Health-Based Capitation Risk Adjustment in Minnesota Public Health Care Programs

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This article documents the history and implementation of health-based capitation risk adjustment in Minnesota public health care programs, and identifies key implementation issues. Capitation payments in these programs are risk adjusted using an historical, health plan risk score, based on concurrent risk assessment. Phased implementation of capitation risk adjustment for these programs began January 1, 2000. Minnesota's experience with capitation risk adjustment suggests that: (1) implementation can accelerate encounter data submission, (2) administrative decisions made during implementation can create issues that impact payment model performance, and (3) changes in diagnosis data management during implementation may require changes to the payment model.

BACKGROUND

Problem

Minnesota began a prepaid managed care demonstration, under an 1115 waiver (Weiner et al., 1998), for its public health care programs in 1985. A key component of this demonstration is that the State pays participating managed care organizations a fixed, prepaid premium or monthly capitation payment for each health plan enrollee. Capitation is defined as a contract arrangement whereby a purchaser agrees to pay health plans a fixed payment per capita/enrollee per month in return for which health plans assume responsibility for the provision of all covered services for their enrolled populations (Hurley, Freund, and Paul, 1993). Health plans are then effectively at risk for additional health care costs that exceed capitation revenues.

There are formally three distinct prepaid public program populations administered by the State of Minnesota: (1) the Prepaid Medical Assistance Program (PMAP), (2) Prepaid General Assistance Medical Care (PGAMC), and (3) Prepaid Minnesota Care (PMNC). PMAP is Minnesota's Medicaid managed care program that serves low-income residents, including Aid to Families with Dependent Children (AFDC)-eligible families, pregnant females, children, and the elderly. PMAP operates in 83 of Minnesota's 87 counties and continues to expand.

PGAMC is a managed care program that serves low-income Minnesota residents who do not qualify for PMAP or other State or Federal health insurance programs. PGAMC primarily serves single or married Minnesota residents between the ages of 21 and 64 who have no children.

PMAP and PGAMC were implemented in 1985. There were approximately 249,000 PMAP enrollees and 28,000 PGAMC enrollees in calendar year (CY) 2000.

PMNC is a subsidized insurance program for Minnesotans who have somewhat greater assets than people eligible for PMAP or

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PGAMC, but no other access to public or private health insurance. PMNC began in October 1992 and converted to a prepaid managed care program in 1996. PMNC is jointly funded by the Federal Government, a 1.5-percent tax on health care provider revenues, and enrollee premiums, which are assessed on the basis of a sliding scale. Approximately 165,000 persons were enrolled in PMNC in 2000. This article focuses exclusively on the PMAP and PMNC programs.

From the inception of these programs and until January 1, 2000, capitation payment rates have been based on combinations of the demographic characteristics, age, sex, prepaid program, region, institutional status, Medicare coverage status, pregnancy status, parental status, and family income. Rates for some programs were further adjusted by region. Over time, experts and policymakers have become increasingly concerned about biased selection, the profit realized by enrolling healthier, low-cost enrollees, and the financial penalties that can result for health plans from enrolling sicker, high-cost enrollees, and generally the inadequacy of demographic-based capitation rate-setting systems (Newhouse et al., 1989; Fowles et al., 1996).

As a result, it has become apparent that the demographic basis of capitation rates does not sufficiently reflect the relative health based risk of prepaid populations. To address this need, a number of methods of measuring population health status have been developed in recent years, supported in part by the Federal Government for possible application to the Medicare Program (Weiner et al., 1996; Ellis et al., 1996; Medicare Payment Advisory Commission, 1998).

Risk-Adjustment Mandate in Minnesota

Proposals to set capitation rates for these programs on the basis of health status-based risk adjustment first surfaced in the Minnesota health policy arena in 1993, as a part of State and national level health care reform proposals (Minnesota Departments of Health and Human Services, 1996). In 1994, legislation was passed that required the submission of a report by the Minnesota Departments of Health and Commerce regarding the implementation of risk adjustment. The report, submitted to the Minnesota legislature in early 1995, recommended the development of a risk-adjustment mechanism for the PMAP, PGAMC, and PMNC programs. Legislation passed during that session required the Minnesota Departments of Health and Human Services to jointly develop the risk-adjustment system, in consultation with a stakeholder advisory committee—the Public Programs Risk Adjustment Work Group (PPRAWG).

Risk-Adjustment Method Evaluation Criteria

The main criterion by which we chose to evaluate risk-adjustment options reflected the fundamental objective of this initiative: to improve the accuracy with which capitation payments are targeted to the illness burden of prepaid populations. Given this objective, a secondary priority was to minimize the administrative impacts of adopting risk adjustment. Given these priorities, the two major criteria by which we chose to evaluate alternative risk-assessment methods were: non-random or skewed group predictive performance and administrative feasibility (Minnesota Department of Health and Minnesota Department of Commerce, 1995). Throughout our evaluation, however, we also monitored individual level predictive performance (i.e., R^2 statistics) for any inconsistencies with non-random group-level results.

Non-random/skewed group predictive performance refers to the relative degree to which alternative risk-adjustment methods can produce unbiased predictions for skewed or non-random subpopulations (Dunn et al., 1996). Methods that underpredict for certain non-random subpopulations and overpredict for others create clear incentives for risk selection, to the extent that the subpopulations are readily identifiable by participating health plans.

By administrative feasibility, we mean the degree to which alternative methods can be implemented efficiently. To maximize administrative feasibility, the State chose to build on existing work in this area, and focus on models and methods that would utilize existing claims, encounter, and eligibility data systems, or minimize changes in those systems wherever possible. In fact, key features of the risk-adjustment model implemented for these programs resulted directly from the adaptation of risk-adjustment methods to the existing capitation ratesetting systems.

PAYMENT MODEL DEVELOPMENT AND KEY CHARACTERISTICS

Selection of Population-Based Method

The State considered two basic types of capitation risk-adjustment methods: (1) targeted conditions methods, and (2) population-based methods. Targeted conditions methods essentially focus on a small subset of specific clinical conditions that are usually treated in inpatient settings, and account for a small fraction of a given population and a significant, but relatively small proportion of expenditures (Managed Risk Medical Insurance Board, 1995). The principal advantage of a targeted conditions method is that it would require the submission of the number of recipients with each of the targeted conditions only each year. This is significantly easier than if conditions typically treated in ambulatory settings were included, because inpatient diagnosis data are usually more accessible. One important disadvantage of such a method, however, is that it creates an incentive to find recipients with the targeted conditions, and reduces incentives for ambulatory care.

Population-based diagnosis classification methods, on the other hand, focus on entire populations. That is, when assessing the risk of any given entity (e.g., enrollees of a benefit plan or health plan), all enrollees would be included in the assessments, including those for whom there was (1) no health care utilization, (2) only ambulatory utilization, or (3) both inpatient and ambulatory utilization during the year. An important advantage of these methods is that they minimize incentives to avoid enrolling people with particular types of conditions, because all enrollees are assessed and a comprehensive array of both ambulatory- and inpatient-based conditions are included. However, one disadvantage is that they require participating health plans to maintain both inpatient and ambulatory data management systems.

Nevertheless, in 1997 the Minnesota Departments of Health and Human Services recommended that the risk-adjustment mechanism should be based on a population-based diagnosis classification method. Once the State narrowed the scope of required encounter data to elements that were uniformly collected across health plans, the participating health plans indicated their support for this recommendation through the PPRAWG.

