



The Johns Hopkins ACG® System:

**State of the Art Technology and
A Tradition of Excellence
In One Integrated Solution**

**White Paper - General
December , 2012**



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1. Executive Summary

1.1 Executive Summary

One System, Many Tools, Many Solutions

While population health care needs are rising, resource availability is not, which increases the need for a better understanding of the morbidity burden of populations. Moreover, the increasing interest in the equitable delivery of healthcare, along with the improvement of data systems and data collection, as well as the progressive integration of primary, secondary and community care by management systems all result in growing global interest in risk adjustment.

The Johns Hopkins ACG® System responds to this growing need by creating a common language for healthcare analysis that benefits healthcare practitioners, purchasers, and consumers. The ACG System has broad applicability within the government and private sectors of healthcare delivery systems worldwide. The Johns Hopkins ACG System methodology has been applied to:

- ▲ Predict and prioritize high-risk users for inclusion in care management
- ▲ Provide a context for clinical screening applications
- ▲ Fairly allocate resources within regions, clinics and practitioners
- ▲ Set capitation payments
- ▲ Evaluate access to care
- ▲ Assess the efficiency of clinics and clinical practices
- ▲ Improve quality
- ▲ Monitor outcomes
- ▲ Perform clinical analysis, evaluation and research

The ACG System's suite of tools has been used to support basic and complex applications in finance, administration, care delivery, and evaluative research for over two decades. These applications have been both real-time (concurrent) and forward-looking (prospective). No other risk adjustment methodology has been used for so many purposes in so many places, while at the same time showing such high levels of quantitative and qualitative success. Internationally, the ACG System is the standard tool used by numerous private and public health care organizations, practitioner networks, consultants and research institutes. The flexibility and customizability offered by the ACG System demonstrates that we recognize that one size does not fit all.

The ACG System was developed by faculty at the Johns Hopkins Bloomberg School of Public Health to help make health care delivery more efficient and more equitable. Like health management and analysis itself, using case-mix or risk adjustment methods involves art as well as science.

For more technical information about the ACG System, please refer to the Johns Hopkins ACG System Technical White Paper.

1.2 Benefits to Your Organization

ACG International seeks collaborators internationally to further our mission, the primary goal of which is to improve the delivery of health care and, thereby, the health status of populations. The benefits of such a collaboration can be delineated for both sides.

Benefits to collaborators include:

- ▲ Ability to offer scientifically proven technology as an addition to the solutions they currently offer their clients.
- ▲ Ability to enhance their current offering by transforming available data into useful information for decision makers.
- ▲ Ability to utilize the resulting output to impact and expand on the health care programs they deliver.
- ▲ Affiliation with a world-renowned academic health care institution and the leading School of Public Health in the world.

Benefits to The Johns Hopkins University:

As an academic institution, our perspective is not the same as a commercial organization. We will benefit through the collaborator's ability:

- ▲ To identify opportunities in local markets.
- ▲ To approach strategic decision-makers through their established networks.
- ▲ To enhance the ACG System's product line through feedback regarding gaps in its current product offering.
- ▲ To acquire necessary datasets to enable customization of the models.

It is anticipated that both parties will mutually benefit from the public announcements of collaborative projects, which will enhance the standing of both parties as well as the resulting revenue streams.

2. Business Challenge

As recognized experts in reforming health care delivery processes, the ACG System Team is constantly confronted with questions from health authorities pertaining to resource allocation, practitioner performance assessment, and disease/case management issues, such as:

▲ Resource allocation:

- How do we distribute limited health care resources--whether they be financial, human resources, or targeted programs--to ensure those resources are directed to the patients/clinicians/practices/clinics/regions most equitably?
- How can payment schedules be adjusted based on the complexity of patients?
- How can financial risk be transferred to individual practitioners or groups of clinicians in a fair way? In doing so, how do we eliminate the incentive to see healthier patients?

▲ Profiling:

- How do we achieve adequate clinician performance management to ensure that the services rendered match the needs of the patient?
- How do we ensure that comparisons of regions/clinics/practitioners take into consideration the variance in morbidity burden?
- How do we ensure that intervention monitoring is assessed in a fair way given the variance in population morbidity?
- How do risk-bearing entities direct demand to the most efficient practitioners?
- How can risk-bearing entities detect fraud and abuse?
- How can a regulating entity detect practitioners that are restricting access to care?

▲ Disease/Case Management:

- How do we identify patients who could most benefit from intervention with targeted programs to ensure improved health status, while preserving a healthy bottom line?
- How do risk-bearing entities partner with clinicians in order to prevent disease?

Through our many years of experience in addressing these issues in diverse health care systems, the ACG System Team has the answers. The challenges faced in the NHS (UK) are not unlike the hurdles facing a health fund in Israel. For further information on specific projects, the reader is referred to the Case Studies outlined in Section 6.

3. Solution Description

Case-mix is the process by which the health status of a population is taken into consideration when setting budgets or capitation rates, evaluating practitioner performance, or assessing outcomes of care. The ACG System is a person focused case-mix system that captures the multidimensional nature of an individual's health. Over time, each person develops a constellation of conditions. Based on the pattern of these morbidities, using available information derived from both outpatient or "ambulatory" physician visit records and in-patient or hospital claims data, the ACG System assigns each individual to a single group (an "ACG") which permits the effects of the clustering of morbidities to be captured in estimates of resource use. The result is that individuals within a given ACG have experienced a similar pattern of morbidity and resource consumption over the course of a given year.

