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The Pharmacy-based Cost Group model: validating and adjusting the classification of medications for chronic conditions to the Dutch situation

Leida M. Lamers*, René C.J.A. van Vliet

Department of Health Policy and Management, Erasmus MC (University Medical Center Rotterdam), P.O. Box 1738, 3000 DR Rotterdam, The Netherlands

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Abstract

In 2002, the Dutch government implemented a Pharmacy-based Cost Group (PCG) model in the social health insurance sector. This model uses specific types of medication prescribed to individuals in a base year as markers for chronic conditions, which are then employed to adjust capitation payments to their sickness fund in the subsequent year. In this study, a classification of prescribed medication is derived for 22 chronic conditions, based on an assessment of the relation between prescribed medication and diagnoses indicated by physicians on their prescriptions. Of the 22 chronic conditions in this classification, 13 were included in the PCG model that is currently used in the Netherlands.

Keywords: Risk adjustment; Capitation payments; Prescribed drugs

1. Introduction

Adequate risk adjustment is critical to the success of market-oriented health care reforms in many countries. The purpose of these reforms is to make resource allocation in health care more efficient, more innovative and more responsive to the consumers' preferences. Regulated competition among insurers as well as among providers is a crucial element in these reforms. Consumers may choose among competing health insurance plans, which are largely financed through premium-replacing risk-adjusted capitation payments. In 1993, capitation payments based on demographic variables were introduced in the Dutch social health insurance market. In the Netherlands, sickness funds, the insurance organisations in the social sector, provide compulsory health insurance coverage for the approximately 60% of the population in the lowest income brackets, about 10 million persons. The benefit package, which is the same for all sickness fund members, is broad—including hospital care, physician services, prescribed drugs—and virtually without deductibles and copayments. There is a yearly open-enrolment period.

In a competitive environment, risk-adjusted capitation payments should induce sickness funds to

* Corresponding author. Tel.: +31-10-4088525; fax: +31-10-4089094.
E-mail address: lamers@bmg.eur.nl (L.M. Lamers).

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concentrate more on cost-containment and efficiency instead of indulging in risk selection. The risk-adjusted capitation payments should account for predictable variations in annual per person health care expenditures, as far as these are related to health status. Various studies have shown that demographic variables are too crude as risk adjusters [1,2]. The capitation system can be improved by extending the set of risk adjusters with measures that are more directly related to health. Promising health status risk adjusters are based on diagnostic information from prior health care utilisation [3,4]. Extending a demographic model with inpatient diagnostic information improves the predictive accuracy of the capitation model substantially [5,6]. Ambulatory care diagnoses [7,8] and information about chronic conditions deduced from the prior use of prescribed drugs [9,10] have also been shown to be good predictors of future health care expenditures.

In the Netherlands, the capitation payment system is supplemented with risk sharing between the Central Fund and the sickness funds. In 2001, this concerned about 65% of the costs [11]. A major disadvantage of this high extent of risk sharing is that it greatly reduces the sickness funds' incentives for efficiency and cost-containment. The government intends to reduce this risk sharing arrangement in the coming years. However, sickness funds will accept more financial responsibility only when the capitation payment formula improves at the same time. The Dutch government wanted to improve the capitation payment formula by introducing a health status risk adjuster. Pharmacy-based Cost Groups (PCGs)—an outpatient morbidity measure based on prior use of prescribed drugs—was the best option, because of its predictive value and the availability of data.

1.1. Information about chronic conditions based on prior use of prescribed drugs

Von Korff et al. [12] used population based automated outpatient pharmacy data in the US to construct a measure of chronic disease status, the chronic disease score (CDS). The CDS appeared to be correlated with physician-rated disease severity and was found to predict hospitalisation and mortality in the following year after controlling for age, gender and health care visits. A replication of this study showed that the CDS was stable from year to year and had construct and predictive validity [13]. A revised version of the CDS covered a wider range of medications than the original one [9]. The revised CDS is a set of dummy variables that indicate a pharmacy prescription during a base period for a medication or medication class representing particular chronic diseases. In total 28 different conditions were distinguished. The revised CDS model—containing 28 binary variables together with age and sex—explained 10% of the variation in total medical expenditures of adults enrolled in an HMO in the next 6-month period. Age and sex alone explained 3% of the variation in total charges. Lamers replicated and extended the study on the revised CDS using automated outpatient pharmacy data of one Dutch sickness fund [10]. A potential problem with risk adjusters based on (diagnostic) information from claims data is manipulation, which may be prevented to a large extent by employing fewer groups and by putting "alike" conditions in the same group. Therefore, the 28 original chronic conditions were clustered into seven PCGs according to empirically determined similarities in future costs. The clustering of conditions into these seven PCGs hardly affected the predictive accuracy of the model. The PCG model explained 10% of the differences in next year's expenditures between individuals, which was almost twice the R^2 of a model containing only demographic variables.