Selection of ACG Case-Mix System

Three diagnosis classification systems were initially proposed as candidates for the risk-adjustment model—ACGs (then known as ambulatory care groups) (Weiner et al., 1996), diagnosis cost groups (Ellis et al., 1996), and the disability payment system

(Kronick et al., 1996). After some discussion, key stakeholders supported this proposal. Based on considerable preliminary testing we conducted, and studies conducted by others that have addressed the relative predictive accuracy of these methods (Dunn et al., 1996), staff recommended the Johns Hopkins ACG case-mix system as the basis of the risk-adjustment model. Based on those recommendations, and that the ACGs were the most widely used population-based case-mix system, the Minnesota Commissioners of the Departments of Health and Human Services recommended to the legislature that the ACG case-mix system be the basis of the capitation risk-adjustment payment model in the Minnesota prepaid public programs (Minnesota Department of Health, 1998).

At the time, within the ACG case-mix system there were two options for diagnosis classification: ambulatory diagnostic groups (ADGs) and ACGs, now known as adjusted clinical groups (Johns Hopkins University School of Hygiene and Public Health, Health Services Research and Development Center, 2000). The ADG classification system is a multivariate system, whereas the ACG system is a mutually exclusive categorization system. The ACG system was selected primarily because it could be implemented with only minor changes to the existing capitation payment system managed in Minnesota. A model based on ADGs, however, because it would have been a multivariate, additive model, would have required significant changes to those systems. ACGs could simply replace the existing demographic rate cells as new rate cells in the existing payment system.

Implementation

As of January 1, 2000, Minnesota began to phase-in health-based capitation risk adjustment to replace the demographic capitation payment model. In the following, we briefly review the key decisions, and rationales for those decisions, that led to the particular characteristics of the capitation risk-adjustment payment model adopted for Minnesota prepaid public health care programs.

The capitation risk-adjustment payment model implemented by Minnesota to this point is distinguished by three key characteristics: (1) the risk-assessment model is concurrent or retrospective; (2) capitation rates assigned to health plan enrollees are risk adjusted based on historical, health plan level risk scores; and (3) the implementation of capitation risk adjustment is being gradually phased-in over time. These are the three features of the Minnesota risk-adjustment payment model that, taken together, distinguish it from most other risk-adjustment payment models in use at the time (University of Maryland Baltimore County, 2003). Taken together, this type of payment model represented what was viewed as the most efficient method of implementing capitation risk adjustment in Minnesota, given its history and experience with prepaid public health care programs.

Selection of Concurrent Risk-Adjustment Model

Originally, the State planned to implement a prospective risk-adjusted capitation model for these populations. In general, capitation models make payments to health plans for their enrollees based on enrollees' expected level of utilization in advance of their actual utilization of services. A key assumption underlying capitation models is that the relative size of the advance payments is sufficient to cover the actual utilization generated by the covered populations during the covered period. In a demographic (risk-adjusted) capitation model, the relative size of the advance payments is based on the relative levels of expected utilization for various demographic categories (e.g., females, age 18-30).

What distinguishes a prospective risk-adjusted capitation model is that the relative size of the advance payment levels is based on a measure of the prior risk of each enrollee, where the prior risk of each enrollee is captured by explicit measures of their health status from one point in time, to predict their utilization for a later payment period. Enrollee health status is measured based on the diagnoses on their health care claims and encounters from a period prior to the payment period. The risk assessment is defined as prospective because it reflects the ability of an assessment of risk observed during one time period to predict utilization that occurs during a later time period.

When implemented, a prospective risk-adjusted capitation rate is assigned to each health plan enrollee based on the ACG to which they were assigned from their prior diagnosis history. One key advantage of a prospective model is that payment levels assigned to each enrollee can be tailored to their own individual expected level of utilization that can be predicted from their prior health status. Another is that, by focusing on conditions that predict future utilization, they attach importance to chronic versus acute conditions, and thus, encourage more disease management focusing on more manageable (e.g., chronic) conditions (Van de Ven and Ellis, 2000).

One complication of a prospective model, however, is that it requires access to a diagnosis history for current enrollees from a prior risk-assessment period. As a result, new enrollees are effectively not risk adjustable. Therefore, assuming such a model, some other method of developing rates becomes necessary for new enrollees. Further, because a prospective model requires a period of continuous enrollment during the risk-assessment period to increase the reliability of risk assessment (Starfield, 1998), enrollees without the required period of enrollment would also by definition be non-risk adjustable. And, rates for the non-risk adjustable subpopulations would, therefore, need to be based on some other method, such as demographics. Assuming full implementation of prospective risk-adjusted capitation as a replacement of the demographic method, two distinct ratesetting systems would become necessary: (1) the risk-adjusted capitation payment system, and (2) a demographic rate cell system for the non-risk adjustable subpopulations.

Given that fully implementing a prospective risk-adjusted payment model meant substituting two ratesetting systems, for one demographic system, the State selected a concurrent risk-adjustment model for implementation. A concurrent risk-adjustment model is one in which capitation payment levels are based on the current risk of each enrollee. In its ideal form, a concurrent model would be one in which the current risk of each enrollee reflects the ability of enrollee health status observed at one time to predict their utilization from the same time period. Prediction, as it is used here, refers to the measured, systematic ability of explanatory variables (e.g., diagnoses observed during a given period of time), to anticipate observed variation in outcome variables (e.g., utilization observed during the same time period).

The major advantages of a concurrent model are: (1) because diagnoses and services are taken from the same period, predictive performance is arguably higher than for a prospective model, and (2) all enrollees are effectively risk adjustable. The major disadvantage, however, is that because the conceptually ideal form of a concurrent model is based on an assumption of instant access to diagnosis data at the time it is needed to assess enrollee risk, it is not feasible. In particular, because it takes some time to process the claims/encounter records from which the diagnosis data are taken (e.g., 3 to 6 months), the time period from which diagnoses are taken (the risk-assessment period) must necessarily precede the period for which capitation payments are made (payment period). To adapt the concurrent model to this data processing reality, the State developed the concept of the historical, health plan risk score—so that risk assessment could take place prior to, and independent of, the payment period.

Development of the Historical, Health Plan Risk Score

In general, the State defined an historical, health plan risk score as a relative risk score assigned to participating health plans, based on the assessment of the concurrent risk of the member populations from a period prior to the beginning of the payment period. Operationally, historical, health plan risk scores are the mean program specific, concurrent ACG relative risk weight for a given health plan population across all individuals enrolled for 1 or more months in the health plan during the 1-year risk-assessment period ending 9 months prior to the beginning of the payment period. The ACG weights reflect the concurrent relative risk of health plan populations for any given program during the risk-assessment period.

These health plan risk scores are then used to risk adjust statewide, program- specific conversion factors, or base capitation rates. The result is that a fixed or constant capitation rate is assigned to each health plan participating in each program. All members of a given health plan during a payment period are then assigned the same fixed capitation rate assigned to their health plan. Health plan risk scores reflect each health plan's aggregate risk profile for the relevant, prior 1-year risk assessment period—hence the term historical, health plan risk score. To compensate for the fact that the health plan risk scores reflect health plan risk profiles that are, by definition, historical and therefore may not track sufficiently with current costs, the State chose to update these risk scores and payment rates quarterly. In fact, the issue of the inconsistency between enrollee utilization during the payment period and that capitation payments are both constant across all enrollees, and a reflection of a prior member population is significant.

Another important assumption underlying the decision to use the historical, health plan risk score that should be acknowledged, however, is that given the size of the prepaid health plan populations, the State expected considerable stability in the scores over time. For example, for the PMAP population, the size of health plan populations participating in the Twin City metropolitan area ranged from 23,413 to 90,892 enrollees in State fiscal year (FY) 2000. Nevertheless, however, the decision to update the health risk scores and rates quarterly was intended to address changes in these risk scores overtime.

