

INGENIX[®]

Symmetry[™] Pharmacy Risk Groups[™]

A Pharmacy-Based Approach to Health Risk Assessment

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Overview and Background

Assessment of member health risk has become a critical need of health care organizations. Health plans and other managed care organizations are increasingly adopting tools that allow them to better understand and predict health risks of the members they enroll and the potential medical care costs associated with those risks. Member health risk can vary for a number of reasons, including a person's current health, genetic makeup, socioeconomic status, and environment. Whether to support accurate payment, obtain meaningful comparisons of provider performance, or identify patients of highest risk, sound methods of health risk assessment are critical tools for any health care organization.

Adjusting for differences in health risk can be thought of as a two-step process. The first step, risk assessment, involves measuring an individual or group's expected health care costs or utilization. Risk adjustment is the mechanism for adjusting for differences in risk, as measured by the risk assessment. In all applications, risk adjustment will only be as good as the underlying risk assessment method.

In this paper, we describe an innovative approach to health risk assessment called Pharmacy Risk Groups™ (PRG™). PRG were originally developed in 2003 and use an individual's claims for pharmaceutical prescriptions and demographic information to assess prospective health risk. PRG are designed to assist organizations that do not have access to complete medical claims or want to perform more timely health risk assessment. Although medical claims can provide advantages in measuring patient risk, a pharmacy-based model provides the following benefits:

- **Minimal data requirements**—Enrollment data and member pharmacy claims are all that is needed to run PRG.
- **Timely prediction**—Very short claim lag and completion time allow users to assess members' health risk in a timely manner, as pharmacy claims are usually available for analysis within two weeks for most organizations.
- **Clean and accurate information**—Information obtained from pharmacy data is typically reliable and complete.
- **Frequent risk assessment**—Because pharmacy data is readily available, requires fewer resources to extract, and is relatively clean, organizations can perform risk assessment in more frequent intervals than is practical with medical claims data—as often as on a nightly basis, if relevant.
- **Cost effective**—As PRG are easy to implement and operate, minimal IT and data warehouse resources are required.

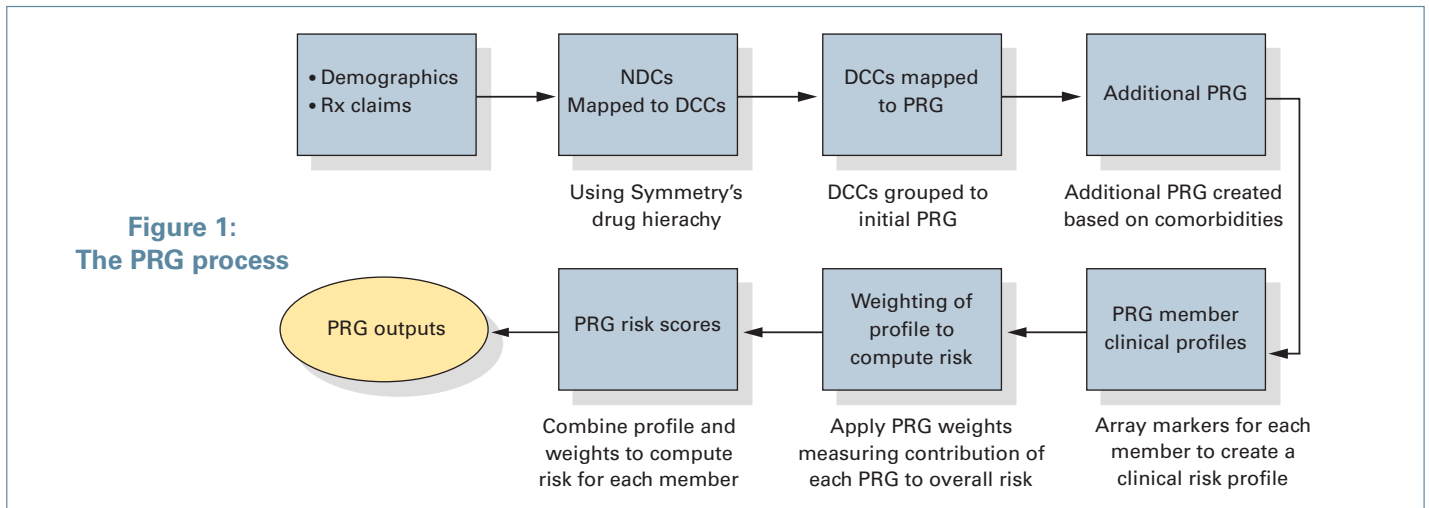
The next section of the paper provides an overview of PRG, including a summary of the data used in its development. The final section provides a summary and conclusions.

