# A Comparative Analysis of Claims-based Methods of Health Risk Assessment for Commercial Populations

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# Section I. Introduction

### Introduction: The use of Claims-based Risk Assessment Continues to Grow

The use of health risk assessment methods based on medical diagnosis codes from administrative claim data continues to grow. The federal government has implemented a process that uses medical diagnosis codes to adjust payments to Medicare+Choice contractors. Numerous states have implemented methods that use medical diagnosis codes to adjust payments to managed care plans for Medicaid enrollees. Diagnosis-based methods of risk assessment have also been used by employers in analyzing how employee contributions should vary by choice of provider or health plan. Health insurers are increasingly using, or are considering using, diagnosis or pharmacy-based methods of risk assessment for provider profiling, case management, provider payment, and rating/underwriting.

There has also been a significant increase in the activity and interest in risk assessment methods that rely on pharmacy information from administrative claim data. A number of researchers have recently developed pharmacy-based risk assessment methods, and a number of others are planning to develop such methods. This is a reflection of the advantages of pharmacy data over medical diagnosis data. In general, the advantages are that pharmacy data is timelier, more complete, and less costly to collect and validate. At the same time, concerns have been raised regarding pharmacy-based risk assessment methods, including the ability to keep pace with rapid changes in drug technology and the ability to manipulate risk assessment scores if the methods are not sufficiently sensitive to gaming.

The strong interest and potential growth in "consumer-driven" health plans (e.g., defined contribution plans) may also increase the need for more accurate health risk assessment. Many of these health plans involve giving the employee more responsibility and more choice in benefit plan offerings. With increased choice comes the possibility of significant differences in health status among the pools of employees that select a given benefit plan option. Accordingly, it will be even more important to understand and quantify differences in health status when analyzing the cost efficiency of different health plans for the purpose of establishing employee contribution requirements. Adjusting for health status selection is also important in analyzing the impact of these new plans on the employer's overall cost for health benefits.

### Definitions

To provide a framework for this study, *risk adjustment* can be defined as the process of adjusting payments to health plans or health care providers in order to reflect the health status of the members. Risk adjustment is commonly described as a two-step process. The first step involves *risk assessment*, which refers to the method used to assess the relative risk of each person in a group. The relative risk reflects the predicted overall medical claim dollars for each person relative to an average person. The second step in the risk adjustment process is *payment adjustment,* which refers to the method used to adjust payments in order to reflect differences in risk, as measured by the risk

assessment step. It is common to refer to a particular risk assessment method as a *risk adjuster*.

## Background: Why is Risk Adjustment Important?

The use of diagnosis and pharmacy-based methods of health risk assessment for payment and for profiling reflects the desire to provide equitable compensation and make appropriate comparisons. This is necessary since the health status of enrollees can vary significantly across health plans and health care providers. One major goal of risk adjustment is to induce health plans and providers to compete on the basis of efficiency and quality, rather than selection. A second major goal is to preserve choice for consumers and have consumers pay an appropriate price for their choice of health benefit plan.

## Purpose of Study: Provide an Independent Comparison of Currently Available Risk Adjusters

The purpose of this study is to provide an independent comparison of several currently available risk adjusters. Specifically, the primary goals of this study include:

1. Comparison of the predictive performance of several recently developed pharmacy-based risk adjusters.
2. Comparison of the predictive performance of several commonly used diagnosis-based risk adjusters.
3. Comparison of the performance of pharmacy-based risk adjusters with diagnosis-based risk adjusters.

The secondary goals of this study include:

1. Comparison of predictive performance using risk weights provided with the models with risk weights developed from the data set used for this study.
2. Comparison of the performance of the risk adjusters with prospective and concurrent applications.
3. A test of two risk adjusters originally developed for Medicaid populations on commercial populations.
4. Analysis of the change in performance of diagnosis-based risk adjusters since publication of the 1995 Society of Actuaries study.
5. Introduction and analysis of a new measure of predictive accuracy which has advantages over the current commonly used measures.

Many of the pharmacy-based risk adjusters have been developed recently. Some of the diagnosis-based risk adjusters have undergone significant modifications over the last few years and new diagnosis-based risk adjusters have been developed.

The most recent comprehensive study, completed by the Society of Actuaries, was published in 1995. Most of the more recent studies do not provide comprehensive comparative results, since they examine only results for a single risk adjuster or are limited to 2 or 3 risk adjusters.

This study should provide useful information to payors and insurers for evaluating diagnosis and pharmacy-based risk adjusters.

### Other Considerations in Selecting a Risk Assessment Model

This study focuses on evaluating the predictive accuracy of health-based risk assessment models. While improved accuracy is the primary reason for implementing any health-based risk adjustment model, other criteria should be considered when selecting a model. These include: 1) ease of use of the software, 2) availability of standard reports, 3) cost of the software, 4) access to data of sufficient quality, 5) the underlying logic or perspective of a model that makes it best for a specific application, 6) whether the model provides both useful clinical as well as financial information, 7) whether the model will be used mostly for payment to providers/plans or for underwriting/rating/case management, 8) the reliability of the model across settings, over time or with imperfect data, 9) whether the model is currently in use in the market or organization, and 10) the susceptibility of the model to gaming or upcoding. A general discussion of other considerations in selecting a model is presented in Section IV.

### Research Team

The research team consisted of consultants and researchers at Milliman USA Inc. and Dave Knutson from the Park Nicollet Institute Health Research Center. Bob Cumming, FSA, MAAA, was the principal investigator for this study and leader of the Milliman USA research team. Brian Cameron, FSA, MAAA, and Brian Derrick, both of Milliman USA, assisted with the research and numerical analysis. The Milliman staff performed the numerical analysis of the risk adjusters. Dave Knutson assisted with study design and with drafting the report.

The research team does not endorse any particular risk adjuster and has not been involved in the development or marketing of any of the risk adjusters examined in this study.

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**Important Notes**

There are a number of competing methods for performing health risk assessment using diagnosis and/or pharmacy data. The number of methods that could be included in this study was restricted due to the availability of resources and time. In addition to the vendors and products included in this study, other vendors and products are currently available in the marketplace. The performance of these other products has not been evaluated and the exclusion of a particular product in this study does not indicate any judgment about those product's performance or characteristics.

# Section II. Study Design

**Risk Assessment Models Evaluated: Diagnosis and Pharmacy-based Models**

There are a number of approaches that can be used for health risk assessment. This study focuses on methods that use medical diagnosis codes and/or pharmacy codes in administrative claim data to drive the risk assessment. For this study, seven health risk assessment models were evaluated, including three diagnosis-based models, three pharmacy-based models, and one model based on diagnosis and pharmacy data.

Specifically, the following models were evaluated:

- Adjusted Clinical Groups (ACGs) Version 4.5
- Chronic Illness and Disability Payment System (CDPS) Version 1.7
- Diagnostic Cost Groups (DCGs) Version 5.1
- Medicaid Rx
- RxGroups Version 1.0
- RxRisk
- Episode Risk Groups (ERGs) Version 4.2

The ACGs, CDPS, and DCGs are based on diagnosis data available from administrative claim records. Medicaid Rx, RxGroups, and RxRisk use pharmacy data. The ERGs use diagnosis and pharmacy data, and, to a small extent, some surgical procedure code data. The model versions referenced above were the most recently available when the study began in May of 2001.

The following section provides a brief description of each of the risk adjusters. For a more detailed description see Section VI of this report. Section VI also discusses some of the diagnosis and pharmacy-based risk assessment models that were not included in this study.

*Adjusted Clinical Groups*

Adjusted Clinical Groups (ACGs) is a diagnosis-based risk assessment model developed by Jonathan Weiner and other researchers at Johns Hopkins University. ACG Version 4.5, released in 2000, was used for this study. The ACGs classifies each member into one of 81 categories based on inpatient and ambulatory diagnosis codes for the member. ACGs differ from the other models in this study in that the ACG categories are mutually exclusive; that is, a member is classified into only one category. Many of the ACGs also reflect age/gender characteristics; thus, there are no separate age/gender variables in the model. The ACGs are also unique among the models included in this study in that they do not provide a set of standard risk weights.

*Chronic Illness and Disability Payment System*

The Chronic Illness and Disability Payment System (CDPS) is a diagnosis-based risk assessment model developed by Richard Kronick and other researchers at the

University of California, San Diego. CDPS Version 1.7, released in 2000, was used for this study. This model was originally developed for use with Medicaid populations, including disabled and Temporary Aid for Needy Families (TANF) populations. The CDPS model is an update and expansion of a prior model developed by Kronick and published in 1996 called the Disability Payment System (DPS). The DPS model was developed for the Medicaid disabled population.

The CDPS model assigns each member to one or more of 67 possible medical condition categories based on diagnosis codes. Each member is also assigned to one of 16 age/gender categories. For each member, the model predicts total medical costs based on the medical condition categories and age/gender category assigned. The model provides two sets of risk weights – one set calibrated for a TANF population and another set calibrated for a disabled population. In this analysis, the weights for the TANF population were used, since a TANF population is more similar to the commercial population used for this analysis. The model also provides different sets of risk weights for adults and children, both of which were used for this analysis.

*Diagnostic Cost Groups*

The Diagnostic Cost Groups (DCGs) model is a diagnosis-based risk assessment model originally developed by researchers including Randall Ellis and Arlene Ash at Boston University. The DCG models include a number of variations depending on the type of population being analyzed (commercial, Medicaid, Medicare), the source of the diagnosis data (inpatient only versus all encounters) and the purpose of the model (payment versus explanation).

For this analysis, DCG Version 5.1 of the commercial all-encounter model, released in 2000, was used. For the prospective analysis, the payment version of the model was used. For the concurrent analysis, the explanation version of the model was used (since DxCG Inc. does not offer a concurrent model designed for payment purposes). The commercial DCG models can predict both medical expenses including pharmacy spending and medical expenses excluding pharmacy expenses. For this analysis, the predictions included both medical expenses and pharmacy spending.

The DCG model assigns each member to one or more of 136 possible medical condition categories (called hierarchical condition categories (HCCs)) based on diagnosis codes. Each member is also assigned to one of 32 age/gender categories. Based on these medical condition and age/gender categories, the model predicts the total medical costs for each member.

*Medicaid Rx*

Medicaid Rx is a pharmacy-based risk assessment model developed by Todd Gilmer and other researchers at the University of California San Diego. This model was developed and released in 2000. The model was originally designed and intended for a Medicaid population and is an update and expansion of the Chronic Disease Score model developed by researchers at Group Health Cooperative of Puget Sound.

The Medicaid Rx model assigns each member to one or more of 45 medical condition categories based on the prescription drugs used by each member and to one of 11 age/gender categories. Based on the medical conditions and age/gender categories,

the model predicts the overall medical costs for each member. The model includes separate sets of risk weights for adults and children.

*RxGroups*

RxGroups is a pharmacy-based risk assessment model developed by DxCG Inc in conjunction with Kaiser Permanente and clinicians from CareGroup and Harvard Medical School. RxGroups Version 1.0 released in 2001 was used. The RxGroups model can be used alone to predict total medical costs for each member or it can be used in conjunction with hospital inpatient diagnosis codes.

The RxGroups model will assign each member to one or more of 127 drug therapy categories and to one of 32 age/gender categories. RxGroups is somewhat different than the other pharmacy-based risk adjusters, in that it uses drug therapy categories as opposed to medical condition categories.

*RxRisk*

RxRisk is a pharmacy-based risk assessment model developed by Paul Fishman at Group Health Cooperative of Puget Sound. This model was developed and released in 2001. RxRisk is a combination of the original Chronic Disease Score model, designed for adults, and the Pediatric Chronic Disease Score model.

The RxRisk model assigns each member to one or more of 27 medical condition categories (for adults) or to one or more of 42 medical condition categories (for children). The model also assigns each member to one of 22 age/gender categories. Based on these categories the model predicts total medical costs for each member.

*Episode Risk Groups*

The Episode Risk Groups (ERGs) is a risk assessment model developed by Symmetry Health Data Systems. The ERGs are based on the Episode Treatment Groups (ETGs) model also developed by Symmetry which group medical services into episodes of care. These groupings are used for provider profiling. The ERGs were developed and released in 2001. The ERGs used in this analysis are based on Version 4.2 of the ETGs.

The ERG model assigns each member to one or more of 119 possible medical condition categories (called episode risk groups). Since the ERG output did not include a set of age/gender indicator variables, 22 age/gender categories were added when the risk weights were recalibrated for this analysis. The medical condition categories assigned to a member depend primarily on that member's diagnosis codes and pharmacy data. In a small number of cases, the ERGs assigned to a member depend on the presence of a defining surgery code. This differs from the other risk adjusters included in this study, which do not depend on the whether a particular procedure was performed.

The ERGs provide two sets of risk weights depending on whether the input data includes pharmacy information.

**Data Used for Study: Commercial Group Population**

The data used for this study includes claim and enrollment information for commercial employer group business. The data is limited to those members continuously enrolled from January 1, 1998 to December 31, 1999 for which medical and pharmacy claim data and enrollment information, including age and gender, are available. The data includes a nationwide mix of both Preferred Provider Organization (PPO) and Health Maintenance Organization (HMO) business.

The claim expenditure data is reported after provider discounts but before member cost sharing is deducted (i.e., it reflects total payments to health care providers). The data used permits up to 15 diagnoses per inpatient admission and up to 2 diagnoses per outpatient claim. For this analysis, all of the reported diagnoses are used.

The data was reviewed for general reasonableness and any categories of business that appeared to have data issues were removed. For any categories of business that included a significant number of encounter claims, the number of claims and dollar amounts by type of claim were reviewed for reasonableness. Mental illness and pharmacy claims were tested for completeness by examining the number and dollar amount of mental health and pharmacy claims. The percentage of non-users based on the pharmacy and medical claims data was examined as well.

The final data set used for this analysis included 749,145 members.

**Study Methodology: 50/50 Split Design with Offered & Recalibrated Weights**

Each risk adjuster was analyzed using three applications:

1. Prospective Model with Offered Risk Weights.
2. Prospective Model with Recalibrated Risk Weights.
3. Concurrent Model with Recalibrated Risk Weights.

These applications represent different approaches to implementing the risk adjuster model. The following section describes the differences in the three applications.

*Prospective vs. Concurrent*

A *prospective* application of a risk adjuster involves using claims data from a prior period of time to project medical claim costs for a future period. A *concurrent* (sometimes called retrospective) application involves using claims data from a period of time to project medical claim costs for that same period. In this study, the prospective models use diagnosis and pharmacy data from 1998 to predict total medical claim costs for each member for 1999. The concurrent model uses diagnosis and pharmacy data from 1999 to predict total medical claim costs for each member for 1999.

*Offered vs. Recalibrated Risk Weights*

For each risk adjuster, there is a *risk weight* for each medical condition category. The risk weight reflects an estimate of the marginal cost for a given medical condition relative

to the base cost for individuals with no medical conditions. The *offered* risk weights are the standard risk weights that are provided with the risk adjuster software. The *recalibrated* risk weights were developed as part of this study and are based on the data set described above.

As mentioned previously, the ACGs do not include a standard set of risk weights with the software, since they expect that users will want to recalibrate the risk weights to reflect their own situation. (Since the ACGs is a categorical model, it is easier to recalibrate the risk weights since they can be calculated directly, without performing a regression analysis.)

*Claim Truncation*

For each application, the results were analyzed using three scenarios for truncating large claims: truncate large claims at $50,000, truncate large claims at $100,000, and no truncation. The truncation applies to total claim dollars for a given member for 1999.

Truncation of large claims is common when analyzing the predictive accuracy of risk adjusters for a variety of reasons, including:

1. Truncation limits the impact of outliers. This should provide more stability in the results when recalibrating the models and when analyzing predictive accuracy.
2. Large claims for a given person are generally not predictable. Accordingly, some researchers argue that they should be removed or limited when doing the analysis.
3. Truncation simulates the impact of reinsurance or stop loss at those levels.
4. Some measures of predictive accuracy are overly sensitive to large claims.

*Steps in Study Methodology*

The analysis for the offered weight application consists of three steps:

1. Separation of the data set into two equal-sized subsets: (1) a calibration subset and (2) a validation subset.
2. Assignment of individual scores for each member in the validation data subset using each risk adjuster and the offered weights (the score for a particular member reflects an estimate of the relative cost for that member).
3. Analysis of predictive accuracy using the validation data set to compare the score (i.e., predicted claims) of each member or group of members to actual claim dollars.

The analysis for the recalibration applications consists of five steps:

1. Separation of the data set into two equal-sized subsets: (1) a calibration subset and (2) a validation subset.
2. Assignment of medical condition categories (including drug therapy categories) and age/gender categories to each member using each risk adjuster.
3. Performance of a linear regression using the calibration data subset to determine the recalibrated risk weights.
4. Use of the recalibrated risk weights to assign scores for each member in the validation data subset.

5. Analysis of predictive accuracy using the validation data set to compare the score (i.e., predicted claims) of each member or groups of members to the actual claim dollars.

Each of these steps is described below.

*Step 1. Separation of Data into Calibration and Validation Data Subsets*

To allow for development and testing of recalibrated risk weights, a 50/50 split design was used for the study. Specifically, each member was randomly assigned into one of two subsets: (1) the calibration data subset and (2) the validation data subset, placing half of the population in each subset. The split design was used to avoid overfitting the data which could exaggerate the goodness of fit and various other measures of predictive accuracy.

*Step 2. Grouping Each Member Using each Risk Adjuster*

Each member is grouped (i.e., assigned to certain medical condition categories, including drug therapy categories, and age/gender categories) by each risk adjuster model. Each risk adjuster model produces a set of indicator variables (0 or 1) representing the condition and age/gender categories assigned. For the prospective analysis, the indicator variables are based on 1998 diagnosis and pharmacy data. For the concurrent analysis, the indicator variables are based on 1999 diagnosis and pharmacy data.

The risk adjuster software was used to group each member for each of the risk adjusters. Milliman researchers ran the software for each of the risk adjusters, except for the ERGs. For the ERGs, Symmetry grouped the members into medical condition categories. (For the ERGs, the rest of the analysis, including recalibration and measurement of predictive performance, was done by Milliman using the same methodology as used for the other risk adjusters.)

*Step 3. Calculation of Recalibrated Risk Weights*

The calibration data subset was used to develop a new set of risk weights using the study data. In general, to calculate the risk weights for a particular risk adjuster, the following multivariate linear regression model is used:

$$P = \sum_i ( RWMCC_i \times MCC_i ) + \sum_k ( RWAG_k \times AG_k )$$

Where:

P = total claim payments for 1999 (including medical and pharmacy)
$RWMCC_i$ = risk weight for medical condition category i
$MCC_i$ = indicator variable (0 or 1) for medical condition category i
$RWAG_k$ = risk weight for age/gender category k
$AG_k$ = indicator variable (0 or 1) for age/gender category k

A linear regression is performed to determine a set of risk weights that best fit the calibration data set.

A separate calibration analysis was performed for each level of claim truncation. Also, separate calibrations are performed for the prospective and concurrent applications. Accordingly, there are six sets of recalibrated risk weights for each risk adjuster.

In this analysis, the initial results included some negative risk weights for some of the risk adjusters. This can occur due to noise in the data or, in some cases, there may be a clinical explanation. The majority of the negative risk weights were not statistically significant.

For this study, any negative risk weights in the initial results were set to 0 in order to determine the final set of risk weights. This adjustment had very little impact on the results of the study. Negative risk weights are typically removed when developing a payment model for actual implementation since, according to Richard Kronick, "it would be awkward to reduce plan payments because of additional diagnoses" (Kronick et al, 2000). Similarly, negative risk weights might create a financial incentive to avoid treatment or coding of treatment for certain medical conditions. It should be noted that Kronick includes negative risk weights in his general analysis of risk adjustment models for Medicaid populations. Kronick states that "… we included a number of ADGs that have statistically significant, negative parameter estimates and that would likely be excluded if an ADG payment model were implemented…"

A number of other adjustments are commonly used in developing a final set of risk weights for a payment model for actual implementation. These other adjustments can include: removing variables that are not statistically significant, smoothing the age/gender risk weights, blending the developed risk weights with the "offered" risk weights, combining various variables in the payment model, recalibrating the risk weights after removing any variables, clinical review of the relationships, testing the stability of the risk weights with different claim truncation levels, and testing the stability of the risk weights using subsets of the data. This study does *not* include any of these further adjustments.

The ACG model does not have a separate set of age/gender variables since age/gender is built into the ACG categories. The structure of the ACG methodology, which places each individual into exactly one category, allows a direct calculation of risk weights, rather than the use of a linear regression to develop them.

*Step 4. Assignment of Score for each Member in the Validation Data Subset*

Each member in the validation data subset is scored using the indicator variables described in Step 2 and the recalibrated risk weights from Step 3.

*Step 5. Analysis of Predictive Accuracy*

In the final step, the predictive performance of the models is analyzed by comparing the risk scores with the actual claim dollars incurred. This comparison is done for both individuals and groups of individuals as described below.

**Measures Used to Analyze Predictive Accuracy: Individual and Non-Random Groups**

A variety of measures were used to compare the predictive accuracy of the risk adjusters examined in this study. In general, these measures compare actual claim dollars with predictions from the risk adjuster models. This comparison is performed on two levels: (1) by individual and (2) by group.

*Measures of Predictive Accuracy- Individual Level*

The individual measures of predictive accuracy include:

1. Individual R-squared,
2. Mean absolute prediction error, and
3. A new measure, derived from mean absolute prediction error. (This new measure is presented and discussed separately in Section VII of this report.)

*Individual R-squared* is described as the percentage of the variation in medical claim costs explained by the risk adjuster model. Variation refers to the difference in medical costs for a given individual compared to the average medical cost for all individuals. The formula for R-squared is:

$$R^2 = 1 - ( \sum_i ( a_i - \hat{a}_i )^2 ) / ( \sum_i ( a_i - \bar{a} )^2 )$$

Where:

$a_i$ = actual claim dollars for person i
$\hat{a}_i$ = predicted claim dollars for person i (based on a regression model)
$\bar{a}$ = mean of the actual claim dollars
i goes from 1 to n, where n is the number of people

*Mean absolute prediction error* is calculated as follows. First, the prediction error for each individual is determined by calculating the difference between predicted medical costs and actual medical costs. Next, the absolute value of each of these prediction errors is calculated, and, finally, the mean of the absolute prediction error across all individuals is determined. The formula for mean absolute prediction error (MAPE) is:

$$MAPE = ( \sum_i | a_i - \hat{a}_i | ) / n$$

Where:

$a_i$ = actual claim dollars for person i
$\hat{a}_i$ = predicted claim dollars for person i
i goes from 1 to n, where n is the number of people

Different arguments are made regarding the merits of alternative methods for measuring goodness of fit. Individual R-squared is a standard statistical measure for assessing model results. It is commonly used for measuring predictive accuracy of risk adjusters. It is a single summary measure on a standardized scale of 0 to 1, where 0 indicates that the model explains 0% of the variation in cost among the individuals and 1 indicates that the model explains 100% of the variation i.e., 100% accuracy in the predictions. The

standardized scale helps with comparability between studies. However, there still are many potential issues associated with comparing individual R-squared from one study with another that may make the comparisons inappropriate or invalid. These issues include differences in the data sets, study design, and data quality.

Individual R-squared has certain drawbacks. Because it squares each prediction error, it tends to be overly sensitive to the prediction error for individuals with large claims. According to the prior Society of Actuaries (SOA) study, "because $R^2$ squares the errors of prediction, it can be greatly affected by a relatively small number of cases with very large prediction errors. Given the typical distribution of health expenditures across individuals, where a small number of individuals have relatively large expenditures, this is a concern for our analysis." (Dunn, et al., 1995) This is one of the reasons for truncating large claims when individual R-squared is used as a measure of predictive accuracy. The prior SOA study generally presents results with claims truncated at $25,000.

Another concern with individual R-squared is that it might give the appearance of poor performance. For example, individual R-squared is typically around 10% to 20% for prospective applications. As a result, health care decision makers may question the value of risk adjustment i.e. "Why invest in an expensive and complicated process that explains at most 15% of the variation in claims?" In fact, the key issue for most risk adjustment applications is the accuracy of the predictions for groups of people, rather than for each individual. As a result, many researchers also look at group level measures, such as those described below. One study showed that a diagnosis based risk adjuster that explained only 9% of the variation in claims across individuals, explained over 80% of the variation across certain groups. (Ash, et al, 1998) This result may vary significantly based on how the groups are defined.

The mean absolute prediction error is also a single summary measure of predictive accuracy. On the positive side, it does not square the prediction errors and, so, is not overly sensitive to large claims. However, it is not expressed on a standardized scale, so comparisons across studies are difficult to make.

*Measures of Predictive Accuracy – Group Level*

A group level measure of predictive accuracy involves adding up the total predicted claims for a group of individuals and comparing that value to the actual claims for the same group. This comparison gives a *predictive ratio*. A predictive ratio that is closer to 1.0 indicates a better fit. The predictive ratio is the reciprocal of the common actual-to-expected (A to E) actuarial ratio.

The group level measures differ in terms of how the groups are determined. There are two general approaches: (1) *non-random groups* and (2) *random groups*. Non-random refers to grouping individuals based on selected criteria. The common criteria used for analyzing risk adjusters include groups based on medical condition or amount of claim dollars. Non-random groups can also be defined based on other criteria, such as a being part of a particular employer group. This is sometimes referred to as using *real groups.* Random groups refer to groups created by selecting individuals at random from the study data set.

*Non-Random Groups used for This Study*

This study uses non-random groups based on the following criteria:

1. Medical condition in 1998,
2. Medical condition in 1999,
3. Quintiles based on medical claim dollars for 1999, and
4. Ranges of medical claim dollars for 1999.

The medical conditions used for this study include: breast cancer, congestive heart failure, asthma, depression, and HIV. As is common in these types of studies, the medical conditions are determined using medical diagnosis codes. It should be noted that this approach might create a fundamental bias in favor of risk adjusters that are based on diagnosis data. This reflects that a risk adjuster which distinguishes among people based on particular criteria (e.g., diagnosis codes) will naturally tend to perform better when predicting expenditures for groups of people determined using the same type of criteria.

Note: For different medical conditions, the performance of the risk adjuster models may change significantly. For a given medical condition, a risk adjuster will naturally tend to perform better on this test if it has a medical condition category that matches more closely with the definition of the medical condition used in this study.