We should also acknowledge the issue created by the use of data regarding all health plan enrollees, irrespective of length of enrollment, when health plan risk scores are based on concurrent risk assessment. Because there is a positive relationship between enrollment length and the reliability of the diagnosis data as a measure of health or morbidity status (Gifford, 2002), requiring a minimum length of enrollment to be considered risk adjustable (e.g., 6 months) should increase the reliability of the diagnosis data used for risk assessments. Although the per member per month (PMPM) risk-assessment method—by weighting observations by enrollment length—appears to address this problem to some degree, we have tested this issue in the discussion section.

Development of Concurrent ACG Weights

Concurrent ACG weights used for CYs 2000-2002 were based on State FY 1996 fee-for-service (FFS) program eligibility and claims data. Minnesota chose to develop ACG weights from data based on its own program populations to ensure that the benefits sets and populations underlying the weights are the same or comparable to current enrollee populations and benefit sets. In State FY 1996, because these programs were operating FFS primarily in nonmetro Minnesota, these weights are arguably not applicable to their prepaid counterparts operating primarily in the Twin City metropolitan area. However, because these data have been the basis of capitation rates for these programs to this point, and because they represented the only data source available for this purpose at the time, the State chose to use them for these programs as the basis of the initial ACG weights.

ACG weights were developed for the combined PMAP and PMNC population which was comprised mainly of pregnant women and children. We combined these populations because several ACGs for these populations were insufficiently populated when weights were calculated for these populations separately, and the benefit sets for these programs are approximately the same. The ACG weights and underlying data for the combined FFS State FY 1996 PMAP/PMNC population are available on request from the author. The weights are based on the mean State FY 1996 PMPM charge for each ACG, for which the charge distribution was truncated at three standard deviations above the mean ACG-specific PMPM State FY 1996 charges.

The decision to truncate charges resulted from the observation of a number of ACGs with both small numbers of enrollees and one or two enrollees for which total State FY 1996 charges far exceeded, and were therefore, not typical of the charges of the other cases assigned to the same ACG. We were concerned both that the: (1) ACG weights would be very unstable; and (2) resulting ACG weights might create a number of ACGs for which the capitation payment would so exceed enrollee actual costs, that an attractive opportunity for gaming the system would be created. Three possible methods for reducing the impact of outliers were compared (Edwards, Knutson, and Gifford, 1999).

In the first simulation, total individual State FY 1996 charges were truncated at $25,000 to simulate a $25,000-per enrollee annual stop loss or reinsurance threshold. Most health plans participating in PMAP in Minnesota carry some form of private reinsurance, and the $25,000 threshold was selected to represent a reasonable approximation of the level of coverage held by health plans. In the second simulation, PMPM charges were truncated at three standard deviations above the mean for each specific ACG. In the third simulation the charge data from all enrollees for whom the standardized residual exceeded 2.0 was removed from the weight calculation.

Results showed that the second method, truncating PMPM charges at three standard deviations above the mean within ACGs, both maximized predictive performance of

Table 1
Projected Changes in Revenues for Health Plans Due to Risk Adjustment Implementation

Health Plan	Degree of Implementation	
	100 Percent Payment Effect	5 Percent Payment Effect
Blue Plus	-15.6	-0.8
Itasca Medical Care	3.2	0.2
Group Health Plan	1.9	0.1
Medica Health Plans	13.3	0.7
UCare Minnesota	2.6	0.1
HealthPartners	-11.7	-0.6
First Plan of Minnesota	1.8	0.1
Metropolitan Health Plan	0.5	0.0

SOURCE: Minnesota Department of Human Services, Payment Policy Division, internal report, October 1999.

the corresponding ACG weights and minimized the exclusion of observed charges from the weight calculation. Thus, truncating charges at three standard deviations above the specific ACG mean prior to the calculation of ACG weights was adopted. To maintain budget neutrality, all charges removed from the payment system as a result of outlier truncation were added to the base rates.

Impact Analysis and Phase-In

Originally, the State planned to simulate the implementation of fully risk-adjusted rates for these programs in CY 1999, during which time capitation payments to participating health plans would continue to be based on the demographic method to give them time to adjust to projected revenue changes. The risk-adjustment payment model was to be fully implemented then in CY 2000. However, rather than introduce health-based risk adjustment immediately, and fully in year one (CY 2000), the State chose to: (1) conduct an analysis of the impact of the new payment model on health plan public program revenues, and (2) phase-in implementation based on the results of that impact analysis.

Impact Analysis

The objective of the impact analysis was to project the degree to which health plan public program capitation revenues would be impacted by 100 and 5 percent implementation. The analysis was based on health plan encounter data covering services provided during the period January 1999-March 1999. This period was selected because it was the longest period of time for which encounter data was available, at the time the impact analysis was conducted. In Table 1, results are expressed in terms of the percentage change in revenues attributable to the implementation of risk-adjusted capitation payment model.

Results indicated considerable variation in both the direction and degree of health plan revenue changes. Because these revenue changes were viewed as significant, full implementation in CY 2000 was considered not feasible. To give health plans time to adapt to these impacts, the State chose to phase-in the risk-adjustment payment model beginning with CY 2000 contracts.

Implementation Phase-In

During the phase-in period, capitation payments for each enrolled individual are set to the weighted sum of two components: (1) a demographic rate cell rate, and (2) a risk-adjusted rate based on enrollees' health plan risk score. Note that the phase-in effectively creates the need to administer two payment models—a risk-adjustment and demographic model. This fact

Table 2

Rate of Risk Adjustment Phase-In, by Calendar Years

Year	Risk Adjustment Weight	Demographic Weight
	Percent	
2000	5	95
2001	30	70
2002	50	50
2003	50	50
2004	50	50

SOURCE: Minnesota Department of Human Services, Payment Policy Division, October 2005.

has implications for the relative advantages and disadvantages the payment model chosen by Minnesota.

The expression below shows the operational formula currently used to calculate capitation payments for enrollees in these programs.

$$\text{Cap Pmt}_{i\,h\,p} = \text{WgtD} \times \text{DemRCWt}_{i\,h\,p} \times \text{RBRate}_{p\,r} + \text{WgtRA} \times \text{HPRS}_{h\,p} \times \text{SBRate}_{p}.$$

where: WgtD = weight assigned to demographic rate cell component of rate;
DemRCWt = existing demographic rate cell weight;
RBRate = regional base rate
WgtRA = weight assigned to risk adjustment component of rate;
HPRS = historical health plan risk score;
SBRate = statewide base rate;
i = individual enrollee;
h = health plan;
r = Minnesota region (i.e., Hennepin County, rest of seven county Twin City area, and rest of Minnesota); and
p = program.

The rate at which risk adjustment has been phased-in over the first 4 years of implementation is summarized in Table 2.

The phase-in was frozen at 50 percent for CY 2003 contracts for a number of reasons: (1) uncertainty associated with the intention to recalibrate CY 2004 ACG weights based on health plan encounter data, (2) steady increases in aggregate program level risk scores, and (3) uncertainty related to the need to upgrade the ACG casemix system from 4.0 to be compatible with current *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) (Centers for Disease Control and Prevention, 2003) code usage.

