

# Measuring Outcomes of a Chronic Obstructive Pulmonary Disease Management Program

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## ABSTRACT

Chronic obstructive pulmonary disease (COPD) is a progressive disease of the lungs and is the fourth leading cause of death in the United States. It is characterized by decreasing elasticity of the airways with diminished lung function. The COPD disease management program is provided by a respiratory disease management company specializing in providing patient education, self-management tools and support, case management, and follow-up to members of contracted managed care organizations who have asthma and COPD. Begun in 1994, the program has provided services to over 200,000 such members through population-based programs since 1996. Out of 6,428 COPD patients who have been in the program for at least 90 days, those who report that their breathing interferes with their normal activities more than slightly decreased from 62% to 48% ( $p < 0.01$ ). Those reporting nighttime awakening with shortness of breath more than occasionally decreased from 25% to 14% ( $p < 0.01$ ), and those complaining of wheezing more than occasionally decreased from 24% to 13% ( $p < 0.01$ ). One claims analysis showed a case mix and trend-adjusted net savings rate in a mixed commercial and Medicare COPD population of 16.7%. An analysis of a different health plan population shows total claims costs for a mixed commercial and Medicare HMO COPD population 11% lower at 1 year after implementing the program as compared with the previous year, after adjusting for the cost trend in the overall population. Savings were 5.4% after program fees. This article discusses the program's approach to outcomes data collection and analysis, and reviews its outcomes.

## INTRODUCTION

### *Chronic obstructive pulmonary disease*

**C**HRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD) is a progressive disease of the lungs that is the fourth leading cause of death in the United States. It is characterized by progressively increasing secretions and decreasing elasticity of the airways resulting in irreversible diminished lung function. Experts believe that smoking causes 80–90% of COPD and that it has an annual cost of \$32 billion.<sup>1</sup> Sixteen mil-

lion Americans are diagnosed with a form of COPD, and as many may be undiagnosed.<sup>2</sup> Its incidence has increased 41% since 1982.<sup>1</sup> While mortality from the major causes of death (coronary heart disease and stroke) is decreasing, mortality from COPD continues to rise.<sup>1</sup> The prevalence of COPD in the over-65 population is believed to be nearly 10%.<sup>3</sup>

### *Program overview*

The COPD disease management program provides patient education, self-management

tools and support, case management, and follow-up to members of contracted managed care organizations with asthma and COPD. This program was founded in 1994 and has provided services to over 200,000 such members through population-based programs since 1996. Over 5,500 members with asthma and 8,000 members with COPD have received intense, one-on-one interventions. While the program is built around a specific clinical process, overall program designs vary depending on the goals and requirements of individual managed care organization (MCO) clients.

## MATERIALS AND METHODS

### *Clinical model*

*Patient identification.* Specific programs administered for different clients may be strictly referral-based, but typically referrals are seen as a complement to claims-based case finding (Figure 1). While there is often no assurance that case-finding criteria are applied uniformly by facilities or providers, let alone the MCOs themselves, there is reasonable assurance that referred cases are more likely to be true positives than cases identified using broad claims criteria.

A pool of potential program participants is typically identified based on diagnosis codes for COPD (chronic bronchitis and emphysema) appearing in claims history. Certain procedure codes and National Drug Codes (NDCs) may be used with the diagnosis codes. Table 1 lists some common criteria. Thresholds for these criteria vary with the program design and general approach. Programs focused on the total COPD population will use more sensitive specifications to include more potential candidates. Programs with severity-based criteria will use thresholds to select candidates with a minimum cost or utilization level.

*Stratification/predictive modeling.* For populations identified from claims, predictive models are used to focus effort on members with the highest likelihood of high future costs. Predictive modeling provides a means of prioritizing (stratifying) candidates to maximize the proba-

