care practices can voluntarily take part in a Dutch practice accreditation program. The preparatory phase consists of the collection of data on practice management and patient care. The measurement instruments used are previously validated questionnaires such as the "VIP", a visitation instrument for practice organization, and the "Europep" that measures patient experiences [12,13]. The questionnaires are filled in by general practitioners (GPs), nurses, and patients. There are also questionnaires for a trained observer who pre-audits the practice. Clinical performance is measured with the use of patient information that is extracted from electronic medical records; the GP or nurse extracts the information either automatically or manually with an extraction form.

When all data are collected and submitted through an online questionnaire system, the practice receives a report that includes information on its own performance and the performance of other practices as benchmarks. This information helps to identify which areas could be improved upon. The GPs then write improvement programs with a plan–do–study–act cycle. The first audit is carried out after the approval of these plans to confirm adequate participation and to grant accreditation. After this audit a three-year accreditation cycle starts. At the end of each year the practice staff evaluate whether the objectives of improvement programs are met and write new improvement programs for the following year. The prolongation of the accreditation depends on this process. Accreditation is not based on the actual quality of care itself but rather on the quality of the improvement initiatives according to a structured program. After three years, a new cycle starts with the data-collection phase. In our current study, we have excluded these repeated measurements; we have included only data from the first cycle.

Measures

Our outcome measures were recorded HbA1c, systolic blood pressure, and total cholesterol values. Organizational determinants related to high-quality diabetes care, derived from a review of trials [1], were linked to specific items from validated questionnaires [12]. GPs, other practice staff, patients, and trained observers filled in these questionnaires as part of the Dutch Accreditation program. We composed 12 measures, some with multiple items (see Box 1), and their composite score (see Supplementary Appendix 1 available online at http://informahealthcare.com/doi/abs/10.3109/02813432.2014.960252). Furthermore, we gathered data from these questionnaires on practice type, size and urbanization, the number of diabetes patients per 1000 patients, and the volume of GP per 1000 patients (expressed as a full-time equivalent, FTE). Patients' age and gender were extracted from the patients' medical record, as well as the year of data collection (2006/2007/2008/2009). Patients' age was considered as a proxy for comorbidity.

Statistical analysis

We used means and percentages as appropriate to summarize patient and practice characteristics and establish whether determinants were implemented in our study population. Correlations of all measures (Pearson's correlation coefficient or Spearman's correlation coefficient as appropriate) were calculated to check for multicollinearity; the cut-off point for exclusion was set at $r > 0.15$. We performed separate multilevel regression analyses on each of the three outcome measures: HbA1c, total cholesterol, and systolic blood pressure in SPSS (version 20). We examined the effect of the composite score of the 12 determinants, while controlling for patient characteristics (age and gender) and practice characteristics (practice type, year of data collection). Other practice characteristics were not included in the model because of correlations above $r = 0.15$ with practice type.

In order to explore which underlying determinants of the composite score were related to outcomes, we repeated the multilevel regression analyses on each of the 12 determinants in Box 1 separately. As effects may be smaller in patient populations with higher baseline control [1], we also performed logistic regression analyses while comparing the extremes, that is the practices that performed in the highest and lowest quartiles.

Results

Study population

Patients who were mainly under specialist care during the study period were excluded. Data on 11 751

Table I. Description of participating practices and scores on determinants.