Calculating Health Plan Risk Scores

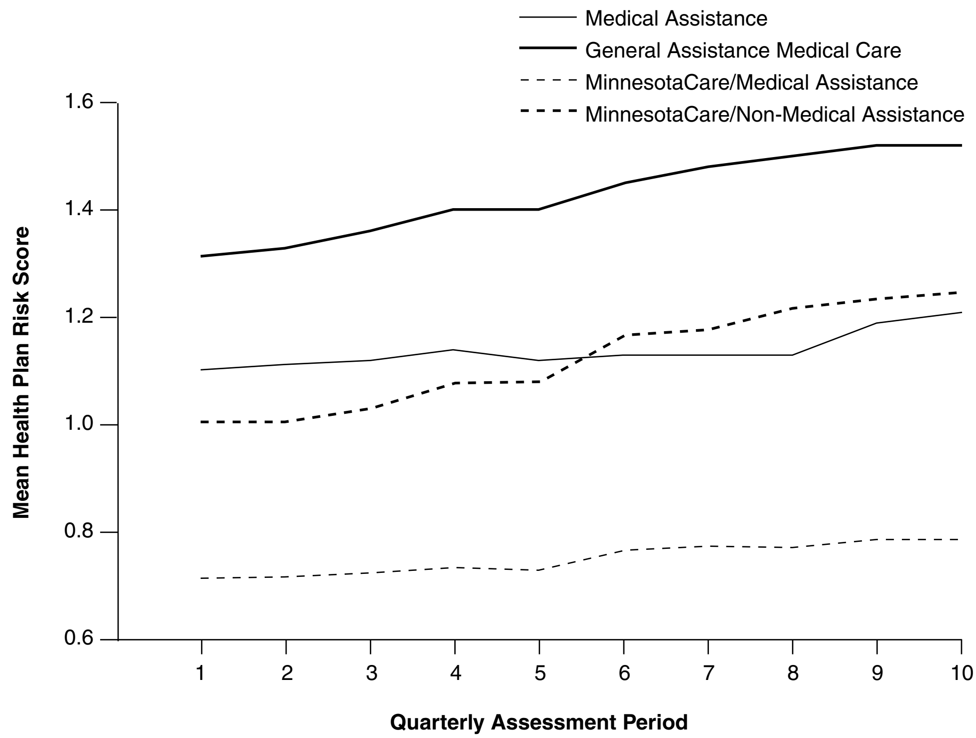
A health plan risk score (HPRS) is the mean program specific ACG weight for a given health plan across all health plan member months, as expressed by the following equation:

$$\text{HPRS}_{h\,p} = \frac{\sum \text{ACGWT}_{\text{pmpm}\,hp}}{\sum \text{Months}_{hp}}$$

where: $\sum \text{ACGWT}_{\text{pmpm}\,hp}$ = the sum of the FFS SFY96 ACG pmpm weights for health plan hp; and $\sum \text{Months}_{hp}$ = the sum of health plan member months for health plan hp.

Operationally, ACG weights are assigned to health plan members based on the ACGs assigned from the diagnoses on the claims and encounter records from the health plan for the services covered by the health plan during the risk-assessment period. We refer to this method as the health plan specific diagnosis assessment method. This method is distinguished from one that would use the diagnoses on the claims and encounter records from all services that occurred during the assessment period across all providers. We refer

Figure 1
Trends in Mean Health Plan Risk Scores, by Public Program: April 1998-June 2001



SOURCE: Minnesota Department of Human Services, Payment Policy Division, June, 2002.
NOTE: Twelve-month period included in quarterly risk assessments used to calculate health plan risk scores (e.g., 1st period 4/1/98-3/31/99 used to calculate risk scores for setting rates for 1/1/2000 - 3/31/2000).

to this method as the all health plan diagnosis assessment method. The decision regarding diagnosis assessment method also raises questions regarding the reliability of the risk-assessment model and has also been the focus of some systematic testing, which we will discuss again later (Gifford, 2001).

Calculating ACG Weights

Finally, the ACG weights assigned to health plan enrollees are the ratio of the mean State FY 1996 PMPM charges for each ACG to the mean State FY 1996 PMPM charge across all ACGs for each FFS State FY 1996 program population, as expressed by the following equation:

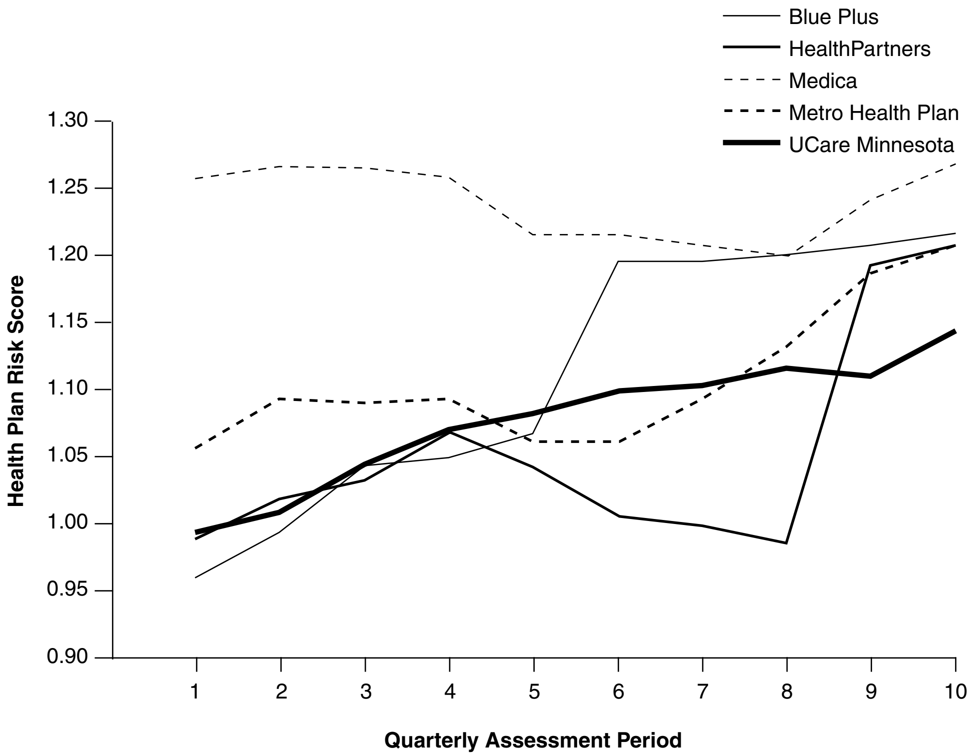
$$ACGWT_{pmpm\ c} = \frac{\text{Mn SFY96 Chg}_{pmpm\ c}}{\text{Mn SFY96 Chg}_{pmpm}}$$

where: $\text{Mn SFY96 Chg}_{pmpm\ c}$ = mean SFY 1996 pmpm charge across all providers for ACG c; and $\text{Mn SFY96 Chg}_{pmpm}$ = mean SFY 1996 pmpm charge across all providers and across all ACGs for a given FFS SFY96 program population.

Program enrollees were assigned ACGs based on all diagnoses observed across all months of enrollment in a given program in State FY 1996, irrespective of enrollment length. Then, as a result of weighting enrollee observations by months of enrollment, the relevant concurrent ACG weight is effectively

Figure 2

Trends in Health Plan Risk Scores, by Health Plan: Medical Assistance, April 1998-June 2001



SOURCE: Minnesota Department of Human Services, Payment Policy Division, June, 2002.

NOTE: Twelve-month period included in quarterly risk assessments used to calculate health plan risk scores (e.g., 1st period 4/1/98-3/31/99 used to calculate risk scores for setting rates for 1/1/2000 - 3/31/2000).