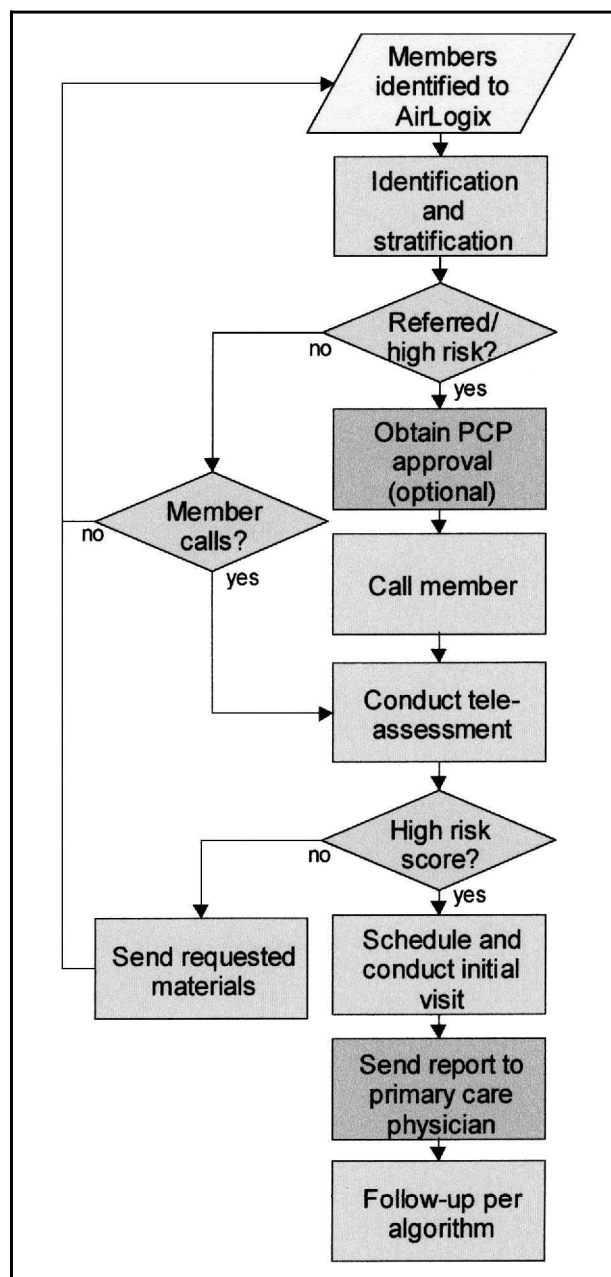


FIG. 1. Typical chronic obstructive pulmonary disease program flow chart. PCP=primary care physician.

bility of intervening with future high-cost members as early as possible. The model used may be a general experience-based model that can be applied to most claims datasets or a client-specific model developed using statistical analyses on the client's own data. While statistical models will better predict which members will utilize acute care services, many plans do not have, will not, or cannot produce the volume and quality of data required to develop such a model.

TABLE 1. COPD CRITERIA

ICD-9 diagnosis codes	
Chronic bronchitis	491.x
Emphysema	492.xx
Chronic airway obstruction (nonspecific code)	496
HCPCS codes	
Home oxygen and equipment	E0424–E0450, E1357–E1385
Revenue codes	
Home oxygen and equipment	600–609
National drug codes	
NDCs for oral and inhaled bronchodilators	

*Tele-assessment.* Once prioritized by risk, targeted members receive a telephone call and a brief survey to further establish each individual's correct intervention path. Depending on the requirements of the MCO, either the entire identified group or a subset believed to be high-risk may receive these calls. The tele-assessment contains 19 clinical and six demographic questions to validate appropriateness for the program, evaluate symptom severity and functional status, and establish willingness to participate in the program at a given level.

*Intervention principles.* Once members have been screened via claims and/or tele-assessment, they are assigned to an initial intervention. This intervention may be mailed educational materials and self-management tools, or a focused assessment and education session by telephone or in the patient's home.

**a) Physician interaction.** Physicians participate in the process near the beginning to review and approve care plans based on American Thoracic Society<sup>4</sup> and Global Initiative on Obstructive Lung Disease (GOLD)<sup>5</sup> guidelines for the treatment of COPD. The program provides specific, concrete opportunities for physicians to see and apply the guidelines using a care plan tool provided by the program. Figure 2 shows an example of the report. Physicians are also consulted whenever a patient's condition appears to change for the worse.

**b) One-on-one patient interaction.** Patients are taught to use the care plan, a multi-dose inhaler (MDI) spacer, and a diary (which the program supplies). This approach is centered on

one-on-one interactions between patients and respiratory care practitioners. Licensed Respiratory Therapists provide expertise in respiratory disease and special training in patient education, assess patients and their environments, and teach patients about their disease, management. In addition, patients are given support and encouragement on smoking cessation and pointers on trigger avoidance and general lifestyle issues such as home ergonomics, fitness, nutrition, and safety.

**c) Availability of home visit.** When conditions warrant, therapists meet patients in their homes for these sessions. This provides a more effective educational experience, as well as a chance for therapists to assess patients' condition and observe the environment for triggers, safety hazards, and opportunities for ergonomic changes in the home to help them cope with reduced lung function. Table 2 describes the telephone and home initial visit activities.

**d) Care management.** In addition to educating members about their disease and self-management, therapists also gather information about other health-related needs to be addressed. Either working with MCO case management personnel or directly, therapists help patients receive appropriate home medical equipment, other health services, and/or social or financial support. These needs may or may not be directly associated to COPD, but help contribute to patients' general health, well being, compliance, and safety. In addition, this helps assure that the MCOs do not continue paying for services or equipment that are not effective, functional, or being used.

**e) Follow-up.** Follow-up by telephone and in the home is usually ongoing. The frequency and type of follow-up depends on the patient's symptoms, his or her compliance with the care plan, care plan changes, and case management issues.

*Clinical outcomes data.* A questionnaire completed on the initial visit includes baseline clinical data (acute care services used, symptom frequency, smoking status, functional sta-



TABLE 2. INITIAL VISIT ACTIVITIES

- Telephone and home initial visits include:
- Baseline outcomes data collection
  - Review of individualized self-management guide
  - Explanation of disease process
  - Medication review: medication description and equipment cleaning
  - Self-monitoring instructions: symptom and peak flow diary recording
  - Environment assessment: identifying triggers and home safety issues
  - Individualized education: seasonal issues, lifestyle, exercise, breathing techniques
- Home initial visits also include:
- Physical assessment by a respiratory care practitioner
  - Spirometry screening and/or oxygen saturation evaluation
  - Environmental assessment by a respiratory care practitioner

tus/quality of life, oxygen use, and immunizations) and patient history. Each subsequent telephone or home visit generates additional data points for acute care services, symptoms, smoking status, functional status, oxygen use and immunizations. These surveys continue until the member completes the program (if the program design includes a defined completion point), the member declines further participation, the program contract with the MCO ends, or the member become ineligible, depending on the agreement with the MCO. Surveys occur at intervals determined by each patient's condition and need for follow-up. The follow-up home survey and follow-up telephone survey contain the same questions. Table 3 describes the components of the questionnaires. Data collected in the home include items not available over the telephone, such as physical assessment and observations about the home environment and patients' use of equipment.