*Grouping Individuals using Base Year vs. Prediction Year Information*

There are two alternate approaches in determining the non-random groups. One approach uses claim information from the base year (i.e., 1998) to define the group. The other approach uses claim information from the prediction year (i.e., 1999) to define the group. For medical conditions, the groups were constructed using both approaches. For claim dollars, the groups were constructed based on 1999 claim dollars.

Predictive ratios for groups based on claim information from the base year (e.g., medical condition in 1998) will naturally tend to be closer to 1 than predictive ratios for groups based on claim information from the prediction year (e.g., medical condition in 1999). This can occur for two reasons: (1) the tendency for health care expenditures to “regress toward the mean” for a given group of people and/or (2) the difficulty in predicting claim levels, based on historical claim information, for people that are newly diagnosed with a medical condition.

Measures that use groups based on claim information from the prediction year may be more useful when analyzing risk adjusters for applications such as underwriting/rating, identification of people for case or disease management, provider profiling, and provider payment. These types of measures help us answer questions such as: How well can the risk adjuster predict people’s claims for the next year? How well can the models predict who will have a large claim next year? How well do the models adjust for those people that have a particular medical condition next year?

Measures that use groups based on claim information from the base year may be more useful when analyzing risk adjusters for applications such as health plan payment. These types of measures help us answer questions such as: If a health plan, directly or

indirectly, selected members based on their claim history (i.e., past medical conditions or expenditures), would the health plan receive a fair payment for the upcoming year?

# Section III. Results

**Individual Level Results**

*General Findings*

- For prospective risk assessment, the pharmacy-based models perform at a level similar to the diagnosis-based models. The pharmacy-based models perform slightly better when using the mean absolute prediction error as the performance measure. The diagnosis-based models perform slightly better when using R-squared as the performance measure.
- For concurrent risk assessment, the diagnosis-based models outperform the pharmacy-based models.
- For prospective risk assessment, the R-squared performance of the models varies from 9.8% to 19.3%, with offered weights and claims truncated at $100,000.
- For prospective risk assessment, the R-squared performance of the models varies from 14.0% to 19.8%, with recalibrated weights and claims truncated at $100,000.
- For concurrent risk assessment, the R-squared performance of the models varies from 29.2% to 54.7%, with recalibrated weights and claims truncated at $100,000.
- The risk adjusters originally developed and calibrated for Medicaid populations (CDPS and Medicaid Rx) showed significant improvement in their predictive performance when the risk weights were recalibrated. The performance of CDPS, as measured using R-squared, increased from 12.5% to 18.6%, with claims truncated at $100,000. The performance of Medicaid Rx increased from 9.8% to 16.5%.
- The general performance of the other risk adjusters increased slightly after recalibration, as measured by R-squared. The increase in performance varied from a 2.9% increase in R-squared for DCGs (with claims truncated at $50,000) to a 0.1% decrease in R-squared for RxGroups (with claims not truncated).
- Recalibration tended to result in a greater increase in performance when claims are truncated at $50,000 and a smaller increase in performance when claims are not truncated. (This is true even when the increase in R-squared is expressed on a relative or percentage basis.)
- As one would expect, the concurrent models significantly outperform the prospective models.
- It appears that the performance of the diagnosis-based risk adjusters has improved significantly since the 1995 Society of Actuaries (SOA) study. This improvement likely results from a combination of more detailed data reporting and refinement of the risk assessment models. (Note: the prior SOA study used only the primary diagnosis code and a number of the risk adjusters in the prior SOA study used only inpatient or only ambulatory diagnosis codes.)

Note: In most real-life prospective applications, the performance of the pharmacy-based models, relative to the diagnosis-based models, would be better than shown in this study due to shorter time lags for receiving pharmacy claim data compared to medical claim data.

The following section provides a more detailed presentation of the study results.

*Prospective Model – Offered Weights*

Table 3.1 summarizes R-squared and mean absolute prediction error for each risk adjuster when used for a prospective application with the offered weights. A higher R-squared indicates better predictive accuracy. A lower mean absolute prediction error indicates better predictive accuracy. Results for the ACG method are not available (NA) since the ACGs do not come with offered weights. The table shows the type of risk adjuster based on what data is used for the risk assessment: diagnosis data (diag), pharmacy data (Rx), or diagnosis and pharmacy data (Diag+Rx).

Table 3.1: Summary of R-squared and Mean Absolute Prediction Error – Prospective Model with Offered Weights

| Risk Adjuster | Type of Risk Adjuster | R-Squared with claims truncated at: | | | Mean Absolute Prediction Error with claims truncated at: | | |
|---|---|---|---|---|---|---|---|
| | | $50,000 | $100,000 | None | $50,000 | $100,000 | None |
| ACG | Diag | NA | NA | NA | NA | NA | NA |
| CDPS | Diag | .134 | .125 | .103 | 2095 | 2210 | 2299 |
| DCG | Diag | .195 | .180 | .143 | 1987 | 2098 | 2187 |
| Medicaid Rx | Rx | .116 | .098 | .071 | 2103 | 2222 | 2310 |
| RxGroups | Rx | .206 | .181 | .134 | 1916 | 2027 | 2113 |
| RxRisk | Rx | .175 | .148 | .111 | 1988 | 2108 | 2200 |
| ERG | Diag+Rx | .218 | .193 | .146 | 1875 | 1987 | 2082 |

As shown in Table 3.1, the ERGs perform well on each of the six measures. This is not surprising given that the ERGs use more information than any of the other risk adjusters included here. As described previously, the ERGs use diagnosis, pharmacy, and, in a small number of cases, certain surgery procedure codes. The other risk adjusters use either diagnosis or pharmacy data, but not both. Many of the risk assessment models specifically do not consider the treatment that an individual receives so that the risk scores are not biased by the practice patterns of the health care providers. This is a concern when using risk adjusters for health plan payment or provider payment. However, when using risk adjusters for underwriting/rating or case management, this is not an issue.

The CDPS and Medicaid Rx models do not perform as well as the other models. This is not surprising, given that these models were originally designed and calibrated for Medicaid populations. As the results below show, when these models are recalibrated for a commercial population, their performance improves significantly.

In general, the performance of the pharmacy based risk adjusters is similar to the performance of the diagnosis based risk adjusters. The pharmacy based risk adjusters perform better, relative to the diagnosis based risk adjusters, when using mean absolute prediction error. The diagnosis based risk adjusters perform better, relative to the pharmacy based risk adjusters, when using R-squared. Also, the relative performance of the pharmacy based risk adjusters tends to improve when using lower levels for truncating large claims. This would seem to indicate that the diagnosis based risk adjusters tend to do a relatively better job in predicting for large claims.

The level of claim truncation used by the developers of the risk adjusters to determine the offered weights could affect the results shown in Table 3.1. For example, suppose that the developers of the ERGs determined the offered weights using a $100,000 claim truncation level. If the developers re-determined the offered weights using untruncated claims, then one might expect the R-squared for the ERGs to increase at the untruncated claim level and decrease at the $100,000 claim truncation level.

*Prospective Model – Recalibrated Weights*

Table 3.2 summarizes R-squared and mean absolute prediction error for each risk adjuster when used for a prospective application with the recalibrated weights.

Table 3.2: Summary of R-squared and Mean Absolute Prediction Error – Prospective Model with Recalibrated Weights

| Risk Adjuster | Type of Risk Adjuster | R-Squared with claims truncated at: | | | Mean Absolute Prediction Error with claims truncated at: | | |
|---|---|---|---|---|---|---|---|
| | | $50,000 | $100,000 | None | $50,000 | $100,000 | None |
| ACG | Diag | .172 | .140 | .099 | 1972 | 2100 | 2193 |
| CDPS | Diag | .208 | .186 | .149 | 1944 | 2070 | 2164 |
| DCG | Diag | .224 | .198 | .154 | 1902 | 2032 | 2133 |
| Medicaid Rx | Rx | .200 | .165 | .119 | 1931 | 2062 | 2159 |
| RxGroups | Rx | .222 | .185 | .132 | 1882 | 2014 | 2113 |
| RxRisk | Rx | .188 | .154 | .111 | 1960 | 2091 | 2187 |
| ERG | Diag+Rx | .230 | .197 | .148 | 1854 | 1983 | 2079 |

When interpreting and using the results shown in Table 3.2, keep in mind that R-squared can be overly sensitive to large claims. As mentioned in the prior section, this becomes a more significant issue when claims are truncated at higher limits (i.e., $100,000 or no truncation). This is not a concern with the mean absolute prediction error, since it does not square the prediction error.

As shown in Table 3.2, the ACGs do not perform as well as some of the other risk adjusters. This may reflect that the ACGs use mutually exclusive medical condition categories, while all of the other models are additive. That is, the other models can assign an individual to multiple medical condition categories and then add together the risk weight for each such condition to develop a prediction for each individual. The additive models allow much more flexibility in describing the overall medical condition of a given individual since you can use virtually any combination of the different medical condition categories. (Note that some of the additive risk adjusters use hierarchical designs that limit, to some degree, the possible combinations of medical condition categories.)

In comparing the performance of various risk adjusters, one should consider how the models will be implemented. For example, the ACGs do not come with a standard set of weights since the expectation is that the user will calibrate the model. However, the other risk adjusters do come with a standard set of risk weights. Accordingly, health plans might typically use the DCGs with the standard set of weights, rather than go through the process of recalibration. (Note: The recalibration of the ACGs, since it uses mutually exclusive categories rather than additive categories, is more straightforward and more likely to give reasonable results than the recalibration of the other risk adjusters.) So, for this scenario, it might be more appropriate to compare the performance of the recalibrated ACGs to the performance of the DCGs with offered weights. Based on the mean absolute prediction error with claims truncated at $100,000, the performance of the two models is nearly identical (the mean absolute prediction error for the ACGs with recalibrated weights is 2100 and the mean absolute prediction error for the DCGs with offered weights is 2098).

The pharmacy based models tend to perform better, relative to the diagnosis based models, when using the mean absolute prediction error as the measure, whereas, the diagnosis based risk adjusters tend to perform better, relative to the pharmacy based models, when using R-squared. For example, when comparing related products (i.e., DCG & RxGroups from DxCG Inc. and CDPS & Medicaid Rx from the University of California, San Diego researchers) the diagnosis based product outperforms the pharmacy based product based on R-squared whereas the pharmacy based product outperforms the diagnosis based product based on mean absolute prediction error.

*Concurrent Model – Recalibrated Weights*

Table 3.3 summarizes R-squared and mean absolute prediction error for each risk adjuster when used for a concurrent application with the recalibrated weights.

Table 3.3: Summary of R-squared and Mean Absolute Prediction Error – Concurrent Model with Recalibrated Weights

| Risk Adjuster | Type of Risk Adjuster | R-Squared with claims truncated at: | | | Mean Absolute Prediction Error with claims truncated at: | | |
|---|---|---|---|---|---|---|---|
| | | $50,000 | $100,000 | None | $50,000 | $100,000 | None |
| ACG | Diag | .429 | .376 | .282 | 1487 | 1599 | 1685 |
| CDPS | Diag | .440 | .418 | .355 | 1576 | 1697 | 1799 |
| DCG | Diag | .564 | .547 | .466 | 1394 | 1509 | 1618 |
| Medicaid Rx | Rx | .372 | .328 | .244 | 1661 | 1797 | 1909 |
| RxGroups | Rx | .420 | .376 | .279 | 1569 | 1707 | 1823 |
| RxRisk | Rx | .339 | .292 | .213 | 1724 | 1854 | 1956 |
| ERG | Diag+Rx | .474 | .427 | .347 | 1441 | 1582 | 1700 |

As can be seen from Table 3.3, the diagnosis based models outperform the pharmacy based models when used for concurrent risk assessment.

*Comparison of Results with and without Recalibration*

Table 3.4 compares the performance of the risk adjustment models with and without recalibration of the risk weights. By far, the largest gains in performance occurred for the CDPS and Medicaid Rx risk adjusters.

Table 3.4: Comparison of Performance of Risk Adjustment Models with and without Recalibration of Risk Weights – Prospective Models

| Risk Adjuster | Type of Risk Adjuster | R-Squared with claims truncated at $100,000 with: | | Mean Absolute Prediction Error with claims truncated at $100,000 with: | |
|---|---|---|---|---|---|
| | | Offered Weights | Recalibrated Weights | Offered Weights | Recalibrated Weights |
| ACG | Diag | NA | .140 | NA | 2100 |
| CDPS | Diag | .125 | .186 | 2210 | 2070 |
| DCG | Diag | .180 | .198 | 2098 | 2032 |
| Medicaid Rx | Rx | .098 | .165 | 2222 | 2062 |
| RxGroups | Rx | .181 | .185 | 2027 | 2014 |
| RxRisk | Rx | .148 | .154 | 2108 | 2091 |
| ERG | Diag+Rx | .193 | .197 | 1987 | 1983 |

Table 3.5 shows the increase in performance due to recalibration of the risk weights for the prospective model. Specifically, the table shows the increase in R-squared between the prospective model with the recalibrated weights and the prospective model with the offered weights.

Table 3.5: Increase in Performance due to Recalibration – Prospective Model

| Risk Adjuster | Type of Risk Adjuster | Increase in R-Squared due to Recalibration with claims truncated at: | | |
|---|---|---|---|---|
| | | $50,000 | $100,000 | None |
| ACG | Diag | NA | NA | NA |
| CDPS | Diag | .074 | .062 | .046 |
| DCG | Diag | .029 | .018 | .012 |
| Medicaid Rx | Rx | .084 | .067 | .047 |
| RxGroups | Rx | .015 | .004 | -.001 |
| RxRisk | Rx | .014 | .005 | .001 |
| ERG | Diag+Rx | .012 | .003 | .002 |

The CDPS and Medicaid Rx models show a very significant increase in performance due to recalibration. This might be expected since the offered weights for both of these models have been calibrated for Medicaid populations. The DCGs show a moderate improvement in performance. The other models show somewhat smaller increases in performance.

It is interesting to note that the increase in performance tends to decline when there is less claim truncation. (This occurs even when the increase is expressed on a relative or percentage basis, rather than additive basis.) One possible explanation for this pattern is that, although recalibrated risk weights provide a better fit, when the risk weights are

based on untruncated claims it is likely that there will be more anomalies in the resulting risk weights that may require review and smoothing. (In this analysis, any negative risk weights were removed, but no review or smoothing beyond that occurred.) Another possible factor that might explain some of this pattern relates to the level of claim truncation used by the developers to determine the offered risk weights. For example, if the developers used no claim truncation, then the offered weights will fit the data better at that level of claim truncation and a smaller increase in performance due to recalibration would be expected.

*Comparison of Prospective and Concurrent Results*

Table 3.6 compares the performance of the prospective and concurrent risk adjustment models with recalibrated risk weights.

Table 3.6: Comparison of Performance of Prospective and Concurrent Risk Adjustment Models - With Recalibration of Risk Weights

| Risk Adjuster | Type of Risk Adjuster | R-Squared with claims truncated at $100,000 for: | | Mean Absolute Prediction Error with claims truncated at $100,000 for: | |
|---|---|---|---|---|---|
| | | Prospective Model | Concurrent Model | Prospective Model | Concurrent Model |
| ACG | Diag | .140 | .376 | 2100 | 1599 |
| CDPS | Diag | .186 | .418 | 2070 | 1697 |
| DCG | Diag | .198 | .547 | 2032 | 1509 |
| Medicaid Rx | Rx | .165 | .328 | 2062 | 1797 |
| RxGroups | Rx | .185 | .376 | 2014 | 1707 |
| RxRisk | Rx | .154 | .292 | 2091 | 1854 |
| ERG | Diag+Rx | .197 | .427 | 1983 | 1582 |

As can be seen from Table 3.6, the concurrent models significantly outperform the prospective models.

Table 3.7 shows the increase in performance between the prospective and concurrent model. In particular, the table shows the increase in R-squared between the concurrent model and the prospective model with recalibrated weights.

Table 3.7: Increase in Performance between Concurrent and Prospective Model

| Risk Adjuster | Type of Risk Adjuster | Increase in R-Squared with claims truncated at: | | |
|---|---|---|---|---|
| | | $50,000 | $100,000 | None |
| ACG | Diag | .258 | .236 | .183 |
| CDPS | Diag | .232 | .232 | .207 |
| DCG | Diag | .341 | .349 | .311 |
| Medicaid Rx | Rx | .173 | .164 | .126 |
| RxGroups | Rx | .198 | .191 | .147 |
| RxRisk | Rx | .151 | .138 | .102 |
| ERG | Diag+Rx | .245 | .230 | .199 |

The diagnosis based risk adjusters show a larger increase in performance than the pharmacy based risk adjusters when changing from a prospective application to a concurrent application. (This is also true when the increase in performance is expressed on a relative or percentage basis, rather than an additive basis.) In general, the increase in performance for the ERGs falls in between the diagnosis based risk adjusters and the pharmacy based risk adjusters. (When the increase is expressed on a relative or percentage basis, it is strictly true that the ERGs fall in between the diagnosis and pharmacy based risk adjusters.)

*Comparison of Results with Prior Society of Actuaries Study*

Table 3.8 compares the prospective performance of the diagnosis-based risk adjusters in this study to the performance of the diagnosis-based risk adjusters in the prior Society of Actuaries study. Table 3.9 shows a similar comparison but for a concurrent application.

Table 3.8: Comparison of Performance of Diagnosis-based Risk Adjusters in this Study to Performance of Diagnosis-based Risk Adjusters in Prior Society of Actuaries study – Prospective Application

| Study | Prospective Application: Range of R-Squared among the Diagnosis-based Risk Adjusters with claims truncated* at: | | |
|---|---|---|---|
| | Low | Medium | High |
| Current Study | 17.2% to 22.4% | 14.0% to 19.8% | 9.9% to 15.4% |
| Prior SOA Study – All Pools | 6.1% to 11.2% | Not Available | Not Available |
| Prior SOA Study – For Three Pools | 6.0% to 11.1% | 6.0% to 8.7% | 3.9% to 6.1% |

* The claim truncation levels refer to the following: (a) for the current study, low/medium/high refer to truncation levels of $50,000, $100,000, and no truncation and (b) for the prior SOA study, low/medium/high refer to truncation levels of $25,000, $50,000, and no truncation.

Table 3.9: Comparison of Performance of Diagnosis-based Risk Adjusters in this Study to Performance of Diagnosis-based Risk Adjusters in Prior Society of Actuaries study.- Concurrent Application

| Study | Concurrent Application: Range of R-Squared among the Diagnosis-based Risk Adjusters with claims truncated* at: | | |
|---|---|---|---|
| | Low | Medium | High |
| Current Study | 42.9% to 56.4% | 37.6% to 54.7% | 28.2% to 46.6% |
| Prior SOA Study – All Pools | 25.2% to 42.8% | Not Available | Not Available |
| Prior SOA Study – For Three Pools | 25.4% to 50.4% | 22.4% to 47.2% | 13.1% to 33.4% |

* The claim truncation levels refer to the following: (a) for the current study, low/medium/high refer to truncation levels of $50,000, $100,000, and no truncation and (b) for the prior SOA study, low/medium/high refer to truncation levels of $25,000, $50,000, and no truncation.

In general, these tables seem to indicate that the performance of diagnosis-based risk adjusters has improved significantly since the prior study. However, some of this improvement in performance may be due to differences in the two studies, including the use of different risk adjusters, the use of different data sets, and some differences in study methodology. Specifically, some of the differences between the current study and the prior SOA study include:

1. The prior SOA study used only the primary diagnosis code. The current study uses the first 2 diagnosis codes for ambulatory claims and up to 15 diagnosis codes for inpatient claims.
2. A number of the risk adjusters in the prior SOA study were run using only ambulatory claims or only inpatient claims. In the current study, all of the diagnosis-based risk adjusters were run using ambulatory and inpatient diagnosis data.
3. For the prospective analysis, the prior study had about half the number of members as used in this study. This might make it more difficult to get credible risk weights when recalibrating.

It is also possible that the quality of the data in the current study is better, which provides better results.

The prior study used claim data from 1991 and 1992. The current study uses claim data from 1998 and 1999. Given medical inflation between these time periods, the two sets of claim truncation levels are roughly equivalent.

**Group Level Results**

*General Findings*

- For prospective risk assessment based on results by 1998 medical condition, the diagnosis-based risk adjusters perform better than the pharmacy-based models. (As mentioned previously, the tests based on medical conditions may be biased in favor of the diagnosis-based risk adjusters.)
- For prospective risk assessment based on results by 1999 medical condition, the diagnosis-based risk adjusters perform similar to the pharmacy-based models on an overall basis.
- For prospective risk assessment based on results by claim dollar quintile, the pharmacy-based models tend to perform similar to or slightly better than the diagnosis-based risk adjusters.
- For concurrent risk assessment based on results by 1999 medical condition, the diagnosis-based risk adjusters perform better than the pharmacy-based risk adjusters. The difference is most notable for congestive heart failure (CHF).
- For concurrent risk assessment based on results by claim dollar quintile, the diagnosis-based risk adjusters tend to perform better than the pharmacy-based risk adjusters.
- All of the risk adjusters tend to overpredict for people with below average claim levels and tend to underpredict for people with above average claim levels.
- The risk adjusters originally developed and calibrated for Medicaid populations (CDPS and Medicaid Rx) showed significant improvement in their predictive performance when the risk weights were recalibrated.
- The performance of the other risk adjusters generally increased slightly after recalibration.
- As one would expect, the concurrent models significantly outperform the prospective models.

A more detailed presentation and discussion of the study results follows. The results shown in the following tables are based on no truncation of large claims. In general, truncating the large claims tends to bring the predictive ratios closer to 1.0, as one would expect. Truncation did not appear to cause any significant changes in the overall results or general relationships among risk adjusters. The only major change that occurred due to truncation involved the predictive ratios for Medicaid Rx and RxGroups for the HIV medical condition in 1999.

*Medical Condition in 1998*

Table 3.10 shows predictive ratios by medical condition for the prospective model with offered weights and untruncated claims. Members have been grouped together based on whether or not they had a particular medical condition in 1998, which was determined using diagnosis codes. Table 3.11 shows similar results for the prospective model with recalibrated weights.

Table 3.10: Predictive Ratios by Medical Condition in 1998 – Prospective Model with Offered Weights – Untruncated Claims

| Medical Condition | Predictive Ratio for Risk Adjuster: | | | | | | | Actual 1999 Claim$ PMPY |
|---|---|---|---|---|---|---|---|---|
| | Diagnosis based: | | | Rx based: | | | Diag+Rx: | |
| | ACG | CDPS | DCG | Medicaid Rx | RxGroup | RxRisk | ERG | |
| Breast Cancer | NA | .57 | .92 | .59 | .80 | .67 | 1.14 | 8,383 |
| CHF | NA | .47 | .86 | .37 | .71 | .59 | .76 | 17,692 |
| Asthma | NA | .98 | .97 | .91 | .87 | .87 | .93 | 4,119 |
| Depression | NA | .82 | 1.02 | .74 | .88 | .83 | .84 | 5,773 |
| HIV | NA | .46 | .94 | .60 | .84 | .62 | .81 | 15,902 |

When using offered risk weights, CDPS and Medicaid Rx do not perform as well as the other models. Similar to the prior results, when the models are recalibrated, the performance of these two models improves the most as can be seen when the results in Table 3.10 are compared with Table 3.11 below. The performance of the other models is about the same or shows a slight improvement when the risk weights are recalibrated.

Table 3.11: Predictive Ratios by Medical Condition in 1998 – Prospective Model with Recalibrated Weights – Untruncated Claims

| Medical Condition | Predictive Ratio for Risk Adjuster: | | | | | | | Actual 1999 Claim$ PMPY |
|---|---|---|---|---|---|---|---|---|
| | Diagnosis based: | | | Rx based: | | | Diag+Rx: | |
| | ACG | CDPS | DCG | Medicaid Rx | RxGroup | RxRisk | ERG | |
| Breast Cancer | .81 | .84 | .92 | .76 | .78 | .73 | .99 | 8,383 |
| CHF | .51 | .79 | .85 | .57 | .69 | .60 | .75 | 17,692 |
| Asthma | .96 | .95 | .96 | .89 | .91 | .87 | .94 | 4,119 |
| Depression | .85 | .91 | .97 | .88 | .89 | .87 | .91 | 5,773 |
| HIV | .34 | .95 | .91 | .92 | .97 | .68 | .91 | 15,902 |

The models tend to underpredict the aggregate claims for each of these pools of members. However, for certain risk adjusters and certain medical conditions, the predicted claims may be very close to actual e.g., the ERGs for breast cancer show a predictive ratio of .99. The models tend to perform the worst on congestive heart failure (CHF). This may reflect that CHF is a fairly expensive condition and many of these models may lump together CHF with less expensive conditions. The two lowest predictive ratios occur for HIV and CHF for the ACG risk adjuster. This may reflect that the ACGs tend to use broader categories that are not clinically specific. As a result, it

may be more difficult to accurately predict the cost levels for very severe conditions such as CHF and HIV.

The diagnosis-based models tend to perform slightly better than the pharmacy-based models. For example, when comparing related risk adjusters (i.e., risk adjusters from the same developers such as CDPS & Medicaid Rx and DCG & RxGroups), the predictive ratios for the diagnosis-based risk adjuster tend to be closer to 1.0.

Note: As discussed in Section II, measures of predictive accuracy based on medical conditions that are defined using diagnosis codes may be biased in favor of the diagnosis-based risk adjusters.

For different medical conditions, the performance of the risk adjuster models may change significantly from the general performance levels shown in the tables in this section. For a given medical condition, a risk adjuster will naturally tend to perform better on this test if it has a medical condition category that matches more closely with the definition of the medical condition used in this study.

*Medical Condition in 1999*

Table 3.12 shows predictive ratios by medical condition in 1999 for the prospective model with offered weights and untruncated claims. Using diagnosis codes, members have been grouped together based on whether or not they had a particular medical condition in 1999. Table 3.13 shows results for the prospective model with recalibrated weights. Table 3.14 shows results for the concurrent model.