PRG

A good risk assessment model should have a number of qualities:

- **Predictive ability**—In addition to other factors, a model should maximize predictive accuracy—how close actual levels of costs or utilization are to those predicted by the model.
- **Clinical relevance**—The markers used in describing risk should be meaningful medically, allowing clinicians and others to interpret and understand the relationship between an observed marker and a patient's risk.
- **Administrative practicality**—To support general use, the information used in risk assessment must be routinely available—for example, age and gender, or the medications recorded on pharmacy claims. The expense and complexity involved in administering a model also is an important consideration.

In developing PRG, we selected a solution to best meet these objectives. In particular, the fundamental building blocks of PRG are a member's mix of pharmacy prescriptions—the unique occurrences of a drug used in treating a disease or condition and how that drug relates to others prescribed for the member. The nature and mix of these treatments provides a pharmacy-based clinical profile that can serve as a marker of the member's future need for medical care.



The PRG process involves several phases:

Drug Code Hierarchy—Using Ingenix’s proprietary Symmetry Drug Hierarchy, the National Drug Codes (NDCs) recorded on pharmacy claims are assigned to unique drug classification codes (DCCs).

DCCs to PRG—DCCs for a member are further categorized into one of 105 initial pharmacy risk groups (PRG). The PRG are markers of member risk and combine DCCs of similar clinical and risk characteristics.

Additional PRG—Additional PRG are defined based on member age and the combination of initial PRG observed. These PRG reflect comorbidities or other characteristics that suggest a patient is of higher risk.

PRG Profile—Age, gender, and mix of PRG provide a clinical and demographic risk profile for a member. Members can be assigned zero, one, or more PRG. Members with pharmacy treatments that indicate multiple medical conditions will have multiple PRG.

PRG Risk Score—Using pre-determined weights and a member’s PRG profile, a risk score is computed. A member’s risk score is simply the sum of the weights attached to each PRG and demographic characteristic observed in his or her profile.

Figure 1 provides an overview of the PRG process. In the remainder of this section, we describe each of these steps in greater detail.

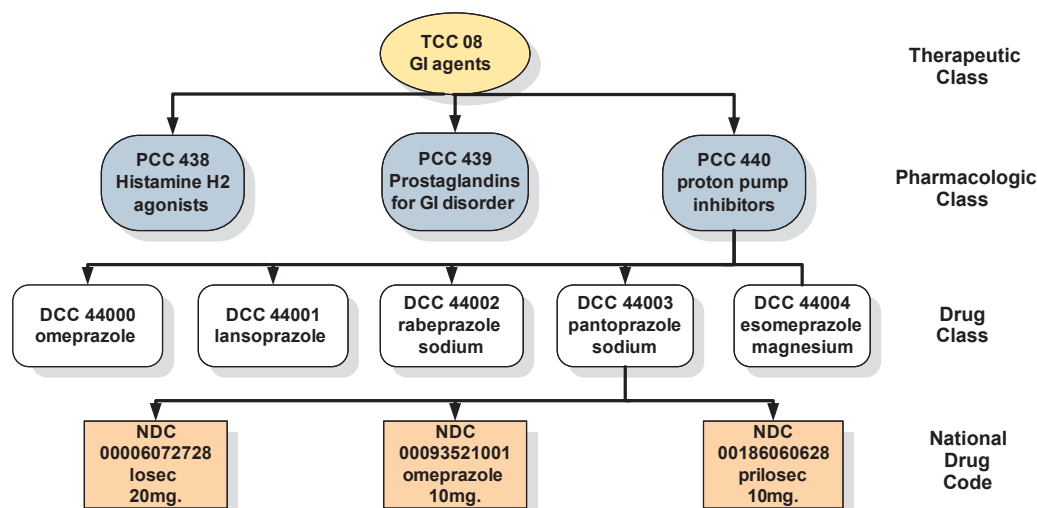
1. Symmetry’s Drug Code Hierarchy—Mapping NDCs to DCCs. The NDCs on a member’s pharmacy claims provide a detailed description of the particular agents prescribed, including the labeler (manufacturer, packager, or distributor), the product itself (with strength, dosage, and formulation), and how the drug is packaged.¹ The details included in an NDC are useful in many applications. However, the key information for health risk assessment is the general description of the agent itself, a description that can be linked to a therapeutic usage—the types of diseases and conditions for which it is typically prescribed. If a strong link can be established between an agent and therapeutic usage, the drugs prescribed for a member can be useful in predicting his or her overall morbidity and health risk.