A risk adjuster for capitation payments should have properties like *validity*, *feasibility*, *invulnerability to manipulation*, and should provide *no perverse incentives* [3,14]. A valid risk adjuster is a good predictor of future health care costs, should measure the need for medical care and relate to health status. With the inclusion in a capitation model of a health status measure deduced from prior use there is always the danger of rewarding inefficient providers and encouraging more utilisation than is strictly necessary. The predictive accuracy and feasibility of the PCG model for the Dutch sickness fund sector [10,15] made this model the best option for the Dutch government to improve the capitation payment formula. However, two issues had to be addressed before PCGs could be implemented as a new risk adjuster. First, the US classification of medications representing chronic conditions that underlies the PCG model should be validated and adjusted to the Dutch situation and second, the possibilities for gaming the PCG system should be reduced. This study

deals with the first issue. When a drug is used to identify persons with a certain chronic condition in order to increase next year's capitation payment for those persons, it is a necessary prerequisite that the drug concerned is primarily prescribed for that chronic condition. When a drug is also used for other chronic diseases or used for acute conditions, it should not be included in the PCG model. This study examines whether the classification of the revised CDS needs adjustment for the Dutch situation by assessing the relation between medication and diagnoses for each of the 28 original chronic conditions.

This paper is organised as follows. First, the data and methods used in the empirical analyses are described. Then, we present the results of our analyses and finally the findings are discussed.

2. Methods

The relation between medication and diagnoses for each of the 28 chronic conditions was studied, with the classification of the revised CDS [9] as a starting point. Table 1 gives an overview of the anatomical therapeutic chemical (ATC)-codes, as an indicator for medication [16] for the chronic conditions belonging to the revised CDS. In this table 25 conditions are distinguished, whereas the revised CDS had 28. The reason is that an earlier study showed that in the Netherlands ammonia detoxicants—in the revised CDS assumed to be indicative of 'liver failure'—are regularly prescribed for acute health problems not related to 'liver failure' [10]. Therefore, liver failure was excluded from this study. Furthermore, the conditions 'renal disease' and 'end stage renal disease' are put together; the same holds for 'psychotic illness' and 'bipolar disorders'.

An evaluation by four physicians and a pharmacist working for Dutch sickness funds resulted in a few modifications of the original list from the revised CDS.

To assess the relation between medication and diagnoses, claims data from Dutch sickness funds were inappropriate due to the fact that diagnoses are not included in the claims data, mainly because of privacy concerns. Therefore, a database with electronic patient records of about 150 Dutch general practitioners (GPs) was used [17] to study the relation between medication and the disease diagnosed by the GP who gave the prescription. In 1999, 150,636 sickness fund members were registered as patients of these GPs. Each prescription contained a code from the anatomical therapeutic chemical classification index [16]. For each prescription the diagnosis, in the form of a code from the International Classification of Primary Care (ICPC), was known as well [18]. All prescriptions in 1999 for drugs with ATC-codes for the chronic conditions distinguished (see Table 1) were selected from the database. Per chronic condition we calculated the proportion of diagnoses on the prescriptions relevant for the condition concerned.[1] For example, in case of a prescription for anxiolytics the diagnosis "depressive disorder" (ICPC-code P76) is not considered to be a relevant diagnosis, whereas "anxiety disorder/anxiety state" (ICPC-code P74) is. Only drugs prescribed *specifically* for treating certain chronic conditions can be used to assign persons to these chronic conditions, which are subsequently used as risk adjusters. Therefore, only drugs prescribed in at least half of the cases for relevant diagnoses will be included in our new classification of medications to be used to identify persons to chronic conditions. This resulted in a new classification with 20 chronic conditions.