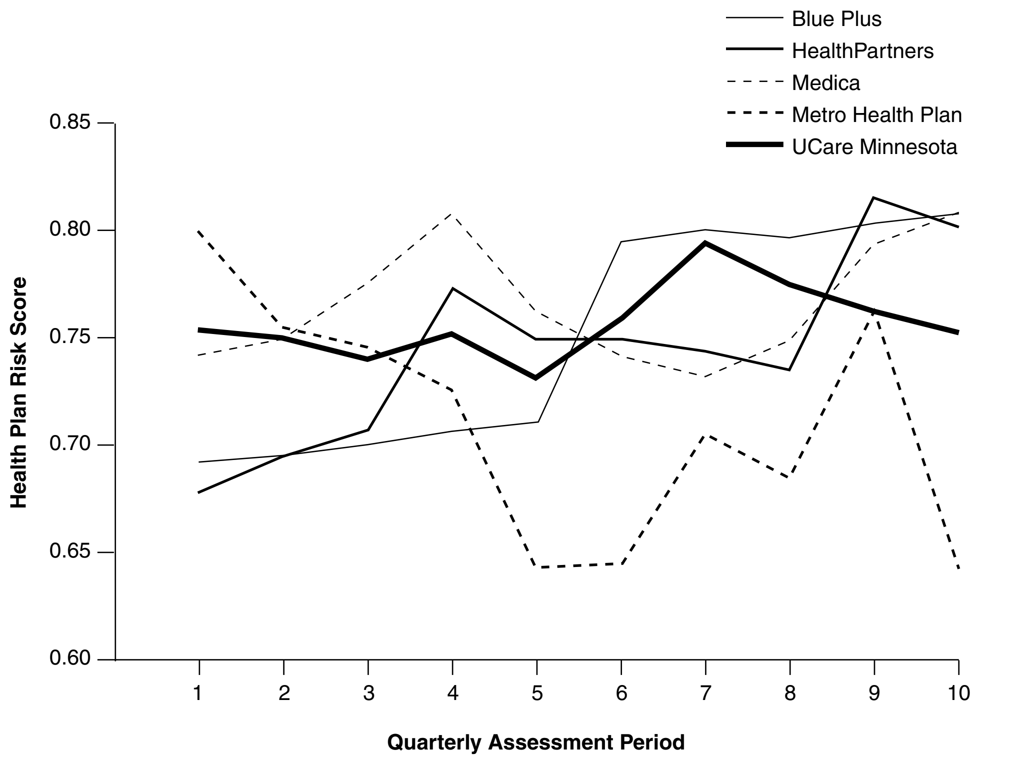
assigned to each month of program enrollment. As a result, within any given ACG, the degree to which the ACG weights reflect the charge data of the assigned enrollees is directly proportional to their length of enrollment.

Figure 1 shows aggregate health plan risk scores for each program across participating health plans. Figures 2 and 3 show health plan risk scores for each of the 10 quarterly risk assessments used to risk adjust capitation payments from January 2000-June 2002 for the PMAP and PMNC programs (Table 3 contains source data). Rates for the first quarter of CY 2000 were adjusted by the health plan risk scores based on the period April 1998-March 1999. Then, rates for the second quarter of CY 2000 were adjusted by health plan risk scores from the period July 1998-June 1999, and so on.

Because health plan risk scores are essentially the mean FFS State FY 1996 ACG weight for a given program, they reflect the risk of prepaid health plan populations relative to the risk of the parallel FFS FY 1996 population. For example, because the mean risk score for the PMAP began at 1.1097, the average risk of the PMAP population, across participating health plans, was approximately 11 percent higher than the combined FFS State FY 1996 PMAP/PMNC MA population (Figure 1).

This finding can be explained to significant degree by two observations. First, the PMAP/PMNC populations were combined

Figure 3
Trends in Health Plan Risk Scores, by Health Plan: MinnesotaCare Medical Assistance, April 1998-June 2001



SOURCE: Minnesota Department of Human Services, Payment Policy Division, June 2002.

NOTE: Twelve-month period included in quarterly risk assessments used to calculate health plan risk scores (e.g., 1st period 4/1/98-3/31/99 used to calculate risk scores for setting rates for 1/1/2000 - 3/31/2000).

when the ACG weights were developed, due to a few small cell/ACG sizes for the PMAP/PMNC population. Because the combined PMAP/PMNC set of ACG weights were used to calculate health plan risk scores for health plans participating in these prepaid programs, and because the PMNC has a higher eligibility income threshold, we expected it to have lower risk relative to the PMAP population.

Regarding patterns in the trends in health plan risk scores, although the overall trend is upward, there were two other observations worth noting. First, a sharp increase in the Blue Plus risk score between assessment periods 5 and 6 corresponds to the time (i.e., approximately late CY 1999 to early 2000) when that health plan improved its encounter data system to include all diagnoses on each claim. Second, a similar sharp increase occurred in the HealthPartners risk score between assessment periods 8 and 9, which was approximately when that health plan made an improvement to its encounter data system.

DISCUSSION

The history, characteristics, and implementation of health-based capitation risk adjustment in Minnesota has identified important issues regarding implementation methods that others evaluating health-based capitation risk-adjustment methods may find useful to consider. Specifically,

Table 3

Trends in Health Plan Risk Scores by Program, Health Plan, and Assessment Period April 1998 to June 2001

Assessment Period	1 4/1998-3/1999	2 7/1998-6/1999	3 10/1998-9/1999	4 1/1999-12/1999	5 4/1999-3/2000	6 7/1999-6/2000	7 10/1999-9/2000	8 1/2000-12/2000	9 4/2000-3/2001	10 7/2000-6/2001
Eligibility Program										
Medical Assistance	1.1097	1.1248	1.1359	1.1504	1.1312	1.1471	1.1459	1.1460	1.1919	1.2119
GAMC	1.3212	1.3419	1.3619	1.4053	1.4013	1.4520	1.4821	1.5001	1.5362	1.5394
MnCare/MA	0.7139	0.7155	0.7208	0.7485	0.7354	0.7779	0.7854	0.7784	0.7916	0.7900
MnCare/Non-MA	1.0131	1.0157	1.0281	1.0789	1.0810	1.1882	1.1996	1.2233	1.2454	1.2569
Medical Assistance (MA) Assessment Period										
Health Plan										
Blue Plus	0.9609	0.9989	1.0428	1.0527	1.0728	1.1910	1.1992	1.2017	1.2165	1.2319
HealthPartners	0.9867	1.0214	1.0360	1.0775	1.0473	1.0125	1.0011	0.9803	1.1934	1.2100
Medica	1.2643	1.2735	1.2699	1.2605	1.2254	1.2202	1.2084	1.1995	1.2461	1.2716
Metro Health Plan	1.0593	1.0951	1.0876	1.0968	1.0622	1.0594	1.0914	1.1340	1.1844	1.2158
UCare Minnesota	0.9954	1.0104	1.0439	1.0796	1.0837	1.1022	1.1062	1.1215	1.1184	1.1425
MinnesotaCare MA Assessment Period										
Health Plan										
Blue Plus	0.6935	0.6955	0.7002	0.7151	0.7187	0.7946	0.8021	0.7981	0.8085	0.8170
HealthPartners	0.6795	0.6950	0.7066	0.7745	0.7518	0.7559	0.7471	0.7349	0.8216	0.8058
Medica	0.7437	0.7521	0.7790	0.8107	0.7650	0.7418	0.7380	0.7535	0.7906	0.8185
Metro Health Plan	0.8040	0.7592	0.7452	0.7243	0.6469	0.6481	0.7095	0.6886	0.7681	0.6403
UCare Minnesota	0.7583	0.7528	0.7418	0.7550	0.7337	0.7675	0.7968	0.7781	0.7667	0.7513
Eligibility Program										
Medical Assistance	1.1097	1.1248	1.1359	1.1504	1.1312	1.1471	1.1459	1.1460	1.1919	1.2119
GAMC	1.3212	1.3419	1.3619	1.4053	1.4013	1.4520	1.4821	1.5001	1.5362	1.5394
MnCare/MA	0.7139	0.7155	0.7208	0.7485	0.7354	0.7779	0.7854	0.7784	0.7916	0.7900
MnCare/Non-MA	1.0131	1.0157	1.0281	1.0789	1.0810	1.1882	1.1996	1.2233	1.2454	1.2569
MinnesotaCare Non-MA Assessment Period										
Health Plan										
Blue Plus	0.9370	0.9437	0.9490	0.9772	0.9933	1.1877	1.2014	1.2305	1.2575	1.2785
HealthPartners	1.0198	1.0247	1.0754	1.2025	1.1773	1.1607	1.1454	1.1498	1.3076	1.3183
Medica	1.1061	1.1263	1.1610	1.2367	1.1914	1.1712	1.1802	1.2025	1.2635	1.2952
Metro Health Plan	1.2004	1.1551	1.1751	1.2172	1.2351	1.2707	1.3533	1.3909	1.4186	1.3910
UCare Minnesota	1.1444	1.1394	1.1356	1.1591	1.1659	1.2304	1.2331	1.2475	1.2125	1.2208
General Assistance Medical Care Assessment Period										
Health Plan										
Blue Plus	1.0182	1.0798	1.0979	1.1243	1.1103	1.3011	1.3528	1.3905	1.4272	1.4612
HealthPartners	1.2820	1.3092	1.3578	1.3724	1.3537	1.3174	1.2923	1.3052	1.4940	1.4800
Medica	1.4158	1.4437	1.4651	1.5085	1.5113	1.5771	1.6469	1.6574	1.6760	1.6597
Metro Health Plan	1.5052	1.5091	1.5225	1.5973	1.6025	1.6139	1.6098	1.6386	1.6868	1.7136
UCare Minnesota	1.2062	1.2391	1.2811	1.3241	1.3433	1.3602	1.3919	1.4054	1.3878	1.4355