More than 390,000 unique NDCs are currently available to describe prescription drugs—too many groupings to support any practical approach to risk assessment. To categorize these codes, PRG uses a robust, clinically based classification system called the Ingenix Symmetry Drug Code Hierarchy.² This system was initially developed by

¹ National Drug Code (NDC). U.S. Food and Drug Administration, Center for Drug Evaluation and Research, 2005.

² Ingenix, Inc., 2007.

Figure 2:
Symmetry's Drug
Code Hierarchy



Symmetry Health Data Systems to support its Episode Treatment Group® (ETG®) methodology. Based on a series of clinical and statistical algorithms, ETG combines inpatient and outpatient medical and pharmacy services into mutually exclusive and exhaustive categories called *episodes of care*.³ Examples of ETG base categories are diabetes, congestive heart failure, and ischemic heart disease. Given its ability to categorize drugs for assignment to disease and condition episodes of care, the Drug Code Hierarchy provides a natural link between NDC and therapeutic usage, a link that provides a sound basis for the development of a health risk assessment model.

Figure 2 provides an example of the different levels of classification provided by the Drug Code Hierarchy. The lowest level is the NDC. NDCs map uniquely into Drug Class Codes (DCCs) that describe the general ingredient for the NDC. DCCs are further assigned to Pharmacologic Class (PCCs) and Therapeutic Class (TCCs) codes. The PCCs and TCCs provide the link between the general ingredient described by an NDC and the typical therapeutic use. In this example—for GI Agents—the three NDCs all map to DCC 44000 (Omeprazole). That DCC and other selected agents map to PCC 440 (Proton Pump Inhibitors) which further are assigned to the GI Agents TCC.

³ Ingenix, Inc. Episode Treatment Groups.® User's Guide, Release 7.0, 2007.

As a first step, PRG uses the Drug Code Hierarchy and map all NDCs for a patient to a unique DCC. PRG uses a 12-month experience period. All available pharmacy claims for a member during this period are used for mapping to DCCs and creating markers of risk.

2. Pharmacy Risk Groups (PRG)—Mapping DCCs to PRG.

The DCC grouping provides a record of the different drug ingredients identified for an individual. A key step in developing PRG is deciding how these DCCs can best be used as markers of risk. One option is to use all of the approximately 3,000 DCCs as separate risk markers. This approach was not chosen for several reasons. First, such a large number of risk factors would likely produce relatively small sample sizes for some markers, resulting in implausible or imprecise estimates of their contribution to risk. Second, the level of clinical detail provided by the DCCs also could produce imprecision due to the potential overlap in the impact of clinically related agents on patient risk—over- or underestimating risk for members with different combinations of these agents.

A decision was made to combine DCCs into larger groups to create PRG. In mapping DCCs to PRG, the primary goal was to combine drugs of similar clinical and risk characteristics. Both clinical input and empirical evidence guided this process. The mapping involved a number of steps and assumptions:

- DCCs indicating the same disease or condition and patients of similar risk were combined. To enhance both clinical relevance and also homogeneity in terms of risk, the grouping of DCCs occurred primarily within the same PCC and TCC—with most agents in the relevant PCCs assigned to the same PRG. Exceptions included agents within a PCC that are used to treat very different medical conditions of differing risk, or both. In these cases, DCCs within the same PCC were assigned to separate PRG.
- DCCs with relatively low prevalence were combined with other DCCs based on clinical similarity and implications for risk assessment.
- PRG assignment does not vary with the number of DCCs or prescriptions observed for an individual within the same PRG. Patients with single or multiple agents or prescriptions within a PRG receive identical assignments. Further, for practical and other reasons, measures of dosage recorded on pharmacy claims, such as number of days' supply and metric quantity, also do not impact PRG assignment.
- Not all DCCs are used. Many agents have no measurable impact on future risk for a patient and are not assigned to a PRG. Further, to promote consistency, pharmaceutical agents not typically covered and provided through a prescription drug benefit are not used. Agents administered largely in an inpatient or facility setting or distributed primarily over-the-counter are examples.

Using this approach, a total of 105 PRG were initially identified. These PRG are described in Table 1. Note that additional PRG can be defined for a patient based on the combinations of these initial PRG and other criteria (Step 3).