Table 3.12: Predictive Ratios by Medical Condition in 1999 – Prospective Model with Offered Weights – Untruncated Claims

| Medical Condition | Predictive Ratio for Risk Adjuster: | | | | | | | Actual 1999 Claim$ PMPY |
|---|---|---|---|---|---|---|---|---|
| | Diagnosis based: | | | Rx based: | | | Diag+Rx: | |
| | ACG | CDPS | DCG | Medicaid Rx | RxGroup | RxRisk | ERG | |
| Breast Cancer | NA | .37 | .59 | .40 | .54 | .46 | .73 | 11,508 |
| CHF | NA | .24 | .42 | .22 | .41 | .34 | .39 | 25,409 |
| Asthma | NA | .71 | .68 | .74 | .71 | .71 | .71 | 4,675 |
| Depression | NA | .60 | .69 | .60 | .70 | .66 | .65 | 6,629 |
| HIV | NA | .30 | .56 | .48 | .70 | .49 | .61 | 16,637 |

As can be seen in Table 3.12, CDPS and Medicaid Rx do not perform as well as the other models when using the offered risk weights. However, when the models are recalibrated, the performance of these two models improves the most. This can be seen when comparing the results in Table 3.12 with the results in Table 3.13 below. The performance of the other models is about the same or shows a slight improvement when the risk weights are recalibrated.

Table 3.13: Predictive Ratios by Medical Condition in 1999 – Prospective Model with Recalibrated Weights – Untruncated Claims

| Medical Condition | Predictive Ratio for Risk Adjuster: | | | | | | | Actual 1999 Claim$ PMPY |
|---|---|---|---|---|---|---|---|---|
| | Diagnosis based: | | | Rx based: | | | Diag+Rx: | |
| | ACG | CDPS | DCG | Medicaid Rx | RxGroup | RxRisk | ERG | |
| Breast Cancer | .52 | .54 | .60 | .52 | .53 | .50 | .64 | 11,508 |
| CHF | .27 | .39 | .42 | .34 | .40 | .36 | .40 | 25,409 |
| Asthma | .72 | .69 | .71 | .72 | .73 | .70 | .74 | 4,675 |
| Depression | .65 | .66 | .69 | .70 | .71 | .69 | .70 | 6,629 |
| HIV | .26 | .59 | .56 | .75 | .79 | .55 | .68 | 16,637 |

The predictive ratios for groups based on medical condition in 1999 tend to be lower than the predictive ratios based on medical condition in 1998. This is to be expected since some of the members will be newly diagnosed with a medical condition in 1999 and it is not possible to accurately predict the claim levels for such people based on their prior conditions and prior claims.

Based on Table 3.13, when related risk adjusters are compared (i.e., CDPS vs. Medicaid Rx and DCG vs. RxGroup), the diagnosis-based risk adjusters perform similarly to the pharmacy-based risk adjusters. The biggest difference in performance occurs for the HIV medical condition.

Table 3.14: Predictive Ratios by Medical Condition in 1999 – Concurrent Model with Recalibrated Weights – Untruncated Claims

| Medical Condition | Predictive Ratio for Risk Adjuster: | | | | | | | Actual 1999 Claim$ PMPY |
|---|---|---|---|---|---|---|---|---|
| | Diagnosis based: | | | Rx based: | | | Diag+Rx: | |
| | ACG | CDPS | DCG | Medicaid Rx | RxGroup | RxRisk | ERG | |
| Breast Cancer | .81 | .82 | .88 | .72 | .77 | .67 | .91 | 11,508 |
| CHF | .56 | .90 | .92 | .53 | .60 | .53 | .67 | 25,409 |
| Asthma | 1.03 | 1.12 | .95 | .86 | .87 | .83 | .90 | 4,675 |
| Depression | .94 | .91 | .94 | .85 | .86 | .83 | .84 | 6,629 |
| HIV | .49 | 1.11 | .99 | 1.09 | 1.11 | .64 | .85 | 16,637 |

As one would expect, the concurrent model performs significantly better than the prospective model.

Based on Table 3.14, when related risk adjusters are compared (i.e., CDPS vs. Medicaid Rx and DCG vs. RxGroup), the diagnosis-based risk adjusters perform better than the pharmacy-based risk adjusters. The performance is markedly different for the CHF medical condition.

*Claim Dollar Quintiles based on 1999 Claim Dollars*

Table 3.15 shows predictive ratios for each risk adjuster by claim dollar quintile. The quintiles represent groupings of members based on each member's 1999 claim dollars. Quintile 1 represents the 20% of the population that had the lowest claim dollars. Quintile 5 represents the 20% of the population that had the highest claim dollars. Specifically, quintile 1 had actual claim dollars per member per year of $11. Quintile 5 had actual claim dollars per member per year of $8,799 (or about 4 times the overall average of $2,232).

Tables 3.16 and 3.17 show similar results except that Table 3.16 is for the prospective model with recalibrated weights and Table 3.17 is for the concurrent model.

Table 3.15: Predictive Ratios by Claim Dollar Quintile – Prospective Model with Offered Weights – Untruncated Claims

| 1999 Claim $ Quintile | Predictive Ratio for Risk Adjuster: | | | | | | | Actual 1999 Claim$ PMPY |
|---|---|---|---|---|---|---|---|---|
| | Diagnosis based: | | | Rx based: | | | Diag+Rx: | |
| | ACG | CDPS | DCG | Medicaid Rx | RxGroup | RxRisk | ERG | |
| 1 | NA | 130.79 | 105.56 | 116.37 | 88.65 | 106.07 | 74.80 | 11 |
| 2 | NA | 8.78 | 6.41 | 8.36 | 5.98 | 6.74 | 5.77 | 194 |
| 3 | NA | 3.37 | 2.88 | 3.28 | 2.78 | 2.94 | 2.89 | 596 |
| 4 | NA | 1.59 | 1.65 | 1.64 | 1.68 | 1.68 | 1.76 | 1,560 |
| 5 | NA | .40 | .51 | .43 | .54 | .49 | .54 | 8,799 |
| Total | NA | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 2,232 |

These results indicate that all of the risk adjusters tend to overpredict for people with below average claim levels and tend to underpredict for people with above average claim levels. The predictive ratios are quite high for quintile 1 mainly because predicted claim dollars are divided by actual claim dollars and the actual claim dollars pmpy is very close to 0. In any given year, a significant percentage of the population will have zero claims, but none of the prospective risk adjusters predict a score of zero for a given member. As a result, the prediction ratios, which have a number very close to zero in the denominator, are extremely high.

Similar to the individual level results, CDPS and Medicaid Rx do not perform as well as the other models when using the offered risk weights. When the models are recalibrated, the performance of these two models improves the most as shown in Table 3.17 below. The performance of the other models tends to be the same or show a slight improvement when the risk weights are recalibrated.

Table 3.16: Predictive Ratios by Claim Dollar Quintile – Prospective Model with Recalibrated Weights – Untruncated Claims

| 1999 Claim $ Quintile | Predictive Ratio for Risk Adjuster: | | | | | | | Actual 1999 Claim$ PMPY |
|---|---|---|---|---|---|---|---|---|
| | Diagnosis based: | | | Rx based: | | | Diag+Rx: | |
| | ACG | CDPS | DCG | Medicaid Rx | RxGroup | RxRisk | ERG | |
| 1 | 92.16 | 98.16 | 80.26 | 88.04 | 82.76 | 97.70 | 68.21 | 11 |
| 2 | 6.92 | 6.38 | 6.04 | 6.10 | 5.85 | 6.30 | 5.55 | 194 |
| 3 | 3.10 | 2.91 | 2.94 | 2.85 | 2.79 | 2.85 | 2.86 | 596 |
| 4 | 1.73 | 1.68 | 1.73 | 1.73 | 1.71 | 1.71 | 1.78 | 1,560 |
| 5 | .48 | .51 | .53 | .52 | .54 | .51 | .55 | 8,799 |
| Total | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 2,232 |

For the prospective model, when comparing related risk adjusters, the pharmacy-based models tend to perform similar to or slightly better than the diagnosis-based risk adjusters. For the concurrent model, shown in Table 3.17 below, the diagnosis-based risk adjusters tend to perform better than the pharmacy-based risk adjusters.

Table 3.17: Predictive Ratios by Claim Dollar Quintile – Concurrent Model with Recalibrated Weights – Untruncated Claims

| 1999 Claim $ Quintile | Predictive Ratio for Risk Adjuster: | | | | | | | Actual 1999 Claim$ PMPY |
|---|---|---|---|---|---|---|---|---|
| | Diagnosis based: | | | Rx based: | | | Diag+Rx: | |
| | ACG | CDPS | DCG | Medicaid Rx | RxGroup | RxRisk | ERG | |
| 1 | 13.96 | 29.42 | 6.58 | 34.92 | 28.91 | 50.77 | 6.41 | 11 |
| 2 | 3.48 | 3.22 | 3.15 | 4.06 | 3.82 | 4.42 | 3.00 | 194 |
| 3 | 2.32 | 2.06 | 2.19 | 2.30 | 2.23 | 2.32 | 2.21 | 596 |
| 4 | 1.64 | 1.57 | 1.53 | 1.63 | 1.58 | 1.62 | 1.66 | 1,560 |
| 5 | .73 | .74 | .77 | .69 | .72 | .66 | .75 | 8,799 |
| Total | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 2,232 |

Table 3.17 shows results based on the concurrent model. As one would expect, the results improve significantly when compared to the prospective model. On a concurrent basis, the diagnosis-based models tend to perform better than the pharmacy-based models. On a prospective basis, the diagnosis-based models tend to perform at a similar level as the pharmacy-based models.

*Claim Dollar Ranges based on 1999 Claim Dollars*

Appendices B, C, and D provide information on predictive ratios by claim dollar range. Due to the size of the tables, the results are shown only in the appendices. The tables in appendices B, C, and D show that all of the models significantly overpredict the claims for people with low claim levels and significantly underpredict the claims for people with high claims levels. The prediction error is larger for people with claim levels farther from the average.

**Number of Individuals Grouped by each Risk Adjuster**

*Percentage of Individuals Grouped*

This section presents some statistics regarding the number of individuals who were grouped (i.e., assigned a risk score based on one or more medical condition or drug therapy categories) by each risk adjuster.

Table 3.18 shows the percentage of the members that were grouped for 1998 by each risk adjuster. These percentages are based on the overall dataset, which includes both the calibration and validation subsets.

Table 3.18: Percentage of Members in the Study Dataset that are Grouped by each Risk Adjuster

| % of Members grouped by Risk Adjuster: | | | | | | |
|---|---|---|---|---|---|---|
| ACG | CDPS | DCG | Medicaid Rx | RxGroup | RxRisk | ERG |
| 79.5% | 41.4% | 79.5% | 63.2% | 71.4% | 48.5% | 77.9% |

As shown in Table 3.18, the ACGs and DCGs group the most members into a medical condition category. Given that both group nearly 80% of the population, the ACGs and DCGs take nearly everyone that has a medical claim and assigns them to a medical condition category. For ACGs, members assigned to ACG 5100 (which is "No Diagnosis or Only Unclassified Diagnosis & Non-Users") are defined as not grouped. For DCGs, members assigned to one or more of the HCC1 to HCC136 medical condition categories are defined as grouped.

CDPS groups the fewest members into a medical condition category. This is to be expected given the design of CDPS, which focuses on major illnesses and ignores relatively minor illnesses. Although CDPS only groups about ½ the number of members as ACGs and DCGs, on a prospective basis, it performs a little better than the ACGs and almost as well as the DCGs.

The pharmacy-based risk adjusters group between 49% and 71% of the members. The highest percentage for the pharmacy-based risk adjusters (71%) is less than the highest percentage for the diagnosis-based risk adjusters (80%). This reflects that more of the members have a medical claim than have a prescription drug claim.

For this dataset, the percentage of the population that had a medical claim in 1998 is 80.1% and the percentage of the population that had a prescription drug claim in 1998 is 71.4%. Note that RxGroups includes the following catch-all categories: RxG 125 for miscellaneous, recognized NDCs; RxG 126 for ungrouped NDCs; and RxG 127 for missing NDC value. Accordingly, it is not surprising that the percentage of the people assigned to one or more RxGroup categories matches the percentage of the people that have a pharmacy claim.

*Cross-tabs for Percentage of People Grouped*

The following tables present cross-tabs that show the percentage of the people grouped by each risk adjuster. Each table shows a cross-tab for a combination of two risk

adjusters. Note that the columns and rows may not sum exactly due to rounding differences.

Table 3.19: Cross-tab for Percentage of People Grouped by DCG & ACG

| Grouped by DCGs: | Grouped by ACGs: | | |
|---|---|---|---|
| | No | Yes | Total |
| No | 20.5% | 0.1% | 20.5% |
| Yes | 0.0% | 79.5% | 79.5% |
| Total | 20.5% | 79.5% | 100.0% |

Table 3.20: Cross-tab for Percentage of People Grouped by DCG & CDPS

| Grouped by DCGs: | Grouped by CDPS: | | |
|---|---|---|---|
| | No | Yes | Total |
| No | 20.5% | 0.0% | 20.5% |
| Yes | 38.1% | 41.4% | 79.5% |
| Total | 58.6% | 41.4% | 100.0% |

Table 3.21: Cross-tab for Percentage of People Grouped by DCG & ERG

| Grouped by DCGs: | Grouped by ERG: | | |
|---|---|---|---|
| | No | Yes | Total |
| No | 17.9% | 2.7% | 20.5% |
| Yes | 4.2% | 75.3% | 79.5% |
| Total | 22.1% | 77.9% | 100.0% |

Table 3.22: Cross-tab for Percentage of People Grouped by RxGroups & Medicaid Rx

| Grouped by RxGroups: | Grouped by Medicaid Rx: | | |
|---|---|---|---|
| | No | Yes | Total |
| No | 28.6% | 0.0% | 28.6% |
| Yes | 8.2% | 63.2% | 71.4% |
| Total | 36.8% | 63.2% | 100.0% |

Table 3.23: Cross-tab for Percentage of People Grouped by RxGroups & RxRisk

| Grouped by RxGroups: | Grouped by RxRisk: | | |
|---|---|---|---|
| | No | Yes | Total |
| No | 28.6% | 0.0% | 28.6% |
| Yes | 22.9% | 48.5% | 71.4% |
| Total | 51.5% | 48.5% | 100.0% |

Table 3.24: Cross-tab for Percentage of People Grouped by DCG & RxGroups

| Grouped by DCGs: | Grouped by RxGroups: | | |
|---|---|---|---|
| | No | Yes | Total |
| No | 15.0% | 5.6% | 20.5% |
| Yes | 13.7% | 65.8% | 79.5% |
| Total | 28.6% | 71.4% | 100.0% |

Table 3.25: Cross-tab for Percentage of People Grouped by CDPS & Medicaid Rx

| Grouped by CDPS: | Grouped by Medicaid Rx: | | |
|---|---|---|---|
| | No | Yes | Total |
| No | 30.3% | 28.3% | 58.6% |
| Yes | 6.5% | 34.9% | 41.4% |
| Total | 36.8% | 63.2% | 100.0% |

# Section IV. Other Considerations in Selecting a Risk Adjuster

This study compares the predictive performance of a number of common health-based risk assessment methods for employees and dependents. In addition to predictive performance, there are other considerations when selecting a risk adjustment method. This section describes some of these considerations.

The initial question to ask is whether the benefit of the higher predictive power produced by health-based risk assessment methods is worth the cost of obtaining and analyzing health data on individuals. With the rise of interest in consumer choice and need for better measures of provider and plan accountability, it is likely that accounting for selection bias will be a critical issue for modern health insurance, whether for payment, budgeting, medical management, or evaluation.

### Considerations in Selecting a Risk Assessment Method

In addition to predictive performance, the selection of a risk assessment method involves other considerations, including data issues, logic for assessing risk, and implementation environment.

*Data Issues*

From the perspective of data used to assess risk, methods can be categorized by their reliance on demographic, prior expenditure, and/or health data, including self-reported health status. This study examines methods that use claims-based health data. These health data-based risk adjustment methods can be further divided into methods that rely on diagnosis codes from claims or encounter data, or methods that rely on prescription data as a proxy for diagnoses. Models using other health data, such as survey data on self-reported chronic disease or functional status are not included in this study.

Methods that rely on demographic risk factors, such as age, gender, and program eligibility status, are easy to administer. These methods are not measures of the care process, and therefore do not produce the incentive to change treatment or coding to maximize risk scores. Unfortunately, these methods have poor predictive value at an individual-level or for risk-skewed groups.

An individual's total prior medical expenditure is a reasonably good predictor of future expenditure. These data are easier to manage than detailed encounter data. However, the incentives related to providing care in an efficient manner are poor and the information is not useful for medical management, except in identifying high-cost cases

Health status measures, such as diagnoses and prescriptions, are good predictors and provide useful medical management information. Diagnostic data must be obtained by plans from providers. Sometimes obtaining this data is difficult for some types of plans either because the plan has a capitation contract with providers that does not require

data for payment or because they are staff or group model plans which have little or no fee-for-service experience. Ambulatory diagnoses are also somewhat unreliably coded – but the diagnostic risk assessment software available has built-in safeguards to reduce the effect of incomplete data.

Changes in coding patterns are expected. For diagnosis-based methods, the main concern is ambulatory diagnoses. Historically, these codes have not been used as the basis for payment or rate setting. When producing more diagnosis codes or when more detailed diagnosis significantly increase revenue, the potential for upcoding is real. Upcoding may occur through the discovery of new cases with a primary condition, the improved refinement of coding for severity, or the increase in the coding of all related conditions affecting treatment. The effect of upcoding creates the appearance of a higher risk population when it is compared with the population used to calibrate the prediction model. The results inflate the estimate of the total cost for a population.

Some plans or purchasers may have better access to prescription data. Prescription data are timely, relatively clean, and complete for major ambulatory drugs. In addition, these data do not need to be obtained from providers, eliminating a difficult data collection step. The incentives for efficiency may be poor if prescribing is increased in order to raise a plan or provider's risk score. Prescription-based risk assessment models generally rely on drugs believed to be non-discretionary. However, with off-label prescribing, and to the extent that discretion remains in prescribing drugs for additional diseases or for less severe or marginal forms of the disease, caution should be exercised when prescription-based models are considered for provider payment applications.

Table 4.1 compares types of risk assessment methods based on data sources.

Table 4.1: Comparison of Risk Measures

| **Criteria** | **Risk Measures** | | | |
|---|---|---|---|---|
| | **Demographics** | **Prior Expenditures** | **Prescriptions** | **Health Diagnoses** |
| Data Quality | High | Medium | High | Medium |
| Prediction | Low | High | High | High |
| Administrative Burden | Low | Medium | Medium | High |
| Utilization incentive | Low/None | High | High* | Low |
| Diagnosis coding incentive | Low/None | Low | Low | High |

* High for prescription drugs, low for all other services.

*Logic in Assessing Risk*

When one wishes to assess risk for a disease-specific application, the different logical approaches used by the methods evaluated in this study to produce risk scores may result in one method being better suited for the application than another.

The methods evaluated in this study differ to some extent in the number of conditions they incorporate. Some use almost all known diseases to assign risk scores. Others exclude minor, acute conditions under the assumption that these conditions are not relevant to risk selection, do not represent significant per capita costs, and including them may produce a clinically needless proliferation of these codes. If the user of risk adjustment wished to categorize all patients for an evaluation of how primary care providers are managing these frequent acute minor problems, for example, then one of the methods that includes these conditions would be preferred.

Another difference is the assignment of disease measures to risk categories. The process may produce categories that are much too heterogeneous for a specific disease of interest. Some conditions are lumped with related, yet clinically quite distinct diseases with similar costs. A disease such as diabetes, on the other hand, has its own category in most of these methods and payment is affected by coding diabetes more specifically. For other conditions, more detailed coding to describe severity will not change the assignment to a risk category beyond the simple identification of the disease.

The approach to assigning individual risk scores also varies. Some methods are additive, with additional payment made for each additional identified disease category. For payment applications, some of these categories may be arranged in hierarchies of related conditions, e.g., pulmonary conditions, with payment made for only the highest cost category in the hierarchy, the assumption being that the lower cost categories in the hierarchy indicate complications related to the more significant condition. This approach avoids “double” counting. Other methods address this relatedness of conditions by assigning individuals to mutually exclusive risk categories derived by interacting all of the individual’s conditions or by identifying the individual’s dominant condition.

The methods evaluated in this study have been designed to be as robust to data problems as possible while preserving predictive performance. The models typically require only one occurrence of the diagnosis or prescription in the assessment period to assign risk. The number of times the same code appears is irrelevant. Discretionary or ill-defined indicators are often excluded or assigned so as to minimize gaming incentives. This means that data need not be perfectly complete and detailed to be adequate for risk adjustment.

*Implementation Environment*

Another important consideration is the environmental context in which health-based risk adjustment is being implemented. One such issue, for employers especially, is the concern with access to private information. A third party may need to collect and analyze the data. In addition, the payment model may require special calibration for the specific application or population. The model may also need to be updated frequently because the relationship between the risk measure and medical expenditures may change rapidly, e.g., as prescribing patterns and the kinds of new drugs on the market change. Other factors may also need to be considered. If other major purchasers are using a particular approach, it may be less confusing to the market if the same approach is used. If multiple management uses are to be made of the risk assessment, then the use that most greatly distinguishes the performance of candidate risk assessment methods may dominate the decision. Finally, the cost of licensing and maintaining the software should be taken into account. Prices vary and some are in the public domain but may require additional outside consultants for successful implementation.

**Uses of Health-based Risk Adjustment**

There are many uses for health-based risk adjustment by purchasers and plans. When selecting a health-based risk adjustment method, two features differentiate the applications.

1) Does the application involve payment to providers or plans?
2) Does the application's perspective focus on targeted sub-populations, or is it global?

Using the two distinguishing characteristics, specific applications can be categorized for the following four uses:

*Provider or Plan Payment / Global Perspective*

These uses include health plan premium rate setting and provider capitation. Under these conditions any of the diagnosis-based methods may be preferred because they are good predictors and may introduce less of a gaming incentive than the prescription-based models. Risk selection at the provider level is usually more extreme than risk selection across health plans. When capitation or volume target incentives are used to pay providers, the concern with diagnosis gaming and over-treatment become important. The use of actual utilization data, such as prescriptions, to indicate a disease and increase payment should be avoided or approached with caution. Diagnosis data is not immune from gaming but criteria exist for diagnosing many, if not most, major conditions and this helps provide a basis for validation. An additional benefit of using health-based risk adjustment for capitation is that providers are strongly incented to provide the data.

*Provider or Plan Payment / Targeted Perspective*

These uses include setting disease management payment levels, e.g., carve-outs, high cost case management, or disease-specific payments. While limiting the selection to diagnosis-based models to avoid perverse incentives, one would need to explore which of the methods best captures the severity and complications associated with managing a specific disease on one hand with high cost complex cases with many co-morbidities on the other. It may also be true that for the diseases of interest, one could become satisfied that the prescription indicating the presence of the condition or its severity is non-discretionary, and then prescription-based systems or a combination of systems may be considered.

*No Provider or Plan Payment / Global Perspective*

These uses include setting defined contribution levels for employers and employees, provider efficiency profiling, total medical cost forecasting, and budgeting. Any of the methods could be applied for these uses because secondary incentives are weak when payment is not involved. Other factors, such as data cost and other uses for the risk assessment information would dominate the selection. A relatively new use of health-based risk adjustment in rate setting is to adjust employee premiums in defined contribution products. Different approaches to managing the extent of risk segmentation vs. pooling in new products that offer not only a choice of providers but choice among

widely differing benefit plans (including spending accounts) will probably become more important to employers as the products are implemented, and as the employers become concerned with limiting the cost to employees and dependents with serious chronic conditions.

*No Provider or Plan Payment / Targeted Perspective*

These uses include high-cost case identification, individual underwriting, and disease management program planning and budgeting. The selection would be based on which method is most accurate and least costly to administer regardless of data source.

# Section V. Considerations in Implementing a Risk Adjuster

There are a number of additional considerations beyond selecting the risk assessment method that must be considered when implementing health-based risk adjustment. A number of lessons can be learned from purchasers and plans that pioneered the implementation of health-based risk adjustment. The implementation lessons of these purchasers have been the subject of the Risk Adjustment Impact Study, a three-year study funded by the Robert Wood Johnson Foundation, through its Health Care Financing and Organization initiative.

One component of the study described and evaluated the implementation experiences of a number of employer and public purchasers who had pioneered the implementation of health-based risk adjustment. A panel of experts, consultants with actuarial expertise who represented these purchasers, considered a number of implementation issues. Among these were lag issues, data issues, and model calibration issues. Because purchasers have not yet broadly applied prescription-based models, the following discussion addresses diagnosis-based models.

### Lag Issues

One concern for implementation is the lag between the date the health problem was coded or the prescription was ordered and the use of the information for payment adjustment. Lags reduce the accuracy of the payment in two ways: (1) the length of the eligibility requirement will exclude some beneficiaries who do not meet the requirement, and (2) the longer the lag, the more the predictive power is lost. It is more difficult to accurately predict future, more distant, time periods than proximal time periods.

Lags occur in three ways, including: (1) the length of the assessment window, (2) the time required for claims and enrollment data to be available to a plan or purchaser, and (3) the time to implement the risk scoring.

*The Length of the Assessment Window Required by the Model*

A prospective, individual model requires continuous eligibility throughout the assessment period and for each month that payment is made. A concurrent model does not require a lengthy diagnosis history. Applying an aggregate plan-level risk score to adjust future payment eliminates the requirement that an individual be continually enrolled from the assessment period to the payment period.

*The Time Required for Claims Run-out*

Plans will have unequal claims run-out periods. The purchaser is unlikely to be able to influence this claims lag. It is important to allow sufficient time for all the plans to reach a similar level of data completion; otherwise payment will be biased. Prescription data may lag by only a month or less before it is available to a plan. The claim data that

contains diagnoses may require four or more months to be adequately complete. Prescription data has the benefit of no provider-required data submission to a plan, so that a potential barrier is eliminated.

**The Time Required for Eligibility Data to be Updated**

It may require two months to receive updates of changes in eligibility status of plan members from purchaser. For some large employers, the retroactive adjustment for new enrollment, enrollment status changes, or terminations may take even longer.

*The Time to Execute the Risk Scoring and the Frequency of Risk Scoring*

Purchasers can control how often and how fast they compute and assign risk scores. Combined with the usual claims run-out lag, the range can be from a minimum of six-months up to 24 months.

Data delays are an implementation problem for any risk adjustment model. For individual-level prospective models, the enrollee must be continuously eligible for 6-12 months in the assessment period, 6-18 months in the claims delay period, and 1-12 months in the payment period for a health plan to be paid for the risk of that enrollee. This continuous enrollment requirement can remove up to 40% to 50% of any currently enrolled Medicaid population from the clinical condition risk assessment (e.g., all new enrollees), thus dramatically reducing the predictive performance of the total capitation system. Therefore, it is important to know the extent to which the delay has reduced the performance of the model compared to its “laboratory” tested results that often included no delay.