In a second phase, the newly derived classification of drugs was used in another (claims) database to estimate a capitation model containing demographic variables and information on chronic conditions. This data set contained information for 6,353,716 members of all ages of 13 Dutch sickness funds. Demographic information for each member was available such as date of birth, sex, place of residence and insurance ground. The latter is the compulsory cause for enrolment with a sickness fund, for example: (a) wage earners with a salary below a certain threshold; (b) recipients of disability or unemployment benefits; (c) elderly people with low incomes. The data set further comprised annual health care expenditures for 1997

[1] A list with ICPC-codes for diagnoses representing the chronic conditions is available from the authors upon request. This list is a translation by the researchers of the disease and condition names occurring in the US classification of medications for chronic conditions into ICPC-codes. The list was approved by the steering committee for this study, which included medical and pharmacist experts.

Table 1
ATC-codes per chronic condition

Chronic condition	ATC-code (1999)	Description of ATC-code
Coronary and peripheral vascular disease	B01A, C04AD03	Antithrombotic agents, pentoxifylline
Epilepsy	N03A (excluding N03AE01)	Antiepileptics
Hypertension	C02	Antihypertensives: antiadrenergic agents, centrally acting, ganglion-blocking, peripherally acting, other antihypertensives
	C03A, C03EA01	Low-ceiling diuretics, thiaziden
	C07	Beta blocking agents
	C08	Calcium channel blockers
	C09A, C09B	Angiotensin-converting enzyme (ACE) inhibitors
HIV/AIDS	J05AB06, J05AD01, J05AE, J05AF	Ganciclovir, foscarnet, protease inhibitors, nucleoside reverse transcriptase inhibitors
Tuberculosis	J04A	Drugs for treatment of tuberculosis
Rheumatologic conditions	H02	Corticosteroids for systematic use
	M01CB, M01CC01, P01BA02, L01BA01, A07EC01	Gold preparations, penicillamine, hydroxychloroquine, methotrexate, sulfasalazine
Hyperlipidemia	C10A	Cholesterol and triglyceride reducers
Malignancies	L01 (excluding L01BA01), L03AA02/03/10, A04AA	Antineoplastic agents, filgrastim, molgramostim, lenograstim, serotonin (5HT3) antagonists
Parkinson's disease	N04B	Dopaminergic agents
Renal disease (including ESRD)	B03XA01, V03AE01	Erythropoietin, polystyrene sulphonate
Cardiac disease/ASCVD/CHF	C01	Cardiac therapy: Cardiac stimulants and glycosides, Antirrhythmics: class I and III, vasodilators used in cardiac diseases
	C03C, C03EB01	High-ceiling diuretics
Diabetes	A10A	Insulins
	A10B	Oral blood glucose lowering drugs
Glaucoma	S01E	Antiglaucoma preparations
Peptic acid disease	A02A, A02B	Antacids. drugs for treatment of peptic ulcer
Cystic fibrosis	A09AA02	Multienzymes
Transplantations	L04AA01/5/06, L04AX01	Ciclosporin, tacrolimus, mycophenolic acid, azathioprine
Respiratory illness, asthma	R03	Antiasthmatics
Thyroid disorders	H03A, H03B	Thyroid preparations, Antithyroid preparations
Gout	M04A	Antigout preparations
Crohn's and ulcerative colitis	A07EC (excluding A07EC01)	Mesalazine, olsalazine
Pain and inflammation	M01A	Non-steroids antiinflammatory and antirheumatic products
Pain	N02A	Opioids
Depression	N06AA	Tricyclic antidepressants
	N06AB, N06AE	Selective serotonin reuptake inhibitors
	N06AF, N06AG	Monoamine oxidase inhibitors
	N06AX	Other antidepressants
Psychotic illness (including bipolar disorders)	N05A	Antipsychotics
Anxiety and tension	N05B	Anxiolytics

ASCVD: arteriosclerotic cardiovascular disease, CHF: congestive heart failure, ESRD: end stage renal disease, HIV: human immunodeficiency virus.

and 1998 (including the costs of inpatient room and board, inpatient and outpatient specialist care, dental care, physiotherapy, ancillary services and prescribed drugs) and information on drugs, prescribed by GPs as well as medical specialists, for 1997. Pharmacy claims contained an ATC-code. Based on these ATC-codes persons with claims for medications and therapeutic classes indicative for the 20 chronic conditions could be identified.