3. Additional PRG. Additional PRG are defined based on observed combinations of the PRG described in Step 2. The majority of these added PRG are designed to capture the impact on risk of a patient's comorbidities. For example, a patient prescribed agents related to the treatment of coronary artery disease (CAD) who also has one or more prescriptions for insulin (suggesting diabetes) may have a different level of risk related to these agents than a patient with only the CAD agent or only insulin. A patient receiving multiple CAD-related agents from different PRG is another example. For selected agents, such as glucocorticoid agents,

separate PRG were also defined depending on whether the patient was 0-18 years or older than 18, based on their differing impact on risk for children and adults.

The final model includes 136 PRG. The PRG added or modified in Step 3 are noted in Table 1 with an asterisk (*).

4. PRG Profile. Members' age, gender, and mix of PRG are used to create their PRG profile. Seven age groups are used for each gender for this purpose: 0–5, 6–11, 12–18, 19–34, 35–44, 45–54, and older than 54.

Every member is assigned to an age-gender group. Members can also be assigned to zero, one, or more PRG depending on their mix of pharmacy agents. Members without pharmacy claims will have no PRG. For these members, risk is based solely on age and gender.

5. Measuring the Contribution of PRG to Member Risk—PRG Risk Weights. The next step is the assignment of a weight to each PRG and demographic marker of risk. These weights describe the contribution to risk of being in a specific age-gender group or having a particular agent included in a PRG. The model of risk can be defined as:

$$Risk_i = \sum a_s * asex_{i,s} + \sum b_p * PRG_{i,p}$$

where $Risk_i$ is the PRG risk score for person i ; $asex_{i,s}$ and $PRG_{i,p}$ indicate their age-gender group (s); and PRG (p) assignments, and the a 's and b 's are the risk weights. The age-gender and PRG markers are a series of 0,1 variables, set to 1 if the marker is observed for an individual, 0 otherwise. Each member has his or her own profile of age-gender and PRG; however, the risk weights are pre-defined by enrollment period within each PRG, and, given the same length of enrollment, will be the same for all individuals.⁴ The risk score is the sum of the age/gender weight, the PRG assignment weights, and any possible additional PRG weights.

The risk weights for PRG were estimated using multiple linear regression and enrollment and pharmacy claims data for a large managed care population. These data also were used to test the predictive accuracy of the PRG model, as described below. The PRG development data were obtained from

⁴The risk weights are pre-set and delivered as part of the PRG software. Alternatively, PRG customers with large patient populations (more than 500,000 members) might want to estimate weights using their own experience.