**Data Issues**

Implementation will be more challenging if there is not some early testing and data handling in the planning phase. A simulation may be the first time the purchaser will be handling massive amounts of data, especially the encounter data. It is wise to expect a great deal of last minute processing of encounter data.

The critical data quality issues for risk adjustment are not necessarily those that are captured in a fee-for-service edit system. It will be necessary to selectively bypass some of these fee-for-service edits.

Data should be examined for reasonableness. Examining the frequency distributions of various data elements will help identify incomplete encounter data. Although there are no norms, there is some information about what non-contact percentages to expect. Data may be missing because of sub-capitation or because of carve-outs. A common problem is missing mental health provider data for a program that covers mental health services. Each person should have similar benefits such as prescription drugs, co-insurance, or deductible levels.

Different types of plans have different types of data problems. Staff model HMOs that have limited experience with fee-for-service billing will have concerns about data layout

for encounters and the bundling of services. Plans whose systems truncate the number of diagnosis codes per record will raise concerns about the number of diagnoses.

Data quality can be an issue at the plan level and also at the provider level. Data concerns at the plan level revolve around completeness, while data issues at the provider level include both completeness and accuracy.

For diagnosis data, the concern at the plan level is to capture all diagnoses already recorded by the provider. Plans may be missing diagnoses for two reasons:

- They may be missing encounter data from some providers.
- They may be truncating the number of diagnoses per encounter supplied by the provider.

The California Joint Purchaser study of data quality for risk adjustment found that diagnosis data quality, as measured by the number of diagnoses per encounter and other indicators, varies significantly across medical groups. Plans that rely on data from a limited number of medical groups may have their risk underestimated.

Plans whose payments have been adjusted by purchasers using diagnosis-based risk adjusters, such as those participating in the Colorado and Maryland Medicaid programs, have in many cases made significant improvements in addressing plan-level problems with data completeness.

Prescription data is complete and accurate at the plan-level for most significant conditions and does not involve data transfer from providers.

For diagnosis coding at the provider level, there are three possible activities that can change the number and distribution of diagnoses and can increase the measured risk for a population when, in fact, the underlying morbidity of the population may be stable:

- Diagnostic discovery -- Increased number and severity of diagnoses are reported, all of which are appropriate. The correction of previous underreporting will reduce the problem of lack of persistence of diagnoses and will more fairly represent the illness burden of the population.
- Diagnostic creep -- Increased number and severity of diagnoses for cases where the diagnosis is uncertain. This represents an upward bias in response to payment incentives. Many groupers try to minimize this problem by bundling related diagnoses and by excluding ill-defined codes.
- Tentative diagnoses -- Represents a potential source of error when a diagnosis is appropriately used to justify a diagnostic procedure (rule-out) or to signal the need to treat a person without confirmatory diagnostic tests as if the patient has the disease (presumptive), because delay in treatment is harmful. Here too, the groupers have rules for excluding codes that are highly likely to be tentative.

Purchasers have so far not detected significant changes in provider-level coding patterns, but it is important to keep looking and to set up monitoring and auditing systems that examine coding practices.

Some purchasers have begun medical record audits and some have not. One strategy develops linkages with other measurement activities such as quality assurance. Others

seek to automate data-quality monitoring through clinical edits and audits of encounter data for illogical combinations or changes in the relationship between diagnoses and services provided.

**Model Calibration Issues**

Experience has taught that imported risk weights can be sufficiently valid and stable for many applications if they are based on a similar population with similar covered costs. For some applications described above, however, it may be preferable to calculate weights on the user's population. This requires both a sufficiently large population and adequate data. Whether a user imports or calculates its own, weights must be updated at regular intervals to account for changes in practice patterns, coding changes, and significant changes in benefit design. Because prescribing patterns change much more rapidly than general treatment patterns, prescription-based models will age more rapidly and will need more frequent updates.

Although many of the diagnosis-based models are calibrated, of necessity, on fee-for-service data, and experience has taught us that these weights are reasonably valid for managed care applications, there is a desire to move, when possible, to encounter-based weights. There may be some gain in validity from encounter-based weights that reflect the clinical and coding practices of a managed care environment.

Using encounter data for weights requires the highest standard for completeness. Although duplications of diagnoses can be tolerated in the risk assessment, duplications of charges could cause significant errors when establishing proper weights. Another issue to consider in developing weights is how to apply charges to encounter data.

# Section VI. Description of Risk Adjusters

This section briefly describes the background and key features of the risk adjusters evaluated in the study.

**Diagnosis-based Models**

The Johns Hopkins Adjusted Clinical Groups (ACGs) was developed by Jonathan Weiner and Barbara Starfield at Johns Hopkins University in the mid-1980s. This method was initially developed for epidemiological research on primary care. The system logic began with a clinical focus and was later modified to explain variation in total medical expenditures. This focus led ACG developers to be concerned with the total morbidity rather than specific diseases. ACGs was developed and tested on data from a few commercial HMOs and two state Medicaid data sets. ACGs was the first system to be used by health plans, primarily for profiling.

Most diagnoses are assigned to one of about 30 Adjusted Diagnosis Groups (ADGs). The assignment is based on clinical criteria such as severity, chronic or acute, and prognosis. ADGs, compared with the building blocks of DCG models, generally are not defined by specific disease but combine diseases with similar clinical management issues. ADGs are then combined with age and gender to produce mutually exclusive ACGs based on an analysis of clusters of ADGs. The approach emphasizes the number and severity of co-morbidities. An individual can have many ADGs, but only one ACG. Payment weights can be derived for ADGs in an additive model or, as is most common, for ACGs as defined rate cells. Under a recent contract with CMS, ACGs were revised and calibrated for the Medicare population. ACGs is licensed by Computer Science Corporation, Inc. ACGs are used by two Medicaid programs, a few employers and a number of health plans.

The Chronic Disease and Disability Payment System (CDPS) was developed by Richard Kronick and Tony Dreyfus at the University of California – San Diego in the mid-1990s as a demonstration project for providing managed care to a disabled population. Then called the Disability Payment System (DPS), CDPS is a new version that has been revised and expanded for the entire Medicaid population by refining or adding diagnosis categories important to a TANF population, e.g., pregnancy.

Most medium to high-cost chronic illness diagnoses are used to assign risk scores. Diagnoses are initially assigned to chronic condition categories. These categories retain the identity of the disease by diagnosis categories. The chronic illness categories are arranged into hierarchies. Only the highest cost category in a disease hierarchy is used to produce an individual's total risk score. An individual's risk score is computed by adding the weights for the age and gender category and any medical categories across the hierarchies. Within the hierarchies, only the highest cost category identified is used to assess risk. In this way CDPS is similar to HCCs.

Currently, seven states Medicaid managed care programs are using CDPS. Under a recent contract with CMS, CDPS was revised and calibrated for a Medicare population.

Before this study, CDPS had not been formally modeled for a commercial population. CDPS is available for essentially a no cost license by contacting the developers at University of California-San Diego.

Diagnostic Cost Groups (DCGs) was developed in the mid-1980s as an inpatient-data model for Medicare data. The original models were developed by Arlene Ash and Randall Ellis at Boston University. A number of models followed, including Hierarchical Condition Categories (HCCs), a comprehensive diagnosis model. The models have been refined over the years, and HCC models have now been developed for Medicaid and commercial populations in addition to Medicare.

The method assigns most diagnosis codes to categories called DxGroups. These categories are similar to disease categories. The DxGroups are then combined with related diseases into Condition Categories. A number of categories are arranged in hierarchies of diseases of similar type, primarily the same body system. Within hierarchies, only the weight of the highest cost category is used to assess to risk. An individual's risk score is computed by adding the weights of age and gender category and of each Hierarchical Condition Category identified. The DCG system is licensed by DxCG, Inc.

The Principle Inpatient Diagnosis model of DCGs is currently used to risk adjust a portion of payments to health plans in the Medicare+Choice program and a CMS customized version of the HCC model has been selected for the Medicare + Choice program for implementation in 2004. Employers and health plans are also using DCGs.

**Pharmacy-based Models**

Medicaid Rx was developed by the researchers who developed CDPS. The model was developed and validated for a Medicaid population. The prescription risk assessment logic is based on the Chronic Disease Score (CDS) model developed by researchers at Group Health Cooperative of Peugeot Sound. Medicaid Rx was created by revising CDS to include primarily chronic conditions prevalent in the Medicaid population. The Medicaid Rx model uses prescription data (NDC codes) to indicate the presence of a chronic disease. Prescriptions with multiple uses are often excluded. Medicaid Rx in a few instances adds some prescriptions that are typically prescribed for acute illnesses if the prescription is long standing, e.g. antibiotics for chronic infections. Additional information on Medicaid Rx is available from the CDPS developers at the University of California – San Diego.

RxRisk, formerly the Chronic Disease Score (CDS), was developed by researchers Paul Fishman and Michael Von Korpf at Group Health Cooperative of Puget Sound. RxRisk was developed from the research, modeling CDS for different populations. CDS was one of the first prescription data models to be developed and tested. RxRisk uses outpatient pharmacy data (NDC codes) to classify patients into disease categories. An individual's risk score is computed by adding the weights for age and gender categories with the weights for any identified disease category.

RxGroups were developed by the DxCG researchers in cooperation with Kaiser Permanente. Prescription data (NDC codes) are assigned to RxGroups. RxGroups are then combined to create Aggregated RxGroups. These Aggregated RxGroups are arranged into hierarchies, and a hierarchical additive model that includes age and

gender factors is used to compute an individual's total risk score. Another version of RxGroups combines inpatient diagnoses with ambulatory prescriptions. Additional information on RxGroups is available from DxCG, Inc.

**Models based on Diagnosis and Pharmacy Data**

Episode Risk Groups (ERGs) were developed in 2001 by Dan Dunn and researchers at Symmetry Health Data Systems, Inc. An ERG is a derivative of the Episode Treatment Groups (ETGs), an episode of care analysis system. Over 600 episodes from the ETG system are combined to produce ERGs. A surgical episode and medical episode for the same condition are combined in most instances, reducing the problem of risk adjustment for the care provided rather than for health status. The ERGs are then used to calculate a person's risk score by adding the weights for each identified ERG. ERGs are licensed by Symmetry Health Data Systems, Inc. ERGs are currently being distributed to customers of the ETCG system.

**Other Models – Not Included in this Study**

Other new risk assessment models are currently being tested and should be considered for future studies as they become more widely distributed. These include Clinical Risk Groups (CRGs) developed by 3M Health Systems. CRGs uses diagnoses and a selected set of non-discretionary procedures to calculate a risk score. Ingenix offers several predictive models that also rely on claims data, including one that uses only prescription drug data. In addition, CMS recently announced a Selected Condition derivative of HCCs to be used for Medicare+Choice in 2004. This model includes 61 condition categories and requires only about 3400 ICD-9 codes. The original HCC model included over 100 condition categories and used most of the over 15,000 ICD-codes.

# Section VII. A New Measure of Predictive Accuracy

The researchers have developed a new measure of predictive accuracy. The researches believe that this new measure has advantages over existing, commonly used measures. The new measure quantifies predictive accuracy at the individual level. The following defines the new measure, and compares the new measure to some commonly used measures.

## A New Measure of Predictive Accuracy

The researchers have developed a new measure of predictive accuracy, called *Cumming's Prediction Measure (CPM)*. (Since the researchers have not seen this measure defined or promoted in the research literature dealing with risk adjusters, it has been named, for the time being, after the developer. This should help to indicate that this is a newly developed measure, which has not yet been well studied, at least in the area of risk adjuster research.)

*Cumming's Prediction Measure*

Cumming's Prediction Measure (CPM) is calculated as shown below:

CPM = 1 – (Mean Absolute Prediction Error) / (Mean Absolute Deviation from Average)

The *mean absolute prediction error* is calculated as follows. First, the prediction error for each individual is determined by calculating the difference between predicted medical costs and actual medical costs. Next, the absolute value of each of these prediction errors is calculated, and, finally, the mean of the absolute prediction error across all individuals is determined.

The *mean absolute deviation from average* is calculated as follows. First, the deviation from average for each individual is determined by calculating the difference between the actual medical costs for that individual and the average medical costs across all individuals. Next, the absolute value of each of these deviations is calculated, and, finally, the mean of the absolute deviation across all individuals is determined.

*Comparison with Other Measures*

The commonly used measures of predictive accuracy on an individual level include R-squared and mean absolute prediction error. These measures have certain advantages and disadvantages, as discussed in Section II of this report.

Cumming's Prediction Measure (CPM) combines the best qualities of Individual R-squared and mean absolute prediction error. CPM is a single, summary statistic of goodness of fit. Like individual R-squared, CPM is expressed on a standardized scale of 0 to 1 where 0 indicates that the model explains 0% of the variation in cost among the individuals and 1 indicates that the model explains 100% of the variation. However, CPM uses the absolute value of the prediction errors rather than the square of the

prediction errors and, so, is not overly sensitive to large claims. In this respect, it is similar to the mean absolute prediction error.

Both CPM and R-squared can be described as the percentage of the variation in cost among individuals that is explained by the model. The difference is that R-squared measures variation using the square of each prediction error, whereas, CPM measures variation using the absolute value of each prediction error.

The sensitivity of R-squared to large prediction errors is a concern. According to the prior Society of Actuaries (SOA) study, "because $R^2$ squares the errors of prediction, it can be greatly affected by a relatively small number of cases with very large prediction errors. Given the typical distribution of health expenditures across individuals, where a small number of individuals have relatively large expenditures, this is a concern for our analysis." (Dunn, et al., 1995) This is one of the reasons for truncating large claims when individual R-squared is used as a measure of predictive accuracy. Because of this concern, the prior SOA study generally presents results with claims truncated at $25,000.

CPM is closely related to the mean absolute prediction error, from which it is derived. For a given level of claim truncation, CPM will always provide the same relative ranking of risk adjuster performance as the mean absolute prediction error. However, CPM also expresses how well each risk adjuster performs on an absolute basis, whereas, the mean absolute prediction error does not. For example, a CPM of 20% means that the risk adjuster explains 20% of the variation in cost, which is generally viewed as good performance. However, since the mean absolute prediction error is not expressed on a standardized scale, it, by itself, tells us little or nothing about the performance of a model. For example, a mean absolute prediction error of $2,000 could correspond to a model that explains 1% of the variation or could correspond to a model that explains 20% of variation. It is not possible to determine which might be the case without further information.

*Generalized CPM*

The generalized formula for the CPM measure is:

$$CPM^x = 1 - ( \sum_i | a_i - \hat{a}_i |^x ) / ( \sum_i | a_i - \bar{a} |^x )$$

Where:

$a_i$ = actual claim dollars for person i
$\hat{a}_i$ = predicted claim dollars for person i
$\bar{a}$ = mean of the actual claim dollars
x = power factor (x=1 for the standard CPM measure)
i goes from 1 to n, where n is the number of people

When x is set equal to 1, $CPM^x$ is the same as the CPM measure defined above. When x is set equal to 2, $CPM^x$ is the same as R-squared.

Some researchers argue that the importance of a prediction error grows more rapidly than a linear function of the size of the error i.e., an error that is twice as big is more than twice as serious. Accordingly, some researchers advocate R-squared since, in essence,

it weights large errors much more heavily than small errors. The problem is that large prediction errors can end up dominating the calculation of R-squared. As a result, significant improvements in the predictive accuracy for people with small or medium size claims might have little or no impact on the R-squared measure.

With the generalized CPM measure the user can decide, through the selection of the power factor, how much extra weight, if any, to apply to the larger errors. For example, one might decide to use a power factor of 1.2. This will weight the larger prediction errors more heavily, but the resulting measure is less likely to be dominated by a few large claims, as can occur with R-squared. Similarly, if the user wanted to underweight the larger errors, for some of the same reasons that claims are truncated, the user could select a power factor of slightly less than 1, for example 0.9.

*The Super Generalized CPM*

The super generalized CPM is:

$$SCPM^x = 1 - ( \sum_i | a_i - \hat{a}_i |^x \times w_i ) / ( \sum_i | a_i - \bar{a} |^x \times v_i )$$

Where:

$a_i$ = actual claim dollars for person i
$\hat{a}_i$ = predicted claim dollars for person i
$\bar{a}$ = mean of the actual claim dollars
$w_i$ = a set of weights for the prediction errors
$v_i$ = a set of weights for the deviations from average
i goes from 1 to n, where n is the number of people

Note that when the weights are set as $w_i = | a_i - \hat{a}_i |^{x-1}$ and $v_i = | a_i - \bar{a} |^{x-1}$, then $SCPM^x$ is the same as $CPM^x$. In $CPM^x$, if x is other than 1, then the weights used in the numerator differ from the weights used in the denominator. An alternative approach would be to define a set of weights that are the same for both the numerator and denominator. (The researchers have not yet explored the implications of such an approach.) If $w_i = v_i$ , then $SCPM^x$ will still have the desirable property that the measure equals 0 if the model predicts the average claim amount for each person.

**Illustration of Sensitivity of R-Squared to Large Prediction Errors**

The following example is intended to illustrate the impact of large prediction errors on R-squared and CPM. In order to make the results more evident, the example is a simplified scenario.

*Example*

Suppose that you have a group of 10,000 members with actual and predicted claim dollars as shown in Table 8.1. In Table 8.1, the members are put into one of four groups (low, medium, high, and very high) based on the amount of medical claims dollars. Also, suppose that a risk adjuster has predicted claims for each member as shown in the table. The last column of the table shows the prediction error for each member.

Table 8.1

| Claim Size | Number of Members | Actual Claims per member (in 000's) | Actual Claims (in 000's) | Predicted Claims per member (in 000's) | Predicted Claims (in 000's) | Prediction Error per member (in 000's) |
|---|---|---|---|---|---|---|
| Low | 8,000 | .400 | 3,200 | 1.024 | 8,192 | -.624 |
| Medium | 1,900 | 4.000 | 7,600 | 3.000 | 5,700 | 1.000 |
| High | 99 | 28.000 | 2,772 | 6.500 | 644 | 21.500 |
| Very High | 1 | 1,000.000 | 1,000 | 40.000 | 40 | 960.000 |
| Total | 10,000 | 1.457 | 14,572 | 1.458 | 14,576 | |

Table 8.2 shows the components of the absolute prediction error (which is the basis of CPM) and the square prediction error (which is the basis of R-squared).

Table 8.2

| Claim Size | Absolute Value of Prediction Error per member (in 000's) | Absolute Value of Prediction Error (in 000's) | % of Total Absolute Prediction Error | Square of Prediction Error per member (in $000^2$) | Square of Prediction Error (in $000^2$) | % of Total Square Prediction Error |
|---|---|---|---|---|---|---|
| Low | .624 | 4,992 | 50.0% | .389 | 3,112 | .3% |
| Medium | 1.000 | 1,900 | 19.0% | 1.000 | 1,900 | .2% |
| High | 21.500 | 2,129 | 21.3% | 462.250 | 45,763 | 4.7% |
| Very High | 960.000 | 960 | 9.6% | 921,600.000 | 921,600 | 94.8% |
| Total | | 9,981 | 100.0% | | 972,375 | 100.0% |

In this example, the total *square* prediction error (which is 972,375) is dominated by the prediction error on one claim, the one member with the $1,000,000 claim. Although this claim represents only 6.9% of the overall claim dollars, it counts for 94.8% of the overall prediction error. For the total *absolute* prediction error (which is 9,981) this one large claim accounts for only 9.6% of the overall prediction error.

As mentioned above, R-squared (which is derived from the total square prediction error) is overly sensitive to the prediction error for large claims. The corollary to this statement would be that R-squared is unduly insensitive to improvement in predictions for small or medium size claims. To illustrate this point, consider two alternative scenarios: (A) being able to decrease the prediction error by $1,000 for the one member with the very high claim, versus (B) being able to perfectly predict the claims for each of the 1,900 people with medium size claim amounts (i.e. decreasing the prediction error by $1,000 for each of these 1,900 people). It would seem that most users of risk adjusters would consider scenario B to be a much bigger improvement in predictive performance than scenario A. However, if we calculate the impact on the total square prediction error, we find that scenario A shows a bigger improvement than scenario B. In particular, the total square prediction error decreases by 1,919 in scenario A while the decrease in scenario B is only 1,900.

**Impact of New Measure on Model Fitting**

In calibrating the models in this study, a linear regression model was used which minimizes the mean square prediction error. Accordingly, the R-squared measure corresponds to the way the risk weights are calibrated. Some researchers might then argue that R-squared is the most appropriate measure, since it corresponds to the way the risk weights were determined. The researchers for this study believe that one should first define what is believed to be the most appropriate measure (or measures) of predictive accuracy and let that drive the way the model is calibrated, rather than vice versa.

If CPM is adopted as a new standard in measuring predictive accuracy, this might impact the way models are calibrated. In particular, calibration methods that attempt to minimize the mean absolute prediction error, rather than mean square prediction error, might lead to further improvements in model performance. It might also be surmised that methods that try to minimize the mean absolute prediction error might lead to more stable and reasonable risk weights since such methods are not impacted as much by a few large claims.

**Comparison of Numerical Results: R-Squared and CPM**

The following provides a detailed comparison of the numerical measures of predictive accuracy using R-squared and Cumming's Prediction Measure (CPM). This information is intended to help readers get more comfortable with this new measure by benchmarking it against an existing, commonly used measure.

*Prospective Model – Offered Weights*

Table 8.3 summarizes R-squared and CPM for each risk adjuster when used for a prospective application with the offered weights. A higher value indicates better predictive accuracy. The ACG method is not included in these tables since it does not come with offered weights.

Table 8.3: Summary of R-squared and CPM – Prospective Model with Offered Weights

| Risk Adjuster | Type of Risk Adjuster | R-Squared with claims truncated at: | | | CPM with claims truncated at: | | |
|---|---|---|---|---|---|---|---|
| | | $50,000 | $100,000 | None | $50,000 | $100,000 | None |
| ACG | Diag | NA | NA | NA | NA | NA | NA |
| CDPS | Diag | .134 | .125 | .103 | .127 | .128 | .127 |
| DCG | Diag | .195 | .180 | .143 | .172 | .172 | .169 |
| Medicaid Rx | Rx | .116 | .098 | .071 | .124 | .123 | .123 |
| RxGroups | Rx | .206 | .181 | .134 | .202 | .200 | .197 |
| RxRisk | Rx | .175 | .148 | .111 | .172 | .168 | .164 |
| ERG | Diag+Rx | .218 | .193 | .146 | .219 | .216 | .209 |

As can be seen in Table 8.3, CPM is similar in magnitude to R-squared. However, rankings of performance based on CPM differ slightly from rankings based on R-squared. (As mentioned above, CPM provides the same performance rankings as the mean absolute prediction error.) In general, the pharmacy-based risk adjusters rank slightly higher when using CPM than when using R-squared.

The CPM measure tends to be less sensitive to the level of claim truncation. For example, the CPM measure varies between 20.9% and 21.9% for the ERGs, depending on the level of claim truncation. Whereas, the R-squared measure varies between 14.6% and 21.8% for the ERGs.

Since R-squared is overly sensitive to large claims, many researchers truncate the claim dollars. To the extent that different studies use different levels of claim truncation, it makes the results of the studies more difficult to compare. The sensitivity of R-squared to the level of claim truncation also leads to a variety of opinions regarding what is the "right" or "optimal" level of claim truncation for analyzing predictive performance.

*Prospective Model – Recalibrated Weights*

Table 8.4 summarizes R-squared and Cumming's Prediction Measure (CPM) for each risk adjuster when used for a prospective application with recalibrated weights.

Table 8.4: Summary of R-squared and CPM – Prospective Model with Recalibrated Weights

| Risk Adjuster | Type of Risk Adjuster | R-Squared with claims truncated at: | | | CPM with claims truncated at: | | |
|---|---|---|---|---|---|---|---|
| | | $50,000 | $100,000 | None | $50,000 | $100,000 | None |
| ACG | Diag | .172 | .140 | .099 | .179 | .171 | .167 |
| CDPS | Diag | .208 | .186 | .149 | .190 | .183 | .178 |
| DCG | Diag | .224 | .198 | .154 | .208 | .198 | .190 |
| Medicaid Rx | Rx | .200 | .165 | .119 | .196 | .186 | .180 |
| RxGroups | Rx | .222 | .185 | .132 | .216 | .205 | .198 |
| RxRisk | Rx | .188 | .154 | .111 | .184 | .175 | .169 |
| ERG | Diag+Rx | .230 | .197 | .148 | .228 | .218 | .210 |

*Comparison of Results with and without Recalibration*

Table 8.5 shows the increase in performance due to recalibration of the risk weights for the prospective model. Specifically, the table shows the increase in R-squared and CPM between the prospective model with the recalibrated weights and the prospective model with the offered weights.

Table 8.5: Increase in Performance due to Recalibration – Prospective Model

| Risk Adjuster | Type of Risk Adjuster | Increase in R-Squared due to Recalibration with claims truncated at: | | | Increase in CPM due to Recalibration with claims truncated at: | | |
|---|---|---|---|---|---|---|---|
| | | $50,000 | $100,000 | None | $50,000 | $100,000 | None |
| ACG | Diag | NA | NA | NA | NA | NA | NA |
| CDPS | Diag | .074 | .062 | .046 | .063 | .055 | .052 |
| DCG | Diag | .029 | .018 | .012 | .036 | .026 | .021 |
| Medicaid Rx | Rx | .084 | .067 | .047 | .072 | .063 | .058 |
| RxGroups | Rx | .015 | .004 | -.001 | .014 | .005 | .000 |
| RxRisk | Rx | .014 | .005 | .001 | .012 | .007 | .005 |
| ERG | Diag+Rx | .012 | .003 | .002 | .009 | .002 | .001 |

The increase in performance as measured by R-squared is fairly consistent with the increase in performance as measured by CPM.

*Concurrent Model – Recalibrated Weights*

Table 8.6 summarizes R-squared and Cumming's Prediction Measure (CPM) for each risk adjuster when used for a concurrent application with the recalibrated weights.