		Study population (2006–2009)		Dutch population (2008) [14–16]
	Practice characteristics	*Percentage or value*		
1	Practice type:[1]			
	Single-handed practice	20.2%		42.3%
	Non-single handed, not in health Care center	57.6%		
	Practice with 2 GPs	23.6%		31.5%
	Group practice (>2 GPs)	13.8%		26.1%
	Other practice type	20.2%		
	Practice within primary healthcare center	22.2%		
2	Practice size: number of patients	4961		3888
3	Number of FTE[2] GP per 1000 patients	0.43		0.43
4	Practice location:[3]			
	Rural	12.6%		12.2%
	Semi-urban	38.2%		41.1%
	Urban	49.2%		46.7%
5	At least one of the GPs in the practice provides vocational training	48%		30%
	Total % GPs that provide vocational training	31%		19%
6	Number of diabetic patients per 1000 patients	43		43
7	Year of participation:			
	2005/2006	22.9%		
	2007	42.2%		
	2008/2009	34.8%		
	Scores on determinants	*Study population*		
		Percentage or mean (SD)		
8	Volume of NP (FTE per 1000 patients)[4]	0.14 (0.06)		
9	Availability of annual report	48%		
10	Percentage of patients familiar with complaints procedure	51.1 (12.5)		
11	Sum score EPR (score between 0 and 7)	5.38 (1.03)		
12	Availability of diabetic clinic	88%		
13	Sum score consultation partners (score between 0 and 5)	3.77 (1.18)		
14	Sum score collaboration partners (score between 0 and 2)	0.46 (0.69)		
15	GP education (hours per year)	51 (12.9)		
16	Nurse education (hours per year)	17 (17.2)		
17	Availability of guidelines (score between 0 and 1)	0.95 (0.17)		
18	Sum score patient leaflets (score between 0 and 2)	1.68 (0.56)		
19	Availability of patient reminder system	78%		
	Patient characteristics	*Study population*		*GIANTT 2007 [17]*
		Mean (SD) or percentage		
20	Patient age	65.9 (12.1)		66.6 (12.3)
21	Patient gender, male	51%		48%
22	HbA1c value, % mmol/mol	6.8 (1.0)		6.9 (1.0)
		51 (10.9)		52 (10.9)
23	Total cholesterol value, mmol/l	4.7 (1.1)		4.4 (1.1)
24	Systolic blood pressure, mm Hg	140 (18)		142 (20)
25	HbA1c within target value (7.0)	67.4%		61%
26	Total cholesterol within target value (5.0)	63.2%		
27	Systolic blood pressure within target value (150)	70.9%		
	Within 140	46.9%		44%
	Within 160	84.0%		87%
	Aggregated average and percentile scores on practice level	*25th percentile*	*Average*	*75 th percentile*
28	HbA1c %, mmol/mol	7.0 (53)	6.8 (51)	6.5 (48)
29	Total cholesterol, mmol/l	4.9	4.7	4.5
30	Systolic blood pressure, mm Hg	144	140	136

Notes: [1]Figures based on the Dutch population distinguish between solo, duo, and group practices. In our study there were also the options "part of health care center", which can be either solo, duo, or group, and "other practice type", which consists mostly of duo or group practices within a cooperation construction other than a health care center. [2]FTE = Full-time equivalent. [3]A rural location is defined as less than 500 addresses per km^2, semi-urban as between 500 and 1500 addresses per km^2, and urban as more than 1500 addresses per km^2. [4]NP = nurse practitioner, FTE = full-time equivalent.

diabetes patients from 354 practices remained (mean value of 33.2 patients per practice, minimally 10 patients per practice). The study population contained slightly more large practices in urban regions compared with the Dutch population (Table I). Practices that offer vocational training were overrepresented, as

it was already known that the accreditation program would become mandatory for them in the ensuing years.

Measures

Table I gives the mean scores and standard deviations (SD) or percentages (in case of dichotomous measures) on the measures included in the study. The percentage of patients with a value below the target for HbA1c, cholesterol, and blood pressure was relatively high (between 63% and 71%). However, 68.4% of all patients had at least one intermediate outcome that was above the target, i.e. diabetes control was not according to guidelines on all aspects.

Organizational determinants

The included practices had high scores on the organizational determinants, indicating favorable conditions for high-quality diabetes care (see Table I). Determinants that were implemented on a broad scale included the diabetic clinic, a patient reminder system, and guideline availability. Also, in most practices (89%) a nurse practitioner (NP) was part of the practice team. More possibilities for further implementation were found on collaboration with partners and the familiarity of patients with the complaints procedure.

Impact of composite organizational measure

Table II shows that systolic blood pressure levels were lower in practices with a higher determinant sum score ($p = 0.017$). The additional implementation of one determinant led to a decrease of 0.5 in the systolic blood pressure, with a maximum estimated decrease of six points. No effects were found regarding HbA1c or cholesterol levels.

Impacts of organizational items

Of 36 possibilities (12 items $\times$ 3 outcomes) we found three significant effects. HbA1c levels were lower in practices that made more use of their Electronic Patient Registry (EPR, $B = -0.088$, $p < 0.000$). HbA1c levels were higher in practices with a diabetic clinic ($B = 0.327$, $p < 0.000$), and practices that wrote an annual report ($B = 0.103$, $p = 0.032$). None of the 12 measures was found to have an influence on total cholesterol or systolic blood pressure, see Supplementary Appendix 2 available online at http://informahealthcare.com/doi/abs/10.3109/02813432.2014.960252.

