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ORIGINAL REPORT

Development of a minimal set of prescribing quality indicators for diabetes management on a general practice level

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ABSTRACT

Objective To identify the relevant prescribing quality domains of type 2 diabetes mellitus care as a basis for the selection of a minimal set of prescribing quality indicators from a set of previously validated indicators.

Methods We used the principal factor analysis to identify the underlying dimensions or domains of prescribing quality for 76 general practitioners participating to the Groningen Initiative to Analyse Type 2 Diabetes Treatment project in the Netherlands. From a set of 10 prescribing quality indicators covering various aspects of cardiovascular and metabolic management, we selected a subset of indicators with the highest loading within each identified domain. Next, we evaluated the effect of using this subset on the quintile ranking of practices on their prescribing quality scores.

Results We identified five prescribing quality domains in our data set: two assessing initiation of pharmacotherapy for different risk factors in diabetic patients, two on stepwise intensification of treatment, and one on treatment of patients with cardiovascular disease. A composite score comprising the indicators selected from each of the domains showed good agreement with the composite score comprising all indicators with 82% of general practitioners either not changing their position or shifting their ranking by only one quintile.

Conclusions We showed that a minimal set of prescribing quality indicators for type 2 diabetes mellitus care should not just focus on the management of different clinical risk factors but also reflect different steps of treatment intensification. The results of our study are relevant for stakeholders when selecting quality indicators to assess the quality of prescribing in diabetic patients. Copyright © 2011 John Wiley & Sons, Ltd.

KEY WORDS—quality health care indicator; type 2 diabetes mellitus; quality of healthcare assessment; drug prescribing

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INTRODUCTION

The demand for accountability in health care and the need for improving the quality of provided care have resulted in the development of a large number of quality indicators for an increasing number of diseases.[1,2] Quality measurement and reporting have the potential to improve the quality of care and reduce health care costs but can also cause administrative and financial burden of collecting and reporting quality information. To minimize this burden, it is important to seek strategies to reduce the number of quality indicators used.[3–5] This article describes the process and results of selecting a minimal set of prescribing quality indicators (PQIs) for treatment of type 2 diabetes mellitus (T2DM).

Stakeholders using quality information, such as health care providers, policy makers, and payers, have to deal with a large number of quality indicators because of the growing number of different quality-reporting programs. The number of quality indicators included in national sets is varying from country to country. For example, the number of quality measures included in Healthcare Effectiveness Data and Information Set 2010 set in the USA is about half of the number of indicators included in Quality and Outcome Framework in the UK.[6,7] Although both sets are comprehensive, there is lack of understanding on what the number of indicators in such sets should be. Besides such comprehensive programs, many sets of quality indicators exist focusing on specific diseases, for example, diabetes management.[8–14] The availability of various quality indicators creates a possibility to choose the most appropriate indicators for specific user aims. However, this also introduces the challenge

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of selecting the indicators while maintaining the comprehensiveness of the selected set.

Diabetes is a chronic condition with increasing prevalence in the world. Although lifestyle modification plays an important role in treatment of T2DM patients, most of them eventually require pharmacotherapy because of progressive nature of the disease.[15,16] Currently, to evaluate and improve the quality of drug treatment in T2DM patients, a large number of PQIs exists worldwide.[17]

Combining measures to a composite score is one way to reduce the number of indicators included in quality assessment. Composite scores provide an advantage of quick overview of the provided quality of care in a certain area.[18] However, they do not reduce the burden related to collecting and reporting much data on an individual indicator level.

Several approaches are available to make a selection of relevant prescribing indicators from a larger set. One can start choosing indicators on the basis of stakeholders' specific preferences and areas of interest.[4,19] It is possible to further narrow down the choice of indicators on the basis of clinimetric characteristics, such as the grade of evidence supporting the indicators, the concurrent and predictive validity, and the availability of data,[17,20] or discard all indicators that do not show room for improvement.[21] Another approach to systematically minimize the number of quality indicators is the use of data reduction techniques, such as factor analysis, allowing to uncover hidden relationships between different PQIs.[22]

The aim of this study is to identify relevant prescribing quality domains of T2DM management that can serve a basis for selecting a minimal set of PQIs to be applied on a general practice level.