Table 8.6: Summary of R-squared and CPM – Concurrent Model with Recalibrated Weights

| Risk Adjuster | Type of Risk Adjuster | R-Squared with claims truncated at: | | | CPM with claims truncated at: | | |
|---|---|---|---|---|---|---|---|
| | | $50,000 | $100,000 | None | $50,000 | $100,000 | None |
| ACG | Diag | .429 | .376 | .282 | .381 | .369 | .360 |
| CDPS | Diag | .440 | .418 | .355 | .343 | .330 | .317 |
| DCG | Diag | .564 | .547 | .466 | .419 | .405 | .385 |
| Medicaid Rx | Rx | .372 | .328 | .244 | .308 | .291 | .275 |
| RxGroups | Rx | .420 | .376 | .279 | .347 | .327 | .307 |
| RxRisk | Rx | .339 | .292 | .213 | .282 | .268 | .257 |
| ERG | Diag+Rx | .474 | .427 | .347 | .400 | .376 | .354 |

As can be seen in Table 8.6, CPM is similar in magnitude to R-squared. However, CPM tends to be more stable as the level of claim truncation is changed. Except for CDPS and DCGs, CPM is sometimes higher and sometimes lower than R-squared. For CDPS and DCGs, R-squared is always higher than CPM for the levels of claim truncation used in this study.

As can be seen in Table 8.6, whether based on R-squared or CPM, the diagnosis-based models outperform the pharmacy-based models when used for concurrent risk assessment.

*Comparison of Prospective and Concurrent Results*

Table 8.7 compares the performance of the prospective and concurrent risk adjustment models with recalibrated risk weights. Table 8.7 compares performance as measured by R-squared and CPM.

Table 8.7: Comparison of Performance of Prospective and Concurrent Risk Adjustment Models - With Recalibration of Risk Weights

| Risk Adjuster | Type of Risk Adjuster | R-Squared with claims truncated at $100,000 for: | | CPM with claims truncated at $100,000 for: | |
|---|---|---|---|---|---|
| | | Prospective Model | Concurrent Model | Prospective Model | Concurrent Model |
| ACG | Diag | .140 | .376 | .171 | .369 |
| CDPS | Diag | .186 | .418 | .183 | .330 |
| DCG | Diag | .198 | .547 | .198 | .405 |
| Medicaid Rx | Rx | .165 | .328 | .186 | .291 |
| RxGroups | Rx | .185 | .376 | .205 | .327 |
| RxRisk | Rx | .154 | .292 | .175 | .268 |
| ERG | Diag+Rx | .197 | .427 | .218 | .376 |

As can be seen from Table 8.7, whether based on R-squared or CPM, the concurrent models significantly outperform the prospective models.

Table 8.8 shows the increase in performance between the prospective and concurrent model. In particular, the table shows the increase in R-squared and CPM between the concurrent model and the prospective model with recalibrated weights.

Table 8.8: Increase in Performance between Prospective and Concurrent Model

| Risk Adjuster | Type of Risk Adjuster | Increase in R-Squared with claims truncated at: | | | Increase in CPM with claims truncated at: | | |
|---|---|---|---|---|---|---|---|
| | | $50,000 | $100,000 | None | $50,000 | $100,000 | None |
| ACG | Diag | .258 | .236 | .183 | .202 | .198 | .193 |
| CDPS | Diag | .232 | .232 | .207 | .153 | .147 | .139 |
| DCG | Diag | .341 | .349 | .311 | .211 | .206 | .195 |
| Medicaid Rx | Rx | .173 | .164 | .126 | .113 | .105 | .095 |
| RxGroups | Rx | .198 | .191 | .147 | .131 | .121 | .110 |
| RxRisk | Rx | .151 | .138 | .102 | .098 | .094 | .088 |
| ERG | Diag+Rx | .245 | .230 | .199 | .172 | .158 | .144 |

As can be seen in Table 8.8, the increase in performance as measured by CPM is slightly smaller than the increase in performance as measured by R-squared. The increase in performance as measured by CPM tends to be more stable as the level of claim truncation is changed. For example, for ACGs, the increase in CPM only varies from .193 to .202 depending on the level of claim truncation, whereas the increase in R-squared varies from .183 to .258.

# Section VIII. Recommendations for Follow-up Studies

This section summarizes recommendations for follow-up studies. These are studies that may build upon the research performed here.

Recommendations for follow-up studies:

- Analyze other risk adjusters/predictive models that are common in the marketplace or actively being marketed. This might include 3M's CRGs, the Ingenix predictive models, and the Medicare selected diagnoses models.
- Make the analysis more realistic by incorporating: (a) claim lag differences between diagnosis data and pharmacy data, (b) population turnover, and (c) time lag between the risk assessment period and the payment adjustment period.
- Examine results for "real" groups of members. This might include analyzing results by employer group and benefit option (e.g., HMO vs. PPO, low deductible vs. high deductible).
- Compare the risk adjusters included in this study with predictive models based on measures of prior use.
- Analyze the possible increase in performance due to refinement of the risk weights for a given population. The refinements might include smoothing, blending, and removing non-statistically significant variables.
- Analyze results for other types of populations, such as, Medicaid and Medicare populations.
- Analyze the impact on the ERG results of using only diagnosis data or only diagnosis plus pharmacy data. (The ERGs, as presented in this study, use diagnosis codes, pharmacy data, and a limited number of surgical procedure codes.)
- Analyze results using base year, rather than prediction year, claim dollars to define non-random groups.
- Compare the consistency of pharmacy and diagnosis based models in identifying people with a particular type of medical condition. This might also include analysis of the persistency of certain chronic conditions when defined by diagnosis codes and/or pharmacy codes.
- Analyze the increase in performance that might be possible due to using alternative methods of model fitting. Specifically, the impact of using methods that try to minimize the mean absolute prediction error as opposed to methods that minimize the mean square prediction error.
- Analyze the impact on predictive performance of using more than 12 months of data in the base period.

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**EXHIBIT B-1: Individual Measures of Predictive Accuracy - Prospective Model - Offered Weights**

Two sets of results are shown - one based on all members (full data set) and one based on the validation data set.

| | | Full Data Set: | | Validation Data Set: | | | | |
|---|---|---|---|---|---|---|---|---|
| Risk Adjuster | Claim Truncation | R-Sqrd | Mean Abs Error | R-Sqrd | Mean Abs Error | Cumming's Prediction Measure | Claim Truncation | Mean Absolute Deviation |
| ACG | $50,000 | | | NA | NA | NA | $50,000 | 2400.92 |
| | $100,000 | | | NA | NA | NA | $100,000 | 2534.22 |
| | None | | | NA | NA | NA | None | 2632.75 |
| CDPS | $50,000 | | | 0.1344 | 2095.30 | 0.1273 | | |
| | $100,000 | 0.1228 | 2219.15 | 0.1247 | 2209.81 | 0.1280 | | |
| | None | 0.0975 | 2305.56 | 0.1025 | 2299.43 | 0.1266 | | |
| DxCG | $50,000 | | | 0.1947 | 1987.17 | 0.1723 | | |
| | $100,000 | 0.1771 | 2107.94 | 0.1802 | 2098.05 | 0.1721 | | |
| | None | 0.1398 | 2193.31 | 0.1425 | 2187.36 | 0.1692 | | |
| MedicaidRx | $50,000 | | | 0.1155 | 2103.21 | 0.1240 | | |
| | $100,000 | 0.0978 | 2229.74 | 0.0975 | 2222.05 | 0.1232 | | |
| | None | 0.0715 | 2315.69 | 0.0712 | 2310.16 | 0.1225 | | |
| RxG1 | $50,000 | | | 0.2063 | 1916.17 | 0.2019 | | |
| | $100,000 | 0.1798 | 2035.34 | 0.1808 | 2026.85 | 0.2002 | | |
| | None | 0.1357 | 2117.85 | 0.1335 | 2113.10 | 0.1974 | | |
| RxRisk | $50,000 | | | 0.1746 | 1988.17 | 0.1719 | | |
| | $100,000 | | | 0.1482 | 2108.41 | 0.1680 | | |
| | None | | | 0.1106 | 2199.98 | 0.1644 | | |
| ERG | $50,000 | | | 0.2181 | 1875.36 | 0.2189 | | |
| | $100,000 | | | 0.1934 | 1987.30 | 0.2158 | | |
| | None | | | 0.1460 | 2082.04 | 0.2092 | | |

**EXHIBIT B-2: Individual Measures of Predictive Accuracy - Prospective Model - Recalibrated Weights**

Two sets of results are shown - one based on the recalibrated risk weights as calculated ("As Is") and one based on setting any negative diagnosis or age/gender risk weights to 0 ("Min 0").

| | | Risk Weights: As Is | | Risk Weights: Min 0 | | | | |
|---|---|---|---|---|---|---|---|---|
| Risk Adjuster | Claim Truncation | R-Sqrd | Mean Abs Error | R-Sqrd | Mean Abs Error | Cumming's Prediction Measure | Claim Truncation | Mean Absolute Deviation |
| ACGs | $50,000 | 0.1716 | 1971.73 | 0.1716 | 1971.73 | 0.1788 | $50,000 | 2400.92 |
| | $100,000 | 0.1399 | 2099.93 | 0.1399 | 2099.93 | 0.1714 | $100,000 | 2534.22 |
| | None | 0.0989 | 2193.01 | 0.0989 | 2193.01 | 0.1670 | None | 2632.75 |
| CDPS | $50,000 | 0.2079 | 1944.18 | 0.2079 | 1944.15 | 0.1902 | | |
| | $100,000 | 0.1863 | 2070.46 | 0.1863 | 2070.42 | 0.1830 | | |
| | None | 0.1484 | 2163.70 | 0.1485 | 2163.63 | 0.1782 | | |
| DxCG | $50,000 | 0.2236 | 1894.90 | 0.2236 | 1901.86 | 0.2079 | | |
| | $100,000 | 0.1978 | 2023.37 | 0.1978 | 2032.08 | 0.1981 | | |
| | None | 0.1542 | 2121.38 | 0.1542 | 2132.78 | 0.1899 | | |
| MedicaidRx | $50,000 | 0.1997 | 1931.30 | 0.1997 | 1931.30 | 0.1956 | | |
| | $100,000 | 0.1647 | 2062.26 | 0.1647 | 2062.26 | 0.1862 | | |
| | None | 0.1185 | 2158.67 | 0.1186 | 2158.68 | 0.1801 | | |
| RxG1 | $50,000 | 0.2216 | 1881.89 | 0.2216 | 1882.15 | 0.2161 | | |
| | $100,000 | 0.1849 | 2013.99 | 0.1849 | 2014.34 | 0.2051 | | |
| | None | 0.1323 | 2112.25 | 0.1323 | 2112.80 | 0.1975 | | |
| RxRisk | $50,000 | 0.1884 | 1960.23 | 0.1884 | 1960.23 | 0.1836 | | |
| | $100,000 | 0.1535 | 2091.14 | 0.1535 | 2091.15 | 0.1748 | | |
| | None | 0.1111 | 2187.22 | 0.1111 | 2187.26 | 0.1692 | | |
| ERG | $50,000 | | | 0.2296 | 1854.06 | 0.2278 | | |
| | $100,000 | | | 0.1966 | 1982.69 | 0.2176 | | |
| | None | | | 0.1479 | 2078.98 | 0.2103 | | |

**EXHIBIT B-3: Individual Measures of Predictive Accuracy - Concurrent Model - Recalibrated Weights**

Two sets of results are shown - one based on the recalibrated risk weights as calculated ("As Is") and one based on setting any negative diagnosis or age/gender risk weights to 0 ("Min 0").

| | | Risk Weights: As Is | | Risk Weights: Min 0 | | | | |
|---|---|---|---|---|---|---|---|---|
| Risk Adjuster | Claim Truncation | R-Sqrd | Mean Abs Error | R-Sqrd | Mean Abs Error | Cumming's Prediction Measure | Claim Truncation | Mean Absolute Deviation |
| ACGs | $50,000 | 0.4294 | 1486.51 | 0.4294 | 1486.51 | 0.3809 | $50,000 | 2400.92 |
| | $100,000 | 0.3762 | 1599.41 | 0.3762 | 1599.41 | 0.3689 | $100,000 | 2534.22 |
| | None | 0.2818 | 1685.11 | 0.2818 | 1685.11 | 0.3599 | None | 2632.75 |
| CDPS | $50,000 | 0.4402 | 1576.37 | 0.4402 | 1576.40 | 0.3434 | | |
| | $100,000 | 0.4177 | 1696.96 | 0.4178 | 1697.02 | 0.3304 | | |
| | None | 0.3550 | 1798.81 | 0.3551 | 1798.85 | 0.3167 | | |
| DxCG | $50,000 | 0.5647 | 1395.65 | 0.5641 | 1394.33 | 0.4193 | | |
| | $100,000 | 0.5470 | 1514.12 | 0.5468 | 1509.00 | 0.4046 | | |
| | None | 0.4655 | 1628.39 | 0.4655 | 1618.28 | 0.3853 | | |
| MedicaidRx | $50,000 | 0.3724 | 1661.10 | 0.3724 | 1661.10 | 0.3081 | | |
| | $100,000 | 0.3284 | 1798.80 | 0.3284 | 1797.03 | 0.2909 | | |
| | None | 0.2444 | 1911.31 | 0.2444 | 1908.72 | 0.2750 | | |
| RxG1 | $50,000 | 0.4200 | 1565.17 | 0.4200 | 1568.61 | 0.3467 | | |
| | $100,000 | 0.3760 | 1698.66 | 0.3759 | 1706.59 | 0.3266 | | |
| | None | 0.2792 | 1814.12 | 0.2791 | 1823.39 | 0.3074 | | |
| RxRisk | $50,000 | 0.3392 | 1723.82 | 0.3392 | 1723.82 | 0.2820 | | |
| | $100,000 | 0.2918 | 1854.15 | 0.2918 | 1854.15 | 0.2684 | | |
| | None | 0.2132 | 1955.61 | 0.2132 | 1956.30 | 0.2569 | | |
| ERG | $50,000 | | | 0.4744 | 1440.99 | 0.3998 | | |
| | $100,000 | | | 0.4268 | 1582.00 | 0.3757 | | |
| | None | | | 0.3465 | 1699.79 | 0.3544 | | |

**EXHIBIT C-1: PREDICTIVE RATIOS - PROSPECTIVE OFFERED WEIGHT MODEL - UNTRUNCATED CLAIMS**

**Predictive Ratios: Ratio of Predicted Claims for 1999 to Actual Claims for 1999**
**Prospective Model: Use 1998 Claim Information to Predict 1999 Claim Dollars**
**Offered Weights: Use Risk Weights Provided by Vendors to Score each Member**
**Claims: Untruncated**

Members are grouped based on: (a) 1999 claims for quintiles and dollar ranges, and (b) 1998 and 1999 claims for medical condition.

| 1999 Claim $ Quintiles | Percentiles | Members | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-20% | 74,914 | 130.79 | 105.56 | 116.37 | 88.65 | 106.07 | 74.80 | 11 |
| 2 | 20-40% | 74,909 | 8.78 | 6.41 | 8.36 | 5.98 | 6.74 | 5.77 | 194 |
| 3 | 40-60% | 74,921 | 3.37 | 2.88 | 3.28 | 2.78 | 2.94 | 2.89 | 596 |
| 4 | 60-80% | 74,915 | 1.59 | 1.65 | 1.64 | 1.68 | 1.68 | 1.76 | 1,560 |
| 5 | 80-100% | 74,914 | 0.40 | 0.51 | 0.43 | 0.54 | 0.49 | 0.54 | 8,799 |
| Total | | 374,573 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 2,232 |

| Group | Actual 1999 Claims $ Range | Members | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-500 | 176,099 | 10.78 | 8.32 | 10.03 | 7.48 | 8.56 | 6.97 | 150 |
| 2 | 500-1000 | 55,258 | 2.88 | 2.57 | 2.83 | 2.49 | 2.61 | 2.61 | 723 |
| 3 | 1000-1500 | 31,499 | 1.92 | 1.90 | 1.95 | 1.90 | 1.94 | 2.01 | 1,230 |
| 4 | 1500-2000 | 21,254 | 1.50 | 1.60 | 1.56 | 1.62 | 1.61 | 1.70 | 1,732 |
| 5 | 2000-4000 | 42,235 | 1.02 | 1.16 | 1.10 | 1.23 | 1.20 | 1.26 | 2,831 |
| 6 | 4000-6000 | 18,028 | 0.68 | 0.83 | 0.72 | 0.89 | 0.83 | 0.91 | 4,884 |
| 7 | 6000-8000 | 9,644 | 0.51 | 0.64 | 0.53 | 0.69 | 0.63 | 0.70 | 6,903 |
| 8 | 8000-10000 | 5,591 | 0.41 | 0.53 | 0.43 | 0.58 | 0.51 | 0.58 | 8,919 |
| 9 | 10000-12000 | 3,549 | 0.36 | 0.48 | 0.38 | 0.53 | 0.45 | 0.51 | 10,921 |
| 10 | 12000-14000 | 2,281 | 0.32 | 0.43 | 0.34 | 0.47 | 0.40 | 0.45 | 12,948 |
| 11 | 14000-16000 | 1,679 | 0.28 | 0.38 | 0.31 | 0.43 | 0.35 | 0.40 | 14,936 |
| 12 | 16000-18000 | 1,202 | 0.25 | 0.33 | 0.28 | 0.39 | 0.33 | 0.36 | 16,964 |
| 13 | 18000-20000 | 925 | 0.24 | 0.34 | 0.26 | 0.37 | 0.31 | 0.36 | 18,982 |
| 14 | 20000-22000 | 736 | 0.22 | 0.31 | 0.25 | 0.33 | 0.29 | 0.32 | 20,955 |
| 15 | 22000-24000 | 592 | 0.22 | 0.30 | 0.23 | 0.32 | 0.27 | 0.30 | 23,013 |
| 16 | 24000-26000 | 487 | 0.19 | 0.28 | 0.23 | 0.30 | 0.25 | 0.27 | 24,946 |
| 17 | 26000-28000 | 365 | 0.18 | 0.26 | 0.20 | 0.27 | 0.22 | 0.26 | 26,932 |
| 18 | 28000-30000 | 323 | 0.17 | 0.25 | 0.18 | 0.27 | 0.22 | 0.25 | 28,976 |
| 19 | 30000-40000 | 1,034 | 0.16 | 0.25 | 0.17 | 0.25 | 0.20 | 0.24 | 34,520 |
| 20 | 40000-50000 | 583 | 0.13 | 0.20 | 0.13 | 0.20 | 0.16 | 0.20 | 44,519 |
| 21 | 50000-60000 | 343 | 0.11 | 0.18 | 0.10 | 0.17 | 0.13 | 0.16 | 54,609 |
| 22 | 60000-80000 | 334 | 0.10 | 0.16 | 0.10 | 0.15 | 0.11 | 0.15 | 68,675 |
| 23 | 80000-100000 | 182 | 0.09 | 0.14 | 0.09 | 0.13 | 0.10 | 0.12 | 89,116 |
| 24 | 100000+ | 350 | 0.07 | 0.10 | 0.05 | 0.09 | 0.06 | 0.09 | 167,951 |

| Condition in 1999 | Members | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|
| Breast Cancer | 2,499 | 0.37 | 0.59 | 0.40 | 0.54 | 0.46 | 0.73 | 11,508 |
| Heart Disease | 1,682 | 0.24 | 0.42 | 0.22 | 0.41 | 0.34 | 0.39 | 25,409 |
| Asthma | 14,261 | 0.71 | 0.68 | 0.74 | 0.71 | 0.71 | 0.71 | 4,675 |
| Mental Illness | 11,790 | 0.60 | 0.69 | 0.60 | 0.70 | 0.66 | 0.65 | 6,629 |
| HIV | 205 | 0.30 | 0.56 | 0.48 | 0.70 | 0.49 | 0.61 | 16,637 |

| Condition in 1998 | Members | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|
| Breast Cancer | 2,285 | 0.57 | 0.92 | 0.59 | 0.80 | 0.67 | 1.14 | 8,383 |
| Heart Disease | 1,420 | 0.47 | 0.86 | 0.37 | 0.71 | 0.59 | 0.76 | 17,692 |
| Asthma | 13,598 | 0.98 | 0.97 | 0.91 | 0.87 | 0.87 | 0.93 | 4,119 |
| Mental Illness | 11,115 | 0.82 | 1.02 | 0.74 | 0.88 | 0.83 | 0.84 | 5,773 |
| HIV | 168 | 0.46 | 0.94 | 0.60 | 0.84 | 0.62 | 0.81 | 15,902 |

**EXHIBIT C-2: PREDICTED CLAIMS - PROSPECTIVE OFFERED WEIGHT MODEL - UNTRUNCATED CLAIMS**

**Predicted Claims: Predicted Claims Per Member Per Year for 1999**
**Prospective Model: Use 1998 Claim Information to Predict 1999 Claim Dollars**
**Offered Weights: Use Risk Weights Provided by Vendors to Score each Member**
**Claims: Untruncated**

Members are grouped based on: (a) 1999 claims for quintiles and dollar ranges, and (b) 1998 and 1999 claims for medical condition.

| 1999 Claim $ Quintiles | Percentiles | Members | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-20% | 74,914 | 1,434 | 1,157 | 1,276 | 972 | 1,163 | 820 | 11 |
| 2 | 20-40% | 74,909 | 1,702 | 1,244 | 1,622 | 1,159 | 1,307 | 1,118 | 194 |
| 3 | 40-60% | 74,921 | 2,006 | 1,718 | 1,953 | 1,656 | 1,752 | 1,722 | 596 |
| 4 | 60-80% | 74,915 | 2,485 | 2,579 | 2,565 | 2,613 | 2,627 | 2,745 | 1,560 |
| 5 | 80-100% | 74,914 | 3,532 | 4,462 | 3,744 | 4,760 | 4,312 | 4,755 | 8,799 |
| Total | | 374,573 | 2,232 | 2,232 | 2,232 | 2,232 | 2,232 | 2,232 | 2,232 |

| Group | Actual 1999 Claims $ Range | Members | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-500 | 176,099 | 1,616 | 1,248 | 1,504 | 1,122 | 1,283 | 1,046 | 150 |
| 2 | 500-1000 | 55,258 | 2,082 | 1,855 | 2,043 | 1,801 | 1,886 | 1,887 | 723 |
| 3 | 1000-1500 | 31,499 | 2,356 | 2,342 | 2,394 | 2,343 | 2,383 | 2,473 | 1,230 |
| 4 | 1500-2000 | 21,254 | 2,591 | 2,765 | 2,697 | 2,809 | 2,796 | 2,938 | 1,732 |
| 5 | 2000-4000 | 42,235 | 2,888 | 3,276 | 3,112 | 3,483 | 3,402 | 3,576 | 2,831 |
| 6 | 4000-6000 | 18,028 | 3,313 | 4,076 | 3,504 | 4,337 | 4,050 | 4,425 | 4,884 |
| 7 | 6000-8000 | 9,644 | 3,518 | 4,413 | 3,637 | 4,732 | 4,328 | 4,812 | 6,903 |
| 8 | 8000-10000 | 5,591 | 3,693 | 4,771 | 3,874 | 5,154 | 4,588 | 5,148 | 8,919 |
| 9 | 10000-12000 | 3,549 | 3,969 | 5,211 | 4,193 | 5,754 | 4,878 | 5,545 | 10,921 |
| 10 | 12000-14000 | 2,281 | 4,172 | 5,517 | 4,415 | 6,033 | 5,138 | 5,786 | 12,948 |
| 11 | 14000-16000 | 1,679 | 4,112 | 5,661 | 4,571 | 6,375 | 5,255 | 5,943 | 14,936 |
| 12 | 16000-18000 | 1,202 | 4,220 | 5,666 | 4,703 | 6,600 | 5,556 | 6,128 | 16,964 |
| 13 | 18000-20000 | 925 | 4,643 | 6,533 | 4,917 | 7,084 | 5,978 | 6,823 | 18,982 |
| 14 | 20000-22000 | 736 | 4,710 | 6,427 | 5,291 | 6,981 | 6,060 | 6,612 | 20,955 |
| 15 | 22000-24000 | 592 | 4,981 | 6,985 | 5,362 | 7,329 | 6,231 | 6,804 | 23,013 |
| 16 | 24000-26000 | 487 | 4,715 | 6,878 | 5,616 | 7,463 | 6,282 | 6,840 | 24,946 |
| 17 | 26000-28000 | 365 | 4,869 | 7,059 | 5,394 | 7,140 | 5,996 | 6,994 | 26,932 |
| 18 | 28000-30000 | 323 | 4,936 | 7,305 | 5,353 | 7,925 | 6,513 | 7,140 | 28,976 |
| 19 | 30000-40000 | 1,034 | 5,693 | 8,555 | 5,908 | 8,631 | 6,990 | 8,268 | 34,520 |
| 20 | 40000-50000 | 583 | 5,574 | 9,122 | 5,707 | 8,897 | 7,155 | 8,900 | 44,519 |
| 21 | 50000-60000 | 343 | 6,040 | 9,744 | 5,685 | 9,212 | 7,319 | 8,861 | 54,609 |
| 22 | 60000-80000 | 334 | 6,933 | 11,033 | 6,821 | 10,224 | 7,440 | 10,067 | 68,675 |
| 23 | 80000-100000 | 182 | 7,977 | 12,507 | 7,701 | 11,148 | 8,881 | 10,545 | 89,116 |
| 24 | 100000+ | 350 | 11,020 | 17,260 | 7,687 | 14,915 | 10,465 | 15,840 | 167,951 |

| Condition in 1999 | Members | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|
| Breast Cancer | 2,499 | 4,282 | 6,807 | 4,631 | 6,175 | 5,299 | 8,387 | 11,508 |
| Heart Disease | 1,682 | 6,071 | 10,726 | 5,698 | 10,494 | 8,715 | 9,948 | 25,409 |
| Asthma | 14,261 | 3,307 | 3,185 | 3,468 | 3,299 | 3,297 | 3,337 | 4,675 |
| Mental Illness | 11,790 | 3,947 | 4,584 | 3,962 | 4,645 | 4,352 | 4,334 | 6,629 |
| HIV | 205 | 4,953 | 9,349 | 7,987 | 11,633 | 8,230 | 10,200 | 16,637 |

| Condition in 1998 | Members | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|
| Breast Cancer | 2,285 | 4,796 | 7,754 | 4,952 | 6,710 | 5,627 | 9,597 | 8,383 |
| Heart Disease | 1,420 | 8,337 | 15,181 | 6,461 | 12,618 | 10,363 | 13,378 | 17,692 |
| Asthma | 13,598 | 4,055 | 4,001 | 3,767 | 3,583 | 3,595 | 3,846 | 4,119 |
| Mental Illness | 11,115 | 4,750 | 5,864 | 4,272 | 5,095 | 4,794 | 4,845 | 5,773 |
| HIV | 168 | 7,238 | 14,871 | 9,566 | 13,371 | 9,829 | 12,951 | 15,902 |