Comparison highest and lowest quartile practices

Of the 34 measured effects, three effects were significant. Practices that made more use of their EPR (increase of one on a scale of seven) were more likely to score in the highest quartile (OR = 1.8), see Table III. If the amount of nurse education was relatively high (above the median), there was a higher likelihood that the practice performed within the highest quartile on total cholesterol (OR = 2.51). Regarding the average systolic blood pressure, better availability of patient leaflets increased the odds (OR = 2.59) that practices comprised part of the "best practices".

Table II. Multilevel models (cluster measure = practice, data on patient level) on continuous outcomes of HbA1c, cholesterol, and blood pressure for determinant composite score.

	HbA1c (%)		Total cholesterol (mmol/l)		Systolic blood pressure (mm Hg)	
	Estimate (95% CI)	p-value	Estimate (95% CI)	p-value	Estimate (95% CI)	p-value
Parameter[1]	n = 7281 patients		n = 7122 patients		n = 7320 patients	
Intercept	6.77 (6.53–7.01)	0.000	4.54 (4.30– 4.77)	0.000	118.8 (114.9–122.7)	0.000
Sum score determinants	0.008 (−0.018–0.035)	0.546	0.005 (–0.020–0.030)	0.698	−0.50 (–0.91– −0.09)	0.017
Patient age	−0.002 (−0.004– −0.000)	0.049	−0.001 (−0.003–0.001)	0.419	0.34 (0.31–0.38)	0.000
Patient gender	0.028 (−0.017–0.074)	0.221	−0.354 (−0.402– −0.306)	0.000	−0.53 (–1.33–0.28)	0.199
Year data collection:						
2007	0.071 (−0.042–0.185)	0.217	−0.014 (−0.122–0.095)	0.804	2.39 (0.61–4.18)	0.009
2008	0.079 (−0.038– −0.196)	0.187	−0.170 (−0.282– −.059)	0.003	2.30 (0.46–4.13)	0.014
2009	0.149 (−0.028–.325)	0.098	−0.091 (−0.258–0.076)	0.284	1.68 (−1.08–4.43)	0.231
Practice type:						
Single-handed	−0.020 (−0.134–0.094)	0.729	−0.026 (−0.134–0.083)	0.638	−1.39 (−3.18–0.39)	0.125
Health center	0.076 (−0.042–0.194)	0.206	0.149 (0.037–0.262)	0.010	0.02 (−1.82–1.87)	0.981

Notes: [1]Reference categories: patient gender male, data collection in 2006, practice with more than one GP, which is not part of a health center.

Table III. Logistic regression comparison practices in highest and lowest quartile, corrected for patient age, gender, practice type, and year of data collection.

	HbA1c		Total cholesterol		Systolic blood pressure	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
Parameter	n = 109 practices		n = 120 practices		n = 122 practices	
Volume of NP[1]	0.031 (0.00–11.94)	0.253	6.25 (0.00–18334.95)	0.653	29.62 (0.03–33804.60)	0.345
Annual report	0.40 (0.14–1.13)	0.083	0.68 (0.25–1.83)	0.442	0.66 (0.22–1.94)	0.447
Complaints procedure	1.02 (0.98–1.07)	0.294	0.99 (0.95–1.03)	0.481	0.98 (0.94–1.03)	0.403
Use of Electronic Patient Registry	1.80 (1.12–2.88)	0.014	0.97 (0.64–1.48)	0.892	1.65 (0.95–2.85)	0.074
Diabetic clinic	[2]	[2]	0.55 (0.08–4.01)	0.554	0.37 (0.06–2.07)	0.255
Consultation partners	1.40 (0.91–2.16)	0.126	1.00 (0.70–1.43)	0.992	1.20 (0.81–1.78)	0.359
Collaboration partners	1.19 (0.57–2.51)	0.643	1.27 (0.62–2.63)	0.512	1.40 (0.68–2.88)	0.363
GP education	0.75 (0.31–1.82)	0.519	0.80 (0.32–1.99)	0.636	1.62 (0.65–4.05)	0.301
Nurse education	1.13 (0.45–2.82)	0.800	2.51 (1.02–6.15)	0.045	1.15 (0.43–3.11)	0.778
guidelines	[2]	[2]	1.01 (0.06–17.40)	0.997	0.34 (0.01–14.76)	0.571
Patient leaflets	0.40 (0.16–1.01)	0.051	1.11 (0.41–3.04)	0.833	2.59 (1.06–6.35)	0.037
Reminder system	1.03 (0.30–3.57)	0.958	0.66 (0.23–1.89)	0.443	1.39 (0.44–4.41)	0.579

Notes: [1]NP = nurse practitioner. [2]The determinants diabetic clinic and guidelines could not be included in the analysis regarding HbA1c because these variables were a constant in one of the quartile groups.