The questionnaires were developed internally. They are largely derived from the Health Status Questionnaire (HSQ 2.0)<sup>6</sup> and the COPD Type Specification.<sup>7</sup> All program Respiratory Therapists are specially trained to administer the surveys, which have been used consistently since the program began.

*Clinical data collection.* Early in the program, responses gathered in patients' homes were

recorded on scanable forms and faxed nightly to a dedicated connection that entered the data directly into the clinical database. Unreadable or invalid responses were flagged and reviewed manually to assure data quality. Since 1999, most field responses are entered into an application developed for this purpose on laptop computers by the therapists while in the patients' homes and then uploaded nightly to the database. Most entries are limited to drop-down boxes, with most other validity checks also occurring at the point of data entry. Figure 3 shows two samples of screens into which the therapists enter the data while in patients' homes. Responses gathered over the phone are similarly entered directly into the database through an internally developed care management application. Daily exception reports identify invalid or suspicious entries for review.

*Claims outcomes*

*Data.* Client health plans provide monthly population datasets. They are used to identify and prioritize new candidates and track and reprioritize known candidates. The datasets include medical and pharmacy claims data, eligibility data, capitation data (if applicable), and

TABLE 3. QUESTIONNAIRE COMPONENTS

- History (51 questions)
- Triggers (12 questions—baseline only)
  - Comorbidities (25 questions—baseline only)
  - Family history of asthma
  - History of pulmonary rehabilitation
  - Smoking history (7 questions—baseline only)
  - Allergies (2 questions)
  - Disabled from walking
- Acute care/disability days (4 questions)
- Hospital days for breathing
  - Hospital admits for breathing
  - ER/urgent care visits for breathing
  - Missed work days for breathing
- Signs and symptoms (21 questions)
- If you have to prop yourself at night to sleep, how is it done?
  - Symptom frequency (8 questions)
  - Phlegm (5 questions)
  - Colds and virus infections (3 questions)
- Oxygen/equipment use (7 questions)
- Smoking status (2 questions)
- Functional status: limited activity (11 questions)
- Immunizations (2 questions; flu and pneumonia)

The image displays two screenshots of a web-based medical history form. The top screenshot is titled 'Initial Visit - Page 1' and contains the following sections:

- Medical History:** A grid of questions with dropdown menus for 'Yes', 'No', or 'I don't know'.
 

Sinusitis:	No	High Blood Pressure:	No
Chronic bronchitis:	No	Angina (Chest Pain):	No
Emphysema:	Yes	Heart attack:	No
Acute bronchitis:	Yes	Kidney disease:	No
Asthma:	No	Chest Surgery:	No
COPD:	No	Reflux or Indigestion:	No
AIDS:	No	Depression or sadness:	No
Pneumonia:	Yes	Anxiety, panic attacks, phobias:	No
Tuberculosis:	No	Hay fever or allergic rhinitis:	No
Congestive heart failure:	No	Childhood eczema:	No
Sugar Diabetes (diabetes mellitus):	No	Alpha-1 antitrypsin deficiency:	No
Ulcer or GI bleeding (not counting hemorrhoids):	No	Close family members (blood relatives) who have Asthma:	Yes
Arthritis or rheumatism:	No		
- Smoking:** A section with dropdown menus for 'Do you presently smoke?' (No), 'Have you ever smoked?' (Yes), and 'Any interest in quitting?'. It also includes checkboxes for 'Anyone else in your home smoke?' (Cigarettes, Cigars, Pipes, Other) and input fields for 'Packs per Day', 'Number of Years Smoking', and 'Pack years smoking' (105.00).
- Symptoms:** A section with dropdown menus for 'How often do you have the following symptoms?'.
 

Difficulty exhaling (chest tightness):	Never	Cough:	Everyday
Wheezing or whistling sound in the chest:	Occasionally	Hands that tremble:	All the time

The bottom screenshot is titled 'Initial Visit - Page 3' and contains the following sections:

- Phlegm:** Questions about phlegm frequency, quantity, consistency, and color, each with a dropdown menu.
- Limited Physical Activity:** Questions about breathing interference with normal and social activities, and whether a Pulmonary Rehabilitation Program was completed, each with a dropdown menu.
- Oxygen:** Questions about supplemental oxygen use at home, flow rate, and usage frequency, each with a dropdown menu.

