Risk-Adjusted Capitation Based on the Diagnostic Cost Group Model: An Empirical Evaluation with Health Survey Information

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Objective. To evaluate the predictive accuracy of the Diagnostic Cost Group (DCG) model using health survey information.
Data Sources/Study Setting. Longitudinal data collected for a sample of members of a Dutch sickness fund. In the Netherlands the sickness funds provide compulsory health insurance coverage for the 60 percent of the population in the lowest income brackets.
Study Design. A demographic model and DCG capitation models are estimated by means of ordinary least squares, with an individual's annual healthcare expenditures in 1994 as the dependent variable. For subgroups based on health survey information, costs predicted by the models are compared with actual costs. Using stepwise regression procedures a subset of relevant survey variables that could improve the predictive accuracy of the three-year DCG model was identified. Capitation models were extended with these variables.
Data Collection/Extraction Methods. For the empirical analysis, panel data of sickness fund members were used that contained demographic information, annual healthcare expenditures, and diagnostic information from hospitalizations for each member. In 1993, a mailed health survey was conducted among a random sample of 15,000 persons in the panel data set, with a 70 percent response rate.
Principal Findings. The predictive accuracy of the demographic model improves when it is extended with diagnostic information from prior hospitalizations (DCGs). A subset of survey variables further improves the predictive accuracy of the DCG capitation models. The predictable profits and losses based on survey information for the DCG models are smaller than for the demographic model. Most persons with predictable losses based on health survey information were not hospitalized in the preceding year.
Conclusions. The use of diagnostic information from prior hospitalizations is a promising option for improving the demographic capitation payment formula. This study suggests that diagnostic information from outpatient utilization is complementary to DCGs in predicting future costs.

Key Words. Risk-adjusted capitation payments, diagnostic information, health insurance, health survey

As in many countries, market-oriented healthcare reforms are high on the political agenda in the Netherlands. 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 financed largely through premium-replacing capitation payments. In 1993, as part of a move to a more market-oriented healthcare system, risk-adjusted capitation payments were introduced in the Dutch public health insurance market for noncatastrophic risks. (For catastrophic risks there is a mandatory national insurance program.) The insurance organizations in the social sector—the so-called sickness funds—were formerly reimbursed for all costs incurred by their members. They now receive risk-adjusted capitation payments.

In the Netherlands the sickness funds provide compulsory health insurance coverage for people in the lowest income brackets (about 60 percent of the population). Until 1993 there were only one or two sickness funds in most regions, so very little real consumer choice existed. Now all sickness funds are functioning nationwide, and new sickness funds have been allowed to enter the market. Since 1994, sickness funds have had the option to contract selectively with providers of care. They are expected to function as intermediaries between the members and the providers. There is a yearly open enrollment period. The benefit package, which is the same for all sickness funds, is broad, virtually without deductibles and copayments (until 1997). Sickness fund members pay a premium that depends largely on income. This premium is collected into a Central Fund from which the sickness funds receive capitation payments based on demographic variables. In a competitive environment, risk-adjusted capitation should induce sickness funds to concentrate more on cost-containment and efficiency than on indulging in risk selection.

The capitation payments should be adjusted for the members' (exogenous) healthcare needs, which are not under the control of the sickness funds. The payment per member is dependent on the risk group to which a person belongs. The risk-adjusted capitation payments should account for

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predictable variations in annual per-person healthcare expenditures, to the extent that these are related to health status. When the risk groups are too heterogeneous, the capitation system is (1) unfair, that is, the system overpays sickness funds with relatively healthy members and underpays others; and (2) it encourages sickness funds to select against people whose healthcare costs are predictably (far) above their capitation payment (Van de Ven and Van Vliet 1992). Various studies have shown that demographic variables are too crude as risk adjusters (Newhouse 1986; Ash, Porell, Gruenberg, et al. 1989; Anderson, Steinberg, Powe, et al. 1990). For this reason the risk-adjusted capitation system in the Netherlands, which is currently based on age, sex, disability, and region, is supplemented with an extensive ex post equalization among the sickness funds. At present this concerns about 75 percent of the costs. This equalization will be reduced within the next few years.