SOURCE: Minnesota Department of Human Services, Payment Policy Division, internal report, October, 1999.

the Minnesota experience suggests that: (1) multisite encounter-data collection is feasible; (2) important decisions regarding the implementation of concurrent versus prospective, and health plan level versus individualized risk-adjustment models, are likely to be affected by the relative importance of various administrative issues; (3) the implementation of health-based capitation risk adjustment identifies many operational issues and related decisions that can significantly affect model performance; and (4) increases in population risk scores in early stages of implementation strongly suggest the need for adjustments to the payment model to compensate.

Multisite Encounter Data Collection

Risk-adjusted capitation payment models based on diagnosis data for conditions typically treated in inpatient settings have been criticized for not predicting costs adequately, and reducing incentives for ambulatory care. As a result, although efforts are underway to include diagnoses from outpatient settings in risk-adjustment payment models, the health plan industry has cited the burden of such a requirement (Medicare Payment Advisory Commission, 2002). The Minnesota experience strongly suggests that the burden of outpatient encounter data collection is not sufficient to preclude the systematic collection of multisite claims and encounter data.

Explicitly defining the purposes of encounter data collection serves to clearly delimit its possible uses, and thereby reduce significant disincentives to submit the data. Historically, even though the PMAP has been operating since 1985, and health plans were contractually obligated to submit encounter since then, its submission was uneven. One major problem was that because the data was being collected for multiple purposes, uncertainty about undefined possible uses made compliance appear hazardous to participating health plans. Once the required data elements were restricted to just those needed for specified purposes (e.g., quality assurance, risk adjustment), and those uniformly available across participating health plans, the collection of the encounter data became accelerated. However, when it became clear that capitation payments were about to be based on encounter data, its submission was greatly accelerated.

Therefore, the policy decision to base capitation payments on diagnoses from health plan claims and encounter data clearly created a powerful incentive to submit the data. However, we also should emphasize that Minnesota's selection of a concurrent model added to the incentive for encounter data submission.

Concurrent Versus Prospective Models

In a concurrent model, health plan members for whom there were no claims or encounter records for a given assessment period are assigned a relative risk score of zero (0.0). As a result, health plans learned early that health plan risk scores for health plans unable to submit the required encounter data would be effectively set to 0.0. Admittedly, health plan risk scores for health plans that do not submit encounter data under a prospective model, would also be very low. However, when health plan representatives noticed the weight for the non-user cell (i.e., ACG 5200) was 0.0, their sense of urgency regarding the encounter data appeared to increase substantially. Consequently, it became clear early that the prospect of health plan risk scores = 0 was both a distinguishing characteristic of the concurrent model chosen by the State, and a feature of the payment model that appeared to add to the incentive to submit encounter data.

At this point we should emphasize that the decision to include all enrollees, irrespective of enrollment length, in the concurrent risk-assessment model creates a possible payment model performance issue. Recall that in the concurrent risk-assessment model chosen by the State, all individuals enrolled in a health plan for 1 or more months are risk adjustable. However, diagnoses records for individuals with very short lengths of enrollment are likely to be a less reliable measure of their health/morbidity status than for enrollees with longer lengths of enrollment. We have found that although the PMPM method of risk assessment in a way corrects for this problem to some extent, a per member (PMbr) risk-assessment method can adjust for this issue explicitly (Gifford, 2002).

In addition, we want to be clear that one possible advantage of prospective models, over risk adjusting using historical, health plan risk scores, is that they assign payments that are uniquely tailored to the prior risk profiles of each health plan enrollee. As a result, a prospective model is more likely to assign payments to enrollees that are more consistent with their utilization that occurs during the payment period than the historical, health plan level concurrent model, although we know of no empirical evidence to support this hypothesis.

Finally, as a result of the decision to phase-in implementation, the advantage of a single payment system under the historical, health plan level concurrent model versus two under a prospective model diminishes to some degree. Under phase-in, although both models would require both a demographic- and diagnosis-based model, a prospective model would require effectively two demographic payment models: (1) one for the non-risk adjustable subpopulation, and (2) one to accommodate the percentage of the payment that is based on demographics during phase-in—or a total of three payment systems. However, we should recognize that the long-term objective is to phase-out the less accurate demographic model, so that when the risk-adjusted payment model is fully implemented, the historical, health plan level concurrent model will become a single payment system.

Health Plan Versus Individualized Payment Models

The decision to base capitation payment rates on the historical, health plan risk score clearly makes the administration of the concurrent risk-adjustment method more feasible. However, the appropriateness of the model is based on the assumption that, barring major changes in the composition of the participating health plan populations, there is considerable consistency in overall health plan risk scores over time. To the extent this assumption is false, such a model may not track with current aggregate costs as well as a prospective model, even with quarterly updates. In fact, in response to this issue, the State briefly considered a retrospective reconciliation—or settle up as they referred to it—between capitation payments and actual costs from the payment period. Yet the concept was rejected out of concern that it might set an ill-advised precedent. The plan was to effectively settle up for differences between efficiency standardized costs incurred during the payment period and capitation payments. However, due to apprehension that such a policy might invite requests to reconcile payments with costs that may be driven by inefficiency, the idea was rejected.

In addition, we also believe that as a result of the diagnosis assessment method chosen by the State in implementing the historical, health plan risk score, there may be an issue as to whether or not the predictive accuracy of the payment model could be improved. More specifically, because health plan risk is assessed for the 1-year period ending 9 months prior to the beginning of the payment period, there is sufficient time for all (or nearly all) claims and encounter data submissions for the period to be finalized and processed. In fact, we believe that it is the combination of historical, health plan risk scores based on a concurrent model that makes it feasible to implement a risk-adjustment payment model applicable to all enrollees, irrespective of enrollment continuity. And, the quarterly updates introduce sufficient consistency between current and historical risk to make it acceptable to participating health plans.

However, although by adopting the health plan risk score, the health plan specific diagnosis assessment method is a logical operational decision, we suspect it may create a payment model performance issue. In particular, the decision to use only those diagnoses on claims and encounters covered by the health plan for which a risk score is being calculated—health plan specific diagnosis assessment—may compromise the ability of the risk assessment to accurately characterize the morbidity burden of populations. This method contrasts with what we refer to as an all health plan diagnosis assessment method.