FIG. 3. Sample in-home initial visit screens.

updates to member and physician demographics. Medical claims details include relevant cost fields (allowed amount, or paid, withheld, and copayment and deductible amount), procedure and type-of-service codes, and multiple diagnosis codes, as well as member and claim identifiers, and service and processing dates. Pharmacy claims include NDC numbers,

paid, copay, and drug cost amounts, as well as member identifiers and dates. Capitation data are by at least member and month.

For evaluation purposes, claims data should be available for a baseline period (12 months before program initiation or member enrollment) and an identification period which will be an additional 12–24 months before the base-

line period, during which members may be identified with COPD based on claims criteria.

### Methodology

**a) Total costs.** The measurements presented here evaluate differences in total costs between the measurement groups. Total costs are all medical and pharmacy claims regardless of the type of service or the diagnosis codes appearing on the claim. A total cost approach evaluates the disease population, not the disease. Members' behavior changes and health and functional status improvements are likely to affect more than just their COPD, and this will be best reflected in this measurement. In addition, cost-shifting and coding biases are relatively neutralized as compared with an approach that looks at claims only for certain types of service and/or diagnosis codes. On the other hand, the total cost approach may falsely attribute cost savings to the program as opposed to some other cause. Results may also be affected by non-disease-related events (such as accidents and cancers) or their absence. A total cost approach to calculating return on investment (ROI) typically allows for more resources to be available for interventions at a given ROI level.

**b) Cross-sectional population comparison.** Since randomized trials are not generally practical when providing disease management interventions in a managed care environment, identifying changes that are strictly attributable to the intervention are difficult. Measuring costs across an entire population avoids many of the pitfalls associated with measuring specific cases or cohorts of cases before and after program enrollment.

The measurement process has two steps. First, a population is identified using defined criteria applied for a specified period before the program is implemented, and then the outcome is measured for the year before the program begins. This becomes the baseline. During each subsequent year of the contract, populations are identified using the same criteria and measured for the previous year. For example, for a program beginning on January 1, 2002, the baseline measurement might iden-

tify members based on a 30-month claims history (July 1, 1998 through December 31, 2001) using specified frequencies of diagnosis and drug codes, then measure the average cost of these members for the baseline year (January 1 through December 31, 2001). The program or contract period measurement involves moving the anchor date to the end of the first contract year, January 1, 2003, and conducting the same process using the same 30-month and 12-month intervals around that date. Claims runout periods for both the identification and measurement periods should also be specified and/or claims completion factors must be applied to assure comparable measurements. These cross-sectional measurements can be adjusted for underlying cost trends, the presence of outliers, and benefit mix if necessary.

Another key feature of this approach is that changes that occur at the population level result from not only effective clinical interventions, but also the targeting of appropriate members (predictive modeling) and the ability to locate and enroll members for the program (enrollment effectiveness). As such, this methodology may not be appropriate when the program does not actively select members or is not provided with adequate demographic data to locate them. On the other hand, for truly population-based programs, these cross-sectional snapshots capture cost changes at the population level that are the closest to the MCO bottom line of any alternatives.

A concern with this method is that many other factors may have an impact on the differences measured between time periods. Changes in contracting terms, such as fee changes and shifts to or from capitation; benefit design, including copayments; population demographic changes; utilization management program changes; and other quality management efforts may all affect the measurements if they occur at the same time as the disease management program. One could argue that these factors could be responsible for any savings or lack of savings measured. Since it is not possible to maintain *ceteris paribus* in the real world, the methodology must be structured to minimize or account for these factors to the extent possible.

A way to minimize the effect of many of the contracting and benefit changes is to include all

health service and pharmacy costs—allowed claims costs (paid amount plus any copayment or deductible plus any provider withhold amount) and capitation payments—in the cost measurement. Changes in paid amounts only may unintentionally capture changes in provider contracts and member benefits that can be substantial over very short periods. In addition, adjusting for cost trends by claim type helps account for underlying changes in utilization patterns, demographics, benefit structures, and reimbursement rates. Simply measuring cost changes for each type of claim in the entire nonintervention population between the two measurement periods and applying them as trends to the baseline measurement can accomplish this. For instance, if costs for the nonmeasured population increased 6% for the first year of the program, the baseline for the measured population is increased by 6%. This becomes the expected cost of the intervention population so that the program is not burdened with overcoming an increasing cost trend or credited with the effects of a decreasing trend.

Another concern with any program measurement is the impact of infrequent, extremely high cost cases. To the extent that MCOs have programs for end stage renal disease, cancer, and transplants, for instance, members with these conditions may be excluded from participation in the program or carved out of savings calculations (in both the baseline and program periods). Especially in the absence of a prospective exclusion arrangement, a retrospective catastrophic or outlier exclusion methodology is useful to avoid allowing one or two cases in either period from skewing the measurement in either direction. This may be defined as a total cost amount or per member per month average cost over which members are excluded from

the measurement, or a statistical methodology for identifying outlier cases for exclusion. Since costs are not normally distributed across members, it is useful to transform case level measurements to achieve a more normal distribution for determining statistical outliers.

## RESULTS

### *Clinical outcomes*

*Population.* In this analysis, the baseline responses collected since the program began in 1996 are compared with those of the most current visits for all patients as of December 31, 2000. Only patients with at least 90 days between the baseline visit and the most current are reported. This allows sufficient time for interventions to have some affect. This combines members who are currently participating in the program with those who ceased participation at any time and for any reason, provided they had at least 90 days between their baseline and last survey.