Table 1
Pharmacy Risk Groups

| PRG | Description | PRG | Description |
|-----------|---|-----------|--|
| 01 | Anti-Infectives | 04 | Cardiovascular (CV) |
| 01.01 | Amebicides & antifungal antibiotics | 04.01 | Beta adrenergic antagonists, alpha1-adrenergic antagonists |
| 01.02 | Aminoglycosides excluding cystic fibrosis agents | 04.02 | Carvedilol, nitrates & nitrites, digoxin |
| 01.03 | Other arthritis agents | 04.03 | Antihypertensive agents |
| 01.04 | Antituberculosis agents | 04.04 | Antiarrhythmic agents |
| 01.05 | Cephalosporins, macrolides, other selected anti-infective agents | 04.05 | Other cardiovascular agents, not elsewhere classified |
| 01.06 | HIV antiviral agents | 04.06 | Calcium channel antagonists |
| 01.07 | Leprostatic agents used in chemotherapy/major illness | 04.07 | Vasodilating agents |
| 01.08 | Miscellaneous antibiotics, not elsewhere classified | 04.08 | Vasopressors used in shock, midodrine HCL |
| 01.09 | Non-HIV antiviral agents, not elsewhere classified | 04.81* | Higher risk CAD, anti-infectives/antibiotics comorbidity |
| 01.10 | Quinolones | 04.82* | Higher risk CAD, CNS comorbidity |
| 01.11 | Higher cost anti-infectives, not elsewhere classified | 04.83* | Higher risk CAD, GI comorbidity |
| 01.12 | Higher cost arthritis agents | 04.84* | Higher risk CAD, insulin comorbidity |
| 01.81* | Multiple selected anti-infective agents, I | 04.85* | Higher risk CAD, respiratory comorbidity |
| 01.82* | Multiple selected anti-infective agents, II | 04.86* | Moderate/lower risk CAD/hypertension, GI comorbidity |
| 02 | Antineoplastics | 04.87* | Moderate/lower risk CAD/hypertension, insulin comorbidity |
| 02.01 | Antineoplastics, I (nitrogen mustards, nitrosoureas, anthracycline antibiotics) | 04.88* | Moderate/lower risk CAD/hypertension, respiratory comorbidity |
| 02.02 | Antineoplastics, II (androgens/anti-androgens for chemotherapeutic use) | 04.89* | Loop & higher risk diuretics comorbidity |
| 02.03 | Antineoplastics, III (antimetabolites & selected chemotherapy & related agents) | 05 | Central Nervous System (CNS) |
| 02.04 | Antineoplastics, IV (gonadotropin-releasing hormones for chemotherapy) | 05.01 | Migraine agents & selected salicylates |
| 02.05 | Antineoplastics, V (miscellaneous antineoplastics, not elsewhere classified) | 05.02 | Agents used to treat Alzheimer's disease |
| 02.06 | Antineoplastics, VI (hepatitis agents) | 05.03 | Agents used to treat multiple sclerosis |
| 02.07 | Antineoplastics, VII (agents used to treat breast cancer, I) | 05.04 | Agents used to treat ALS |
| 02.08 | Antineoplastics, VII (agents used to treat breast cancer, II) | 05.05 | Agents used to treat Parkinson's disease |
| 03 | Blood Formation and Modification | 05.06 | Amphetamines & miscellaneous CNS stimulants, not elsewhere classified |
| 03.01 | Antihemophilic agents | 05.07 | Anorexiant |
| 03.02 | Anticoagulants - antiplatelets, coumarin, heparins, glycosaminoglycans | 05.08 | Antiemetic agents used in treatment of cancer |
| 03.03 | Folic acid-folinic acid products | 05.09 | Antiemetic agents, not elsewhere classified, >18 years of age |
| 03.04 | Hematopoietic agents | 05.10 | Antipsychotic & antimanic agents |
| 03.05 | Iron & iron combinations | 05.11 | Antivertigo agents-anticholinergics |
| 03.06 | Hemostatics & thrombolytic enzymes | 05.12 | Barbiturate general anesthetics & sedative hypnotics |
| 03.07 | Vitamin B12 & K products | 05.13 | Antidepressants, antianxiety agents, nonbarbiturate sedative hypnotics, not elsewhere classified |

Table 1
Pharmacy Risk Groups

| PRG | Description | PRG | Description |
|-----------|---|-----------|--|
| 05.14 | Narcotic agonist analgesics & agonist-antagonist combinations | 08.06 | Proton pump inhibitors |
| 05.15 | Centrally acting analgesics, muscle relaxants & narcotic analgesic combinations | 08.81* | Selected GI agents with 0-18 years of age |
| 05.16 | CNS & related agents, not elsewhere classified | 09 | Hormones and Synthetic Agents |
| 05.17 | Anticonvulsants | 09.01 | Antidiabetic agents, excluding insulin |
| 05.19 | CNS agents, higher risk, not elsewhere classified | 09.02 | Antithyroid agents & thyroid hormones |
| 05.20 | Agents used to treat gout | 09.03 | Bone resorption inhibitors, agents associated with treatment of osteoporosis |
| 05.21 | Antiemetic agents, not elsewhere classified II | 09.04 | Estrogens, progestins, oxytocics |
| 05.81* | Antipsychotic/anti-manic with antidepressant/antianxiety agents | 09.05 | Glucocorticoids, > 18 years of age |
| 05.82* | Higher risk narcotic agonist analgesics with other analgesic agents | 09.06 | Glucocorticoids, 0-18 years of age |
| 05.83* | Selected CNS agents, single, with antidepressant/antianxiety | 09.07 | Growth hormones |
| 05.84* | Selected CNS Agents, multiple, with antidepressant/antianxiety | 09.08 | Ovulation stimulants |
| 05 | Central Nervous System (CNS) | 09.09 | Anabolic steroids |
| 05.85* | Antiemetics used in treatment of cancer, with evidence of antineoplastics | 09.10 | Insulin |
| 05.86* | Anticonvulsants with respiratory comorbidity | 09.11 | Vasopressin derivatives & other selected hormones/synthetic substitutes |
| 05.87* | CNS agents with selected GI agents | 09.12 | Natural & synthetic androgens |
| 05.88* | CNS agents with respiratory comorbidity | 09.81* | Insulin, anti-infectives/antibiotics comorbidity |
| 05.89* | Antiemetic agents with selected GI agents | 09.82* | Insulin, CNS agents comorbidity |
| 05.90* | Antiemetic agents with noninsulin diabetic agents, selected steroids | 09.83* | Insulin, gastrointestinal agents comorbidity |
| 05.91* | Antiemetic agents with CAD | 09.84* | Non-insulin diabetes, anti-infectives/antibiotics comorbidity |
| 07 | Electrolyte/Caloric/Water Balance | 09.85* | Non-insulin diabetes, CNS agents comorbidity |
| 07.01 | Acidifying agents, alkalinizing agents | 09.86* | Insulin, 3 or more comorbidities |
| 07.02 | Agents used to treat electrolyte disorders, ion exchange resins | 10 | Nutritional Agents |
| 07.03 | Ammonia detoxicants | 10.03 | Prenatal—vitamins / minerals / combination products |
| 07.05 | Diuretics & thiazides, excluding loop & higher risk diuretics, > 18 yrs of age | 10.04 | Nutritional supplements for deficiency states & vitamin D analogs |
| 07.06 | Diuretics & thiazides, excluding loop & higher risk diuretics, 0-18 yrs of age | 11 | Respiratory |
| 07.07 | Loop diuretics | 11.01 | Inhaled corticosteroids |
| 07.08 | Higher risk diuretics | 11.03 | Leukotriene receptor antagonists |
| 08 | Gastrointestinal Agents (GI) | 11.04 | Xanthine-sympathomimetics & other selected respiratory agents |
| 08.01 | Agents used to treat inflammatory bowel disease | 11.05 | Xanthine derivatives |
| 08.02 | Antidiarrheal/antiflatulent agents | 11.06 | Inhaled anticholinergic agents |
| 08.03 | Antacids, anticholinergics & other selected GI agents, not elsewhere classified | 11.81* | Inhaled anticholinergic agents with other respiratory agents |
| 08.05 | GI agents, not elsewhere classified | 11.82* | Respiratory, 3 comorbidities |