We estimated a capitation model with age × sex ($(19 \times 2) - 1 = 37$ dummy variables), degree of urbanisation (four dummy variables), disability × age[2] (four dummy variables) and dummy variables for chronic conditions as the independent variables and health care expenditures in 1998 as the dependent variable. To avoid the assignment of incidental users of drugs to chronic conditions, persons were assigned to a chronic condition based on at least four prescriptions for the particular condition in the base year 1997. Since one prescription can be for 90 daily doses at maximum, with four prescriptions a person can receive medication for roughly a whole year. In the estimated capitation model only one chronic condition per person, i.e. the most expensive one, was counted.[3] The model was assumed to be linear in the coefficients, included an intercept and was estimated by means of ordinary least squares. Predictive performance of the model was evaluated by means of the R^2-value.

All persons who were enrolled during 1997 and at January first 1998 are included in the analyses. For those who disenroled during 1998 (5% of the members), costs were raised to annual rates. At the same time we assigned weights for the part of the year they were in the data set.[4] By applying this procedure, mean costs per person-year for the total data set are not changed.

[2] Disability means that a sickness fund member is a recipient of disability benefits. These members are according to their age assigned into four groups.

[3] An iterative procedure was used to assess the ranking of conditions according to decreasing follow-up costs corrected for demographic variables [20].

[4] For a member, who disenroled at 1 April 1998 and had 100 Euro costs, these costs were annualised to $(12/3) \times 100 = 400$ Euro and a weight of 3/12 was assigned.

3. Results

Table 2 shows the number of prescriptions in 1999 for the 25 chronic conditions distinguished at first and the proportion of diagnoses, indicated by a GP, of these prescriptions that was relevant for the condition concerned. For some conditions various categories of medications are prescribed to a relatively large group of patients. For these conditions—such as hypertension, diabetes and depression—the proportion of relevant diagnoses is given for the various categories of medications.

People suffering from the more severe diseases, such as malignancies, HIV/AIDS, ‘renal disease’, ‘cystic fibrosis’, tuberculosis and transplantations, are often treated by medical specialists or in an inpatient setting. The numbers in Table 2 refer to prescriptions by GPs only. This explains the relative small numbers of prescriptions for these conditions. Only drugs prescribed in at least half of the cases for relevant diagnoses, will be used in our new classification of medications. Because of the small numbers of prescriptions and the severity of the diseases, we made an exception for the conditions malignancies, ‘renal disease’ and transplantations.

For the conditions pain and ‘pain and inflammation’ the number of different diagnoses—in the form of a four digit ICPC-code—were 262 and 550, respectively. With this enormous variety in diagnoses the relevant diagnoses for these conditions could not be assessed. For the conditions ‘coronary and peripheral vascular disease’, ‘psychotic illness’ and ‘anxiety and tension’ the diagnoses on the prescriptions were relevant in less than half of the prescriptions for the conditions concerned. The same holds for the use of corticosteroids (ATC-code H02) for ‘rheumatologic conditions’, and tricyclic antidepressents (ATC-code N06AA) for depression. Only drugs prescribed primarily for the condition concerned, will be used in our classification. This means that using prescribed drugs that are classified in the categories pain, ‘pain and inflammation’, ‘coronary and peripheral vascular disease’, ‘psychotic illness’ and ‘anxiety and tension’ and the use of corticosteroids for ‘rheumatologic conditions’ and tricyclic antidepressents for depression, will not be considered indicative for specific chronic conditions. The drugs for the other conditions in Table 2, with a proportion relevant diagnoses

Table 2
Number of prescriptions and proportion of relevant diagnoses in 1999 per chronic condition