This analysis includes 6,428 cases who are 49.8% female, with an average age of 68.9 years and an average of 391.2 program days. Table 4 describes the measurement group by age category.

*Symptom severity results.* Table 5 presents analysis on the responses to the following symptom frequency questions (with their five-point response scales):

1. How often have you had wheezy or whistling sounds in the chest? (Never, Occasionally, Every day, Many times a day, All the time, No answer)
2. How often have you had chest tightness (difficulty exhaling)? (Never, Occasionally,

TABLE 4. CLINICAL OUTCOME POPULATION DESCRIPTION

<i>Age category</i>	<i>Patients</i>	<i>Average age (years)</i>	<i>Average program days</i>	<i>Percent of all</i>
All	6,428	68.9	391.2	100.0%
64 years old or younger	1,751	56.3	367.8	27.2%
65 years or older	4,677	73.6	400.0	72.8%

TABLE 5. SYMPTOM FREQUENCY OUTCOMES

<i>Patients reporting never/occasionally or never/less than once per week</i>	<i>Period</i>	<i>Complains of wheezing</i>	<i>Complains of chest tightness</i>	<i>Nighttime awakening</i>
All	Baseline	76.2%	83.3%	74.8%
	Current	87.4%	92.1%	85.4%
64 years old or younger	Baseline	66.7%	75.6%	64.5%
	Current	81.1%	88.5%	77.9%
65 years or older	Baseline	79.8%	86.1%	78.6%
	Current	89.8%	93.4%	88.1%

All differences between baseline and current are statistically significant at  $\alpha = 0.01$ .

Every day, Many times a day, All the time, No answer)

- How often does your breathing awaken you at night? (Never, Less than once per week, One to four nights per week, Five or more nights per week, More than once per night, No answer)

The proportions of members reporting the two responses representing the lowest frequencies to the questions for the baseline and most current surveys by age group are shown. All changes in these rates are statistically significant.

*Functional status results.* Table 6 shows analysis on the responses to the following functional status questions (with their five-point response scales):

- How much did your breathing interfere with your normal activities (including work both outside the home and housework)? (Not at all, Slightly, Moderately, Quite a bit, Extremely, No answer)
- How much did your breathing interfere

with your normal social activities with family, friends, neighbors or groups? (Not at all, Slightly, Moderately, Quite a bit, Extremely, No answer)

- Has your breathing limited your grooming? (Never, Occasionally, Every day, Many times a day, All the time, No answer)
- Has your breathing limited your walking 20 feet? (Never, Occasionally, Every day, Many times a day, All the time, No answer)

The proportions of members reporting the two responses representing the lowest disability to the questions for the baseline and the most current surveys by age group, and the statistical significance of any differences are shown.

*Claims outcomes.* Two different methods for measuring savings are demonstrated here. Both are cross-sectional comparisons comparing total costs measured for a baseline population in a baseline period to costs in a contract period. The first compares claims-based strata across the two periods and the other measures total COPD populations.

TABLE 6. QUALITY OF LIFE OUTCOMES

<i>Patients reporting slightly/not at all or never/occasionally</i>	<i>Period</i>	<i>Interferes with normal activities</i>	<i>Interferes with social activities</i>	<i>Shortness of breath walking 20 feet</i>	<i>Shortness of breath grooming</i>
All	Baseline	37.2%	61.0%	81.4%	67.3%
	Current	51.6% <sup>b</sup>	64.1% <sup>b</sup>	82.7% <sup>a</sup>	71.8% <sup>b</sup>
64 years old or younger	Baseline	35.1%	57.6%	83.1%	69.1%
	Current	51.2% <sup>b</sup>	63.9% <sup>b</sup>	83.9%	73.1% <sup>b</sup>
65 years or older	Baseline	37.9%	62.3%	80.7%	66.7%
	Current	51.8% <sup>b</sup>	64.2%	82.3% <sup>a</sup>	71.3% <sup>b</sup>

<sup>a</sup>Statistically significant at  $\alpha = 0.05$ .  
<sup>b</sup>Statistically significant at  $\alpha = 0.01$ .

*Stratified cross-sectional comparison.* In some cases, the regular administrative data extracts are not sufficient or valid for claims performance tracking and reconciliation and separate datasets are extracted for that purpose. The first analysis is such a case. In this case, complete data for specific cohorts and limited time periods were extracted and provided to the program. This situation presented a unique problem in that the program provided for the client MCO was changed after the program had been in operation for six months. At the client's request, in the beginning of 1999, several changes were implemented involving patient selection and payment. This change was further complicated by the policy of allowing members enrolled in the program at the time of the change to remain in the program even if they did not meet the new program criteria.