The capitation system can be improved by extending the set of risk adjusters. Various studies have investigated the possibility of improving the capitation model by means of diagnostic information from previous utilization of inpatient services (Ash, Porell, Gruenberg, et al. 1986, 1989; Ellis and Ash 1995; Lamers and Van Vliet 1996; Ellis, Pope, Iezzoni, et al. 1996). The essence of such models lies in the allocation of people to a restricted number of groups according to the diseases diagnosed during prior hospitalizations. This information is incorporated in the capitation payment model as a risk adjuster. The percentage of variance in per-person expenditures *in the next year* that is predicted by such models is substantially higher than that predicted by models that contain demographic predictors only.

Besides (diagnostic information from) prior utilization, perceived health status, functional health status, and chronic conditions, too, are predictors of future healthcare expenditures (Epstein and Cumella 1988). These health status indicators have improved the predictive accuracy of demographic capitation models (Thomas and Lichtenstein 1986; Newhouse et al. 1989; Van Vliet and Van de Ven 1992; Hornbrook and Goodman 1995, 1996). Perceived health status and functional health status measures as well as measures of self-reported chronic conditions are obtained mostly by surveys. In general, health survey information is not routinely collected by sickness funds and is not available in the sickness fund administrative data. Thus, risk adjusters based on survey information are currently inappropriate in the Dutch context. However, health survey information can be used to evaluate the predictive accuracy of capitation models. This article evaluates the predictive accuracy of Diagnostic Cost Group (DCG) models using health survey data.

In a year, about 7 percent of the sickness fund members of all ages are hospitalized; in a three-year period, the proportion is about 17 percent. Diagnostic data from hospitalizations during the three preceding years, in the form of DCGs as developed by Ash and coworkers (1986, 1989), predict future healthcare expenses better than do DCGs limited to the preceding year (Lamers and Van Vliet 1996). The three-year DCG model explains about 8 percent to 9 percent of the differences among individuals in healthcare expenditures. The maximum predictable portion of medical expenditure variation is estimated at about 20 percent (Newhouse et al. 1989; Van Vliet 1992). The fact that the three-year DCG model captures only one-half of the predictable variance implies either that some groups of people with predictably high expenditures have had no hospital admissions within the three-year period or that the DCG classification needs further refinement. In this article we identify subgroups based on health survey data for which the three-year DCG model is unable to predict costs accurately. As the next step we extend a demographic and the DCG capitation models with the relevant survey information and study the effect on the predictive accuracy of the models. The results of this study can give directions for further improvements of the capitation payment system.

DATA AND METHODS

The empirical analysis in this study is based on panel data of a sickness fund at work in the western part of the Netherlands with about 420,000 members. The membership of this sickness fund is globally representative for all 9.7 million Dutch sickness fund members. The data set represents all of the approximately 245,000 individuals who were continuously enrolled with the sickness fund during the four-year period 1988–1991. Recently, information for a sample of children born during that period was added to the data set.

The panel data set contains demographic information on the enrolled members, such as sex, date of birth, zip code, and cause of insurance. The latter information is the compulsory cause for enrollment in the sickness fund, for example, wage earners with a salary below a certain threshold, recipients of disability or unemployment benefits, and elderly people with low incomes. For each member the data set comprises, for the seven years from 1988 to 1994, administrative information on hospitalizations when applicable and annual healthcare expenditures. (For each new member the data set covers four years, from 1991 through 1994.) The annual per-person healthcare expenditures include the costs of inpatient room and board, both inpatient and outpatient specialist care, dental care, physiotherapy, and ancillary services. The costs of drugs prescribed by physicians were not available.[1] The costs of care provided by the general practitioner (GP) are excluded because GPs receive a uniform annual fee for each patient on their list who is enrolled with a sickness fund, regardless of the patient's medical consumption. All cost data refer to actual charges. The mean healthcare expenditures in 1994 in the panel data set are 1,332 Dutch guilders.[2]