Table 1
Pharmacy Risk Groups

| PRG | Description | PRG | Description |
|-----------|---|-------|---|
| | Other Agents | | |
| 12.01 | Higher cost immunologic agents | 16.04 | Topical skin & mucus membrane anesthetics |
| 12.02 | Agents for xerostomia | 16.05 | Topical wound healing agents |
| 13 | Topical Ophthalmic Preparations | 17.01 | Agents to treat impotence |
| 13.01 | Ophthalmic antihistamines, anti-allergy & non-steroidal anti-inflammatories | 17.02 | Cholinergic muscle stimulants |
| 13.02 | Agents to treat glaucoma | 17.03 | Urinary anticholinergics |
| 13.03 | Cycloplegic mydriatics | 17.04 | Narcotic antagonist antidotes |
| 13.04 | Ophthalmic anti-infectives & corticosteroids | 17.05 | Chelating antidotes—penicillamine, trientine |
| 16 | Topical Skin and Mucous Membranes | 17.06 | Agents to treat enzyme deficiency states |
| 16.02 | Topical corticosteroids | 30.01 | Higher risk agents used to treat cystic fibrosis & other conditions, I |
| 16.03 | Topical enzymes & combinations | 30.02 | Higher risk agents used to treat cystic fibrosis & other conditions, II |

Ingenix's National Managed Care Benchmarks Database, a large national database that comprises claims and membership information aggregated from more than 38 sources.

6. PRG Models and Outputs. PRG provides flexibility around the risk outcomes and models available, including the outcome predicted, the time period for the prediction, and the expenditure threshold for the risk prediction.

In terms of the outcome predicted, health risk assessment typically focuses on projections of total costs for a member, including all services. However, for some pharmacy-specific applications, users may prefer an alternative outcome: members' health risk for pharmacy services only. To accommodate this, PRG users can select either total service costs (medical and pharmacy) or pharmacy costs alone as the outcome measured by the model. The same PRG are used for each of these two outcomes and the different thresholds described above. However, the risk weights included in the model vary by both outcome and threshold selected.

The standard time period assumptions used for PRG include the 12-month risk marker period described above, where all available pharmacy claims for a member are analyzed and used in creating markers of risk. Further, the standard PRG model assumes risk prediction for the 12-month period immediately following the experience period, a "12-0-12" assumption, where the "0" indicates no gap between the risk marker and prediction period.

PRG provides an alternative timing model to support the unique needs of actuaries and underwriters. Actuarial and underwriting (A/U) practices require time between the experience period used in measuring risk and the future time period being predicted. This allows the additional time necessary for claims lag and analysis prior to development of group premiums.