For a program targeting a selected population, it would be desirable to apply the selection criteria to a baseline population and compare it with the program population. Since the program selection criteria were not held constant in this case, this would not be appropriate. As an alternative, baseline and enrolled populations were independently stratified based on prior-year health services utilization and the same-stratum groups were compared. Unfortunately, sufficient claims history was not available to use 2 prior years of claims to stratify members for the analysis, which would have included more members. Table 7 describes the stratification criteria. The baseline period was calendar 1998 and members were stratified based on claims from 1997, and the contract period was calendar 1999 and pro-

gram members were stratified based on claims from 1998. Comparable claims runout periods were used. Members who did not have at least six eligible months in the stratification period were excluded. Outliers were defined as members within a population type with a z-score of the natural log of their PMPM cost greater than 2.576 ( $p < 0.005$ ) and were also excluded. The distribution of the baseline cases was adjusted to reflect the contract period stratum mix to come to an overall measure of savings. The results do not include members who were in the program but did not meet the criteria applied to the stratification data, or their fees.

Table 8 shows baseline measurements by population type and stratum. Table 9 shows contract period measurements by population type and stratum. Table 10 shows the comparison results, including savings and statistical significance. Considerable savings occurred in every stratum in the Medicare group, but only in selected strata in the commercial population. The limitations in the data cited above caused about half of the program contract period participants to be excluded from the analysis. This was primarily due to members not meeting any stratification criteria in the stratification period. This is not unexpected since potential participants were identified using 2 or more years of claims history (compared to one year used here). In addition, some participants may have entered the program based on criteria met during the contract period itself. Given the data that were available, there were concerns that extending the stratification period into the measurement period may have affected the validity of the measurement. As it was, many of

TABLE 7. STRATA CRITERIA

Criteria must have been met in claims incurred in the 12 months prior to the measurement period, applied in this order:	
COPD HCUs	At least 1 HCU with primary diagnosis code starting with 491 or 492
Respiratory HCUs	At least 1 HCU with selected respiratory primary diagnosis code (starting with 460-496 or 510-519)
3 COPD claims	At least 3 different dates of service of any type claim with a primary or secondary diagnosis code starting with 491 or 492
COPD and respiratory claims	Two different dates of service with a primary or secondary diagnosis code starting with 491 or 492 and at least 1 date of service with another respiratory primary diagnosis code for any type claim
Any COPD claims	At least 1 date of service of any type claim with a primary or secondary diagnosis code starting with 491 or 492

HCU = 1 hospital day or 1 ER visit.

TABLE 8. BASELINE PERIOD STRATA SUMMARY

<i>Population type</i>	<i>Stratum</i>	<i>Members</i>	<i>Months</i>	<i>Adjusted PMPM cost<sup>a</sup></i>	<i>Weight<sup>b</sup></i>	<i>Weighted average</i>
Medicare	COPD HCUs	563	6,168.6	\$1,737.93	0.241	
	Respiratory HCUs	406	4,459.0	\$2,210.78	0.312	
	3 COPD Claims	422	4,715.9	\$995.28	0.137	
	COPD & Resp Claims	175	1,978.7	\$1,040.95	0.050	
	Any COPD Claims	1,635	18,534.3	\$1,306.77	0.260	
Medicare total		3,201	35,856.5		0.746	\$1,637.09
Commercial <sup>c</sup>	COPD HCUs	288	3,086.9	\$1,076.94	0.268	
	Respiratory HCUs	136	1,528.8	\$1,990.80	0.230	
	3 COPD Claims	223	2,482.6	\$882.58	0.142	
	COPD & Resp Claims	113	1,227.8	\$667.09	0.079	
	Any COPD Claims	857	9,830.1	\$926.96	0.281	
Commercial total		1,617	18,156.2		0.254	\$1,184.43
Grand total		4,818	54,012.7			\$1,521.95

<sup>a</sup>Baseline costs are adjusted for overall cost trend by line of business. Trend factors were provided by the client.  
<sup>b</sup>Weights are based on contract period on eligible months (Table 7)—by strata for population type total and by population type for grand total.  
<sup>c</sup>HMO and PPO lines of business combined because the HMO group was small and medical management was comparable between them. LOB-specific trend factors were applied to members' baseline costs.

the contract period participants were in the COPD program during at least part of the stratification period.

For reconciling performance guarantees, results are accepted on their face and statistical significance is not required. For program evaluation purposes however, one would like to know whether the results are unique or if they

are likely to be reproducible. This is also essential for the program in determining what level of savings is reasonable to expect and what level may be reasonable to guarantee. Note that if the members from each population are aggregated into only two strata based on their having or not having a respiratory hospitalization or ER visit (HCU) in the stratification

TABLE 9. CONTRACT PERIOD STRATA SUMMARY

<i>Population type</i>	<i>Stratum</i>	<i>Members</i>	<i>Months</i>	<i>PMPM cost</i>	<i>PMPM fees<sup>a</sup></i>	<i>Total net cost</i>
Medicare	COPD HCUs	411	4,710.5	\$1,386.83	\$80.25	\$1,467.08
	Respiratory HCUs	535	6,110.8	\$1,718.37	\$71.17	\$1,789.54
	3 COPD Claims	233	2,678.8	\$789.13	\$69.69	\$858.82
	COPD & Resp Claims	84	971.9	\$616.89	\$71.80	\$688.69
	Any COPD Claims	435	5,091.9	\$855.60	\$68.01	\$923.61
Medicare total		1,698	19,563.9	\$1,232.04	\$72.37	\$1,304.41
Commercial	COPD HCUs	160	1,787.4	\$1,144.05	\$65.98	\$1,210.03
	Respiratory HCUs	134	1,532.0	\$1,528.60	\$60.28	\$1,588.88
	3 COPD Claims	84	949.1	\$1,086.60	\$48.98	\$1,135.58
	COPD & Resp Claims	46	528.0	\$613.72	\$56.73	\$670.45
	Any COPD Claims	160	1,878.1	\$847.57	\$60.97	\$908.54
Commercial total		584	6,674.6	\$1,098.77	\$60.11	\$1,158.88
Grand total		2,282	26,238.5	\$1,198.14	\$69.25	\$1,267.39

<sup>a</sup>Fees for evaluation population. Variations in PMPM rates result from differences between months in program and total eligible months in contract period in each group.