Unique Strengths

Clinical complexity represents more than merely summing diagnosis codes.

Supports the full-spectrum of management applications.

Avoids basing complexity on specific procedures or hospitalizations.

Provides more than a simple score.

Stable over time.

Maximizes the use of available data.

Flexible and Customizable.

The Adjusted Clinical Group actuarial cell methodology assigns all diagnostic codes to one of 32 diagnosis groups, known as Aggregated Diagnosis Groups (ADGs.) Diseases are placed in a diagnosis group (ADG) based on five clinical dimensions: duration, severity, diagnostic certainty, etiology and specialty care. All diseases, even those newly discovered, can be classified along these dimensions and categorized into one of these 32 groups. The Adjusted Clinical Groups uses a branching algorithm to place people into one of 94+ discrete mutually exclusive ACG categories based on each individual's particular combination of ADGs as well as age and gender.

The ACG System has the ability to handle, describe and manage healthier populations (i.e., low users of health care services). Unlike other systems, the ACG System was developed using commercial managed care populations as well as publicly insured populations, both of which closely resemble the general population. Most other case-mix risk adjustment methods were developed using sicker, more specialized patient populations such as the publicly insured elderly, indigent, or disabled populations or those who have already been hospitalized and these other methods have only later been adopted or modified to suit the needs of a more general patient population.

Finally, the ACG System is the only population-based system, which is totally adaptable to a local context. While our beginnings come from the U.S. health care system, we have since developed the ability to take into consideration local cost structures, coding systems, practice behavior, and language adaptations as well as the availability of local markers whether they capture socio-economic, functionality, living arrangement, or other dimensions.

The ACG System has been used in commercial and research settings longer and more extensively than any other system on the market today. It is a tried and true analytical tool, which is developed

from current and on-going research supported by an academic institution, and which has undergone numerous improvements and modifications in response to user needs. The Johns Hopkins ACG System is a statistically valid, diagnosis-based, case-mix methodology that allows healthcare practitioners, health plans, and public-sector agencies to describe or predict a population's past, present or future healthcare utilization and costs as well as detect trends in disease prevalences.

3.1 Components of the ACG System

Adjusted Clinical Groups (ACGs) - One ACG is assigned to each patient based on all of the individual's morbidities.

Adjusted Clinical Group actuarial cells, or ACGs, are the building blocks of the ACG System methodology. ACGs are a series of mutually exclusive, health status categories. They are based on the premise that the level of resources necessary for delivering appropriate healthcare to a population is correlated with the illness burden of that population.

The ACG methodology places people into one of 94+ (depending on user preference) discrete categories based on their accumulated morbidity experience, their age and their sex. The result is that individuals within a given ACG have experienced a similar pattern of morbidity and resource consumption over the course of a given year. A patient/enrollee is assigned to a single ACG based on the diagnoses assigned by all clinicians seeing them during all contacts, regardless of setting. Thus ACGs are truly person-oriented and are not based on visits or episodes

ACGs can be assigned to individuals using readily available diagnostic information derived from outpatient or ambulatory physician visit claims records, encounter records, inpatient hospital records, and computerized discharge abstracts. .

Typically, ACGs perform up to ten times better than age and sex adjustment, the traditional risk-adjustment mechanism used within the health insurance industry.

What makes ACGs different from most other case-mix measures (e.g., Diagnosis-Related Groups--DRGs, Ambulatory Patient Categories--APCs, or Episode Treatment Groups--ETGs) is that in these other systems, the case-mix unit of analysis is based on a designated service period and usually a single distinct clinical condition. For example, the service period may be defined based on a single procedure or an episode of care. In contrast, ACGs are based on all morbidities for which a person receives services over a defined period of time.

Resource Utilization Bands (RUBs)- ACGs roll up to form RUBs.

To simplify things, the ACG System Software will automatically assign a six-level (Low to High) simplified morbidity category termed a Resource Utilization Band, or RUB. The six RUBs are formed by combining the ACG mutually exclusive cells that measure overall morbidity burden.

Utilizing the RUB categories, the table below demonstrates how a simple RUB-based analysis highlights differences in the distribution of morbidity of two example groups, labeled Group 1 and Group 2 that differ according to their case-mix.

**Percentage Distribution of Two Subgroups by
Resource Utilization Band (RUB) Categories**

RUB Category	Total	Group 1	Group 2
1 - Non-users	25.8%	35.6%	22.5%
2 - Healthy Users	13.9%	17.5%	11.1%
3 - Low Morbidity	28.3%	30.1%	25.0%
4 - Moderate	27.6%	13.8%	33.5%
5 - High	3.7%	2.5%	7.4%
6 - Very High	0.7%	0.5%	1.5%

Expanded Diagnosis Clusters (EDCs) - A tool for identifying specific morbidity and removing practitioner coding variability.

Expanded Diagnosis Clusters, or EDCs, complement the unique person-oriented approach that underpins the ACG System. EDCs are a tool that allow for the easy identification of people with specific diseases or symptoms. The EDC methodology assigns diagnostic codes found in claims or encounter data to one of 264 EDCs, which are further organized into 27 categories called Major Expanded Diagnosis Clusters (MEDCs). As broad groupings of diagnosis codes, EDCs help to account for differences in coding behavior between practitioners. MEDCs may be further aggregated into five MEDC types (Administrative, Medical, Surgical, Obstetric/Gynecologic, Psychosocial) providing a concise way of summarizing all diagnosis codes.