**EXHIBIT D-1: PREDICTIVE RATIOS - PROSPECTIVE RECALIBRATED MODEL - CLAIMS TRUNCATED AT $50,000**

**Predictive Ratios: Ratio of Predicted Claims for 1999 to Actual Claims for 1999**
**Prospective Model: Use 1998 Claim Information to Predict 1999 Claim Dollars**
**Recalibrated Weights: Use Calculated Risk Weights (with min of 0) to Score each Member**
**Claims: Truncated at $50,000**

Members are grouped based on: (a) 1999 claims for quintiles and dollar ranges, and (b) 1998 and 1999 claims for medical condition.

| 1999 Claim $ Quintiles | Percentiles | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-20% | 74,914 | 87.72 | 95.47 | 76.58 | 86.17 | 79.99 | 95.26 | 66.31 | 11 |
| 2 | 20-40% | 74,909 | 6.62 | 6.17 | 5.81 | 5.93 | 5.65 | 6.10 | 5.37 | 194 |
| 3 | 40-60% | 74,921 | 2.95 | 2.79 | 2.82 | 2.74 | 2.68 | 2.73 | 2.74 | 596 |
| 4 | 60-80% | 74,915 | 1.62 | 1.58 | 1.64 | 1.63 | 1.61 | 1.60 | 1.67 | 1,560 |
| 5 | 80-100% | 74,914 | 0.48 | 0.50 | 0.52 | 0.52 | 0.54 | 0.50 | 0.55 | 8,048 |
| Total | | 374,573 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 2,082 |

| Group | Actual 1999 Claims $ Range | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-500 | 176,099 | 7.93 | 7.82 | 7.03 | 7.36 | 6.98 | 7.74 | 6.41 | 150 |
| 2 | 500-1000 | 55,258 | 2.62 | 2.49 | 2.53 | 2.46 | 2.40 | 2.44 | 2.49 | 723 |
| 3 | 1000-1500 | 31,499 | 1.89 | 1.83 | 1.89 | 1.87 | 1.84 | 1.84 | 1.91 | 1,230 |
| 4 | 1500-2000 | 21,254 | 1.55 | 1.51 | 1.58 | 1.57 | 1.56 | 1.54 | 1.61 | 1,732 |
| 5 | 2000-4000 | 42,235 | 1.11 | 1.10 | 1.14 | 1.16 | 1.17 | 1.15 | 1.20 | 2,831 |
| 6 | 4000-6000 | 18,028 | 0.76 | 0.77 | 0.80 | 0.79 | 0.82 | 0.79 | 0.85 | 4,884 |
| 7 | 6000-8000 | 9,644 | 0.57 | 0.59 | 0.61 | 0.60 | 0.63 | 0.59 | 0.65 | 6,903 |
| 8 | 8000-10000 | 5,591 | 0.47 | 0.49 | 0.51 | 0.50 | 0.53 | 0.48 | 0.54 | 8,919 |
| 9 | 10000-12000 | 3,549 | 0.41 | 0.43 | 0.45 | 0.44 | 0.47 | 0.42 | 0.47 | 10,921 |
| 10 | 12000-14000 | 2,281 | 0.35 | 0.38 | 0.39 | 0.39 | 0.41 | 0.37 | 0.41 | 12,948 |
| 11 | 14000-16000 | 1,679 | 0.31 | 0.33 | 0.35 | 0.35 | 0.38 | 0.33 | 0.37 | 14,936 |
| 12 | 16000-18000 | 1,202 | 0.28 | 0.30 | 0.31 | 0.33 | 0.35 | 0.31 | 0.33 | 16,964 |
| 13 | 18000-20000 | 925 | 0.26 | 0.30 | 0.31 | 0.30 | 0.32 | 0.29 | 0.32 | 18,982 |
| 14 | 20000-22000 | 736 | 0.23 | 0.26 | 0.27 | 0.27 | 0.29 | 0.26 | 0.28 | 20,955 |
| 15 | 22000-24000 | 592 | 0.23 | 0.26 | 0.27 | 0.26 | 0.28 | 0.25 | 0.27 | 23,013 |
| 16 | 24000-26000 | 487 | 0.21 | 0.23 | 0.24 | 0.24 | 0.26 | 0.24 | 0.25 | 24,946 |
| 17 | 26000-28000 | 365 | 0.19 | 0.21 | 0.22 | 0.21 | 0.22 | 0.20 | 0.23 | 26,932 |
| 18 | 28000-30000 | 323 | 0.19 | 0.21 | 0.22 | 0.21 | 0.23 | 0.21 | 0.22 | 28,976 |
| 19 | 30000-40000 | 1,034 | 0.17 | 0.20 | 0.21 | 0.19 | 0.21 | 0.18 | 0.21 | 34,520 |
| 20 | 40000-50000 | 583 | 0.13 | 0.16 | 0.17 | 0.15 | 0.16 | 0.14 | 0.17 | 44,519 |
| 21 | 50000-60000 | 343 | 0.12 | 0.15 | 0.16 | 0.13 | 0.15 | 0.13 | 0.15 | 50,000 |
| 22 | 60000-80000 | 334 | 0.12 | 0.16 | 0.17 | 0.15 | 0.16 | 0.13 | 0.16 | 50,000 |
| 23 | 80000-100000 | 182 | 0.12 | 0.18 | 0.19 | 0.15 | 0.17 | 0.15 | 0.17 | 50,000 |
| 24 | 100000+ | 350 | 0.14 | 0.25 | 0.24 | 0.17 | 0.20 | 0.16 | 0.23 | 50,000 |

| Condition in 1999 | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|
| Breast Cancer | 2,499 | 0.53 | 0.55 | 0.60 | 0.53 | 0.53 | 0.51 | 0.65 | 9,855 |
| CHF | 1,682 | 0.34 | 0.46 | 0.49 | 0.42 | 0.48 | 0.44 | 0.47 | 17,269 |
| Asthma | 14,261 | 0.73 | 0.69 | 0.73 | 0.73 | 0.74 | 0.71 | 0.76 | 4,245 |
| Depression | 11,790 | 0.64 | 0.68 | 0.71 | 0.70 | 0.71 | 0.69 | 0.71 | 6,107 |
| HIV | 205 | 0.28 | 0.58 | 0.56 | 0.71 | 0.74 | 0.48 | 0.68 | 14,064 |

| Condition in 1998 | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|
| Breast Cancer | 2,285 | 0.83 | 0.85 | 0.91 | 0.76 | 0.77 | 0.73 | 0.99 | 7,190 |
| CHF | 1,420 | 0.61 | 0.87 | 0.92 | 0.67 | 0.79 | 0.71 | 0.83 | 12,335 |
| Asthma | 13,598 | 0.95 | 0.94 | 0.96 | 0.88 | 0.89 | 0.85 | 0.95 | 3,832 |
| Depression | 11,115 | 0.83 | 0.92 | 0.99 | 0.86 | 0.88 | 0.86 | 0.91 | 5,404 |
| HIV | 168 | 0.35 | 0.91 | 0.88 | 0.84 | 0.87 | 0.57 | 0.86 | 13,847 |

**EXHIBIT D-2: PREDICTIVE RATIOS - PROSPECTIVE RECALIBRATED MODEL - CLAIMS TRUNCATED AT $100,000**

**Predictive Ratios: Ratio of Predicted Claims for 1999 to Actual Claims for 1999**
**Prospective Model: Use 1998 Claim Information to Predict 1999 Claim Dollars**
**Recalibrated Weights: Use Calculated Risk Weights (with min of 0) to Score each Member**
**Claims: Truncated at $100,000**

Members are grouped based on: (a) 1999 claims for quintiles and dollar ranges, and (b) 1998 and 1999 claims for medical condition.

| 1999 Claim $ Quintiles | Percentiles | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-20% | 74,914 | 90.22 | 96.87 | 78.68 | 87.48 | 81.90 | 96.92 | 67.49 | 11 |
| 2 | 20-40% | 74,909 | 6.79 | 6.28 | 5.94 | 6.03 | 5.78 | 6.23 | 5.48 | 194 |
| 3 | 40-60% | 74,921 | 3.04 | 2.86 | 2.89 | 2.81 | 2.74 | 2.80 | 2.81 | 596 |
| 4 | 60-80% | 74,915 | 1.69 | 1.64 | 1.69 | 1.69 | 1.67 | 1.67 | 1.73 | 1,560 |
| 5 | 80-100% | 74,914 | 0.48 | 0.51 | 0.53 | 0.52 | 0.54 | 0.51 | 0.55 | 8,481 |
| Total | | 374,573 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 2,168 |

| Group | Actual 1999 Claims $ Range | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-500 | 176,099 | 8.14 | 7.96 | 7.20 | 7.49 | 7.14 | 7.90 | 6.53 | 150 |
| 2 | 500-1000 | 55,258 | 2.70 | 2.55 | 2.60 | 2.52 | 2.47 | 2.51 | 2.55 | 723 |
| 3 | 1000-1500 | 31,499 | 1.96 | 1.89 | 1.95 | 1.93 | 1.90 | 1.91 | 1.97 | 1,230 |
| 4 | 1500-2000 | 21,254 | 1.61 | 1.57 | 1.63 | 1.63 | 1.61 | 1.61 | 1.67 | 1,732 |
| 5 | 2000-4000 | 42,235 | 1.16 | 1.15 | 1.19 | 1.22 | 1.22 | 1.20 | 1.25 | 2,831 |
| 6 | 4000-6000 | 18,028 | 0.80 | 0.81 | 0.84 | 0.84 | 0.87 | 0.83 | 0.89 | 4,884 |
| 7 | 6000-8000 | 9,644 | 0.60 | 0.62 | 0.65 | 0.63 | 0.67 | 0.62 | 0.68 | 6,903 |
| 8 | 8000-10000 | 5,591 | 0.50 | 0.52 | 0.54 | 0.53 | 0.56 | 0.51 | 0.57 | 8,919 |
| 9 | 10000-12000 | 3,549 | 0.44 | 0.46 | 0.48 | 0.47 | 0.50 | 0.45 | 0.50 | 10,921 |
| 10 | 12000-14000 | 2,281 | 0.37 | 0.41 | 0.42 | 0.42 | 0.44 | 0.40 | 0.44 | 12,948 |
| 11 | 14000-16000 | 1,679 | 0.33 | 0.36 | 0.37 | 0.38 | 0.41 | 0.36 | 0.39 | 14,936 |
| 12 | 16000-18000 | 1,202 | 0.30 | 0.32 | 0.33 | 0.35 | 0.37 | 0.33 | 0.36 | 16,964 |
| 13 | 18000-20000 | 925 | 0.28 | 0.33 | 0.34 | 0.33 | 0.35 | 0.31 | 0.35 | 18,982 |
| 14 | 20000-22000 | 736 | 0.25 | 0.29 | 0.30 | 0.30 | 0.31 | 0.29 | 0.31 | 20,955 |
| 15 | 22000-24000 | 592 | 0.25 | 0.28 | 0.29 | 0.28 | 0.30 | 0.27 | 0.29 | 23,013 |
| 16 | 24000-26000 | 487 | 0.23 | 0.25 | 0.26 | 0.26 | 0.28 | 0.25 | 0.27 | 24,946 |
| 17 | 26000-28000 | 365 | 0.20 | 0.23 | 0.25 | 0.23 | 0.24 | 0.22 | 0.25 | 26,932 |
| 18 | 28000-30000 | 323 | 0.20 | 0.23 | 0.24 | 0.23 | 0.25 | 0.22 | 0.24 | 28,976 |
| 19 | 30000-40000 | 1,034 | 0.18 | 0.22 | 0.23 | 0.21 | 0.23 | 0.20 | 0.23 | 34,520 |
| 20 | 40000-50000 | 583 | 0.14 | 0.18 | 0.19 | 0.16 | 0.18 | 0.16 | 0.19 | 44,519 |
| 21 | 50000-60000 | 343 | 0.12 | 0.16 | 0.16 | 0.13 | 0.15 | 0.13 | 0.15 | 54,609 |
| 22 | 60000-80000 | 334 | 0.10 | 0.14 | 0.15 | 0.12 | 0.13 | 0.11 | 0.14 | 68,675 |
| 23 | 80000-100000 | 182 | 0.08 | 0.12 | 0.13 | 0.10 | 0.11 | 0.09 | 0.11 | 89,116 |
| 24 | 100000+ | 350 | 0.08 | 0.15 | 0.15 | 0.10 | 0.12 | 0.10 | 0.14 | 100,000 |

| Condition in 1999 | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|
| Breast Cancer | 2,499 | 0.52 | 0.55 | 0.60 | 0.52 | 0.53 | 0.50 | 0.65 | 10,881 |
| CHF | 1,682 | 0.30 | 0.42 | 0.45 | 0.37 | 0.43 | 0.39 | 0.43 | 21,433 |
| Asthma | 14,261 | 0.73 | 0.69 | 0.72 | 0.73 | 0.74 | 0.71 | 0.75 | 4,458 |
| Depression | 11,790 | 0.64 | 0.67 | 0.70 | 0.70 | 0.71 | 0.69 | 0.71 | 6,423 |
| HIV | 205 | 0.27 | 0.58 | 0.56 | 0.73 | 0.76 | 0.49 | 0.67 | 15,774 |

| Condition in 1998 | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|
| Breast Cancer | 2,285 | 0.81 | 0.85 | 0.92 | 0.76 | 0.77 | 0.73 | 1.01 | 7,935 |
| CHF | 1,420 | 0.56 | 0.84 | 0.90 | 0.61 | 0.74 | 0.66 | 0.80 | 14,964 |
| Asthma | 13,598 | 0.95 | 0.94 | 0.96 | 0.88 | 0.90 | 0.86 | 0.94 | 4,003 |
| Depression | 11,115 | 0.84 | 0.91 | 0.98 | 0.86 | 0.88 | 0.86 | 0.91 | 5,651 |
| HIV | 168 | 0.35 | 0.94 | 0.91 | 0.89 | 0.94 | 0.60 | 0.90 | 15,006 |

**EXHIBIT D-3: PREDICTIVE RATIOS - PROSPECTIVE RECALIBRATED MODEL - UNTRUNCATED CLAIMS**

**Predictive Ratios: Ratio of Predicted Claims for 1999 to Actual Claims for 1999**
**Prospective Model: Use 1998 Claim Information to Predict 1999 Claim Dollars**
**Recalibrated Weights: Use Calculated Risk Weights (with min of 0) to Score each Member**
**Claims: Untruncated**

Members are grouped based on: (a) 1999 claims for quintiles and dollar ranges, and (b) 1998 and 1999 claims for medical condition.

| 1999 Claim $ Quintiles | Percentiles | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-20% | 74,914 | 92.16 | 98.16 | 80.26 | 88.04 | 82.76 | 97.70 | 68.21 | 11 |
| 2 | 20-40% | 74,909 | 6.92 | 6.38 | 6.04 | 6.10 | 5.85 | 6.30 | 5.55 | 194 |
| 3 | 40-60% | 74,921 | 3.10 | 2.91 | 2.94 | 2.85 | 2.79 | 2.85 | 2.86 | 596 |
| 4 | 60-80% | 74,915 | 1.73 | 1.68 | 1.73 | 1.73 | 1.71 | 1.71 | 1.78 | 1,560 |
| 5 | 80-100% | 74,914 | 0.48 | 0.51 | 0.53 | 0.52 | 0.54 | 0.51 | 0.55 | 8,799 |
| Total | | 374,573 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 2,232 |

| Group | Actual 1999 Claims $ Range | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-500 | 176,099 | 8.30 | 8.07 | 7.33 | 7.56 | 7.22 | 7.98 | 6.62 | 150 |
| 2 | 500-1000 | 55,258 | 2.76 | 2.60 | 2.65 | 2.57 | 2.51 | 2.56 | 2.60 | 723 |
| 3 | 1000-1500 | 31,499 | 2.01 | 1.93 | 1.99 | 1.98 | 1.94 | 1.95 | 2.02 | 1,230 |
| 4 | 1500-2000 | 21,254 | 1.65 | 1.61 | 1.67 | 1.67 | 1.66 | 1.65 | 1.71 | 1,732 |
| 5 | 2000-4000 | 42,235 | 1.20 | 1.18 | 1.22 | 1.26 | 1.26 | 1.24 | 1.29 | 2,831 |
| 6 | 4000-6000 | 18,028 | 0.83 | 0.84 | 0.87 | 0.87 | 0.90 | 0.86 | 0.92 | 4,884 |
| 7 | 6000-8000 | 9,644 | 0.63 | 0.64 | 0.67 | 0.66 | 0.69 | 0.65 | 0.71 | 6,903 |
| 8 | 8000-10000 | 5,591 | 0.52 | 0.54 | 0.56 | 0.55 | 0.58 | 0.54 | 0.59 | 8,919 |
| 9 | 10000-12000 | 3,549 | 0.46 | 0.48 | 0.50 | 0.50 | 0.53 | 0.47 | 0.52 | 10,921 |
| 10 | 12000-14000 | 2,281 | 0.39 | 0.43 | 0.44 | 0.44 | 0.46 | 0.42 | 0.46 | 12,948 |
| 11 | 14000-16000 | 1,679 | 0.35 | 0.37 | 0.39 | 0.40 | 0.43 | 0.37 | 0.41 | 14,936 |
| 12 | 16000-18000 | 1,202 | 0.32 | 0.34 | 0.35 | 0.37 | 0.39 | 0.35 | 0.37 | 16,964 |
| 13 | 18000-20000 | 925 | 0.29 | 0.35 | 0.36 | 0.35 | 0.37 | 0.33 | 0.37 | 18,982 |
| 14 | 20000-22000 | 736 | 0.26 | 0.31 | 0.32 | 0.32 | 0.33 | 0.30 | 0.32 | 20,955 |
| 15 | 22000-24000 | 592 | 0.27 | 0.30 | 0.31 | 0.30 | 0.32 | 0.29 | 0.31 | 23,013 |
| 16 | 24000-26000 | 487 | 0.24 | 0.27 | 0.28 | 0.27 | 0.29 | 0.27 | 0.28 | 24,946 |
| 17 | 26000-28000 | 365 | 0.22 | 0.25 | 0.26 | 0.24 | 0.26 | 0.23 | 0.27 | 26,932 |
| 18 | 28000-30000 | 323 | 0.21 | 0.25 | 0.25 | 0.25 | 0.27 | 0.24 | 0.25 | 28,976 |
| 19 | 30000-40000 | 1,034 | 0.19 | 0.24 | 0.25 | 0.22 | 0.24 | 0.21 | 0.25 | 34,520 |
| 20 | 40000-50000 | 583 | 0.15 | 0.20 | 0.21 | 0.17 | 0.19 | 0.17 | 0.20 | 44,519 |
| 21 | 50000-60000 | 343 | 0.12 | 0.17 | 0.18 | 0.14 | 0.16 | 0.14 | 0.16 | 54,609 |
| 22 | 60000-80000 | 334 | 0.11 | 0.16 | 0.16 | 0.13 | 0.14 | 0.11 | 0.15 | 68,675 |
| 23 | 80000-100000 | 182 | 0.08 | 0.13 | 0.15 | 0.10 | 0.12 | 0.10 | 0.12 | 89,116 |
| 24 | 100000+ | 350 | 0.05 | 0.11 | 0.11 | 0.07 | 0.08 | 0.06 | 0.10 | 167,951 |

| Condition in 1999 | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|
| Breast Cancer | 2,499 | 0.52 | 0.54 | 0.60 | 0.52 | 0.53 | 0.50 | 0.64 | 11,508 |
| CHF | 1,682 | 0.27 | 0.39 | 0.42 | 0.34 | 0.40 | 0.36 | 0.40 | 25,409 |
| Asthma | 14,261 | 0.72 | 0.69 | 0.71 | 0.72 | 0.73 | 0.70 | 0.74 | 4,675 |
| Depression | 11,790 | 0.65 | 0.66 | 0.69 | 0.70 | 0.71 | 0.69 | 0.70 | 6,629 |
| HIV | 205 | 0.26 | 0.59 | 0.56 | 0.75 | 0.79 | 0.55 | 0.68 | 16,637 |

| Condition in 1998 | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|
| Breast Cancer | 2,285 | 0.81 | 0.84 | 0.92 | 0.76 | 0.78 | 0.73 | 0.99 | 8,383 |
| CHF | 1,420 | 0.51 | 0.79 | 0.85 | 0.57 | 0.69 | 0.60 | 0.75 | 17,692 |
| Asthma | 13,598 | 0.96 | 0.95 | 0.96 | 0.89 | 0.91 | 0.87 | 0.94 | 4,119 |
| Depression | 11,115 | 0.85 | 0.91 | 0.97 | 0.88 | 0.89 | 0.87 | 0.91 | 5,773 |
| HIV | 168 | 0.34 | 0.95 | 0.91 | 0.92 | 0.97 | 0.68 | 0.91 | 15,902 |

**EXHIBIT D-4: PREDICTED CLAIMS - PROSPECTIVE RECALIBRATED MODEL - CLAIMS TRUNCATED AT $50,000**

**Predicted Claims: Predicted Claims Per Member Per Year for 1999**
**Prospective Model: Use 1998 Claim Information to Predict 1999 Claim Dollars**
**Recalibrated Weights: Use Calculated Risk Weights (with min of 0) to Score each Member**
**Claims: Truncated at $50,000**

Members are grouped based on: (a) 1999 claims for quintiles and dollar ranges, and (b) 1998 and 1999 claims for medical condition.

| 1999 Claim $ Quintiles | Percentiles | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-20% | 74,914 | 962 | 1,047 | 840 | 945 | 877 | 1,044 | 727 | 11 |
| 2 | 20-40% | 74,909 | 1,283 | 1,196 | 1,126 | 1,149 | 1,096 | 1,182 | 1,042 | 194 |
| 3 | 40-60% | 74,921 | 1,758 | 1,665 | 1,682 | 1,633 | 1,595 | 1,627 | 1,633 | 596 |
| 4 | 60-80% | 74,915 | 2,534 | 2,463 | 2,558 | 2,538 | 2,516 | 2,502 | 2,612 | 1,560 |
| 5 | 80-100% | 74,914 | 3,872 | 4,038 | 4,203 | 4,145 | 4,324 | 4,053 | 4,395 | 8,048 |
| Total | | 374,573 | 2,082 | 2,082 | 2,082 | 2,082 | 2,082 | 2,082 | 2,082 | 2,082 |

| Group | Actual 1999 Claims $ Range | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-500 | 176,099 | 1,189 | 1,173 | 1,055 | 1,104 | 1,047 | 1,161 | 961 | 150 |
| 2 | 500-1000 | 55,258 | 1,892 | 1,797 | 1,832 | 1,776 | 1,738 | 1,762 | 1,796 | 723 |
| 3 | 1000-1500 | 31,499 | 2,330 | 2,255 | 2,330 | 2,298 | 2,266 | 2,264 | 2,354 | 1,230 |
| 4 | 1500-2000 | 21,254 | 2,680 | 2,622 | 2,734 | 2,714 | 2,698 | 2,675 | 2,797 | 1,732 |
| 5 | 2000-4000 | 42,235 | 3,145 | 3,108 | 3,234 | 3,290 | 3,308 | 3,245 | 3,401 | 2,831 |
| 6 | 4000-6000 | 18,028 | 3,702 | 3,772 | 3,929 | 3,880 | 4,028 | 3,838 | 4,137 | 4,884 |
| 7 | 6000-8000 | 9,644 | 3,960 | 4,069 | 4,244 | 4,110 | 4,351 | 4,070 | 4,475 | 6,903 |
| 8 | 8000-10000 | 5,591 | 4,214 | 4,356 | 4,541 | 4,415 | 4,691 | 4,320 | 4,788 | 8,919 |
| 9 | 10000-12000 | 3,549 | 4,496 | 4,721 | 4,890 | 4,848 | 5,174 | 4,608 | 5,138 | 10,921 |
| 10 | 12000-14000 | 2,281 | 4,520 | 4,949 | 5,088 | 5,072 | 5,357 | 4,814 | 5,308 | 12,948 |
| 11 | 14000-16000 | 1,679 | 4,662 | 4,923 | 5,175 | 5,262 | 5,629 | 4,957 | 5,466 | 14,936 |
| 12 | 16000-18000 | 1,202 | 4,815 | 5,071 | 5,249 | 5,563 | 5,876 | 5,251 | 5,656 | 16,964 |
| 13 | 18000-20000 | 925 | 4,891 | 5,614 | 5,803 | 5,716 | 6,143 | 5,473 | 6,108 | 18,982 |
| 14 | 20000-22000 | 736 | 4,863 | 5,495 | 5,699 | 5,761 | 6,067 | 5,519 | 5,886 | 20,955 |
| 15 | 22000-24000 | 592 | 5,292 | 5,888 | 6,119 | 5,985 | 6,356 | 5,697 | 6,139 | 23,013 |
| 16 | 24000-26000 | 487 | 5,325 | 5,785 | 6,059 | 5,967 | 6,409 | 5,873 | 6,181 | 24,946 |
| 17 | 26000-28000 | 365 | 5,057 | 5,660 | 6,048 | 5,653 | 6,037 | 5,446 | 6,191 | 26,932 |
| 18 | 28000-30000 | 323 | 5,368 | 5,986 | 6,256 | 6,136 | 6,724 | 5,984 | 6,302 | 28,976 |
| 19 | 30000-40000 | 1,034 | 5,764 | 6,872 | 7,194 | 6,589 | 7,125 | 6,329 | 7,082 | 34,520 |
| 20 | 40000-50000 | 583 | 5,701 | 7,004 | 7,392 | 6,505 | 7,177 | 6,408 | 7,355 | 44,519 |
| 21 | 50000-60000 | 343 | 5,800 | 7,506 | 7,829 | 6,491 | 7,352 | 6,391 | 7,278 | 50,000 |
| 22 | 60000-80000 | 334 | 6,173 | 8,209 | 8,520 | 7,313 | 7,838 | 6,545 | 8,106 | 50,000 |
| 23 | 80000-100000 | 182 | 6,229 | 8,919 | 9,595 | 7,563 | 8,352 | 7,509 | 8,442 | 50,000 |
| 24 | 100000+ | 350 | 7,163 | 12,270 | 12,104 | 8,620 | 9,953 | 8,249 | 11,358 | 50,000 |

| Condition in 1999 | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|
| Breast Cancer | 2,499 | 5,241 | 5,458 | 5,877 | 5,178 | 5,200 | 4,989 | 6,389 | 9,855 |
| CHF | 1,682 | 5,880 | 7,883 | 8,380 | 7,182 | 8,286 | 7,525 | 8,087 | 17,269 |
| Asthma | 14,261 | 3,093 | 2,945 | 3,087 | 3,090 | 3,126 | 2,999 | 3,216 | 4,245 |
| Depression | 11,790 | 3,904 | 4,124 | 4,349 | 4,250 | 4,329 | 4,212 | 4,360 | 6,107 |
| HIV | 205 | 3,963 | 8,117 | 7,945 | 9,950 | 10,429 | 6,718 | 9,507 | 14,064 |

| Condition in 1998 | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|
| Breast Cancer | 2,285 | 5,940 | 6,110 | 6,554 | 5,490 | 5,522 | 5,268 | 7,113 | 7,190 |
| CHF | 1,420 | 7,512 | 10,756 | 11,408 | 8,221 | 9,723 | 8,763 | 10,291 | 12,335 |
| Asthma | 13,598 | 3,623 | 3,584 | 3,676 | 3,359 | 3,409 | 3,245 | 3,634 | 3,832 |
| Depression | 11,115 | 4,462 | 4,979 | 5,342 | 4,642 | 4,736 | 4,641 | 4,920 | 5,404 |
| HIV | 168 | 4,858 | 12,552 | 12,210 | 11,571 | 12,097 | 7,828 | 11,896 | 13,847 |