TABLE 10. PERIOD COMPARISON STRATA SUMMARY

Population type	Stratum	Net PMPM reduction <sup>a</sup>	Total net reduction <sup>c</sup>	Percent net reduction	ROI <sup>b</sup>	<i>p</i> -value of difference <sup>d</sup>
Medicare	COPD HCUs	\$270.85	\$1,275,833	15.6%	4.4	0.350
	Respiratory HCUs	\$421.24	\$2,574,101	19.1%	6.9	0.011
	3 COPD Claims	\$136.46	\$365,537	13.7%	3.0	0.056
	COPD & Resp Claims	\$352.25	\$342,353	33.8%	5.9	0.218
	Any COPD Claims	\$383.15	\$1,950,961	29.3%	6.6	0.000
Medicare total		\$332.69	\$6,508,785	20.3%	5.6	
Commercial	COPD HCUs	(\$133.10)	(\$237,896)	-12.4%	(1.0)	0.049
	Respiratory HCUs	\$401.92	\$615,742	20.2%	7.7	0.566
	3 COPD Claims	(\$253.00)	(\$240,121)	-28.7%	(4.2)	0.968
	COPD & Resp Claims	(\$3.36)	(\$1,775)	-0.5%	0.9	0.449
	Any COPD Claims	\$18.42	\$34,586	2.0%	1.3	0.721
Commercial total		\$25.55	\$170,537	2.2%	1.4	
Grand total		\$254.56	\$6,679,321	16.7%	4.7	

<sup>a</sup>Reductions are calculated as savings. Negative numbers represent *increases* in costs.  
<sup>b</sup>ROI = Return on investment = gross savings/program fees = (net PMPM reduction + PMPM fees)/PMPM fees.  
<sup>c</sup>Net PMPM reduction × contract period eligible months (Table 7).  
<sup>d</sup>*p* value for the differences between the baseline and contract periods based on log(PMPM).

period, there is a significant cost reduction in the non-HCU group in the Medicare population and a significant cost increase in the with-HCU group in the commercial population ( $p < 0.01$ ). If the members are aggregated into these same categories regardless of population type, there is a significant cost decrease in the non-HCU group ( $p < 0.01$ ).

*Population cross-sectional comparison.* An alternative methodology is a true population-based measurement. Even in the absence of a population-based program, this is the best method for a health plan to evaluate the costs associated with specific disease populations defined by diagnosis codes. Savings measured for a cohort over time may not equate to savings for the population if members were selected such that the savings were substantially (or entirely) due to regression to the mean.

As described above, snapshots are taken of independently defined populations at two points in time and compared after adjusting for underlying trends. Members are included irrespective of their participation in the program. The only requirement is that they meet inclusion criteria based on the identification period claims and demographic data and do not meet any identified exclusion criteria.

Table 11 summarizes such an evaluation. In

this case, members meeting COPD criteria were selected from the commercial and Medicare HMO memberships of an MCO client. Each (baseline and contract) measurement period was 12 months and each identification period was the corresponding measurement period plus the previous 12 months (24 months total). Claims were run out four months beyond the end of each measurement period. Costs trends were determined for each claim type (inpatient, outpatient, professional, pharmacy, and capitation) by measuring average cost of each for each population type for the two measurement periods, also holding claims runout periods fixed. No completion factors are used in this example; however, even when applying the same runout periods to both measurements, completion factors should be used if there is a possibility that claims turn-around rates differ between the two periods.

This analysis shows that before any adjustments, average cost (medical and pharmacy claims and capitation payments) increased \$48 in the commercial population and decreased \$57 in the Medicare population. After adjusting for the cost trend between the two periods, costs decreased \$42 (7.5%) in the commercial population and \$156 (18.6%) in the Medicare population. In this case, fees were population-based and not dependent on enrollment or participation in the