Chronic condition	Number of prescriptions	Proportion of relevant diagnoses
Coronary and peripheral vascular disease	20108	0.35
Epilepsy	2906	0.68
Hypertension		
Antihypertensives (see Table 1)	1441	0.68
Low-ceiling diuretics, thiaziden	8332	0.78
Beta blocking agents	21796	0.62
Calcium channel blockers	11084	0.63
ACE inhibitors	18714	0.81
HIV/AIDS	81	0.99
Tuberculosis	37	0.73
Rheumatologic conditions		
Corticosteroids for systematic use	5486	0.03
Other medication (see Table 1)	373	0.59
Hyperlipidemia	10927	0.84
Malignancies	91	0.24
Parkinson's disease	751	0.86
Renal disease (including ESRD)	42	0.40
Cardiac disease/ASCVD/CHF		
Cardiac therapy (see Table 1)	11706	0.87
High-ceiling diuretics	7076	0.53
Diabetes		
Insulins	3391	0.99
Oral blood glucose lowering drugs	13166	0.99
Glaucoma	1171	0.76
Acid peptic disease	22618	0.88
Cystic fibrosis	0	
Transplantations	204	0.20
Respiratory illness, asthma	35348	0.81
Thyroid disorders	4436	0.91
Gout	1204	0.93
Crohn's and ulcerative colitis	468	0.80
Pain and inflammation	37899	Not applicable
Pain	5566	Not applicable
Depression		
Tricyclic antidepressants	5651	0.41
Selective serotonin reuptake inhibitors	12218	0.71
Monoamine oxidase inhibitors	226	0.84
Other antidepressants	2799	0.79
Psychotic illness (including bipolar disorders)	4215	0.43
Anxiety and tension	30437	0.42

Source: Integrated Primary Care Information [17]. ASCVD: arteriosclerotic cardiovascular disease, CHF: congestive heart failure, ESRD: end stage renal disease, HIV: human immunodeficiency virus.

ranging from 0.53 for the use of 'high-ceiling diuretics' in case of 'cardiac disease' to 0.99 for the use of insulin or 'oral blood glucose lowering drugs' for diabetes, are included in the new classification of medications representing chronic conditions (see also the first column of Table 3).

In the second data set with more than 6 million members of 13 sickness funds, persons were assigned

Table 3
Prevalence per 1000 and coefficients (in Euro) for chronic conditions included in the new classification of medications for chronic conditions[a]

Chronic condition[b]	Prevalence per 1000	Coefficient
Hypertension-low	18.4	264
Glaucoma	3.0	338
Depression	10.1	444
Gout	0.5	497
Thyroid disorders	5.2	562
Hyperlipidemia	7.9	615
Hypertension-high	22.1	848
Diabetes-type II	9.2	1027
Respiratory illness, asthma	23.7	1253
Epilepsy	5.0	1404
Acid peptic disease	22.7	1803
Crohn's and ulcerative colitis	1.0	2377
Cardiac disease/ASCVD/CHF	26.4	2758
Tuberculosis	0.1	2766
Rheumatologic conditions	2.0	2972
Parkinson's disease	1.4	3407
Diabetes-type I	7.1	3988
Cystic fibrosis	0.3	6738
Transplantations	0.8	7789
Malignancies	0.4	8709
HIV/AIDS	0.3	14110
Renal disease (including ESRD)	0.1	35276
Prevalence total	167.5	
$R^2 \times 100\%$		9.41

ASCVD: arteriosclerotic cardiovascular disease, CHF: congestive heart failure, ESRD: end stage renal disease, HIV: human immunodeficiency virus.

[a] The 22 chronic conditions mentioned in this table are used together with, age, gender, urbanisation and disability as explanatory variables—in the form of dummies—for a linear regression with health care expenditures as dependent variable.

[b] Assignment to conditions based on greater than or equal to four prescriptions; no comorbidity, i.e. only one condition per person.

to the 20 remaining chronic conditions based on at least four prescriptions in the base year 1997. Two conditions were added as a result of splitting the conditions hypertension and diabetes because of the differences in follow-up costs for the various medications used for these conditions. Persons using insulins were assigned to diabetes-type I; those using oral blood glucose lowering drugs to diabetes-type II. Persons using beta blocking agents and low-ceiling diuretics were assigned to hypertension-low; those using the other medications for hypertension (see Table 1) to hypertension-high. The mean costs in 1998 minus the predicted costs by the demographic model for persons assigned to hypertension-low in 1997 are 275 Euro; while for hypertension-high these extra costs are 1426 Euro.[5] For diabetes-type I and diabetes-type II these figures are 1152 and 3563 Euro, respectively. The estimated model allowed for only one condition per person. As a consequence the same person cannot be assigned to both diabetes-type II and diabetes-type I and similarly for hypertension.

Table 3 shows the prevalences and coefficients for the 22 chronic conditions as well as the R^2-value for the estimated model with chronic conditions. A demographic model (i.e. the model without dummy variables for chronic conditions) explained 5.0% of the differences in health care expenditures in 1998 among individuals. The R^2-value of the chronic conditions model was 9.2%.[6] The overall prevalence of conditions was 16.8%. These 16.8% of the persons made 22% of the costs in 1998.