About 6.5 percent of the members had one or more hospital admissions in a year. For each hospital admission in the period 1988–1993, the diagnosis is known in the form of the relevant code from the International Classification of Diseases, ninth edition, Clinical Modification (ICD-9-CM). According to these diagnoses, individuals are classified in a DCG on an annual basis. Ash, Porell, Gruenberg, et al. (1986, 1989) developed the DCGs in the United States on data of persons 65 years and older. Because we applied DCGs to Dutch data of both aged and non-aged sickness fund members, a new DCG classification was developed (Lamers, Van Gameren, and Van Vliet 1995). This classification with five DCGs, developed with Dutch sickness fund data, is used in the analysis presented here.

Ambulatory care diagnoses are not collected by sickness funds. Sickness funds enter contracts with providers of care on behalf of their members and do not provide care themselves. In the sickness fund, administration information is available only from a classification for paying ambulatory care. This classification is not informative with regard to disease or health status.

Health Survey

In February–April 1993, a health survey was conducted among a random sample from the panel data set. People who received a questionnaire numbered 14,981. Among them were 13,472 adults between 15 and 90 years old and parents of 1,509 children ages 5–14 years. The parents were asked to complete the questionnaire for their child(ren).

Survey data were compared with administrative data for date of birth and sex to assure that the eligible person and not someone else had completed the questionnaire. Questionnaires completed by someone other than the eligible person were considered nonresponses, resulting in a net response rate for adults of 70.0 percent and for children 75.4 percent. The net response rate for the total sample was 70.4 percent. An analysis of the nonresponse showed that response was associated with age, sex, degree of urbanization, and cause of insurance. Women ages 35 through 74 years were more likely to participate in the survey than were younger women. Men in the younger groups, ages 15–54 years, were relatively less often among the respondents, while relatively more men ages 65–74 years participated in the survey. Higher response rates occurred in rural areas. Among the disabled and other policyholders the response rates were lower than among employed policyholders. The main conclusion from the nonresponse analysis was that, after correcting for differences in demographic variables, nonresponse bias or selection bias resulted in a small overestimate of outpatient care (Lamers 1997).

The questionnaire contained questions about health and medical consumption. The respondents were also asked to give demographic information such as date of birth, sex, respondent's country of birth and that of his or her parents, education, marital status, and the number of persons in the household. The health indicator questions referred to perceived health (single item) and perceived health status (questionnaire with 23 health problems); chronic conditions (a list of 24 chronic diseases); functional disabilities (eight items about functional disabilities in communication and mobility and three items about disabilities in activities of daily living); and body-mass index and psychological unwell-being (five negative items of the Affect Balance Scale). The questions about medical consumption referred to consultation with a general practitioner, specialist, physiotherapist, alternative practitioners, and a dentist. The respondents were also asked how many times they had been hospitalized, whether or not they had used home nursing and home help during the previous 12 months, and if they had used prescribed drugs.

Information from the panel data set containing administrative information could be matched with the health survey data. The answers to the survey questions about contact with a specialist, a physiotherapist, and hospital admissions during the last year could also be compared with administrative data from 1992. Although there was a small time lag, the agreement between survey and administrative data was high for contact with a physiotherapist and a specialist. For hospital admissions the survey data gave higher prevalence estimates than the administrative data. Confusion of day case treatment in the hospital with hospitalizations and recall bias resulted in the overestimation of admissions by the survey (Lamers 1995).

Models

First, a basic capitation payment model was estimated. In this so-called demographic model, which is currently used in the Netherlands, age, sex, degree of urbanization, disability, and employment are the independent variables, and healthcare expenditures in 1994 is the dependent variable. Subsequently, we estimated a one-year DCG model that comprises the variables from the demographic model plus five dummies indicating whether or not an individual was hospitalized in 1993 with a diagnosis belonging to one of the five Diagnostic Cost Groups, the 1993 DCGs. A three-year DCG model was also estimated. For the three-year DCG model, the one-year model was extended with the dummies for the 1991 and 1992 DCGs (see also Table 3 further on).