TABLE 11. PERIOD COMPARISON POPULATION SUMMARY

	<i>Commercial</i>	<i>Medicare</i>	<i>Total</i>	
Baseline period				
a. COPD members	1,544	409	1,953	
b. Eligible months	13,982	4,510	18,492	
c. Claims cost	\$6,580,728	\$3,330,419	\$9,911,147	
d. PMPM claims cost	\$470.66	\$738.45	\$535.97	c/b
e. Trend	19.0%	13.4%	17.7%	
f. Adjusted costs	\$7,833,386	\$3,775,518	\$11,608,904	c(1 + e)
g. Adjusted PMPM	\$560.25	\$827.14	\$627.78	f/b
Contract period				
h. COPD members	1,213	361	1,574	
i. Eligible months	13,074	4,067	17,141	
j. Claims cost	\$6,776,575	\$2,771,497	\$9,548,071	
k. PMPM claims cost	\$518.32	\$681.46	\$557.03	j/i
Savings				
l. Gross PMPM savings <sup>b</sup>	\$41.92	\$155.68	\$68.92	g - k
m. Gross savings percent	7.5%	18.6%	11.0%	l/g
n. Gross savings value	\$548,106	\$633,166	\$1,181,273	im
o. Fees <sup>a</sup>	\$164,581	\$433,624	\$598,204	
p. Total costs	\$6,941,155	\$3,205,120	\$10,146,276	j + o
q. Net PMPM	\$530.91	\$788.08	\$591.93	p/i
r. Net PMPM savings <sup>b</sup>	\$29.33	\$49.06	\$34.02	g - q
s. Net savings percent	5.2%	5.9%	5.4%	r/g
t. Net savings value	\$383,526	\$199,543	\$583,069	ir
r. ROI	3.3	1.5	2.0	n/o

<sup>a</sup>This contract was for a combined asthma and COPD program. Fees were allocated based on the distribution of patients meeting the criteria for each condition.

<sup>b</sup>Total net savings in the "Total" column does not equal the difference between the baseline and contract period totals because of the product mix difference between the two periods.

program. They are allocated entirely to the participants in this analysis. These savings are validated by 26% and 13% reductions in adjusted total inpatient days per thousand members per year in the commercial and Medicare populations, respectively, for the same period.

## DISCUSSION

### *Clinical outcomes*

The absence of an appropriate, meaningful physiologic indicator to measure COPD sets it apart from many other chronic diseases. Pulmonary function testing provides a useful gauge of COPD severity, but it is a forced procedure that requires considerable and consistent patient effort, a trained respiratory therapist to conduct the procedure, and costly, specialized equipment. Also, FEV1 is not particularly sensitive to the proper treatment of COPD or predictive of mortality and morbidity, and within-patient variability is considerable.<sup>8</sup> For all of these reasons, the meaningful-

ness and practicality of pulmonary function testing for evaluating and tracking patients' COPD disease-state is limited. After initial diagnosis and staging, the GOLD guidelines recommend follow-up spirometry only after a substantial increase in symptoms or a complication.<sup>5</sup>

In the study population, symptom and functional status improvement is fairly consistent across all groups. Considering the negative relationship between functional status and use of health services,<sup>9</sup> one might challenge the common assumption that more severe members are a better source of savings from reduced health service utilization. The recent study "Confronting COPD in America" verifies that COPD causes significant activity restriction across all age and severity levels, and that COPD sufferers often underestimate the severity of their condition and the benefits of proper treatment.<sup>10</sup>

### *Claims outcomes*

A useful claims outcomes measurement methodology should be fair and objective, cap-

turing or accounting for reasonable costs and sources of variation to the extent possible. To be useful for ongoing performance measurement and the reconciliation of performance guarantees, it must also be understandable and able to be administered by both parties (the program and the MCO). Some observers suggest that this may not be possible.<sup>11</sup>

Both methodologies shown here demonstrate net savings for the MCO from the COPD disease management program. For strictly research or program evaluation purposes, one should prefer a randomized, controlled trial, but this is neither practical nor (in most cases) possible in a managed care environment.

The stratified comparison method allows flexibility, but it requires a stratification methodology that is valid (groups individuals into discrete, meaningful, relatively homogeneous groups) and, if used for reconciliation purposes, that can stratify the population without exception (or nearly so). Many participants were excluded from this analysis due to the limitations of the dataset provided, but also due to limitations inherent in any stratification methodology dependent on health plan administrative data. This means that even with perfect health plan data, some members will meet criteria for entry into the program but not be included in the analysis. In addition, savings in the measurement group may not translate to savings in the COPD population as a whole if the average cost for the nonmeasured group increases.

The total population approach bypasses many of these issues and is possible in this case because of the availability of complete data for an entire enrolled population for a sufficient period. This methodology captures not only the impact of the program on those who received interventions, but also of the predictive model, the strategic decisions about who receives which interventions, and the operational effectiveness of the program.

The difference in the results from the two methodologies, particularly for the commercial population, may be due to selection issues with the stratified method, or anomalies in one or both datasets. Also, since outliers were not ex-

cluded from the total population analysis, this may be a factor.

The results of both approaches also suggest that for COPD patients, high acuity for respiratory diagnoses (as represented by HCU utilization strata or Medicare population) does not predict savings. This is no doubt partly due to the progressivity of the disease: The more severe the state, the less amenable it is to intervention.

Health plan administrative data are reliable and comprehensive in terms of the population, the period, and the services described. One may attempt to make inferences about population functional status based on these data (such as fewer hospital days per thousand members per year means the population has a better functional status), but these cannot be well quantified or meaningfully taken to the individual level.

For some health plans, program cost-effectiveness and ROI are captured completely within these data. Other costs can include MCO administration and opportunity costs. Potential additional benefits for health plans include member retention, product differentiation, and improved productivity of the purchaser workforce, which may increase market share and revenue, as well as claims cost savings that may accrue in future periods.

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