As a stand-alone tool, EDCs can be used to select patients with a specific condition or combination of conditions, as well as to compare the distribution of conditions in one population with another. In addition, EDCs enable tracking of disease prevalence over time. When combined with ACGs, the result is a powerful combination tool for demonstrating variability of cost within disease categories. This is useful for many profiling applications and can help to target individuals for case-management purposes.

Rx-Defined Morbidity Groups (Rx-MGs) – A tool that uses pharmaceutical information to inform predictive models.

Rx-defined Morbidity Groups (Rx-MGs) classify Pharmaceuticals into 60 unique clinical groupings that are the building blocks of the Rx Predictive Model. In addition to the generic drug (active ingredient), the route of administration is a key variable in determining the Rx-MG. Rx-MGs group drugs that are similar in terms of morbidity, duration, stability and therapeutic goal. For example, drugs in the class of corticosteroids may be delivered orally, topically, by injection or inhaled to reduce inflammation. The route of administration is a key consideration in determining whether the drug is being used to treat joint conditions such as arthritis, respiratory conditions such as asthma, or to treat allergic reactions.

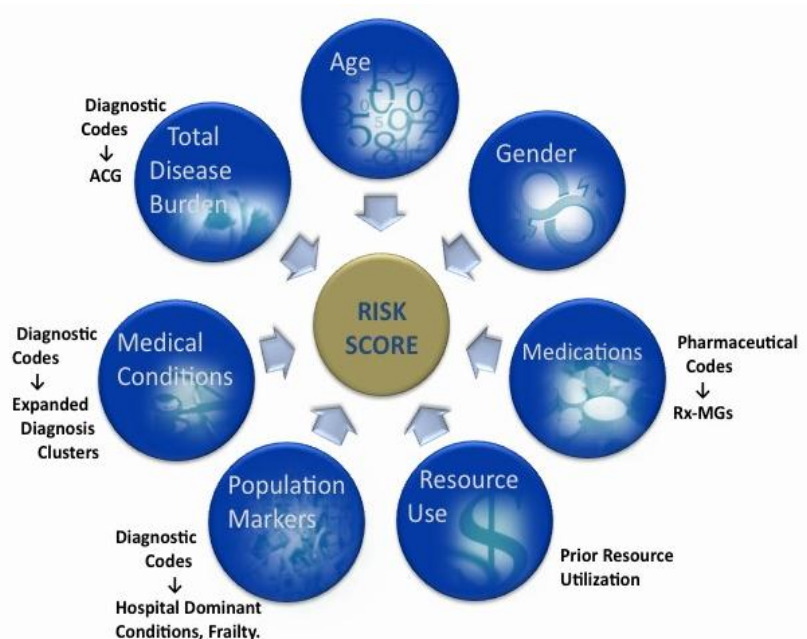
The Rx-MG algorithm is particularly useful in situations where diagnoses are not readily available or are of questionable quality.

Predictive Models – Tools that use health information to predict future service use.

Predictive risk modeling is the prospective (or concurrent) application of case-mix measures and statistical forecasting to predict future health resource needs. Predictive modeling (PM) is used in a variety of manufacturing and service sectors to forecast, for example, costs, profitability, financial risk, purchasing behavior, and likelihood of defaulting on a loan. A predictive model comprises a set of variables (often called risk factors) that are selected because they are likely to influence the occurrence of the event or trend of interest.

Population-based predictive models use health and healthcare information derived from all members of a population to predict future health events or forecast healthcare costs and service use for populations or individual patients.

The ACG System includes three types of predictive models, Dx-PM, Rx-PM and DxRx-PM, which differ according to the data inputs. The first is based on diagnostic codes (i.e., ICD-9-CM, ICD-10, READ, ICPC etc.), the second is built with medication codes (i.e., NDC or ATC codes) and the third uses both diagnostic and medication code inputs.





The ACG Predictive Models predict a large range of financial and clinical outcomes, including:

- ▲ Total healthcare costs
- ▲ Pharmacy costs; Pharmacy use; and Pharmacy prescribing gaps
- ▲ Outpatient costs (and sub-components such as imaging, physician, laboratory, specialty, ED, etc.)
- ▲ Inpatient hospitalizations
- ▲ ICU admissions
- ▲ Physician visits
- ▲ Specialty referrals
- ▲ Morbidity events (such as acute complications of chronic disease)
- ▲ Mortality

	Predictive Model		
	Dx-PM	Rx-PM	DxRx-PM
Age and gender are included to assess age-related and gender-based health needs.	•	•	•
Overall morbidity burden is measured using the ACG categorization of morbidity burden.	•		•
High-impact chronic conditions A sub-set of the ACG System’s Expanded Diagnostic Clusters (EDCs) is used to identify the high impact conditions in the model.	•		•
Hospital dominant condition markers are based on diagnoses that, when present, are associated with a greater than 50 percent probability among affected patients of hospitalization in the next year.	•		•
The medically frail condition marker is a dichotomous (on/off) variable that indicates whether an enrollee has a diagnosis that represents medical problems associated with frailty.	•		•
Rx-Defined Morbidity Groups Rx-MGs Each generic drug/route of administration combination is assigned to a one of sixty Rx-MGs.		•	•

Additionally, a number of enhancements have been made to the ACG System to improve statistical performance, and identify further opportunities for intervention to improve health outcomes. ACG System Version 10.0i builds on the success of previous releases by providing predictive modeling for a population of all ages; coordination markers and enhanced score capability; improved analytics functionality; and support for various codesets. Greater predictive accuracy is also achieved through further refinement of the ACG System’s clinical classifications.