METHODS

Study setting and population

In the Netherlands, patients are registered with a single general practitioner (GP) who has a gatekeeper role in coordinating their medical care. Most patients with T2DM are managed in general practice. Many GPs have a diabetes nurse or assistant who will conduct the routine three-monthly examinations of patients. In our study region, in the north of the Netherlands, there is also a regional diabetes facility that offers support to GPs by providing thrice a month and yearly diabetes follow-up examination of patients. In all cases, the GP is responsible for the patients' management and for prescribing their medication. All GPs participating in a regional program for monitoring diabetes care by the end of 2007 were eligible for inclusion.[23] The inclusion criterion for our study was having eligible patients for all tested indicators.

Data collection

All participating GPs used electronic health records and prescribe electronically, which means that the data set includes full information regarding the prescribed medication. We collected data from the Groningen Initiative to Analyse Type 2 diabetes Treatment database, which contains information from the electronic health records of all T2DM patients registered in the participating practices.[24] In addition, survey information is collected yearly regarding the practice characteristics, including practice size and supporting personnel. The patient data set for our study included information on the demographics, prescribed medication, comorbidities, physical examinations and laboratory measurements as documented in the medical records.

Prescribing quality indicators

Previously, a set of 14 indicators for assessing prescribing quality in T2DM was developed on the basis of several national and international diabetes guidelines.[14] This set of indicators was selected after assessment in two panels of experts on face and content validity. In short, the indicators cover adequate and timely treatment of relevant cardiovascular, renal, and metabolic risk factors as well as prescribing of metformin in overweight patients. The PQIs were calculated by dividing the number of eligible patients who were prescribed the recommended treatment by the total number of eligible patients as specified by the PQIs, and the percentages were obtained by multiplying the received ratio by 100. The operational definitions of the PQIs are described elsewhere.[14] Two indicators were discarded from this original set because of a lack of eligible patients at the general practice level, that is, one focusing on "prescription of statins in patients younger than 40 with a history of cardiovascular disease (CVD)" and one on "prescription of metformin in incident T2DM patients who are overweight." In addition, we modified one indicator focusing on "prescription of statins in all diabetic patients with increased cardiovascular risk" to "prescription of statins in patients with dyslipidemia" to reflect recommendations of the Dutch diabetes guidelines regarding prescription of statins for the study time.[25] The validated set of the indicators included three PQIs focusing on the management of albuminuria with a renin–angiotensin–aldosterone system inhibitor in mutually exclusive subpopulations of T2DM patients, that is, patients without hypertension or with incident

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hypertension or with prevalent hypertension. Because only 17 GPs had eligible patients for all three indicators, we combined them to one indicator to increase the number of eligible patients per practice for the statistical analysis.

Statistical analyses

Descriptive statistics are presented for practice and patient characteristics in the Table 1. We calculated the scores of PQIs and their 95% confidence intervals (midP) using an individual GP as unit of analysis. An exploratory factor analysis was conducted to identify the number of possible underlying dimensions or domains. We used principal factor analysis to model the correlation between indicators and to show the extent to which they reflect the same underlying concepts. We evaluated models with different numbers of factors and selected the model with best conceptual coherence, total variance explained, and communalities of the PQIs. The communality of each indicator, that is, the sum of the squared factor loadings for all factors for a given variable, shows the amount of variance in a given PQI explained by the selected factors: PQI loading across the same identified domains as for the total population. We repeated the analysis in a subpopulation of GPs that had at least 70 T2DM patients to assess whether population size would influence the observed domain structure and factor loadings. This cutoff excludes 16 practices in the lowest practice size quintile.

Table 1. General characteristics of GPs and patient population

	Mean (SE)
General practice characteristics ($n = 76$)	
Total number of patients	3504 (231)
No. T2DM patients treated by GP	80 (8)
No. T2DM patients treated by specialists	36 (5)
No. T2DM patients visiting diabetes facility	17 (1)
Percentage of all T2DM patients per practice	4 (0.1)
Percentage of practices with diabetes nurse or assistant	72
Patient characteristics ($n = 7944$)	
Age	66.3 (12.3)
Duration of diabetes (years)	5.7 (5.8)
Average systolic blood pressure (mmHg)	142.0 (17.3)
Glycated hemoglobin, HbA1c (%)	6.8 (0.9)
Total cholesterol (mmol/L)	4.4 (1.0)
Low-density lipoproteins (mmol/L)	2.4 (0.9)
Body mass index*	29.9 (5.4)
Sex (female) (%)	52.8
Presence of albuminuria (%)	12.7
History of myocardial infarction (%)	14.4
History of CVD (%)†	21.7

*Body mass index: weight in kilograms divided by height in square meters
†History of CVD included history of myocardial infarction, ischemic heart disease, transient cerebral ischemia, stroke/cerebrovascular accident, and atherosclerosis/peripheral vascular disease as registered by GPs.