**EXHIBIT D-5: PREDICTED CLAIMS - PROSPECTIVE RECALIBRATED MODEL - CLAIMS TRUNCATED AT $100,000**

**Predicted Claims: Predicted Claims Per Member Per Year for 1999**
**Prospective Model: Use 1998 Claim Information to Predict 1999 Claim Dollars**
**Recalibrated Weights: Use Calculated Risk Weights (with min of 0) to Score each Member**
**Claims: Truncated at $100,000**

Members are grouped based on: (a) 1999 claims for quintiles and dollar ranges, and (b) 1998 and 1999 claims for medical condition.

| 1999 Claim $ Quintiles | Percentiles | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-20% | 74,914 | 989 | 1,062 | 863 | 959 | 898 | 1,063 | 740 | 11 |
| 2 | 20-40% | 74,909 | 1,316 | 1,218 | 1,152 | 1,170 | 1,120 | 1,207 | 1,063 | 194 |
| 3 | 40-60% | 74,921 | 1,809 | 1,706 | 1,723 | 1,673 | 1,635 | 1,671 | 1,673 | 596 |
| 4 | 60-80% | 74,915 | 2,630 | 2,553 | 2,641 | 2,635 | 2,603 | 2,600 | 2,704 | 1,560 |
| 5 | 80-100% | 74,914 | 4,098 | 4,303 | 4,464 | 4,405 | 4,586 | 4,301 | 4,662 | 8,481 |
| Total | | 374,573 | 2,168 | 2,168 | 2,168 | 2,168 | 2,168 | 2,168 | 2,168 | 2,168 |

| Group | Actual 1999 Claims $ Range | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-500 | 176,099 | 1,221 | 1,193 | 1,080 | 1,123 | 1,070 | 1,185 | 980 | 150 |
| 2 | 500-1000 | 55,258 | 1,949 | 1,844 | 1,879 | 1,824 | 1,783 | 1,813 | 1,843 | 723 |
| 3 | 1000-1500 | 31,499 | 2,411 | 2,328 | 2,400 | 2,378 | 2,337 | 2,346 | 2,429 | 1,230 |
| 4 | 1500-2000 | 21,254 | 2,786 | 2,723 | 2,824 | 2,820 | 2,795 | 2,784 | 2,898 | 1,732 |
| 5 | 2000-4000 | 42,235 | 3,287 | 3,243 | 3,358 | 3,446 | 3,450 | 3,399 | 3,543 | 2,831 |
| 6 | 4000-6000 | 18,028 | 3,893 | 3,972 | 4,122 | 4,096 | 4,237 | 4,048 | 4,348 | 4,884 |
| 7 | 6000-8000 | 9,644 | 4,175 | 4,290 | 4,462 | 4,350 | 4,592 | 4,306 | 4,713 | 6,903 |
| 8 | 8000-10000 | 5,591 | 4,462 | 4,618 | 4,809 | 4,696 | 4,961 | 4,581 | 5,059 | 8,919 |
| 9 | 10000-12000 | 3,549 | 4,801 | 5,043 | 5,213 | 5,184 | 5,507 | 4,916 | 5,476 | 10,921 |
| 10 | 12000-14000 | 2,281 | 4,817 | 5,327 | 5,467 | 5,445 | 5,730 | 5,139 | 5,675 | 12,948 |
| 11 | 14000-16000 | 1,679 | 4,989 | 5,303 | 5,569 | 5,672 | 6,056 | 5,309 | 5,853 | 14,936 |
| 12 | 16000-18000 | 1,202 | 5,163 | 5,451 | 5,628 | 5,976 | 6,300 | 5,627 | 6,036 | 16,964 |
| 13 | 18000-20000 | 925 | 5,274 | 6,178 | 6,363 | 6,208 | 6,676 | 5,934 | 6,673 | 18,982 |
| 14 | 20000-22000 | 736 | 5,229 | 6,058 | 6,236 | 6,270 | 6,588 | 5,975 | 6,398 | 20,955 |
| 15 | 22000-24000 | 592 | 5,752 | 6,458 | 6,696 | 6,506 | 6,907 | 6,185 | 6,675 | 23,013 |
| 16 | 24000-26000 | 487 | 5,771 | 6,306 | 6,602 | 6,471 | 6,942 | 6,342 | 6,686 | 24,946 |
| 17 | 26000-28000 | 365 | 5,478 | 6,232 | 6,672 | 6,176 | 6,580 | 5,920 | 6,804 | 26,932 |
| 18 | 28000-30000 | 323 | 5,845 | 6,673 | 6,856 | 6,692 | 7,362 | 6,490 | 6,862 | 28,976 |
| 19 | 30000-40000 | 1,034 | 6,316 | 7,733 | 8,090 | 7,223 | 7,843 | 6,907 | 7,879 | 34,520 |
| 20 | 40000-50000 | 583 | 6,252 | 8,035 | 8,496 | 7,136 | 7,975 | 7,040 | 8,301 | 44,519 |
| 21 | 50000-60000 | 343 | 6,382 | 8,614 | 8,974 | 7,158 | 8,277 | 7,086 | 8,256 | 54,609 |
| 22 | 60000-80000 | 334 | 6,847 | 9,606 | 9,960 | 8,231 | 8,847 | 7,269 | 9,365 | 68,675 |
| 23 | 80000-100000 | 182 | 6,919 | 10,650 | 11,520 | 8,492 | 9,494 | 8,430 | 9,869 | 89,116 |
| 24 | 100000+ | 350 | 8,067 | 15,423 | 15,131 | 10,050 | 11,834 | 9,547 | 14,201 | 100,000 |

| Condition in 1999 | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|
| Breast Cancer | 2,499 | 5,649 | 5,974 | 6,524 | 5,646 | 5,738 | 5,421 | 7,124 | 10,881 |
| CHF | 1,682 | 6,457 | 9,036 | 9,612 | 7,964 | 9,297 | 8,352 | 9,176 | 21,433 |
| Asthma | 14,261 | 3,247 | 3,093 | 3,221 | 3,253 | 3,287 | 3,155 | 3,354 | 4,458 |
| Depression | 11,790 | 4,133 | 4,288 | 4,510 | 4,468 | 4,551 | 4,414 | 4,539 | 6,423 |
| HIV | 205 | 4,216 | 9,104 | 8,852 | 11,438 | 12,042 | 7,701 | 10,639 | 15,774 |

| Condition in 1998 | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|
| Breast Cancer | 2,285 | 6,444 | 6,730 | 7,318 | 6,022 | 6,128 | 5,758 | 7,992 | 7,935 |
| CHF | 1,420 | 8,354 | 12,599 | 13,411 | 9,191 | 11,030 | 9,806 | 11,945 | 14,964 |
| Asthma | 13,598 | 3,804 | 3,773 | 3,829 | 3,538 | 3,596 | 3,426 | 3,777 | 4,003 |
| Depression | 11,115 | 4,737 | 5,159 | 5,529 | 4,887 | 4,982 | 4,868 | 5,122 | 5,651 |
| HIV | 168 | 5,223 | 14,141 | 13,689 | 13,371 | 14,040 | 9,071 | 13,433 | 15,006 |

**EXHIBIT D-6: PREDICTED CLAIMS - PROSPECTIVE RECALIBRATED MODEL - UNTRUNCATED CLAIMS**

**Predicted Claims: Predicted Claims Per Member Per Year for 1999**
**Prospective Model: Use 1998 Claim Information to Predict 1999 Claim Dollars**
**Recalibrated Weights: Use Calculated Risk Weights (with min of 0) to Score each Member**
**Claims: Untruncated**

Members are grouped based on: (a) 1999 claims for quintiles and dollar ranges, and (b) 1998 and 1999 claims for medical condition.

| 1999 Claim $ Quintiles | Percentiles | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-20% | 74,914 | 1,010 | 1,076 | 880 | 965 | 907 | 1,071 | 748 | 11 |
| 2 | 20-40% | 74,909 | 1,341 | 1,236 | 1,171 | 1,182 | 1,133 | 1,222 | 1,076 | 194 |
| 3 | 40-60% | 74,921 | 1,847 | 1,735 | 1,754 | 1,699 | 1,662 | 1,699 | 1,702 | 596 |
| 4 | 60-80% | 74,915 | 2,699 | 2,615 | 2,697 | 2,706 | 2,668 | 2,672 | 2,771 | 1,560 |
| 5 | 80-100% | 74,914 | 4,262 | 4,498 | 4,657 | 4,607 | 4,789 | 4,496 | 4,862 | 8,799 |
| Total | | 374,573 | 2,232 | 2,232 | 2,232 | 2,232 | 2,232 | 2,232 | 2,232 | 2,232 |

| Group | Actual 1999 Claims $ Range | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-500 | 176,099 | 1,245 | 1,211 | 1,100 | 1,134 | 1,083 | 1,197 | 992 | 150 |
| 2 | 500-1000 | 55,258 | 1,991 | 1,876 | 1,913 | 1,857 | 1,814 | 1,847 | 1,877 | 723 |
| 3 | 1000-1500 | 31,499 | 2,469 | 2,379 | 2,447 | 2,436 | 2,391 | 2,403 | 2,484 | 1,230 |
| 4 | 1500-2000 | 21,254 | 2,861 | 2,793 | 2,885 | 2,897 | 2,867 | 2,863 | 2,970 | 1,732 |
| 5 | 2000-4000 | 42,235 | 3,389 | 3,337 | 3,441 | 3,564 | 3,560 | 3,515 | 3,649 | 2,831 |
| 6 | 4000-6000 | 18,028 | 4,030 | 4,113 | 4,262 | 4,264 | 4,401 | 4,213 | 4,506 | 4,884 |
| 7 | 6000-8000 | 9,644 | 4,332 | 4,444 | 4,622 | 4,538 | 4,783 | 4,493 | 4,890 | 6,903 |
| 8 | 8000-10000 | 5,591 | 4,643 | 4,811 | 5,009 | 4,918 | 5,177 | 4,788 | 5,259 | 8,919 |
| 9 | 10000-12000 | 3,549 | 5,030 | 5,286 | 5,452 | 5,443 | 5,768 | 5,156 | 5,728 | 10,921 |
| 10 | 12000-14000 | 2,281 | 5,034 | 5,598 | 5,755 | 5,731 | 6,017 | 5,401 | 5,940 | 12,948 |
| 11 | 14000-16000 | 1,679 | 5,230 | 5,580 | 5,865 | 5,982 | 6,374 | 5,600 | 6,134 | 14,936 |
| 12 | 16000-18000 | 1,202 | 5,420 | 5,742 | 5,913 | 6,293 | 6,618 | 5,934 | 6,330 | 16,964 |
| 13 | 18000-20000 | 925 | 5,555 | 6,615 | 6,810 | 6,602 | 7,083 | 6,305 | 7,098 | 18,982 |
| 14 | 20000-22000 | 736 | 5,497 | 6,521 | 6,679 | 6,672 | 6,992 | 6,358 | 6,796 | 20,955 |
| 15 | 22000-24000 | 592 | 6,100 | 6,942 | 7,182 | 6,915 | 7,338 | 6,590 | 7,097 | 23,013 |
| 16 | 24000-26000 | 487 | 6,108 | 6,693 | 7,017 | 6,854 | 7,341 | 6,714 | 7,044 | 24,946 |
| 17 | 26000-28000 | 365 | 5,791 | 6,610 | 7,126 | 6,572 | 6,956 | 6,294 | 7,232 | 26,932 |
| 18 | 28000-30000 | 323 | 6,209 | 7,250 | 7,373 | 7,137 | 7,851 | 6,893 | 7,299 | 28,976 |
| 19 | 30000-40000 | 1,034 | 6,728 | 8,390 | 8,776 | 7,714 | 8,365 | 7,372 | 8,502 | 34,520 |
| 20 | 40000-50000 | 583 | 6,668 | 8,859 | 9,345 | 7,626 | 8,562 | 7,545 | 9,001 | 44,519 |
| 21 | 50000-60000 | 343 | 6,816 | 9,459 | 9,819 | 7,699 | 8,956 | 7,661 | 8,957 | 54,609 |
| 22 | 60000-80000 | 334 | 7,352 | 10,699 | 11,060 | 8,913 | 9,606 | 7,854 | 10,296 | 68,675 |
| 23 | 80000-100000 | 182 | 7,436 | 11,980 | 13,112 | 9,231 | 10,427 | 9,167 | 10,887 | 89,116 |
| 24 | 100000+ | 350 | 8,742 | 17,990 | 17,768 | 11,211 | 13,280 | 10,596 | 16,375 | 167,951 |

| Condition in 1999 | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|
| Breast Cancer | 2,499 | 5,949 | 6,261 | 6,851 | 5,969 | 6,072 | 5,719 | 7,401 | 11,508 |
| CHF | 1,682 | 6,892 | 9,972 | 10,679 | 8,631 | 10,143 | 9,021 | 10,077 | 25,409 |
| Asthma | 14,261 | 3,358 | 3,208 | 3,322 | 3,378 | 3,404 | 3,279 | 3,452 | 4,675 |
| Depression | 11,790 | 4,299 | 4,388 | 4,595 | 4,620 | 4,714 | 4,558 | 4,666 | 6,629 |
| HIV | 205 | 4,395 | 9,749 | 9,373 | 12,431 | 13,129 | 9,220 | 11,350 | 16,637 |

| Condition in 1998 | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|
| Breast Cancer | 2,285 | 6,814 | 7,054 | 7,694 | 6,391 | 6,510 | 6,100 | 8,323 | 8,383 |
| CHF | 1,420 | 8,986 | 13,985 | 15,110 | 10,029 | 12,135 | 10,648 | 13,311 | 17,692 |
| Asthma | 13,598 | 3,936 | 3,933 | 3,938 | 3,676 | 3,733 | 3,569 | 3,876 | 4,119 |
| Depression | 11,115 | 4,935 | 5,261 | 5,618 | 5,056 | 5,161 | 5,028 | 5,263 | 5,773 |
| HIV | 168 | 5,470 | 15,166 | 14,524 | 14,585 | 15,348 | 10,889 | 14,442 | 15,902 |

**EXHIBIT E-1: PREDICTIVE RATIOS - CONCURRENT RECALIBRATED MODEL - CLAIMS TRUNCATED AT $50,000**

**Predictive Ratios: Ratio of Predicted Claims for 1999 to Actual Claims for 1999**
**Concurrent Model: Use 1999 Claim Information to Predict 1999 Claim Dollars**
**Recalibrated Weights: Use Calculated Risk Weights (with min of 0) to Score each Member**
**Claims: Truncated at $50,000**

Members are grouped based on: (a) 1999 claims for quintiles and dollar ranges, and (b) 1998 and 1999 claims for medical condition.

| 1999 Claim $ Quintiles | Percentiles | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-20% | 74,914 | 13.91 | 36.38 | 8.04 | 38.80 | 31.89 | 55.22 | 6.55 | 11 |
| 2 | 20-40% | 74,909 | 3.46 | 3.50 | 3.32 | 4.16 | 3.88 | 4.52 | 3.03 | 194 |
| 3 | 40-60% | 74,921 | 2.29 | 2.11 | 2.27 | 2.30 | 2.21 | 2.31 | 2.18 | 596 |
| 4 | 60-80% | 74,915 | 1.60 | 1.54 | 1.54 | 1.57 | 1.53 | 1.54 | 1.60 | 1,560 |
| 5 | 80-100% | 74,914 | 0.71 | 0.71 | 0.74 | 0.67 | 0.70 | 0.64 | 0.74 | 8,048 |
| Total | | 374,573 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 2,082 |

| Group | Actual 1999 Claims $ Range | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-500 | 176,099 | 3.42 | 4.06 | 3.16 | 4.62 | 4.21 | 5.35 | 2.89 | 150 |
| 2 | 500-1000 | 55,258 | 2.16 | 1.98 | 2.13 | 2.13 | 2.05 | 2.12 | 2.07 | 723 |
| 3 | 1000-1500 | 31,499 | 1.80 | 1.69 | 1.72 | 1.73 | 1.68 | 1.71 | 1.77 | 1,230 |
| 4 | 1500-2000 | 21,254 | 1.55 | 1.50 | 1.49 | 1.54 | 1.49 | 1.51 | 1.57 | 1,732 |
| 5 | 2000-4000 | 42,235 | 1.25 | 1.23 | 1.19 | 1.24 | 1.23 | 1.22 | 1.28 | 2,831 |
| 6 | 4000-6000 | 18,028 | 0.99 | 0.99 | 0.96 | 0.94 | 0.97 | 0.92 | 1.04 | 4,884 |
| 7 | 6000-8000 | 9,644 | 0.84 | 0.82 | 0.81 | 0.77 | 0.81 | 0.76 | 0.89 | 6,903 |
| 8 | 8000-10000 | 5,591 | 0.73 | 0.71 | 0.72 | 0.67 | 0.71 | 0.65 | 0.78 | 8,919 |
| 9 | 10000-12000 | 3,549 | 0.66 | 0.64 | 0.67 | 0.62 | 0.66 | 0.58 | 0.70 | 10,921 |
| 10 | 12000-14000 | 2,281 | 0.62 | 0.59 | 0.64 | 0.56 | 0.59 | 0.53 | 0.64 | 12,948 |
| 11 | 14000-16000 | 1,679 | 0.56 | 0.54 | 0.59 | 0.53 | 0.56 | 0.48 | 0.58 | 14,936 |
| 12 | 16000-18000 | 1,202 | 0.53 | 0.49 | 0.56 | 0.50 | 0.54 | 0.46 | 0.53 | 16,964 |
| 13 | 18000-20000 | 925 | 0.50 | 0.48 | 0.54 | 0.45 | 0.49 | 0.42 | 0.51 | 18,982 |
| 14 | 20000-22000 | 736 | 0.49 | 0.47 | 0.53 | 0.43 | 0.47 | 0.39 | 0.49 | 20,955 |
| 15 | 22000-24000 | 592 | 0.48 | 0.45 | 0.52 | 0.41 | 0.45 | 0.38 | 0.47 | 23,013 |
| 16 | 24000-26000 | 487 | 0.46 | 0.45 | 0.53 | 0.40 | 0.44 | 0.37 | 0.43 | 24,946 |
| 17 | 26000-28000 | 365 | 0.44 | 0.40 | 0.50 | 0.35 | 0.39 | 0.32 | 0.41 | 26,932 |
| 18 | 28000-30000 | 323 | 0.43 | 0.42 | 0.52 | 0.35 | 0.41 | 0.33 | 0.41 | 28,976 |
| 19 | 30000-40000 | 1,034 | 0.38 | 0.38 | 0.47 | 0.32 | 0.36 | 0.30 | 0.37 | 34,520 |
| 20 | 40000-50000 | 583 | 0.32 | 0.33 | 0.44 | 0.28 | 0.31 | 0.26 | 0.32 | 44,519 |
| 21 | 50000-60000 | 343 | 0.30 | 0.32 | 0.44 | 0.26 | 0.30 | 0.23 | 0.32 | 50,000 |
| 22 | 60000-80000 | 334 | 0.33 | 0.37 | 0.49 | 0.29 | 0.33 | 0.27 | 0.35 | 50,000 |
| 23 | 80000-100000 | 182 | 0.36 | 0.43 | 0.59 | 0.32 | 0.38 | 0.29 | 0.38 | 50,000 |
| 24 | 100000+ | 350 | 0.38 | 0.56 | 0.67 | 0.36 | 0.42 | 0.30 | 0.45 | 50,000 |

| Condition in 1999 | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|
| Breast Cancer | 2,499 | 0.81 | 0.82 | 0.90 | 0.71 | 0.74 | 0.66 | 0.95 | 9,855 |
| CHF | 1,682 | 0.65 | 0.93 | 0.94 | 0.60 | 0.70 | 0.62 | 0.74 | 17,269 |
| Asthma | 14,261 | 1.03 | 1.09 | 0.96 | 0.86 | 0.86 | 0.83 | 0.93 | 4,245 |
| Depression | 11,790 | 0.90 | 0.91 | 0.94 | 0.84 | 0.85 | 0.81 | 0.85 | 6,107 |
| HIV | 205 | 0.50 | 1.09 | 1.00 | 0.85 | 0.87 | 0.53 | 0.85 | 14,064 |

**EXHIBIT E-2: PREDICTIVE RATIOS - CONCURRENT RECALIBRATED MODEL - CLAIMS TRUNCATED AT $100,000**

**Predictive Ratios: Ratio of Predicted Claims for 1999 to Actual Claims for 1999**
**Concurrent Model: Use 1999 Claim Information to Predict 1999 Claim Dollars**
**Recalibrated Weights: Use Calculated Risk Weights (with min of 0) to Score each Member**
**Claims: Truncated at $100,000**

Members are grouped based on: (a) 1999 claims for quintiles and dollar ranges, and (b) 1998 and 1999 claims for medical condition.

| 1999 Claim $ Quintiles | Percentiles | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-20% | 74,914 | 13.92 | 32.34 | 7.03 | 36.58 | 30.21 | 52.79 | 6.45 | 11 |
| 2 | 20-40% | 74,909 | 3.47 | 3.35 | 3.23 | 4.09 | 3.86 | 4.47 | 3.02 | 194 |
| 3 | 40-60% | 74,921 | 2.31 | 2.09 | 2.24 | 2.30 | 2.22 | 2.32 | 2.20 | 596 |
| 4 | 60-80% | 74,915 | 1.63 | 1.56 | 1.54 | 1.61 | 1.56 | 1.59 | 1.64 | 1,560 |
| 5 | 80-100% | 74,914 | 0.72 | 0.73 | 0.75 | 0.68 | 0.71 | 0.65 | 0.74 | 8,481 |
| Total | | 374,573 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 2,168 |

| Group | Actual 1999 Claims $ Range | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-500 | 176,099 | 3.43 | 3.84 | 3.05 | 4.50 | 4.14 | 5.25 | 2.88 | 150 |
| 2 | 500-1000 | 55,258 | 2.17 | 1.97 | 2.10 | 2.14 | 2.06 | 2.14 | 2.09 | 723 |
| 3 | 1000-1500 | 31,499 | 1.82 | 1.71 | 1.72 | 1.76 | 1.71 | 1.74 | 1.80 | 1,230 |
| 4 | 1500-2000 | 21,254 | 1.57 | 1.53 | 1.49 | 1.58 | 1.53 | 1.55 | 1.60 | 1,732 |
| 5 | 2000-4000 | 42,235 | 1.28 | 1.27 | 1.21 | 1.30 | 1.28 | 1.27 | 1.32 | 2,831 |
| 6 | 4000-6000 | 18,028 | 1.03 | 1.04 | 0.99 | 0.99 | 1.01 | 0.98 | 1.08 | 4,884 |
| 7 | 6000-8000 | 9,644 | 0.88 | 0.87 | 0.85 | 0.82 | 0.85 | 0.81 | 0.92 | 6,903 |
| 8 | 8000-10000 | 5,591 | 0.77 | 0.76 | 0.77 | 0.72 | 0.75 | 0.70 | 0.82 | 8,919 |
| 9 | 10000-12000 | 3,549 | 0.71 | 0.69 | 0.72 | 0.67 | 0.70 | 0.63 | 0.74 | 10,921 |
| 10 | 12000-14000 | 2,281 | 0.67 | 0.64 | 0.70 | 0.61 | 0.64 | 0.57 | 0.69 | 12,948 |
| 11 | 14000-16000 | 1,679 | 0.61 | 0.60 | 0.65 | 0.58 | 0.60 | 0.53 | 0.62 | 14,936 |
| 12 | 16000-18000 | 1,202 | 0.58 | 0.54 | 0.62 | 0.55 | 0.59 | 0.51 | 0.57 | 16,964 |
| 13 | 18000-20000 | 925 | 0.56 | 0.54 | 0.61 | 0.50 | 0.54 | 0.46 | 0.55 | 18,982 |
| 14 | 20000-22000 | 736 | 0.55 | 0.52 | 0.61 | 0.48 | 0.52 | 0.44 | 0.54 | 20,955 |
| 15 | 22000-24000 | 592 | 0.55 | 0.51 | 0.60 | 0.46 | 0.50 | 0.43 | 0.52 | 23,013 |
| 16 | 24000-26000 | 487 | 0.52 | 0.52 | 0.62 | 0.44 | 0.49 | 0.40 | 0.47 | 24,946 |
| 17 | 26000-28000 | 365 | 0.50 | 0.46 | 0.58 | 0.39 | 0.44 | 0.36 | 0.46 | 26,932 |
| 18 | 28000-30000 | 323 | 0.50 | 0.49 | 0.60 | 0.40 | 0.46 | 0.37 | 0.46 | 28,976 |
| 19 | 30000-40000 | 1,034 | 0.44 | 0.45 | 0.56 | 0.36 | 0.41 | 0.34 | 0.42 | 34,520 |
| 20 | 40000-50000 | 583 | 0.38 | 0.40 | 0.53 | 0.32 | 0.36 | 0.30 | 0.37 | 44,519 |
| 21 | 50000-60000 | 343 | 0.32 | 0.36 | 0.50 | 0.27 | 0.32 | 0.25 | 0.34 | 54,609 |
| 22 | 60000-80000 | 334 | 0.29 | 0.33 | 0.44 | 0.24 | 0.28 | 0.23 | 0.30 | 68,675 |
| 23 | 80000-100000 | 182 | 0.25 | 0.31 | 0.43 | 0.22 | 0.26 | 0.19 | 0.26 | 89,116 |
| 24 | 100000+ | 350 | 0.23 | 0.38 | 0.45 | 0.22 | 0.26 | 0.18 | 0.29 | 100,000 |

| Condition in 1999 | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|
| Breast Cancer | 2,499 | 0.80 | 0.82 | 0.90 | 0.72 | 0.76 | 0.66 | 0.94 | 10,881 |
| CHF | 1,682 | 0.60 | 0.91 | 0.92 | 0.56 | 0.64 | 0.57 | 0.70 | 21,433 |
| Asthma | 14,261 | 1.03 | 1.13 | 0.96 | 0.87 | 0.87 | 0.83 | 0.92 | 4,458 |
| Depression | 11,790 | 0.92 | 0.91 | 0.93 | 0.85 | 0.86 | 0.82 | 0.84 | 6,423 |
| HIV | 205 | 0.48 | 1.13 | 1.00 | 0.93 | 0.95 | 0.56 | 0.85 | 15,774 |