Major new predictive models include:

- **Predictive hospitalization models:** Identifies patients with a risk of future unanticipated hospitalizations, using utilization markers such as inpatient hospitalizations, emergency department visits, outpatients visits, dialysis services, nursing services, and major procedures, in addition to the traditional predictive modeling variables. This model's outputs include the risk of: (1) an acute care hospitalization within 12 months or 6 months; (2) an ICU hospitalization within 12 months;(3) an injury-related hospitalization within 12 months; and (4) an extended hospitalization within 12 months (i.e. more than 12 days).
- **Coordination of care:** Contains five complementary markers to assess coordination of care. The markers provide a means to assess dimensions such as: majority source of care; count of unique practitioners providing outpatient care; generalist involvement; and populations at risk for poor coordination.
- **Pharmacy adherence:** Uses administrative claims to Identify gaps in medication adherence for chronic conditions where continuous medication use is warranted. Adherence measures include medication possession; continuous medication availability; prescribing gaps; and conditions indicated for but untreated with medication
- **High pharmacy utilization and cost outliers:** Identifies populations who are consuming drugs above and beyond what might be anticipated based on their morbidity burden. This model uses independent variables such as age, gender, ACG categories, and select high impact conditions defined by EDCs, Rx-MGs, hospital dominant conditions and frailty, to predict unexpected pharmacy costs.

For more information on new data input requirements for ACG Version 10, please refer to the Johns Hopkins ACG System Technical White Paper.

3.2 Predictive Performance of the ACG System

Adjusted R-Square Values

The conventional measure of model performance is the R-Squared statistic. This statistic measures how well the model fits the data and has become a standard measure of performance, especially among underwriters and actuaries who must price products across a range of populations. A value of 1.0 100% would indicate that the model explains all of the variance in the dependent variable of interest.

Global application of the ACG System has proven its validity and robustness under all types of health care systems. The illustration below shows R² values from several countries when using diagnoses to explain the variance in various resource measures in the concurrent year.

Country	Dependent Variables	Age, Gender	Age, Gender, ADGs	ACGs alone
United States	Total Costs (including pharmacy)	0.13	0.55	0.37
Canada - Manitoba	Ambulatory Costs	0.08	0.5	0.43
Taiwan	Physician Costs	0.12	0.52	0.47
	Dr. Visits	0.06	0.58	0.53
Sweden	Primary Care Costs	0.11	NA	0.38
Spain	GP Visits	0.13	0.59	0.53
United Kingdom	GP Visits			0.54

The table below shows R² results when using diagnoses as well as medication based models to predict year-two resource use (note that predicting things in the next time period, year-two resource use, is much more difficult than explaining things after the fact, explaining same year concurrent expenses).

Predictive Model	Total Costs	Pharmacy Costs	Physician Visits
Age, Sex	0.05	0.07	0.05
Diagnostic Based Models			
Age, Sex, ADGs	0.17	0.20	0.25
ACGs	0.16	0.17	0.22
Age, Sex, Charlson Disease Indicators	0.13	0.17	0.10
Dx-PM	0.21	0.29	0.23
Medication Based Models			
Age, Sex, Chronic Disease Score	0.16	0.35	0.12
Rx-PM	0.19	0.44	0.17
Combined Models			

Predictive Model	Total Costs	Pharmacy Costs	Physician Visits
DxRx-PM w/out Prior Costs	0.24	0.46	
DxRx-PM with Prior Costs	0.26	0.57	

Sensitivity and Positive Predictive Value (PPV)

An increasingly important use of the ACG System suite of Predictive Models has been for high-risk case identification. For this application, models are used like a diagnostic test and performance is measured at how well true cases are identified and false positives ignored. The focus tends to be on two key indicators, sensitivity and positive predictive value.

The computational approach for these indicators is as follows:

- **Sensitivity** = True Cases Identified/All True Cases In Population
- **Positive Predictive Value** = True Cases Identified/ All Cases Identified

Sensitivity is likely to be of greatest interest to epidemiologists and others who are focused in the health of the population since they are considering how well the “test” captures all of the high risk individuals in a population. Therefore a value of 100 would indicate that all true cases in a population were identified.

Positive predictive value will likely be of greatest interest to clinicians/care managers who want to know the likelihood that a particular patient is actually high risk. Similarly, a value of 100 would indicate that all cases identified, were, in fact, true cases.

Predictive Model (Predicting Total Cost)	Sensitivity and PPV
Prior Cost	35
Age and Gender	20
Dx-PM w/o Prior Cost	33
Rx-PM w/o Prior Cost	34
DxRx-PM w/o Prior Cost	37

** Sensitivity and PPV are balanced in this example because the size of the group of the highest cost patients matches the size of the highest risk group. Each group consists of 5% of the population. When one identifies a group at risk for being high cost that is of the same size as those that will actually be classified as high cost, PPV and Sensitivity are, by definition, the same. One would separate Sensitivity and PPV when the two group sizes are not equal.*

The table below illustrates, using sensitivity and positive predictive value measures, that the ACG® models are strong performers compared to using prior cost alone. The top 5% of hospitalization probability scores define cases that are identified.