Next, we selected the PQIs with the highest loading within each factor to represent that specific domain of prescribing quality. To evaluate the effect of selecting this subset of PQIs on prescribing quality assessment at general practice level, we assessed changes in the ranking of GPs using all or only this subset of indicators. For this, we calculated two composite scores for each GP averaging scores of individual indicators and ranked GPs on these scores. The first composite score included all 10 initial PQIs, and the second one included PQIs selected using the factor analysis. To compare shifts in ranking, the rankings on both composite scores were divided in quintiles. We considered a rank shift of 0–1 quintile as satisfactory agreement. A shift of two quintiles was considered as intermediate agreement, whereas more than two quintiles were defined as poor agreement.

Finally, we explored the association of practice characteristics, that is, practice size and availability of supporting personnel (such as diabetes nurse or diabetes assistant), with the scores of PQIs using linear regression. The Statistical Package for the Social Sciences for Windows (version 16.0; SPSS Inc., Chicago, IL) was used for all analyses.

RESULTS

From the GPs participating to the Groningen Initiative to Analyse Type 2 diabetes Treatment project at the end of 2007, we included 76 (70%) practices that had eligible patients for all tested indicators covering a total of 7944 T2DM patients. The characteristics of the included practices and their patient population are summarized in the Table 1. The scores of the PQIs calculated on a general practice level varied from 11% (SE 18) to 79% (SE 9) (Table 2).

We carried out the principal factor analysis with two-, three-, four-, and five-factor solutions and considered the five-factor model as being the best interpretable and conceptually meaningful. The factors explained a substantial part of the total variance with a cumulative variance of 16% (one factor), 30% (two factors), 43% (three factors), 56% (four factors), and 67% (five factors) (Table 3). No PQI was excluded from the analysis because all indicators loaded across the factors with correlation coefficients greater than 0.5. Communalities were 0.6 or higher for all PQIs.

The first two factors focused on the general first-step drug treatment recommendations for majority of T2DM patients. The first factor named "starting treatment I" included three indicators reflecting basic treatment for most patients, such as prescription of metformin, statin,

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Table 2. Mean general practice scores of PQIs for T2DM management ($n = 76$)

	PQIs included in the factor analysis (%)	PQI score, mean (SE)		No. eligible patients per PQI, mean (SE)	
1	T2DM patients with systolic blood pressure ≥140 mmHg and prescribed any antihypertensive drug	78.7	(8.8)	73.9	(5.6)
2	T2DM patients prescribed a second antihypertensive drug from a different class if systolic blood pressure remained ≥ 140 mmHg with first class of antihypertensive drug	24.8	(20.7)	13.5	(1.3)
3	T2DM patients with albuminuria prescribed RAAS-inhibitor	75.5	(16.5)	15.3	(1.4)
	PQIs merged to PQI 3 (%)				
	T2DM patients without hypertension with albuminuria prescribed RAAS-inhibitor	54	(32)	4.8	(0.4)
	T2DM incident for hypertension patients with albuminuria prescribed RAAS-inhibitor	89	(31)	1.8	(0.3)
	T2DM prevalent for hypertension patients with albuminuria prescribed a multiple drug regime containing RAAS-inhibitor	78	(22)	9.8	(0.8)
4	T2DM patients with a history of ischemic heart disease or myocardial infarction prescribed β-blocker	63.3	(19.0)	25.7	(3.3)
5	Nonincident T2DM patients with HbA1c >7 % and prescribed any oral antihyperglycemic agent or insulin	96.9	(4.0)	34.0	(2.5)
6	Nonincident T2DM patients not receiving insulin prescribed a second oral antihyperglycemic drug from a different class if with one oral antihyperglycemic drug HbA1c remained >7%	24.8	(16.5)	11.9	(1.0)
7	T2DM patients who are prescribed insulin if with combination of two oral drugs HbA1c remained >7%	11.1	(18.0)	8.3	(1.0)
8	Overweight prevalent T2DM patients prescribed a multiple drug regime containing metformin	70.1	(14.0)	64.0	(5.0)
9	T2DM patients with LDL ≥ 2.5 mmol/L or TC ≥ 4.5 mmol/L who are prescribed a statin	62.6	(12.6)	39.2	(2.9)
10	T2DM patients with a history of CVD prescribed acetyl salicylic acid	62.4	(19.7)	25.8	(3.3)