This study reaffirmed that models using information on the presence of chronic conditions deduced from the use of prescribed drugs are better able to predict future medical expenses than a demographic capitation model. The R^2-value for the chronic conditions model based on the new classification of medications was comparable with the results of earlier studies using Dutch data of sickness fund members. The same holds for the overall prevalence of conditions [10,15]. This suggested that the predictive accuracy of the PCG model was hardly affected by the exclusion from the new classification of chronic conditions and various sorts of drugs that were prescribed in less than half of the cases for relevant diagnoses.

4. Discussion

A valid risk adjuster should measure the need for medical care and relate to health status. This study

[5] The mean costs minus the costs predicted by the demographic model presented here are based on all persons assigned to hypertension-low respectively hypertension-high regardless of assignment to other chronic conditions. Therefore, the presented figures do not equal the coefficients presented in Table 3, which does not allow for comorbidity.

[6] In another study using similar data the *theoretical maximum* R^2-value was estimated at 33% [15,19]. The R^2-value for the estimated model with chronic conditions is 28% of this theoretical maximum.

validated and adjusted to the Dutch situation the classification of medications for chronic conditions underlying the PCG model by assessing the relation between medication and diagnoses for each of 28 chronic conditions. Only drugs prescribed specifically for the condition concerned, were included in the new classification.

This study showed that for 22 chronic conditions a majority of the prescriptions were for relevant diagnoses and therefore were considered indicative for specific chronic conditions. The R^2-value for the chronic conditions model based on the new classification of medications was, as expected based on earlier studies, almost twice the R^2 of the demographic model.

A limitation of the database used for assessing the relation between medication and diagnoses was that only prescriptions by GPs were available. Because of this limitation it was not possible to make reliable estimations of the proportion relevant diagnoses for the more severe diseases that are often treated by medical specialists or in an inpatient setting, such as malignancies, HIV/AIDS, 'renal disease', 'cystic fibrosis', tuberculosis and transplantations. Because of the severity of these conditions, they were included in the new classification regardless of the proportion relevant diagnoses. In the data set that was used to estimate the chronic conditions model, information on outpatient drugs prescribed by GPs as well as specialists was available. Therefore, the prevalences for the above named conditions (based on at least four prescriptions per person in the base year) in Table 3 are higher than the numbers of prescriptions in Table 2. The conditions 'cystic fibrosis', transplantations, malignancies, 'HIV/AIDS' and 'renal disease' have the highest coefficients in the estimated model, i.e. these conditions have the highest predicted follow-up costs. These predictions of high follow-up costs, varying from 6700 to 35,000 Euro, support the assumption of the severity of the conditions.

With the inclusion in a capitation model of a health status measure deduced from prior use there is always the danger of rewarding inefficient providers and encouraging more utilisation than is strictly necessary. In another study various strategies to reduce the possibilities for gaming the PCG system were studied empirically [20]. That study used the new classification of medications for chronic conditions described in this article.[7] The best strategies to mitigate the problem of potential gaming the system appeared to be:

- to use the number of prescribed daily doses to assign people to chronic conditions and to use a high threshold number for this;
- to assign people to one condition and not to more;
- to remove the nine chronic conditions with the lowest future costs.

The results of this study together with the results of the study addressing the reduction of possibilities for gaming, lead to a revised PCG model. The Dutch government decided to implement this PCG model in the sickness fund sector in 2002. The use of a PCG model in practice requires intensive monitoring to mitigate upcoding and inappropriate prescription behaviour. The classification of medications for chronic conditions should be updated at regular intervals for example to include new drugs for chronic conditions.

Many people treated in an inpatient setting will not be assigned to a chronic condition based on outpatient prescribed drugs. The predictable high costs of these persons are missed by the PCG model. Diagnostic Cost Groups (DCGs), a risk adjuster based on diagnostic information from prior hospitalisations, capture the future expenditures of persons suffering from diseases that are treated in inpatient settings [2,6]. DCGs and PCGs appear to be complementary in their ability to predict future costs [15,21]. Therefore, the Dutch government intends to further improve the capitation system by extending the set of risk adjusters with DCGs in 2004.

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[7] Table 3 of this article was the starting point for this study and is also incorporated in the first table of the article referenced under [20].

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