Predictive Model	Positive Predictive Value	Sensitivity
IP Hospitalization with prior cost and diagnosis and pharmacy data input	21.2%	33.3%
IP Hospitalization with prior cost and diagnosis data input	20.8%	32.6%
Prior Cost (as a benchmark to the IP Hospitalization model)	14.2%	22.4%

The C-Statistic is a measure of the probability that the model used will correctly identify true positives. A C-Statistic of 0.5 indicates that true cases are indistinguishable from false positives (or a model no better than chance). A C-Statistic of at least 0.8 is widely accepted as a threshold for good test performance. For models predicting total cost with a 5% cut point, (i.e., top 5% of actual year two costs defines high risk), C-statistics are summarized in the table below.

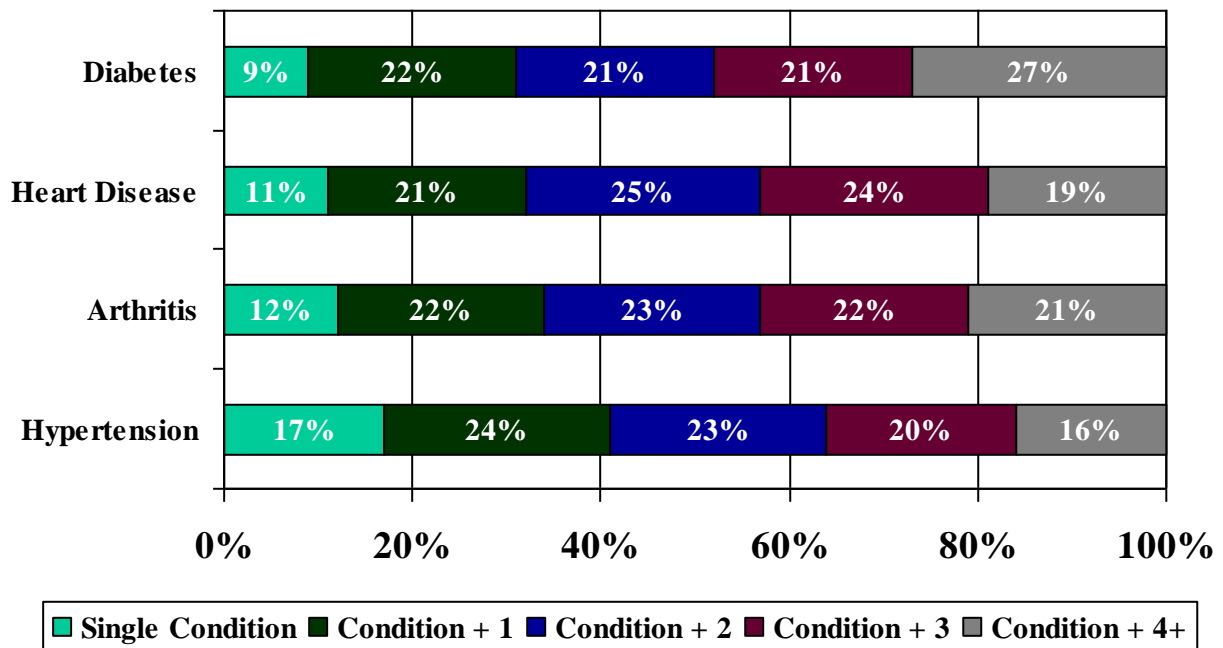
C-Statistics

Predictive Model (Predicting Total Cost)	C-Statistic
Dx Alone	.820
Dx + Prior Total Cost	.833
Rx Alone	.797
Rx + Prior Rx Cost	.802
DxRx Alone	.830
DxRx + Prior Total Cost	.835

(Please refer also to Table 2 and the text that describes C-Statistics on page 9-7 of the ACG System Technical Reference Guide.)

4. Solution Benefits

Our premise is based on the fact that populations vary in their morbidity or, as is most often the case, their co-morbidity. As a recent study demonstrated, only 9% of diabetics had only Diabetes, while almost half (48%) had 3 or more additional conditions.

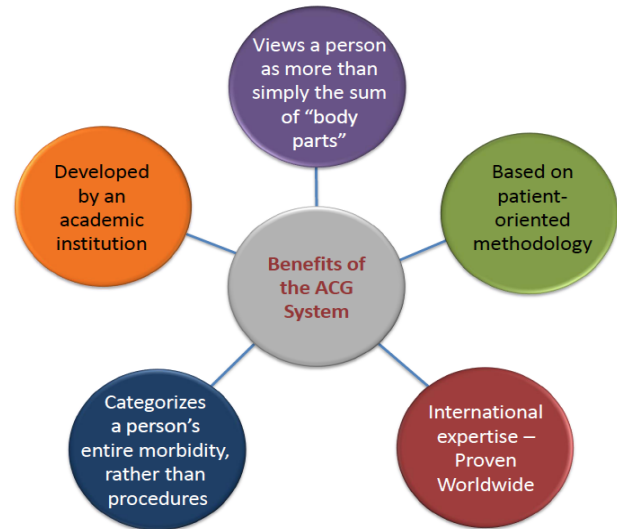


Source: *Chronic Conditions: Making the Case for Ongoing Care, September 2007, Partnership for Solutions*

What Can Be Achieved With Case-Mix Adjustment?