Since people in the panel were continuously enrolled for at least four years, information for the full three-year base period is available. Only for children born after 1991 was the period for gathering diagnostic information shorter than three years. Since 1992, some people from the panel died and others changed plans, resulting in a yearly loss in the panel data set varying between 2.6 percent (1994) and 3.1 percent (1992). All persons who are enrolled with *Zorg en Zekerheid* on January 1, 1994 are included in the analysis. For those who disenrolled during 1994, the costs are raised to annual rates. At the same time we assigned weights for the part of the year they were in the data set. By applying this procedure, mean costs per person-year for the total data set are not changed.

The models are assumed to be linear in the coefficients and they all include an intercept. They are estimated by means of ordinary least squares, with an individual's annual healthcare expenditures in 1994 as the dependent variable and the various sets of risk factors as independent variables ($N = 52{,}674$). The estimated coefficients are used to predict costs for those who completed the health survey. On the basis of the answers to the health survey various subgroups are formed. For these subgroups predicted costs are compared with actual costs in 1994.

After identifying those subgroups for which the actual costs in 1994 are significantly higher than the costs predicted by the three-year DCG model, we studied which subset of relevant survey variables can improve the predictive accuracy of the three-year DCG model. For this selection, stepwise regression procedures were used. Every capitation model is extended with dummies for the selected survey variables.

To assess the predictive accuracy of the demographic, the one-year and three-year DCG model and the variants of these models extended with survey information, a split-sample method is applied, whereby the data set is divided randomly into two halves, labeled the "estimation data set" and the "prediction data set." The models are fitted in the estimation data set and the estimated coefficients are then used to predict costs in the prediction data set. This cross-validation approach reduces the possibility of over-fitting, both deliberate (inclusion of ever more explanatory variables will inevitably increase R^2-values) and by chance (outliers as high as 200 times the average are rare but possible in healthcare expenditures data and may have a substantial impact on estimated models). For this analysis the data set is restricted to respondents to the health survey only ($n = 10{,}570$). Because of the relatively small size of this data set the split-sample method is repeated 30 times. The ability of alternative capitation models to predict future costs is evaluated in the prediction data set by means of R^2-values and by estimating the predictable profits and losses for groups of good and bad risks.

RESULTS

For subgroups based on the health survey actual costs are compared with the predicted costs of the various capitation models. The aim was to find subgroups of people less healthy than the average for which the actual costs were higher than the costs of even the most comprehensive capitation model. For some of the subgroups based on health survey information the actual costs did not differ significantly from the costs predicted by the demographic model ($p > .05$). The demographic model is able to predict the costs of persons in subgroups like education, marital status, visits to the dentist, and body mass index. Tables 1 and 2 show the differences of actual minus predicted costs for some subgroups based on the health survey. For the subgroups in Table 1 the differences of actual minus predicted costs is statistically significant when costs are predicted by the demographic model. The differences of actual minus predicted costs for subgroups of less healthy persons in Table 1 are not statistically significant when costs are predicted by the three-year DCG model. Apparently, healthcare expenditures in these subgroups can be predicted by the DCG models.

For some subgroups based on the health survey the differences between actual and predicted costs are significantly different even when costs are predicted with the three-year DCG model. The differences between actual and predicted costs for some of these groups are presented in Table 2. Tables 1 and 2 show that the differences between actual and predicted costs diminish when costs are predicted by DCG models compared to the demographic models. For example, for those with poor perceived health, the difference between actual and predicted costs of 900 Dutch guilders (demographic model) is reduced to about 700 and 500 guilders, respectively, when costs are predicted by the one-year and three-year DCG models. All groups in

Table 1: Predicted Minus Actual Costs in 1994 for Various Subgroups Based on the Health Survey