To satisfy this need, PRG uses a distinct set of risk weights that reflect a three-month gap between the experience period and the prediction period, "12-3-12" where the "3" represents a three month gap. To accommodate the operational realities of actuarial and underwriting practices, PRG automatically provides an additional prospective A/U risk score for each member based on these weights and timing.

Finally, some applications of health risk assessment may require differing assumptions regarding the maximum dollar amount of interest for each member. To support this flexibility, PRG weights were estimated using different expenditure threshold assumptions. Expenditure threshold describes the level at which a higher-cost member's expenditures were truncated prior to deriving model weights. The application of a threshold amount has importance for several reasons. First, truncating expenditures for higher-cost members limits the impact of extreme outliers on model development and testing. Second, most applications of health risk assessment involve some use of a threshold

or stop-loss. For example, when profiling the economic performance of primary care practitioners, some health plans will truncate expenditures for members with annual costs above some catastrophic amount, such as \$25,000. Payment or rate setting often includes some allowance for higher cost members, either explicitly as part of the rate setting process, or through reinsurance by health plans.

Thresholds of \$25,000, \$100,000, and \$250,000 were used for estimating model risk weights. Costs for members with annual expenditures exceeding these amounts were truncated to the particular threshold for that analysis. For example, a member with annual costs of \$200,000 had his costs adjusted to \$100,000 for the \$100,000 threshold. PRG users can select one of these threshold options depending on their application.

Table 2
Examples of PRG risk score assignment

| DCC | Description | PRG | Description | Risk |
|---|--------------------------------|-------|--|--------|
| Example 1: Male, Age 58 | | | | |
| (RX-MedRx, 100k threshold, 10–12 Months) | | | | |
| 01500 | Ciprofloxacin HCL / Lactate IV | 01.10 | Quinolones | 0.2618 |
| 25605 | Lisinopril | 04.03 | Antihypertensive agents | 0.2289 |
| 00600 | Erythromycin | 01.05 | Cephalosporins, Macrolides, and other Selected Anti-Infective Agents | 0.0902 |
| 32000 | Fluoxetine HCL | 05.13 | Antidepressants, antianxiety agents and nonbarbiturate sedative hypnotics, NEC | 0.3380 |
| 32001 | Sertraline | 05.13 | Antidepressants, antianxiety Agents and Nonbarbiturate sedative hypnotics, NEC | 0.0000 |
| 30302 | Ibuprofen | ----- | Not assigned to a PRG | 0.0000 |
| | | | Males, 55 to 64 | 1.0485 |
| | | | Total Risk Score | 1.9674 |
| Example 2: Male, Age 58 | | | | |
| (RX-MedRx, 100k threshold, 10–12 Months) | | | | |
| 25101 | Carvedilol | 04.02 | Carvedilol, nitrates and nitrites, Digoxin | 0.4848 |
| 50401 | Insulin | 09.10 | Insulin | 1.1489 |
| | Comorbid PRG | 04.84 | Higher risk CAD, insulin comorbidity | 0.6783 |
| | | | Males, 55 to 64 | 1.0485 |
| | | | Total Risk Score | 3.3605 |
| Example 3: Female, Age 52 | | | | |
| (RX-MedRx, 100k threshold, 10–12 Months) | | | | |
| 34604 | Riluzole | 05.04 | Agents to treat ALS | 7.6663 |
| 32000 | Fluoxetine HCL | 05.13 | Antidepressants, antianxiety agents and nonbarbiturate sedative hypnotics, NEC | 0.3380 |
| | | | Females, Age 45 to 54 | 0.6493 |
| | | | Total Risk Score | 8.6536 |

NOTE: Only the total risk score is provided in the PRG output. The scores for the individual PRG markers are presented here for illustration only.

Table 3

Examples of PRG partial enrollment risk score assignment

| PRG | Description | Length of Enrollment | | | |
|--|--|----------------------|------------|------------|------------|
| | | 10-12 months | 7-9 months | 4-6 months | 1-3 months |
| Male, Age 58 (RX-MedRx, 100k threshold) | | | | | |
| 04.02 | Carvedilol, nitrates and nitrites, digoxin | 0.4848 | 0.5327 | | |
| 09.10 | Insulin | 1.1489 | 1.2565 | 1.3562 | 1.6084 |
| 04.84 | Higher risk CAD, insulin comorbidity | 0.6783 | 0.6489 | | |
| | Males, 55 to 64 | 1.0485 | 1.0711 | 1.0957 | 1.2708 |
| | Total Risk Score | 3.3605 | 3.5092 | 2.4519 | 2.8792 |

Examples. Table 2 provides examples of how PRG risk would be calculated for an individual—using the total cost outcome and a threshold assumption of \$100,000.