RAAS inhibitor, renin–angiotensin–aldosterone system inhibitor; HbA1c, glycosilated hemoglobin; LDL, low-density lipoprotein; TC, total cholesterol.

and any antihypertensive medication (Table 3). The second factor, "starting treatment II," consisted of two other PQIs focusing on the treatment initiation of T2DM patients with specific risk factors, that is, prescribing glucose lowering medication in patients with elevated HbA1c levels and prescribing renin–angiotensin system inhibitors in T2DM patients with albuminuria. The third identified factor reflected "treatment of CVD" in T2DM patients and comprised the two PQIs from our set of indicators concerning patients with a history of CVD, focusing on prescription of beta blockers and acetyl salicylic acid. Finally, there were two factors focusing on next steps of treatment intensification. The factor named "step 1 treatment intensification" included only one PQI focusing on adding a second drug in patients with hyperglycemia despite monotherapy with oral glucose lowering medication. The "step 2 treatment intensification" factor comprised a PQI focusing on adding a second class antihypertensive medication if one class was not sufficient to control the blood pressure and a PQI on prescribing insulin in patients with uncontrolled HbA1c levels despite oral glucose-lowering treatment. Additional analysis limited to GPs that had at least 70 T2DM patients showed similar results with PQI loading across the same identified domains as for the total population.

Within each domain, we selected the indicator with the highest loading as the PQIs that could represent that domain, that is, PQI 1 for "starting treatment I," PQI 5 for "starting treatment II," PQI 4 for "treatment of CVD," PQI 6 for "step 1 treatment intensification," and PQI 7 for "step 2 treatment intensification" (Table 3). To assess the effect of this selection on prescribing quality assessment, we ranked GPs using composite score based on the initial 10 PQIs and the composite score on the selected 5 PQIs, that is, PQIs 1, 4. 5, 6, 7. The comparison of these composite scores showed that 81.5% of GPs had an acceptable shift by either remaining within the same quintile or shifting only by one quintile, 10.5% had an intermediate shift by two quintiles, and only 8% had poor agreement because they shifted by more than two quintiles (Table 4).

We found no significant associations between practice size, having a diabetes nurse or diabetes assistant, or making use of the diabetes facility and the composite scores of the PQIs. Also regarding the individual PQI scores, no significant or meaningful associations were found with these general practice characteristics.

DISCUSSION

Using factor analysis, we identified five prescribing quality domains for T2DM within our data set: two on initiation of treatment, two on treatment intensification steps, and one on the treatment of T2DM patients with known CVD. We selected a subset of five indicators, representing each of these domains. On a general practice level, the prescribing quality assessed with this subset adequately reflected the overall prescribing quality using the initial set of 10 indicators.

One might expect that the PQIs focusing on the management of the same risk factor, for example, hypertension or hyperglycemia, would correlate highly and would therefore constitute one domain. Our study,

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Table 3. Factor pattern coefficients from principal component analysis: five factor solutions (number of GPs = 76)

PQI (%)		Factor loadings					Communnalities
		Starting treatment I	Starting treatment II	Treatment of CVD	Step 1 treatment intensification	Step 2 treatment intensification	
1	T2DM patients with systolic blood pressure ≥ 140 mmHg and prescribed any antihypertensive drug	0.865	0.212	0.041	0.089	−0.095	0.811
9	T2DM patients with LDL ≥ 2.5 mmol/L or TC ≥ 4.5 mmol/L who are prescribed a statin	0.676	−0.198	−0.123	−0.225	0.411	0.731
8	Overweight prevalent T2DM patients prescribed a multiple drug regime containing metformin	0.546	0.502	0.157	−0.020	−0.239	0.633
5	Prevalent T2DM patients with HbA1c > 7% and prescribed any oral antihyperglycemic agent or insulin	0.070	0.790	−0.127	−0.045	−0.069	0.652
3	T2DM patients with albuminuria prescribed RAAS inhibitor	0.119	0.543	0.182	0.438	0.355	0.660
4	T2DM patients with a history of ischemic heart disease or myocardial infarction prescribed β-blocker	0.143	0.119	0.730	−0.068	−0.162	0.598
10	T2DM patients with a history of CVD prescribed acetyl salicylic acid	−0.121	−0.192	0.727	0.210	0.105	0.636
6	Prevalent T2DM patients not receiving insulin prescribed a second oral antihyperglycemic drug from a different class if with one oral antihyperglycemic drug HbA1c remained >7%	−0.060	0.007	0.072	0.820	−0.062	0.685
7	T2DM patients who are prescribed insulin if with combination of two oral drugs HbA1c remained >7%	0.033	−0.123	−0.149	0.050	0.804	0.687
2	T2DM patients prescribed a second antihypertensive drug from a different class if systolic blood pressure remained ≥140 mmHg with first class of antihypertensive drug	−0.175	0.254	0.300	−0.374	0.562	0.641