			Predicted Minus Actual Costs in 1994 Mean (s.d.)		
Subgroup	%	*Mean* Actual Costs*	*Demo-graphic*	*One-year DCG*	*Three-year DCG*
0 days in bed due to illness during the last 6 months	61.1	1408	195 (69)	136 (68)	111 (68)
≥ 8 days in bed due to illness	6.8	2322	−796 (279)	−399 (271)	13 (260)
0 health problems (perceived health questionnaire†)	17.3	850	492 (101)	370 (101)	311 (101)
≥ 5 health problems (perceived health questionnaire)	38.2	2164	−335 (119)	−244 (117)	−149 (116)
No psychological unwell-being†	90.7	1429	122 (63)	98 (62)	106 (61)
Psychological unwell-being	9.3	2258	−461 (232)	−344 (226)	−282 (226)
No contact with specialist last year	61.9	882	399 (47)	302 (47)	205 (46)
Contact with specialist last year	38.1	2233	−488 (113)	−343 (111)	−156 (111)
Expect *no* contact with specialist next year	69.1	857	409 (42)	303 (42)	235 (42)
Expect contact with specialist next year	30.9	2511	−671 (134)	−449 (132)	−251 (130)
No hospital admission last year	90.2	1189	229 (48)	147 (47)	56 (47)
Hospital admission last year	9.8	3473	−1585 (313)	−882 (307)	108 (300)
Expect *no* hospital admission next year	95.2	1228	195 (48)	132 (47)	123 (47)
Expect hospital admission next year	4.8	3538	−1763 (413)	−716 (398)	−284 (384)

*For respondents to the health survey, mean costs in 1994 are 1,430 guilders. One US$ is about 2.05 Dutch guilders in March 1998.

†Adults only.

Table 2: Predicted Minus Actual Costs in 1994 for Various Subgroups Based on the Health Survey for Which Actual and Predicted Costs Differ Significantly

			Predicted Minus Actual Costs in 1994 Mean (s.d.)		
Subgroup	%	*Mean* Actual Costs*	*Demo-graphic*	*One-year DCG*	*Three-year DCG*
(Very) good perceived health	79.3	964	320 (42)	256 (42)	216 (42)
Poor perceived health (single item)	20.7	3085	−900 (183)	−715 (180)	−504 (178)
No chronic conditions	35.3	750	405 (57)	319 (57)	248 (57)
≥ 3 chronic conditions	18.0	3144	−1099 (201)	−879 (198)	−646 (195)
No functional disabilities (in mobility and communication)†	90.1	1198	231 (55)	191 (54)	186 (53)
Functional disabilities	9.9	4307	−1414 (305)	−1181 (300)	−986 (296)
No GP visits during last 2 months	48.3	887	391 (62)	299 (61)	257 (60)
Visiting GP ≥ 4 times last 2 months	4.2	3769	−1635 (465)	−1253 (457)	−926 (456)
No use of home nursing during last year	97.6	1321	124 (52)	110 (52)	108 (51)
Use of home nursing during last year	2.4	4847	−2495 (705)	−2225 (689)	−1727 (685)
No use of prescribed drugs during last 2 weeks	58.9	800	340 (42)	266 (42)	230 (42)
Use of ≥ 5 prescribed drugs during last 2 weeks	3.3	5344	−2606 (610)	−2156 (597)	1729 (588)

*For respondents to the health survey, mean costs in 1994 are 1,430 guilders. One US$ is about 2.05 Dutch guilders in March 1998.

†Adults only.

Table 2 have actual costs that cannot be predicted accurately by any of the capitation models. The high actual costs of the groups of persons in poor health in Table 2 seem not to be associated with hospitalizations.