Discussion

Statement of principal findings

In this study, targeted organizational determinants were broadly implemented in routine primary care. A higher score on the composite measure of healthcare organization was associated with better systolic blood pressure control. Exploration of specific organizational factors identified only three significant effects in 36 combinations. Comparison of highest and lowest quartiles yielded similar results (three significant effects out of 34). These results from daily practice suggest that implementation of a combination of organizational determinants (rather than individual organizational items) is crucial for high-quality diabetes care [1,2,18].

Strengths and weaknesses

The current study monitored ongoing care in an average Dutch practice, as opposed to a controlled trial setting where active changes are made to practice management. Most organizational determinants were broadly implemented in routine care, reflecting a longstanding process of improving diabetes care in the Dutch primary care setting. Perhaps the voluntariness of participation in this study contributed to this fact.

Outcomes were similar in the Dutch GIANTT study [17], in which all diabetic patients from general practices were included. This suggests that the selected patient samples formed an adequate reflection of the practice population. The relatively well-controlled population and the small amount of variation within the organizational measures decreased the potential impact of organizational items [19]. Although other individual studies have used similar items to operationalize constructs [20], there were some constructs that were based solely on one dichotomous item, which could have affected the representation of the model.

Findings in relation to other studies

Our observational study showed that, similar to trials, a multifaceted approach to improve the quality of care involving a combination of organizational interventions can be expected to achieve larger effects than single interventions [1,2]. Ose et al. (2009) found that a practice management program had a positive effect on quality of life outcomes [21]. Coleman et al. (2009) evaluated the effects of implementation of the Chronic Care Model (CCM) and concluded that an integrated approach was positively associated with improvements in organization and outcomes of care [22]. Compared with other studies, effect sizes in our study were moderate, as was their clinical relevance. Nevertheless, the differences between practices with highest and lowest quartile organizational performance were substantial. Further research is required to unravel whether multiple favorable organizational determinants imply additive or multiplicative effects. On average, the outcome measures in our study met the standard levels as described in the diabetes guidelines, but the composite measure for organizational determinants still showed a significant effect regarding blood pressure. This is probably due to the fact that blood pressure offered the largest room for improvement [17,23,24].

Regarding the individual organizational determinants we found few and small effects. There was a positive effect of the use of the Electronic Patient Registry (EPR) on diabetes care, which is consistent with the research evidence from the trials [25]. The positive relation between the availability of patient leaflets and blood pressure has been suggested in other studies as well [26]. Less clear was the unexpected negative association of the availability of a diabetic clinic and an annual report with HbA1c. However, in the Netherlands both features are related to large practices, which in turn have a negative association with quality of care [27,28]. The data supported this argument as practice size was somewhat larger for practices with an annual report (5279 versus 4526 patients) as well as for practices with a diabetes clinic (5086 versus 3910 patients).

In our study we used the target values as described in the diabetes guidelines at the time of measurement. However, in daily practice, these are influenced by patient values and preferences and should not be handled strictly. It is likely that GPs might have deviated from the guidelines when they thought strict treatment was not preferred. For instance, in our dataset the percentage of people with a blood pressure above target was higher for the elderly (70 and above) than the younger population (39% versus 30%).

Conclusion

In line with previous research a combination of determinants of practice organization was more strongly related to meeting the targets on diabetes management than a single determinant [1,2,22]. On average the targets for the management of diabetes care as described in the diabetes guidelines were met, but improvement on intermediate diabetes outcomes could still be reached by introducing more structured practice organization.

Declaration of interest

Funding for this work was received from the Dutch College of General Practitioners (NHG) in the Netherlands. No other funding was provided. The funding company is the employer of one of the authors (MB). The authors report no other conflicts of interest. The ethics committee of the Radboud university medical center provided a waiver for the study.

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Supplementary material available online

Supplementary Appendices 1 and 2.