RAAS inhibitor, renin–angiotensin–aldosterone system inhibitor.

however, showed that the PQIs that loaded on the same factor often represented the management of different clinical risk factors related to diabetes. Previous studies have shown that the relationship between prescribing indicators is often unpredictable with very different prescribing indicators correlating to a high degree.[26] Instead of correlations within a risk factor, we observed relationships between different indicators which seemed to be linked to the different steps of treatment intensity. This probably occurred because the prescribing behavior of GPs is influenced by clinical triggers that are not associated with a specific risk factor but rather the medical history of individual patients. Recent studies have shown that medication burden and presence of comorbidities can have similar effects on the start and intensification of treatment for the management of hyperglycemia, hypertension, and dyslipidemia in T2DM patients.[27,28]

Our selection of indicators was based on the highest factor loadings within each identified domain. The reduction we propose would result in a set of 5 instead of 10 indicators. Although this may seem a relative small reduction, it can reduce the data noise and administrative burden associated with reporting on large indicator sets for many practices. In addition, the use of a composite score on the basis of a small set of indicators can increase the comparability of quality measures across different general practices. The indicators comprising the selected minimal set are supported by the highest level of scientific evidence,[14] are accepted by the professionals in the field worldwide, and are operationally feasible.[17] It has been shown that use of quality indicators contributes to improved quality of provided care and patient outcomes.[29,30] In particular, indicators focusing on adequate and timely drug treatment were found to be predictive of better health outcomes.[31]

In our study, we have used complete individual level data on medication prescriptions made by GPs for all their T2DM patients. Although we had a large data set comprising electronic health records of 76 GPs with more than 7944 T2DM patients, our results may not be generalized to other settings. Prescribing patterns of primary care doctors in different countries can be influenced by cultural and organizational differences[32,33] and guideline recommendations, which may vary both across and within countries.[34,35] Therefore, a confirmation of our findings in different data sets and countries is recommended.

To our knowledge, this is the first study to look at the domains of prescribing the quality of T2DM care. Our study showed that factor analysis can be functional for minimizing the number of indicators.

Table 4. Agreement between the composite scores per general practice*

Composite score based on 10 PQI	Composite Score based on 5 PQI: Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quinile 5	Total
Quintile 1	**9**	**3**	2	0	1	15
Quintile 2	**2**	**8**	**5**	1	0	16
Quintile 3	1	**1**	**6**	**5**	2	15
Quintile 4	3	1	**2**	**6**	**3**	15
Quintile 5	0	2	1	**3**	**9**	15
Total	15	15	16	15	15	76

*Rows represent the quintile distribution of GPs based on a composite score of initial 10 PQIs; columns represent the quintile distribution of GPs based on a composite score of the selected five PQIs. Dark gray cells represent GPs with satisfactory agreement between two composite prescribing scores; intermediate gray cells represent GPs with intermediate agreement between two composite prescribing scores; light gray cells represent GPs with poor agreement between two composite prescribing scores.

The results indicate that when making indicator selections, it is important to include prescribing indicators that represent different levels of treatment intensity. For the management of diabetes, this selection should include indicators focusing on the start of treatment, the intensification of treatment, and the management of patients with additional CVDs. The proposed set of indicators can then be used as a tool to monitor and improve the quality of pharmacological management of T2DM patients.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

KEY POINTS

- Using factor analysis we selected five PQI indicators representing different dimensions of prescribing quality in our dataset. This subset of indicators adequately reflected the overall prescribing quality as assessed with a larger set of PQI at a family practice level.
- Factor analysis is helpful for selecting a minimum set of prescribing quality indicators through identification of underlying dimensions of prescribing quality
- A minimal set of PQI for T2DM care should integrate different treatment intensity levels of clinical risk factor management

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Operational definitions for calculation of prescribing quality indicators (PQI) for type 2 diabetes mellitus mangement.

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