Payment Model Performance Issues

One issue results from the selection of what we referred to as a comprehensive concurrent model, in which all enrollees irrespective of enrollment length are included in risk assessments. The issue is the following: because we know that within a 1-year risk assessment period there is a positive relationship between enrollment length and the reliability of diagnoses as a measure of health status, with the PMPM risk-assessment method, the accuracy of risk assessments declines with enrollment length. Assuming some optimal enrollment length threshold for reliable risk measurement, when enrollment length declines below that threshold, the hypothesis is that individuals' true morbidity status is not being given sufficient opportunity to manifest itself. We propose that the two characteristics of the PMPM method of calculating relative risk measures that augment this phenomenon are: (1) health plan member or program enrollee observations are effectively weighted by member months or months of enrollment when calculating weights, and (2) the sum of total utilization incurred PMbr per (risk assessment) period is effectively converted into mean monthly figures per member (i.e., PMPM) (Wrightson, 1990).

Although weighting enrollee observations by enrollment length necessarily counteracts the effects of the positive relationship between enrollment length and the reliability of diagnoses as a measure of health status within a given level of risk, it also means that predictive performance declines with enrollment length. Therefore, when programs are affected by significant enrollment turnover or variation in average enrollment length between health plans, predictive performance for the participating health plans will be affected. In addition, in developing the ACG weights, as enrollment length declines, the step of converting total utilization over the enrollment period into monthly figures results in relative risk weights that are arguably less reliable measures of enrollees' typical monthly utilization than for individuals enrolled for longer periods.

In fact, the issue of the relationship between error in measuring the true morbidity status of individuals and the length of the diagnosis observation time period is, we suggest, implied in the conceptual/clinical basis of the development of the ACG case-mix system—the clustering of morbidity concept. One of the original clinical developers of the ACG system, has argued that risk measurement methods based on the presence of particular diagnoses are less likely to successfully characterize population morbidity than are methods based on morbidity clusters (Starfield, 1998). One possible explanation is that combinations of conditions (i.e., morbidity clusters) interact in ways that may not be sufficiently accommodated by methods that focus on the presence of particular diagnoses, but which may only emerge in clinical records over relatively long periods of time.

Irrespective of the mechanism, however, Starfield argues that a method that categorizes combinations of diagnoses experienced by populations in a period of time (usually a year) is more likely to best characterize the morbidity burden of populations than one that focuses on the occurrence of individual diagnoses. For these reasons, the very conceptual basis of the ACG case-mix system appears to argue that to maximize the accuracy with which we measure the morbidity status of populations we should focus on capturing clusters or combinations of conditions. And, it is arguable that these diagnosis clusters, by virtue of their sheer complexity, are more likely to evidence themselves in diagnostic records as the length of the enrollment period over which diagnoses have been recorded increases. Therefore, as enrollment length decreases, the ability of diagnoses to accurately reflect population morbidity declines, and the PMPM method augments this problem for the reasons previously cited.

As an alternative, the Johns Hopkins University (2000) ACG development team has suggested that the PMbr risk assessment method fundamentally alters this measurement phenomenon. With respect to the methods used in calculating ACG weights, its distinguishing features are (1) member observations are not weighted by member months—the unit of observation is the health plan enrollee or member, (2) the weights and relative risk measures are based simply on total utilization incurred PMbr per year, and (3) the use of an adjustment factor that compensates for the relationship between enrollment length and the reliability with which diagnoses reflect population morbidity. In fact, in testing we performed comparing the predictive performance of the PMPM and PMbr methods, the PMbr method predicted both monthly and total utilization more accurately than the PMPM method across the full range of enrollment length. We argue that the PMbr method measures risk more accurately than the PMPM method because the emphasis (weight) is on people, not months; and that it accommodates the hypothesis that as enrollment length declines, the reliability with which measured risk reflects true risk declines by adjusting risk scores upward correspondingly to compensate (Gifford, 2002).

Health Plan Specific Method

A second payment model performance issue is a possible relationship between the reliability of diagnosis-based risk assessments and the choice between the health plan specific versus all health plan diagnosis assessment methods. In fact, the decision to employ a health plan specific diagnosis assessment method may be a natural, logical consequence of the decision to risk adjust capitation on the basis of historical, health plan risk scores. Because we are trying to measure the prior, concurrent risk of health plan populations, it makes sense to restrict the diagnosis data to that which was on the claims and encounter records for services provided during the period when members were enrolled with the health plan for which a risk score is being calculated. Conceptually, the argument is why should we give health plan B credit for the delivery of a baby that was covered by health plan A.

Operationally, this means that when calculating the risk score for a given health plan, only those diagnoses submitted by that same health plan are used to assign ACGs and ACG weights to the health plan members. However, during any given risk-assessment period, some members of a given health plan member population are also members of another health plan at different times (e.g., as a result of changing health plans during open enrollment). And, although the diagnoses from all the health plans of which Minnesota public program enrollees were members during a given risk-assessment period are available for use in assigning health plan member ACGs, ACG weights, and calculating health plan risk scores, the State currently does not do so. We would refer to such a method as an all health plan diagnosis assessment method. In fact, when we conducted an early test of health plan risk score sensitivity to these alternatives, we found that when health plan member populations are enrolled in multiple health plans in significant numbers, risk scores are meaningfully affected (Gifford, 2001).

However, health plan risk score sensitivity to these methods does not indicate performance differences. In fact, we have not yet tested the relative predictive performance of the all health plan versus the health plan specific methods because recorded charges and payments in the encounter data have not yet been validated, nor have decisions regarding whether or not to price or assign relative values to these data been made.

Once that is accomplished, however, we plan to evaluate the relative accuracy with which each of these methods can predict actual efficiency standardized health plan utilization based on encounter data. In these studies, health plan level predictive performance will be tested by comparing mean predicted utilization to mean actual health plan utilization due solely to risk mix, after controlling for health plan variation in mean utilization within risk (ACG) cell. By controlling for health plan variation in mean utilization within risk cell, we will then compare predicted capitation to mean observed utilization, net of sources of variation in mean utilization for each health plan other than risk or morbidity burden (e.g., efficiency differences).

One hypothesis is that the all health plan method is a better measure of risk simply because it is closer to the goal of assigning all diagnosis codes assigned by providers during a predetermined period of time, the method of assembling diagnoses for ACG assignment recommended by Starfield (1998) and the Johns Hopkins University (2000) ACG development team. This hypothesis is based on the assumption that any decision that increases access to the full array of diagnoses assigned during a given assessment period will in turn increase the likelihood that the combinations of conditions present in populations are given the opportunity to express themselves. The all health plan method may be a better measure simply because it broadens the diagnosis assessment window and increases the chances of capturing the morbidity clusters of populations, versus the occurrence of particular diagnoses at particular points in time.

However, the competing hypothesis is that the diagnoses recorded by the health plan accurately reflect more often than not the problems for which members were treated during the assessment period. Thus, while the issue may reduce to the relative prevalence of acute versus chronic or persistent conditions in these populations, only by empirically testing the relative predictive performance of these methods for the relevant populations, will the issue be resolved.

Risk Scores and Payment Model Characteristics

Finally, a key objective in implementing a capitation risk-adjustment mechanism is to compensate for valid and reliably measured variation in the relative risk among participating health plans, but not for either variation in those measures that does not reflect risk, or inaccuracy in those measures. As a result, now that this payment system has been operating for some time, the issue of the degree to which trends in these scores reflect valid and reliable increases in health-based risk versus phenomena other than risk, and/or other population or systemic changes has important State payment policy implications.