It is likely that the subgroups for which even the three-year DCG model cannot accurately predict the costs overlap to a certain extent. Therefore, we studied which subset of survey variables could improve the predictive accuracy of the three-year DCG model. A subset of eight variables was selected on the basis of stepwise regression procedures. The selected variables were perceived health, having functional disabilities, consulting the GP, use of home nursing, number of prescribed drugs used, having cancer in combination with yes/no under treatment, having diabetes in combination with yes/no under treatment, and the use of medicine for rheumatoid arthritis. Each of the three original capitation models was extended with dummies for these survey variables. Table 3 gives an overview of the risk-adjusters in the various models and shows the R^2-values for the prediction of costs in 1994.

With the demographic model, almost 4 percent of the variance in costs among individuals can be predicted. The predictive accuracy of the demographic model, in terms of R^2-values, improved when the survey variables were included in the model. The one-year and three-year DCG models gave comparable results. The model extended with survey variables yielded the highest R^2-value. The R^2-value for the demographic survey model is about the

Table 3: R^2-Values * 100 for Prediction for Various Capitation Models

Model	*Risk Adjusters*	R^2 * *100**
Demographic model	33 (2 × 17 − 1) age/sex dummies + 4 dummies for urbanization + 1 dummy for disability + 1 dummy for employment	3.78
+ survey	Demographic + dummies for the eight survey variables	6.00
One-year DCG model	Demographic + 5 dummies for DCGs in 1993	6.48
+ survey	One-year DCG + dummies for the eight survey variables	7.89
Three-year DCG model	Demographic + 3 × 5 for DCGs in 1991, 1992, 1993	8.00
+ survey	Three-year DCG + dummies for the eight survey variables	8.64

*The R^2-values are the mean R^2-value of 30 estimations of the models.

same as for the one-year DCG model, a demographic model extended with last year's DCGs. The three-year DCG survey model, the most comprehensive model we estimated, yielded the highest R^2-value with almost 9 percent.

The predicted costs of various models are compared. For each comparison, predicted costs of a "capitation" model are compared with the costs predicted by a more extended "selection" model. We define a "good risk" as a person whose capitation payment, that is, the costs predicted by the capitation model, is higher than the predicted costs of the selection model. For a "bad risk," the opposite holds. Table 4 shows the percentages of good and bad risks for various capitation and selection models as well as the differences between capitation payment minus predicted costs of the selection model concerned. A positive difference implies a predictable profit; a negative difference a predictable loss.

Currently, the capitation payments in the Netherlands are based on the demographic model. Using the demographic model as the capitation model, 10 percent of the members are identified as bad risks based on diagnostic information from hospital admissions in the preceding year with a mean predictable loss of 1,700 Dutch guilders. Based on diagnostic information from hospital admissions in the three preceding years, 15 percent of the

Table 4: Capitation Payment in 1994 Minus Costs Predicted by Selection Model for Good and Bad Risks

				Capitation Payment Minus Predicted Costs by Selection Model		
Capitation Model	*Selection Model*		*%*	*Mean**	*75th Percentile**	*95th Percentile**
Demographic	One-year DCG	Good risks	90.0%	192	238	581
		Bad risks	10.0%	−1717	−2843	−7012
Demographic	Three-year DCG	Good risks	84.8%	338	408	983
		Bad risks	15.2%	−1872	−2550	−6228
Demographic	Demographic plus survey	Good risks	71.0%	434	539	1256
		Bad risks	29.0%	−1082	−1558	−3627
One-year DCG	One-year DCG plus survey	Good risks	71.8%	373	466	1104
		Bad risks	28.2%	−964	−1397	−3250
Three-year DCG	Three-year DCG plus survey	Good risks	70.6%	325	404	997
		Bad risks	29.4%	−796	−1148	−2765

Note: Good risks: costs predicted by capitation model > costs predicted by selection model. Bad risks: costs predicted by capitation model ≤ costs predicted by selection model.