Case-mix adjustment is critical to identifying those patients most in need of health care resources, facilitating clinicians who specialize in treating patients with higher than average illness burden, creating incentives to encourage practitioners to match services to needs, ensuring appropriate comparisons for research and performance assessment and to guarantee equity and ensure fairness in the healthcare arena. To highlight four applications of case-mix :

- 1) Financial Analysis
- 2) Care Management
- 3) Performance Assessment
- 4) Population Profiling



4.1 Financial Analysis

In the past, most payers have calculated budgets and capitation rates based on age and gender and, less frequently, "community rating." Currently, with the increasing number of chronically ill individuals, the need for morbidity-adjusted resource allocation that considers a wider range of characteristics than simply age, gender and geography is critical.

While age, gender and geography can explain much of the variation in resource consumption in very large, randomly selected population groups, in reality, few, if any, of the patient populations captured are truly random -- some form of selection bias is almost always in play. By incorporating patient clinical characteristics -- in addition to simply age and gender -- into the budget process, the ACG System provides a mechanism to improve the fairness in the resource allocation process by better accounting for individuals' expected medical needs. This ensures an equitable distribution of limited health care resources.

Current usages of the ACG System in Sweden, Israel and the UK, as detailed in section 6 (International Experience) illustrate resource allocation applications of the System.

4.2 Care Management

Quality improvement and outcomes management often involve focusing on one or more specific diseases and comparing a process measure (e.g., appropriate use of lab tests, prescription of certain medications) or an outcomes measure (e.g., asthma inpatient admissions or emergency room visits) across several clinicians or health plans. In this context, the ACG System acts as a control for differences in case-mix or severity of illnesses among the populations being compared.

While the use of the ACG System for quality improvement and outcomes management in the aforementioned context is a retrospective activity, the ACG System may also be used prospectively to identify patients who are anticipated to have special needs in the future. Once identified, these patients, who typically suffer from multiple, chronic conditions, can then be case managed in an effort to intervene before the patient becomes a high risk case.

ACG International's collaborations with organizations in Israel and Germany, as outlined in Section 6 (International Experience) represent examples of care management applications of the ACG System.

4.3 Performance Assessment

Performance assessment is a technique for comparing the activities of health plans, health care practitioners, or clinics. Typically, performance assessment involves examination of resource utilization: dollars spent on overall patient care or discrete services such as laboratory, pharmacy or inpatient care. In performance assessment, the principal underlying question is "How does a clinician's pattern of practice compare to that of other clinicians once case-mix is accounted for?" By taking into account the differences in illness burden among different practitioners' patient populations, the ACG System allows one to determine whether variations in practice are a result of practitioners having sicker patient populations or whether these variations are actually attributable to differences in the way clinicians practice medicine.

Examples of performance assessment applications include ACG International's collaborations with Canada and Spain. Please see section 6 (International Experience) for more details.

4.4 Population Profiling

Population profiling is a technique for comparing the morbidity patterns of one or more groups, clinics or regions. By taking into account the differences in illness burden among different patient populations, the ACG System allows one to determine variations in disease prevalence as well as resource use.

Typically, population profiling is the first step to better understanding the health care needs of a population. For example, for subpopulations that differ in age, gender, geographical region, ethnicity or other characteristics, population profiling can assess the differences in health status and identify the health care needs of special groups. Population profiling can also help explain variabilities in referral rates and differences in primary care services costs by linking these changes to changes in morbidity of the populations compared. Having a solid knowledge of the morbidity pattern of different populations also allows for the accurate evaluation of the efficiency of different healthcare practices, as well as the equitable setting of capitation payments.

5. Introducing ACG International

Our Mission

“To become the global leader in supporting healthcare systems’ use of their health information to measure health needs of the population, provide equitable distribution and remuneration of services, as well as achieve improved health status.”

Markets Served

Since 2003, ACG International has seen its reach expand from a single project in Germany to on-going use in several European, North American, Middle Eastern, and African countries. In addition, numerous pilot and academic projects are underway in Europe, Asia, North and South America, as well as former Soviet block countries. In summary, ACG International is active on almost every continent.

The ACG® System is currently licensed in 17 countries worldwide, demonstrating that the ACG System is not just a “U.S.” solution. While our beginnings come from the U.S. health care system, we have since developed the ability to adapt to a local context.

Billions of dollars per year are now routinely exchanged using the ACG System, while the practices of hundreds of thousands of physicians in many nations are now more equitably assessed on an ACG case-mix adjusted basis. The health care of millions of patients is actively managed and monitored using the ACG System. The ACG System has broad applicability within the government and private sectors of many healthcare delivery systems, making the System the most widely used population-based case-mix system in the world.

Products Offered

Our primary product has been the ACG System which is made available through software licenses. The types of licenses currently offered include:

- *Research licenses* held by academic organizations, and individual research organizations. They are project based and therefore are time limited. These can only be issued by The Johns Hopkins University.
- *Pilot licenses* Also time limited, such licenses enable the user to evaluate the software’s capabilities as well as adaptability to their available data.
- *End-User Licenses* are granted to governments, health plans, and practitioners who use the ACG System in their organizations to improve clinical, financial, and managerial decisions.
- *Distributor licenses* have the ability to grant sublicenses to Integrators, as well as to End-Users.
- *Consultant licenses* are granted to firms who wish to use the ACG System as a tool in their consulting work.
- *Integrator licenses* have been granted to companies wishing to integrate the ACG System into a software program they are currently developing. They are then able to promote their software program enhanced through the ACG System.