For instance, differences in trends in risk scores among health plans, combined with observations regarding differences among health plans with respect to data systems, suggest that data system characteristics can have significant impacts on health plan risk scores. In addition, it is entirely conceivable that with the advent of payment being tied to the comprehensive recording of diagnoses by providers, increases in aggregate risk scores may simply reflect better diagnosis coding by providers. The implication of this would be that rising trends in health plan risk scores are in part indications of a reduction in measurement error, not true increases in the risk of these populations, for which the risk-adjustment mechanism was never intended to pay. However, some portion of these trends can be attributed to true increases in the sickness of these populations over time. In either case, once the State determines the relative degree to which these trends reflect measurement error versus true changes in the relative risk of these populations over time, the payment model will need to be adapted correspondingly to compensate.

Next Steps

Given (1) the dated nature of the ACG case-mix system currently in use, (2) that the FFS State FY 1996 data underlying the ACG weights are both dated and do not represent the current prepaid program populations, and (3) steady increases in the program level risk scores, the State intends to update the payment model for CY 2006 contracts. To address the first issue, the State intends to upgrade to ACG version 6.0 which will accommodate more current ICD-9-CM code usage. To address the second, the State completed an encounter data validation study and is updating ACG weights using Federal fiscal year 2002 encounter data for use in 2006 contracts. Regarding the third, the State is acutely aware of the need to make changes to the payment model, in particular the base rates, because, at the time, it had yet to adjust the base rates to compensate for rising program level risk scores, and the State's expenditures for its prepaid programs were steadily increasing. Finally, when the encounter data becomes available, we are encouraging the State to use it to evaluate the payment model performance issues previously identified for use in future implementations.

CONCLUSIONS

The following result from our participation in implementing health-based capitation risk adjustment in Minnesota. First, participating health plans (1) appreciate the use of explicit measures of health status in capitation ratesetting, and (2) as a result are willing to invest in making the necessary changes to their claims and encounter systems. Second, the choice between a health plan level concurrent versus individualized prospective model is significant, and centers largely on the importance of the consistency between capitation payments and costs incurred in the payment period. Third, in the process of implementing health-based capitation risk adjustment, important issues regarding operational decisions that may have significant effects on the performance of the payment model are likely to be raised. Fourth, because health-based capitation risk adjustment ties diagnoses to capitation payments, changes to diagnosis coding and management are likely to occur in the initial stages of implementation. As a result, the composition of changes in aggregate risk scores over time (e.g., real versus measurement error) will be an empirical issue bearing directly on possible changes to the payment model during early stages of implementation.

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REFERENCES

Centers for Disease Control and Prevention: *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM). Internet address: http://www.cdc.gov/nchs/about/otheract/icd9/abticd9.htm. (Accessed 2004.)

Dunn, D., Rosenblatt, A., Taira, D., et al.: Evaluation and Comparison of Risk Assessment Methods—Predictive Accuracy. *A Comparative Analysis of Methods of Health Risk Assessment*. Society of Actuaries, 1996.

Edwards, K., Knutson, D.J., and Gifford, G.: *Risk Adjustment and the Impact of Outliers on Prospective Risk Models: Differential Methods of Determining Where, When, and How to Cut the Edge*. Presented at the 1999 Minnesota Health Services Research Conference. Minneapolis, MN. February 23, 1999.

Ellis, R., Pope, G., Iezzoni, L., et al.: Diagnosis-Based Risk Adjustment for Medicare Capitation Payments. *Health Care Financing Review* 17(3):101-128, Spring 1996.

Fowles J., Weiner J.A., Knutson D.J. et al.: Taking Health Status into Account When Setting Capitation Rates: A Comparison of Risk-Adjustment Methods. *Journal of the American Medical Association*. 276(16):1316-1321, October 23-30, 1996.

Gifford, G.: *Health Plan Risk Score Sensitivity to Health Plan Specific vs. All Health Plan Risk Adjustment Methods*. Prepared for the Public Programs Risk Adjustment Work Group. St. Paul, MN. March 7, 2001.

Gifford, G.: *A Test of a 'Member' Based Method of Risk Adjusting Capitation*. Presented at the Sixth Annual Minnesota Health Services Research Conference, Minneapolis, MN. February 26, 2002.

Gifford, G.: VanCleave, E., Oberstar, J., et al.: *Understanding the Role of Risk in Regional Expenditure Differences: Implications for Capitation Rate Setting*. Presented at the Third Annual Minnesota Health Services Research Conference, Minneapolis, MN. February 23, 1999.

Hurley, R.E., Freund, D.A., and Paul, J.E.: *Managed Care in Medicaid—Lessons for Policy and Program Design*. Health Administration Press. Ann Arbor, MI. 1993.

Johns Hopkins University School of Hygiene and Public Health, Health Services Research and Development Center: *The Johns Hopkins ACG Case-Mix System—Software Documentation & Application Manual*. Version 4.5. Baltimore, MD. February 2000.

Kronick, R., Dreyfus, T., Lee, L., and Zhou, Z.: Diagnostic Risk Adjustment for Medicaid: The Disability Payment System. *Health Care Financing Review* 17(3):7-33, Spring, 1996.

Managed Risk Medical Insurance Board: *Methods for Calculating and Applying Risk Assessment and Risk Adjustment Measures*. Health Insurance Plan of California Working Paper. San Francisco, CA. 1995.

Medicare Payment Advisory Commission: Risk Adjustment. Chapter 2 in *Report to the Congress: Medicare Payment Policy, Volume II*: Analytic Papers. Washington, DC. March 1998.

Medicare Payment Advisory Commission: How Medicare Pays for Services: An Overview. Chapter 1 in *Report to the Congress: Medicare Payment Policy*. Washington, DC. March 2002.

Minnesota Departments of Health and Human Services: *Risk Adjustment in Public Programs—A Progress Report to the Legislature*. St. Paul, MN. January 1996.

Minnesota Department of Health and Minnesota Department of Commerce: *Risk Adjustment: Report from the Commissioner of Health and the Commissioner of Commerce to the Legislature*. St. Paul MN. January 1995.

Minnesota Department of Health: *Risk Adjustment and Rate Setting Methods in Public Programs—A Report to the Legislature*. January 1998.

Newhouse, J.P., Manning, W.G., Keeler, E.B., and Sloss, E.M.: Adjusting Capitation Rates Using Objective Health Measures and Prior Utilization. *Health Care Financing Review* 10(3):41-54, Spring 1989.

Starfield, B.: Morbidity and Primary Care. In: *Primary Care—Balancing Health Needs, Services, and Technology*. Oxford University Press. New York. 1998.

University of Maryland Baltimore County: *A Guide to Implementing a Health-Based Risk-Adjusted Payment System for Medicaid Managed Care Programs*. Centers for Medicare & Medicaid Services. Baltimore, MD. March 2003. Internet address http://www.cms.hhs.gov/medicaid/managedcare/default.asp. (Accessed 2005.)

Van de Ven, W. and Ellis, R.: Risk Adjustment in Competitive Markets. In Culyer, A., and Newhouse, J. (eds.): *Handbook of Health Economics*. Elsevier Science B.V. Amsterdam. 2000.

Weiner, J.A., Dobson, A., Maxwell, S. et al.: Risk-Adjusted Medicare Capitation Rates Using Ambulatory and Inpatient Diagnoses. *Health Care Financing Review* 17(3):77-99, Spring, 1996.

Weiner, J.A., Tucker, A., Collins, A., et al.: The Development of a Risk-Adjusted Capitation System: The Maryland Medicaid Model. *Journal of Ambulatory Care Management* 21(4):29-52, October 1998.

Wrightson, Jr., C.W.: Capitation Rate Development: The Actuarial/Fee-for-Service Method. In: *HMO Rate Setting & Financial Strategy*. Health Administration Press. Ann Arbor, Michigan. 1990.

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