**EXHIBIT E-3: PREDICTIVE RATIOS - CONCURRENT RECALIBRATED MODEL - UNTRUNCATED CLAIMS**

**Predictive Ratios: Ratio of Predicted Claims for 1999 to Actual Claims for 1999**
**Concurrent Model: Use 1999 Claim Information to Predict 1999 Claim Dollars**
**Recalibrated Weights: Use Calculated Risk Weights (with min of 0) to Score each Member**
**Claims: Untruncated**

Members are grouped based on: (a) 1999 claims for quintiles and dollar ranges, and (b) 1998 and 1999 claims for medical condition.

| 1999 Claim $ Quintiles | Percentiles | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-20% | 74,914 | 13.96 | 29.42 | 6.58 | 34.92 | 28.91 | 50.77 | 6.41 | 11 |
| 2 | 20-40% | 74,909 | 3.48 | 3.22 | 3.15 | 4.06 | 3.82 | 4.42 | 3.00 | 194 |
| 3 | 40-60% | 74,921 | 2.32 | 2.06 | 2.19 | 2.30 | 2.23 | 2.32 | 2.21 | 596 |
| 4 | 60-80% | 74,915 | 1.64 | 1.57 | 1.53 | 1.63 | 1.58 | 1.62 | 1.66 | 1,560 |
| 5 | 80-100% | 74,914 | 0.73 | 0.74 | 0.77 | 0.69 | 0.72 | 0.66 | 0.75 | 8,799 |
| Total | | 374,573 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 2,232 |

| Group | Actual 1999 Claims $ Range | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-500 | 176,099 | 3.44 | 3.65 | 2.97 | 4.43 | 4.08 | 5.16 | 2.87 | 150 |
| 2 | 500-1000 | 55,258 | 2.18 | 1.95 | 2.07 | 2.15 | 2.07 | 2.14 | 2.10 | 723 |
| 3 | 1000-1500 | 31,499 | 1.83 | 1.70 | 1.70 | 1.78 | 1.73 | 1.77 | 1.82 | 1,230 |
| 4 | 1500-2000 | 21,254 | 1.59 | 1.54 | 1.48 | 1.60 | 1.55 | 1.59 | 1.63 | 1,732 |
| 5 | 2000-4000 | 42,235 | 1.30 | 1.29 | 1.21 | 1.33 | 1.30 | 1.31 | 1.35 | 2,831 |
| 6 | 4000-6000 | 18,028 | 1.05 | 1.06 | 1.00 | 1.03 | 1.05 | 1.02 | 1.11 | 4,884 |
| 7 | 6000-8000 | 9,644 | 0.90 | 0.90 | 0.88 | 0.86 | 0.89 | 0.85 | 0.95 | 6,903 |
| 8 | 8000-10000 | 5,591 | 0.80 | 0.79 | 0.80 | 0.76 | 0.78 | 0.73 | 0.84 | 8,919 |
| 9 | 10000-12000 | 3,549 | 0.75 | 0.72 | 0.76 | 0.71 | 0.74 | 0.67 | 0.77 | 10,921 |
| 10 | 12000-14000 | 2,281 | 0.70 | 0.69 | 0.75 | 0.64 | 0.67 | 0.60 | 0.72 | 12,948 |
| 11 | 14000-16000 | 1,679 | 0.64 | 0.65 | 0.69 | 0.62 | 0.64 | 0.57 | 0.65 | 14,936 |
| 12 | 16000-18000 | 1,202 | 0.62 | 0.59 | 0.66 | 0.59 | 0.63 | 0.54 | 0.60 | 16,964 |
| 13 | 18000-20000 | 925 | 0.60 | 0.59 | 0.66 | 0.54 | 0.58 | 0.50 | 0.58 | 18,982 |
| 14 | 20000-22000 | 736 | 0.59 | 0.58 | 0.67 | 0.52 | 0.56 | 0.47 | 0.57 | 20,955 |
| 15 | 22000-24000 | 592 | 0.61 | 0.57 | 0.66 | 0.50 | 0.55 | 0.46 | 0.55 | 23,013 |
| 16 | 24000-26000 | 487 | 0.57 | 0.58 | 0.69 | 0.48 | 0.53 | 0.43 | 0.51 | 24,946 |
| 17 | 26000-28000 | 365 | 0.55 | 0.50 | 0.65 | 0.42 | 0.47 | 0.39 | 0.50 | 26,932 |
| 18 | 28000-30000 | 323 | 0.55 | 0.57 | 0.68 | 0.43 | 0.50 | 0.41 | 0.50 | 28,976 |
| 19 | 30000-40000 | 1,034 | 0.49 | 0.51 | 0.63 | 0.40 | 0.44 | 0.37 | 0.46 | 34,520 |
| 20 | 40000-50000 | 583 | 0.42 | 0.47 | 0.61 | 0.35 | 0.40 | 0.33 | 0.40 | 44,519 |
| 21 | 50000-60000 | 343 | 0.36 | 0.41 | 0.57 | 0.30 | 0.36 | 0.27 | 0.38 | 54,609 |
| 22 | 60000-80000 | 334 | 0.33 | 0.40 | 0.51 | 0.27 | 0.32 | 0.25 | 0.34 | 68,675 |
| 23 | 80000-100000 | 182 | 0.28 | 0.38 | 0.51 | 0.24 | 0.30 | 0.22 | 0.30 | 89,116 |
| 24 | 100000+ | 350 | 0.16 | 0.29 | 0.34 | 0.15 | 0.18 | 0.12 | 0.22 | 167,951 |

| Condition in 1999 | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|
| Breast Cancer | 2,499 | 0.81 | 0.82 | 0.88 | 0.72 | 0.77 | 0.67 | 0.91 | 11,508 |
| CHF | 1,682 | 0.56 | 0.90 | 0.92 | 0.53 | 0.60 | 0.53 | 0.67 | 25,409 |
| Asthma | 14,261 | 1.03 | 1.12 | 0.95 | 0.86 | 0.87 | 0.83 | 0.90 | 4,675 |
| Depression | 11,790 | 0.94 | 0.91 | 0.94 | 0.85 | 0.86 | 0.83 | 0.84 | 6,629 |
| HIV | 205 | 0.49 | 1.11 | 0.99 | 1.09 | 1.11 | 0.64 | 0.85 | 16,637 |

**EXHIBIT E-4: PREDICTED CLAIMS - CONCURRENT RECALIBRATED MODEL - CLAIMS TRUNCATED AT $50,000**

**Predicted Claims: Predicted Claims Per Member Per Year for 1999**
**Concurrent Model: Use 1999 Claim Information to Predict 1999 Claim Dollars**
**Recalibrated Weights: Use Calculated Risk Weights (with min of 0) to Score each Member**
**Claims: Truncated at $50,000**

Members are grouped based on: (a) 1999 claims for quintiles and dollar ranges, and (b) 1998 and 1999 claims for medical condition.

| 1999 Claim $ Quintiles | Percentiles | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-20% | 74,914 | 153 | 399 | 88 | 425 | 350 | 605 | 72 | 11 |
| 2 | 20-40% | 74,909 | 671 | 678 | 644 | 807 | 753 | 875 | 588 | 194 |
| 3 | 40-60% | 74,921 | 1,366 | 1,259 | 1,354 | 1,370 | 1,318 | 1,376 | 1,302 | 596 |
| 4 | 60-80% | 74,915 | 2,498 | 2,398 | 2,405 | 2,447 | 2,388 | 2,406 | 2,504 | 1,560 |
| 5 | 80-100% | 74,914 | 5,721 | 5,676 | 5,918 | 5,359 | 5,601 | 5,146 | 5,944 | 8,048 |
| Total | | 374,573 | 2,082 | 2,082 | 2,082 | 2,082 | 2,082 | 2,082 | 2,082 | 2,082 |

| Group | Actual 1999 Claims $ Range | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-500 | 176,099 | 512 | 609 | 473 | 693 | 631 | 803 | 433 | 150 |
| 2 | 500-1000 | 55,258 | 1,559 | 1,431 | 1,540 | 1,539 | 1,480 | 1,530 | 1,497 | 723 |
| 3 | 1000-1500 | 31,499 | 2,209 | 2,075 | 2,122 | 2,128 | 2,072 | 2,098 | 2,181 | 1,230 |
| 4 | 1500-2000 | 21,254 | 2,683 | 2,601 | 2,587 | 2,659 | 2,586 | 2,607 | 2,715 | 1,732 |
| 5 | 2000-4000 | 42,235 | 3,536 | 3,485 | 3,368 | 3,520 | 3,491 | 3,447 | 3,634 | 2,831 |
| 6 | 4000-6000 | 18,028 | 4,841 | 4,825 | 4,665 | 4,589 | 4,715 | 4,504 | 5,064 | 4,884 |
| 7 | 6000-8000 | 9,644 | 5,773 | 5,678 | 5,603 | 5,334 | 5,573 | 5,223 | 6,120 | 6,903 |
| 8 | 8000-10000 | 5,591 | 6,522 | 6,335 | 6,457 | 5,984 | 6,292 | 5,771 | 6,948 | 8,919 |
| 9 | 10000-12000 | 3,549 | 7,249 | 6,957 | 7,295 | 6,721 | 7,167 | 6,366 | 7,613 | 10,921 |
| 10 | 12000-14000 | 2,281 | 7,989 | 7,633 | 8,325 | 7,222 | 7,632 | 6,799 | 8,338 | 12,948 |
| 11 | 14000-16000 | 1,679 | 8,354 | 8,137 | 8,764 | 7,914 | 8,315 | 7,241 | 8,603 | 14,936 |
| 12 | 16000-18000 | 1,202 | 9,004 | 8,365 | 9,472 | 8,532 | 9,148 | 7,863 | 9,074 | 16,964 |
| 13 | 18000-20000 | 925 | 9,498 | 9,156 | 10,279 | 8,611 | 9,308 | 7,917 | 9,618 | 18,982 |
| 14 | 20000-22000 | 736 | 10,236 | 9,752 | 11,175 | 9,052 | 9,906 | 8,260 | 10,207 | 20,955 |
| 15 | 22000-24000 | 592 | 11,160 | 10,417 | 12,055 | 9,550 | 10,419 | 8,837 | 10,812 | 23,013 |
| 16 | 24000-26000 | 487 | 11,426 | 11,192 | 13,289 | 9,884 | 11,086 | 9,108 | 10,699 | 24,946 |
| 17 | 26000-28000 | 365 | 11,732 | 10,745 | 13,490 | 9,441 | 10,503 | 8,693 | 11,081 | 26,932 |
| 18 | 28000-30000 | 323 | 12,508 | 12,134 | 15,062 | 10,276 | 11,994 | 9,687 | 11,997 | 28,976 |
| 19 | 30000-40000 | 1,034 | 13,092 | 13,094 | 16,264 | 11,076 | 12,424 | 10,310 | 12,918 | 34,520 |
| 20 | 40000-50000 | 583 | 14,282 | 14,887 | 19,437 | 12,367 | 13,916 | 11,594 | 14,354 | 44,519 |
| 21 | 50000-60000 | 343 | 14,923 | 16,100 | 21,956 | 12,934 | 14,931 | 11,746 | 15,977 | 50,000 |
| 22 | 60000-80000 | 334 | 16,494 | 18,476 | 24,359 | 14,368 | 16,487 | 13,371 | 17,479 | 50,000 |
| 23 | 80000-100000 | 182 | 18,044 | 21,432 | 29,690 | 16,141 | 19,081 | 14,600 | 19,046 | 50,000 |
| 24 | 100000+ | 350 | 19,085 | 28,003 | 33,598 | 18,100 | 20,779 | 15,080 | 22,743 | 50,000 |

| Condition in 1999 | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|
| Breast Cancer | 2,499 | 7,943 | 8,079 | 8,846 | 6,999 | 7,309 | 6,470 | 9,347 | 9,855 |
| CHF | 1,682 | 11,217 | 16,111 | 16,187 | 10,383 | 12,040 | 10,677 | 12,761 | 17,269 |
| Asthma | 14,261 | 4,358 | 4,636 | 4,095 | 3,651 | 3,666 | 3,508 | 3,942 | 4,245 |
| Depression | 11,790 | 5,495 | 5,581 | 5,754 | 5,118 | 5,180 | 4,969 | 5,167 | 6,107 |
| HIV | 205 | 6,987 | 15,378 | 14,046 | 11,974 | 12,276 | 7,524 | 11,961 | 14,064 |

**EXHIBIT E-5: PREDICTED CLAIMS - CONCURRENT RECALIBRATED MODEL - CLAIMS TRUNCATED AT $100,000**

**Predicted Claims: Predicted Claims Per Member Per Year for 1999**
**Concurrent Model: Use 1999 Claim Information to Predict 1999 Claim Dollars**
**Recalibrated Weights: Use Calculated Risk Weights (with min of 0) to Score each Member**
**Claims: Truncated at $100,000**

Members are grouped based on: (a) 1999 claims for quintiles and dollar ranges, and (b) 1998 and 1999 claims for medical condition.

| 1999 Claim $ Quintiles | Percentiles | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-20% | 74,914 | 153 | 355 | 77 | 401 | 331 | 579 | 71 | 11 |
| 2 | 20-40% | 74,909 | 673 | 650 | 626 | 793 | 749 | 866 | 585 | 194 |
| 3 | 40-60% | 74,921 | 1,375 | 1,247 | 1,333 | 1,369 | 1,326 | 1,383 | 1,311 | 596 |
| 4 | 60-80% | 74,915 | 2,536 | 2,441 | 2,404 | 2,508 | 2,439 | 2,477 | 2,559 | 1,560 |
| 5 | 80-100% | 74,914 | 6,106 | 6,149 | 6,401 | 5,770 | 5,997 | 5,537 | 6,315 | 8,481 |
| Total | | 374,573 | 2,168 | 2,168 | 2,168 | 2,168 | 2,168 | 2,168 | 2,168 | 2,168 |

| Group | Actual 1999 Claims $ Range | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-500 | 176,099 | 514 | 575 | 458 | 675 | 621 | 787 | 432 | 150 |
| 2 | 500-1000 | 55,258 | 1,570 | 1,424 | 1,521 | 1,545 | 1,492 | 1,544 | 1,511 | 723 |
| 3 | 1000-1500 | 31,499 | 2,235 | 2,098 | 2,111 | 2,164 | 2,105 | 2,145 | 2,220 | 1,230 |
| 4 | 1500-2000 | 21,254 | 2,726 | 2,656 | 2,589 | 2,733 | 2,649 | 2,693 | 2,780 | 1,732 |
| 5 | 2000-4000 | 42,235 | 3,622 | 3,601 | 3,414 | 3,669 | 3,612 | 3,610 | 3,752 | 2,831 |
| 6 | 4000-6000 | 18,028 | 5,019 | 5,056 | 4,822 | 4,854 | 4,941 | 4,777 | 5,267 | 4,884 |
| 7 | 6000-8000 | 9,644 | 6,056 | 6,009 | 5,862 | 5,692 | 5,890 | 5,584 | 6,377 | 6,903 |
| 8 | 8000-10000 | 5,591 | 6,899 | 6,744 | 6,843 | 6,434 | 6,692 | 6,204 | 7,279 | 8,919 |
| 9 | 10000-12000 | 3,549 | 7,772 | 7,492 | 7,847 | 7,281 | 7,687 | 6,891 | 8,046 | 10,921 |
| 10 | 12000-14000 | 2,281 | 8,640 | 8,346 | 9,118 | 7,856 | 8,223 | 7,373 | 8,904 | 12,948 |
| 11 | 14000-16000 | 1,679 | 9,086 | 8,981 | 9,643 | 8,700 | 9,035 | 7,923 | 9,226 | 14,936 |
| 12 | 16000-18000 | 1,202 | 9,895 | 9,236 | 10,479 | 9,388 | 9,987 | 8,623 | 9,750 | 16,964 |
| 13 | 18000-20000 | 925 | 10,547 | 10,280 | 11,522 | 9,534 | 10,267 | 8,740 | 10,442 | 18,982 |
| 14 | 20000-22000 | 736 | 11,470 | 10,974 | 12,688 | 10,081 | 10,962 | 9,129 | 11,229 | 20,955 |
| 15 | 22000-24000 | 592 | 12,700 | 11,830 | 13,722 | 10,671 | 11,577 | 9,816 | 11,873 | 23,013 |
| 16 | 24000-26000 | 487 | 12,966 | 12,883 | 15,440 | 11,017 | 12,343 | 10,085 | 11,822 | 24,946 |
| 17 | 26000-28000 | 365 | 13,400 | 12,260 | 15,752 | 10,513 | 11,763 | 9,651 | 12,368 | 26,932 |
| 18 | 28000-30000 | 323 | 14,428 | 14,314 | 17,517 | 11,541 | 13,437 | 10,845 | 13,429 | 28,976 |
| 19 | 30000-40000 | 1,034 | 15,151 | 15,415 | 19,212 | 12,517 | 14,018 | 11,567 | 14,635 | 34,520 |
| 20 | 40000-50000 | 583 | 16,754 | 17,989 | 23,618 | 14,232 | 16,002 | 13,234 | 16,445 | 44,519 |
| 21 | 50000-60000 | 343 | 17,460 | 19,487 | 27,067 | 14,902 | 17,521 | 13,402 | 18,655 | 54,609 |
| 22 | 60000-80000 | 334 | 19,755 | 22,971 | 30,251 | 16,799 | 19,526 | 15,605 | 20,768 | 68,675 |
| 23 | 80000-100000 | 182 | 21,872 | 27,614 | 38,157 | 19,195 | 23,140 | 17,069 | 23,045 | 89,116 |
| 24 | 100000+ | 350 | 23,403 | 37,766 | 44,865 | 22,141 | 25,978 | 17,958 | 29,290 | 100,000 |

| Condition in 1999 | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Truncated Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|
| Breast Cancer | 2,499 | 8,730 | 8,926 | 9,819 | 7,796 | 8,244 | 7,230 | 10,220 | 10,881 |
| CHF | 1,682 | 12,914 | 19,519 | 19,693 | 11,968 | 13,789 | 12,184 | 14,968 | 21,433 |
| Asthma | 14,261 | 4,608 | 5,028 | 4,283 | 3,865 | 3,890 | 3,720 | 4,098 | 4,458 |
| Depression | 11,790 | 5,907 | 5,845 | 6,005 | 5,430 | 5,498 | 5,276 | 5,389 | 6,423 |
| HIV | 205 | 7,610 | 17,840 | 15,752 | 14,691 | 14,931 | 8,854 | 13,363 | 15,774 |

**EXHIBIT E-6: PREDICTED CLAIMS - CONCURRENT RECALIBRATED MODEL - UNTRUNCATED CLAIMS**

**Predicted Claims: Predicted Claims Per Member Per Year for 1999**
**Concurrent Model: Use 1999 Claim Information to Predict 1999 Claim Dollars**
**Recalibrated Weights: Use Calculated Risk Weights (with min of 0) to Score each Member**
**Claims: Untruncated**

Members are grouped based on: (a) 1999 claims for quintiles and dollar ranges, and (b) 1998 and 1999 claims for medical condition.

| 1999 Claim $ Quintiles | Percentiles | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-20% | 74,914 | 153 | 322 | 72 | 383 | 317 | 557 | 70 | 11 |
| 2 | 20-40% | 74,909 | 675 | 625 | 610 | 786 | 741 | 857 | 581 | 194 |
| 3 | 40-60% | 74,921 | 1,381 | 1,228 | 1,308 | 1,371 | 1,327 | 1,385 | 1,316 | 596 |
| 4 | 60-80% | 74,915 | 2,558 | 2,447 | 2,384 | 2,546 | 2,472 | 2,523 | 2,593 | 1,560 |
| 5 | 80-100% | 74,914 | 6,392 | 6,537 | 6,784 | 6,073 | 6,303 | 5,838 | 6,598 | 8,799 |
| Total | | 374,573 | 2,232 | 2,232 | 2,232 | 2,232 | 2,232 | 2,232 | 2,232 | 2,232 |

| Group | Actual 1999 Claims $ Range | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-500 | 176,099 | 516 | 548 | 445 | 664 | 611 | 773 | 430 | 150 |
| 2 | 500-1000 | 55,258 | 1,578 | 1,406 | 1,496 | 1,550 | 1,496 | 1,550 | 1,519 | 723 |
| 3 | 1000-1500 | 31,499 | 2,250 | 2,093 | 2,088 | 2,187 | 2,125 | 2,173 | 2,243 | 1,230 |
| 4 | 1500-2000 | 21,254 | 2,752 | 2,669 | 2,567 | 2,779 | 2,690 | 2,749 | 2,819 | 1,732 |
| 5 | 2000-4000 | 42,235 | 3,673 | 3,654 | 3,419 | 3,765 | 3,694 | 3,722 | 3,830 | 2,831 |
| 6 | 4000-6000 | 18,028 | 5,131 | 5,201 | 4,908 | 5,041 | 5,106 | 4,978 | 5,410 | 4,884 |
| 7 | 6000-8000 | 9,644 | 6,245 | 6,246 | 6,043 | 5,945 | 6,126 | 5,854 | 6,565 | 6,903 |
| 8 | 8000-10000 | 5,591 | 7,165 | 7,046 | 7,143 | 6,758 | 6,998 | 6,541 | 7,520 | 8,919 |
| 9 | 10000-12000 | 3,549 | 8,157 | 7,902 | 8,265 | 7,702 | 8,096 | 7,295 | 8,368 | 10,921 |
| 10 | 12000-14000 | 2,281 | 9,108 | 8,913 | 9,772 | 8,329 | 8,678 | 7,821 | 9,342 | 12,948 |
| 11 | 14000-16000 | 1,679 | 9,626 | 9,680 | 10,343 | 9,286 | 9,609 | 8,462 | 9,644 | 14,936 |
| 12 | 16000-18000 | 1,202 | 10,572 | 9,944 | 11,238 | 10,008 | 10,605 | 9,201 | 10,239 | 16,964 |
| 13 | 18000-20000 | 925 | 11,380 | 11,262 | 12,584 | 10,247 | 11,028 | 9,412 | 11,056 | 18,982 |
| 14 | 20000-22000 | 736 | 12,425 | 12,077 | 13,986 | 10,892 | 11,792 | 9,850 | 12,002 | 20,955 |
| 15 | 22000-24000 | 592 | 13,957 | 13,083 | 15,145 | 11,546 | 12,659 | 10,636 | 12,664 | 23,013 |
| 16 | 24000-26000 | 487 | 14,187 | 14,402 | 17,218 | 11,849 | 13,248 | 10,846 | 12,645 | 24,946 |
| 17 | 26000-28000 | 365 | 14,712 | 13,568 | 17,518 | 11,303 | 12,637 | 10,430 | 13,345 | 26,932 |
| 18 | 28000-30000 | 323 | 16,020 | 16,541 | 19,643 | 12,545 | 14,486 | 11,776 | 14,463 | 28,976 |
| 19 | 30000-40000 | 1,034 | 16,850 | 17,577 | 21,656 | 13,662 | 15,238 | 12,613 | 15,974 | 34,520 |
| 20 | 40000-50000 | 583 | 18,829 | 20,905 | 27,102 | 15,710 | 17,624 | 14,580 | 17,958 | 44,519 |
| 21 | 50000-60000 | 343 | 19,544 | 22,569 | 31,264 | 16,472 | 19,694 | 14,804 | 20,628 | 54,609 |
| 22 | 60000-80000 | 334 | 22,505 | 27,385 | 35,164 | 18,826 | 22,036 | 17,209 | 23,359 | 68,675 |
| 23 | 80000-100000 | 182 | 25,218 | 34,215 | 45,817 | 21,803 | 26,404 | 19,334 | 26,833 | 89,116 |
| 24 | 100000+ | 350 | 27,260 | 48,729 | 57,166 | 25,701 | 30,800 | 20,725 | 36,183 | 167,951 |

| Condition in 1999 | Members | ACG | CDPS | DxCG | M Rx | RxG | RxRisk | ERG | Actual Claims 1999 $ PMPY |
|---|---|---|---|---|---|---|---|---|---|
| Breast Cancer | 2,499 | 9,327 | 9,460 | 10,174 | 8,282 | 8,854 | 7,766 | 10,500 | 11,508 |
| CHF | 1,682 | 14,313 | 22,767 | 23,405 | 13,378 | 15,273 | 13,534 | 16,920 | 25,409 |
| Asthma | 14,261 | 4,802 | 5,255 | 4,419 | 4,024 | 4,057 | 3,883 | 4,228 | 4,675 |
| Depression | 11,790 | 6,232 | 6,033 | 6,224 | 5,658 | 5,711 | 5,489 | 5,551 | 6,629 |
| HIV | 205 | 8,088 | 18,541 | 16,541 | 18,131 | 18,469 | 10,592 | 14,072 | 16,637 |