We also provide consulting services to support the application of the software and the interpretation of the output. Additional services, which we offer include: Training Program and Accreditation and Software Development Services to adapt the ACG System to local contexts.

6. International Experience

The following case studies describe specific examples of the application of the ACG System in select countries. For more information and access to the published literature regarding ACG International's experience, please refer to section 7.3.

▲ **Canada** At the beginning of the 21st century, the government of a western Canadian province started holding physicians accountable for their overall billing patterns, with the annual reporting of each physician's practice profile. This allowed physicians to compare their practice patterns with others, but it also provided the government with a guide to detect outliers suspected of fraud and abuse. In addition, it raised the need to use risk adjustment tools to ensure that physicians were being evaluated fairly.

Audit results showed that, in 3 out of 4 cases, high healthcare expenses were justified by a sicker patient pool. After the ACG System was extensively evaluated in this particular Canadian province, it became accepted as the gold standard case-mix adjustment method for physician profiling. Subsequent audit results then showed that unjustified healthcare expenses were actually confirmed in 3 out of 4 cases identified.

The ACG System continues to be successfully used for physician profiling and the detection of fraud and abuse in this province. The System has been widely adopted in Canada with more than 34 projects currently being conducted across the country, including application to 4,000,000 lives in British Columbia

The ACG System has been extensively employed in a variety of studies, with results published in over a dozen articles since 2010. Topics have included:

- Predicting mortality in a population of adults, both general and with specific diagnoses (e.g. schizophrenia, diabetes)
- Evaluating the equity of primary care capitation payments
- Recognizing the cost burden of chronic disease
- Morbidity, service utilization and health spending in a population aged 65 and older
- Explaining prescription drug use and expenditures
- The co-morbidity burden of a treated asthma population

▲ **Spain** Together with our local collaborator, ACG International has been working with numerous regional governments in Spain since 2005 to provide them with the tools necessary to assess their primary care practitioner's performance in a fair and accurate manner. The ACG System allowed primary care managers to compare performance results from one primary care setting to another, and use this information to determine where practice improvements were needed. The ACG System has already been adopted as the primary care case-mix tool by two regional governments, while several other regional authorities are currently piloting the system.

Depending on the year, between 12% and 31% of the Spanish population are being grouped under the ACG System. In the face of the growing interest for integrated care in Spain, there is more need for other ACG System applications, such as the assessment of the morbidity risk of individual patients to determine resource allocation to different areas and help with risk-stratifying strategies.



The ACG System's predictive models are also being considered for their ability to identify individuals that could benefit from case management strategies.

▲ **Sweden** In Sweden, healthcare is primarily public and funded through state taxes, which are distributed to County Councils, who then allocate resources to their counties' primary care centers and hospitals. The widespread use of the Johns Hopkins ACG® System started in 2008 when Sweden introduced the freedom-of-choice reform for primary care, which created a need for a better morbidity based resource allocation model.

Sixteen of twenty-one local County Councils have an ACG System license, with approximately 88 percent of the Swedish population covered by the System. The System assists with reimbursement calculation as well as with predictive modeling of future resource use.

In 2009, ACG International solidified its presence in Sweden by partnering with a healthcare government agency. With access to its national drug register database, the ACG International team was able to test the pharmacy based predictive model's (Rx-PM™) validity as a risk adjustment tool in the Swedish context. The year-long study, conducted on a database capturing the entire Swedish population, showed that the Rx-PM model not only works very well for Swedish pharmaceutical data, but it also adds the potential of applying pharmaceutical data to additional applications of the system such as profiling of clinicians and high risk patient identification.

There have been several other research studies validating the System. Two articles describe that in Sweden, when people were given the choice of a public or a private primary care clinician, those choosing to stay with a public primary care clinician had higher morbidity burdens as determined by the ACG System [1]. By applying case-mix to payment formulas, a health care authority was able to ensure that payment is provided according to the needs of patients [2].

The ACG System is today a well-accepted model in Sweden for risk adjustment to create fair reimbursement models. To reach this level of acceptance, Sweden has implemented a localization of the ACG System. The Swedish localized weights have clearly contributed to a more relevant system for Swedish conditions. During 2012, the Swedish weights for the system were also updated. The successful customized localization in Sweden can serve as a model for other regions of the world.

Future enhanced use of the ACG System in Sweden will focus on more extended profiling of high-risk patients and application on the local physician level. There are also ongoing studies and projects for utilizing the System in care management programs for patients that have multiple conditions, dementia, or obesity.

[1] Zielinski A, Hakansson A, Beckman A, Halling A. Impact of comorbidity on the individual's choice of primary healthcare provider. *Scandinavian Journal of Primary Health Care* 2011;29:104–9.

[2] Zielinski A, Kronogard M, Lenhoff H, Halling A. Validation of ACG case-mix for equitable resource allocation in Swedish primary health care. *BMC Public Health* 2009;9:347.

▲ **Israel** Since 2006, the ACG International team has collaborated with Israel's largest health fund, a not-for-profit government-mandated insurer and healthcare provider (of primary, secondary and tertiary care) which counts 4 million enrollees and holds 53% of the market share, to better understand its members' needs and characteristics.