*In Dutch guilders. One US$ is about 2.05 Dutch guilders in March 1998.

persons admitted form the group of bad risks, with mean predictable losses of almost 1,900 guilders. The percentiles presented in Table 4 show that the distributions of predictable losses are very skewed, especially when the one-year or three-year DCG model is used as the selection model. The DCG models seem to capture certain serious diagnoses in the baseline period and can predict the high costs related to these conditions. For the demographic and the DCG models, the predicted costs are compared with the predicted costs of the variants of the models with survey information as selection models. Based on survey information nearly 30 percent of the members form the groups of bad risks. The more extensive the capitation model, the lower the predictable profits and losses based on survey information. The predictable profits dropped from 434 guilders per person (demographic model as capitation model) to 325 guilders (three-year DCG model as capitation model); the predictable losses dropped from 1,082 to 796 guilders per person.

For the comparison of predicted costs of the demographic and the DCG models as capitation models, and the variants of these models with survey information as selection models, we make a distinction, within the groups of good and bad risks, between persons with and persons without a hospital admission in the preceding year (Table 5). Among the good risks, relatively many people with a hospital admission appear. Their predictable profits are higher than for those without an admission, varying from 559 guilders (demographic model as capitation model) to 750 guilders (one-year DCG model as capitation model). The group of bad risks contains many persons without a hospital admission in the preceding year. Their predictable losses vary from 1,023 guilders (demographic model as capitation model) to 760 guilders (three-year DCG model as capitation model).

CONCLUSION AND DISCUSSION

Information about health and medical consumption from a health survey was used to form subgroups. For most of these subgroups actual costs in 1994 no longer differed from the costs predicted when costs were predicted by a DCG model. However, for some groups the difference remained statistically significant even when the costs were predicted with the three-year DCG model. A subset of eight survey variables improved the predictive accuracy of this model. The selected variables were perceived health, having functional disabilities, consultation with the GP, use of home nursing, number of prescribed drugs used, having cancer, having diabetes, and the use of medicine for rheumatoid arthritis.

Table 5: Predictable Profits and Losses in 1994 Based on Health Survey Information as a Supplement to Various Capitation Models for Good and Bad Risks by Hospital Admission in 1993

Capitation Model		Hospital Admission in 1993	%	*Predictable Profits and Losses Based on Health Survey Information* Mean*	75th Percentile*	95th Percentile*
Demographic	good risks	no admission	95.3%	428	532	1232
		admission	4.7%	559	747	1545
	bad risks	no admission	89.9%	−1023	−1471	−3442
		admission	10.1%	−1604	−2300	−4988
One-year DCG	good risks	no admission	94.2%	350	437	1017
		admission	5.8%	750	1000	1792
	bad risks	no admission	92.3%	−923	−1326	−3141
		admission	7.7%	−1464	−2148	−4381
Three-year DCG	good risks	no admission	94.3%	306	378	930
		admission	5.7%	645	876	1648
	bad risks	no admission	92.4%	−760	−1084	−2668
		admission	7.6%	−1226	−1773	−3714

Note: Good risks: costs predicted by model without survey informtion > costs predicted by same model extended with survey information. Bad risks: costs predicted by model without survey information ≤ costs predicted by same model extended with survey information.

*In Dutch guilders. One US$ is about 2.05 Dutch guilders in March 1998.

The currently used demographic capitation model has poor predictive accuracy. The predictive accuracy improved when the demographic model was extended with diagnostic information from prior hospitalizations (DCGs). The predictive accuracy of the demographic model also improved when the model was extended with the selected survey variables. This is consistent with other research (Van Vliet and Van de Ven 1992; Hornbrook and Goodman 1995, 1996). In terms of R^2-values, the predictive accuracy of the demographic survey model and the one-year DCG model are comparable. Extending the one-year DCG with survey information improves the predictive accuracy. Another study showed that the predictive accuracy of a model containing demographic variables and Ambulatory Diagnostic Groups (based on diagnostic information from prior ambulatory healthcare utilization) could be improved by including survey measures of functional health status and chronic conditions (Physician Payment Review Commission 1994). This study showed comparable results for the DCG model.