As shown, for Example 1, over a 12-month period, a 58-year-old male was observed to have six unique DCCs, that map to four different PRG—quinolones; antihypertensive agents; selected anti-infectives (macrolides); and antidepressants/antianxiety. (Note that the second antidepressant [DCC 32001] does not add additional risk since it has already been accounted for. Further, the prescription for ibuprofen does not contribute to risk, since that DCC does not map to any PRG.) The individual's age and gender and these four PRG describe his profile of risk. Assuming 10-12 months of continuous enrollment, the sum of the weights assigned to these risk markers provides the overall risk scores for the individual.

The scores in Table 2 reflect each individual's measure of risk relative to that of the overall population used in developing PRG. A score of 1.00 indicates risk comparable to that of the development population, a score of 1.10 indicates 10 percent greater risk, a score of 0.85 indicates 15 percent lower risk, and so on. The 58-year-old male described in Table 2, Example 1 has a PRG prospective risk score of 1.9674—indicating a level of future health risk nearly two times that of the average for the large managed care population used in developing PRG.

Example 2 shows a male, age 58, whose prescription drugs translate into two unique DCCs that map into two initial PRG. These initial PRG trigger a third PRG, based on the presence of both the carvedilol and insulin agents. This member receives separate risk weights for the carvedilol

and the insulin PRG and also receives a third weight due to the comorbid PRG. Relative risk for this patient is 3.3605—indicating a level of future health risk of more than three times that of the average member.

Example 3 includes a 52-year-old female with two DCCs. The first DCC, riluzole, maps to the PRG for agents used in the treatment of ALS. The second DCC describes an antidepressant. The risk weights assigned to these PRG, along with the age-gender weight for the member, produce an overall risk score of 8.6536, more than eight times that of the average member.

Adjustments for Partial Enrollment. A member's length of enrollment may impact his or her risk. In consequence, PRG use separate sets of risk weights that correspond with the member's length of continuous enrollment during the experience period. The enrollment periods are categorized as follows:

| Enrollment period | Days |
|-------------------|---------|
| 1-3 MONTHS | 1-91 |
| 4-6 MONTHS | 92-183 |
| 7-9 MONTHS | 184-274 |
| 10-12 MONTHS | 275-365 |

The scores in Table 3 depict risk for the same 58-year-old male described earlier in Table 2. In this example, a comparison is drawn between the four enrollment periods accommodated by the partial enrollment model. This member's total risk score would depend on the enrollment period to which he is assigned.



For Information: 800.765.6696 | insight@ingenix.com
Ingenix, Inc. | 12125 Technology Dr. | Eden Prairie, MN 55344
www.ingenix.com

Summary and Conclusions

Health risk assessment is fast becoming an important tool for the day-to-day operations and strategic decision making of health care organizations. It can play a key role in allocating resources effectively and targeting opportunities for clinical and financial improvement.

Health risk assessment has a number of practical applications for health care analysis and health services research. It is an integral part of creating valid comparisons of the efficiency and quality of the services provided to patients. It is also used extensively in care management—to identify and target higher risk patients with a given disease or profile. Health risk assessment also plays an important role in underwriting and actuarial activities. In these applications, PRG provides significant advantages, particularly in rating new and existing groups and recognizing their unique operational requirements and business needs.

Beyond health care information applications, risk assessment is an important component of health-based payment systems. Many health care reform efforts, including the federal government's adoption of risk-adjusted payments for Medicare HMOs, include a risk assessment methodology. Others have used risk assessment as a means for deriving global payments to providers ("capitation"). Risk assessment will be critical to the next generation of payment systems.

The Pharmacy Risk Groups model described in this paper provides a powerful, cost-effective, and practical alternative to existing health risk assessment methodologies. The pharmaceutical relevance of PRG presents an effective tool

for understanding patient profiles of medical conditions and how they influence current and future health risk. The predictive capability of PRG will lead to a better understanding of variations in medical costs and practices and how they relate to differences in health risk. Enhanced validity of health-based payments, increased precision of premium rates, and improved effectiveness in targeting patients and populations are the result.

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Corporate Headquarters | 12125 Technology Drive, Eden Prairie, MN 55344
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