The first project with this health fund aimed at examining the differences in healthcare utilization between its low and high socioeconomic status members, controlling for morbidity level using the Johns Hopkins ACG System compared to the Charlson Co-morbidity Index as well as age and gender adjustment. Results of this analysis proved that age and gender adjustments yield an inaccurate positive association between low socioeconomic class and diagnostic tests as well as specialty care use. Moreover, the results demonstrated the superiority of the ACG System in comparison with the Charlson Index in measuring this correlation. The study is part of this health fund's all-encompassing disparity reduction program and can help in directing policy decisions regarding resource use by various socioeconomic groups.

Another study conducted as part of this research collaboration examined the association between co-morbidity, as measured by the ACG System, and the attainment of quality measures, which are part of this particular health fund's ongoing quality monitoring and improvement schemes. The study showed that, unlike outcome measures, process measures attainment was associated with morbidity level such that lower morbidity was associated with poorer performance of quality of care. This study showed that the ACG System provides a valuable tool for identifying patient groups for which quality of care could be improved. It proved far superior to measures of morbidity based on chronic disease counts.

Also, the value of the ACG predictive modeling tools for identifying high-risk users among this health fund's older patient population was assessed. The models were successful in recognizing patients with complex care needs, who could potentially benefit from targeted care management interventions, with better accuracy as compared with locally tailored data-mining tools. Following these successful initiatives, the ACG International team and this same health fund are now looking forward to furthering their partnership by examining the incorporation of information from this health fund's extensive database (including a comprehensive chronic disease registry, full electronic medical record coverage in all community clinics, and data on social support and functional status); improving the predictive capabilities of high-risk case identification tools; and testing the use of continuity of care tools.

An additional study was performed using the ACG-Dx tool for validation testing on an Israeli PPO population. The study used the tool to predict which members would be at future risk for high total cost. The ACG System provides a current risk adjustment analysis, as well as enable predictive modeling for high users. Managed care organizations need to address increasing membership with chronic disease, as well as the goal of providing quality care efficiently. The Israeli PPO study validated the ACG System as a proven method to use in assuring equity and quality of care; disease and case management; identification of populations and future use of healthcare resources; and financial allocation and practitioner reimbursement.

▲ **United Kingdom** Since 2009, numerous contract bids were successfully awarded which utilized the ACG® System. With the current coverage of close to 20% of the English population, the ACG System is becoming the preferred primary care based risk stratification tool in the National Health Service (NHS). Existing applications had focused on the provision of commissioning services within NHS Primary Care Trusts (PCTs), but there is an increased emphasis of high risk patient identification, to target case management and disease program interventions for the UK population. These applications demonstrate that the ACG System is not just a tool for identifying patients at risk of rehospitalization.

From the original project in a PCT in the North West of England, the ACG® System is being applied to more than 20 PCTs/CCGs (Clinical Commissioning Groups) utilizing hospital and primary care data. The primary care Read codes were first introduced in version 8 of the System and have been updated for version 9 and 10, with quarterly updates for diagnosis and pharmacy code. Read is also the standard coding system used in primary care for clinical findings, interventions and prescribing.

Numerous UK Universities have utilized the ACG System in their research over the last two decades. Their prominent work has continued utilizing the Read code mappings. Studies have shown the importance of primary care data related to social as well as clinical dimensions demonstrating the usefulness of integrating social care indicators.

▲ **Germany** In 2009, a sweeping reform implemented an overhaul of healthcare financing, and a morbidity-based risk adjustment of the transfer of funds within the German healthcare system. This process promoted the awareness of the case-mix to an audience of sickness funds, academic institutions, and government decision makers.

Subsequently, a German sickness fund, whose function amongst others is the reimbursement of healthcare practitioners, licensed the ACG System to aid with the management of their members. This sickness fund uses the ACG System primarily for controlling specific activities in the area of data analysis, including population comparisons, cost projections, identification of potential high-cost members, and member cost controlling. Cost controlling is done by establishing profiles of member groups, tracking changes in costs over time, and controlling budgets. This sickness fund is also applying the ACG System in innovative uses such as the outpatient management of patients with psychosocial disease clusters in order to avoid expensive inpatient care. They are also exploring a similar approach for other conditions clusters such as diabetes and hypertension.

The cooperation between this sickness fund and the ACG International team has resulted in the creation of new code sets based on the German adaptation of ICD-10 codes, as well as two new Risk Assessment Variable Sets (RAVS) that are based on this sickness fund's own data.

The ACG System has proven to offer a more comprehensive assessment of morbidity and resource use at the member level compared to the standard morbidity-based risk adjustment tool currently used in Germany.

7. Conclusion

The ACG System is available under the auspices of a world-renowned academic research institution: The Johns Hopkins University. The ACG System Research and Development team has been performing risk measurement and categorization research for over 30 years. The Johns Hopkins Bloomberg School of Public Health has an unwavering commitment to the ongoing development of the ACG System and its dissemination to both private sector and government users. The goal of the ACG System is to promote equitable, effective, and efficient health care around the globe; the Johns Hopkins ACG System is part of our strategy.

Many software vendors integrate the ACG System into their own products. Our collaborators include leading health care analytic firms and health care consulting firms that have integrated the ACG System into their existing products and services.

For more technical information about the ACG System, please refer to the Johns Hopkins ACG System Technical White Paper.

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7.2 More Information

For the latest information about our product and services, please visit our website: :

<http://www.acg.jhsph.edu>

7.3 Bibliography

The link to a full bibliography of internationally acclaimed publications is below:

<http://www.acg.jhsph.org/public-docs/AcgBibliography.pdf>

Further information can also be obtained by visiting: www.acg.jhsph.edu.