The predictable profits and losses based on survey information for the one-year DCG model are smaller than for the demographic model. However, predictable losses are still substantial for the three-year DCG model. This suggests that the DCGs and the survey information are complementary to a certain extent in their ability to predict future healthcare expenditures. The survey information seems to capture the predictable high costs of persons in poor health without a hospital admission during the preceding year(s).

Using self-report health surveys for risk adjustment has some disadvantages: it may be administratively infeasible, administration costs are high, and there is a possibility of gaming. In the Dutch context, where risk adjustment is applied on an individual level, these disadvantages will exceed the advantage of increased predictive accuracy. However, in a situation where risk adjustment is applied to population groups (group health insurance) using self-report health surveys has many advantages (Hornbrook and Goodman 1995). In the Dutch context the main disadvantage of using self-report measures like perceived health or functional health status as a risk adjuster is the lack of this information in the sickness funds administrative data. Since sickness funds are not providers of care themselves, they do not collect such information for clinical management. Besides possibilities for gaming, conducting health surveys only for payment purposes results in high administration costs.

As long as sickness funds can identify high- and low-cost members within a risk cell and as long as the funds are able to discriminate effectively between these groups—which results in substantial profits—sickness funds have incentives for "cream skimming." With the administrative information on prior utilization, sickness funds can easily identify groups of members whose expenditures are expected to be far above their demographic capitation payments. One of the adverse effects of cream skimming is that access to good healthcare may be hindered for the chronically ill. Sickness funds have no incentive to invest in good quality of care for these people. On the contrary, sickness funds that do make improvements in this area will attract the chronically ill, resulting in financial losses if the risk-adjusted capitation payments are inadequate, that is, based on the currently used demographic capitation model.

A DCG capitation model should not reward hospital admissions for diagnoses for which the decision to hospitalize may involve high levels of discretion. For the Dutch situation high-discretion diagnoses are those diagnoses for which day case treatment, a form of outpatient care, may be an acceptable alternative to hospital admission. Day case treatment has become popular in the Netherlands during the last decade. Because of the high costs of inpatient treatment, substitution of day case treatment for inpatient admissions was encouraged as a means to cost containment. The incentives for efficiency and cost containment are reduced when a hospital admission of a person who could be treated in an ambulatory setting (e.g., day case treatment) leads to a higher capitation payment next year for this person. In the Netherlands there are no generally accepted lists of diagnoses or procedures for which day case treatment is appropriate for medical reasons. Therefore, in this study hospital admissions for all diagnoses were used in the DCG models. However, when a DCG model will be implemented in the Dutch social health insurance sector, the problem of not rewarding admissions for high-discretion diagnoses should be addressed.

Most persons who can be considered bad risks based on health survey information have not been hospitalized in the preceding year. Even when costs are predicted with the three-year DCG model, the mean predictable losses for this group are almost 800 guilders. To improve the capitation system, the set of risk adjusters must be extended with a measure that captures the predictable high costs of this group. The selected survey variables that could improve the predictive accuracy of the three-year DCG model suggest that diagnostic information from previous outpatient healthcare utilization, such as ambulatory diagnostic groups (Weiner et al. 1991) or the use of prescribed drugs for chronic conditions (Clark, Von Korff, Saunders, et al. 1995) will be complementary to DCGs in predicting future healthcare expenditures. The use of diagnostic information from prior hospitalizations appears to show promise as an option for improving the capitation payment formula. A combination of diagnoses from both inpatient and outpatient healthcare utilization might be even better. The results of this study are relevant not only for situations where competing sickness funds are capitated, as in the Netherlands, but also when providers are capitated, as in the United Kingdom, or when health maintenance organizations are capitated, as in the United States.

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NOTES

1. Until 1996, prescribed drugs were part of the mandatory national insurance program. Since 1996, when prescribed drugs were transferred to the public and private health insurance market, sickness funds have had financial responsibility for the costs of prescribed drugs.
2. One U.S. dollar equaled about 2.05 Dutch guilders in March 1998.

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