

# A COMPARATIVE ANALYSIS OF CHRONIC AND NONCHRONIC INSURED COMMERCIAL MEMBER COST TRENDS

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## ABSTRACT

Disease management (DM) is increasingly encountered in health plans and employer groups as a health care intervention targeted to individuals with chronic diseases (“Chronics”). To justify the investment by payers in DM, it is important to demonstrate beneficial clinical and financial outcomes. In the absence of randomized control studies, financial results are often estimated in a pre/post-study in which the cost of Chronic in the absence of DM can be predicted by their pre-DM year cost (on a per member per month basis) adjusted for the Nonchronic population’s cost trend. The assumption made, not previously tested, is that absent DM, the Chronic and Nonchronic trends are identical.

We calculated Chronic and Nonchronic trends between 1999 and 2002 and compared them under different assumptions regarding identification of chronic disease and medical services. Qualification for the Chronic group was defined as having coronary artery disease, heart failure, diabetes, asthma, or chronic obstructive lung disease. Our base case used an algorithm that identified a member as Chronic prospectively (that is, from the point of identification forward), with one or more of the chronic conditions. We used a data set of 1.5 million commercially insured members.

When Chronic and Nonchronic members are identified and included in the population prospectively, the average three-year trend over the study period for chronic and nonchronic members adjusted for high cost outliers were 4.9% and 13.9%, respectively. Adjusting the population experience for differences in service mix had little effect on the divergence in trends. However, altering the Chronic selection algorithm to eliminate migration between groups (thus classifying a member as always Chronic if identified as Chronic at any point in the four years) caused the trends to converge (Chronics, 16.3%; Nonchronics 17.2%; total 16.0%). Using the original selection algorithm but risk-adjusting the populations annually also caused their trends to converge (Chronics, 12.5%; Nonchronics 11.9%). Finally, applying an annual “requalification” process (in which members who qualify as Chronic in one year but not the next are excluded in the year in which they fail to qualify), we see some, although not complete, convergence of trends.

Estimating DM program financial outcomes based on the assumption that absent the program, the Chronic population would have had the same trend as the Nonchronic population can lead to erroneous conclusions. Identification of a Chronic member and the point at which that member is reclassified from one subpopulation to another can significantly affect the observed trends in both subpopulations, implying that great care must be taken over classification and interpretation of the resulting trends, and their use in DM savings calculations. Trends calculated using a prospective identification methodology introduce a bias into estimates of outcomes. We refer to this effect, which has not previously been described or discussed in the literature, as “migration bias.” It is critical to understand how trends in a reference population can vary according to selection criteria for disease in the chronic population, service mix, and changes in risk over time.

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## 1. BACKGROUND

### 1.1 Disease Management

Disease management (DM) is “a system of coordinated healthcare interventions and communications for populations with (chronic) conditions in which patient self-care efforts are significant.”<sup>1</sup> DM includes identification of health plan members with chronic diseases, prioritization of members for interventions (often called stratification) by current or predicted risk for worsening illness, and coordination of care between care providers and patients. An important function in DM is measuring the clinical and economic outcomes of DM programs. It is believed that improving clinical outcomes reduces health care costs (demonstrated in claims) by reducing the probability of clinical adverse events such as heart attacks, strokes, episodes of heart failure, or complications of diabetes.

Early DM outcomes studies generally compared a cohort, pre- and post-intervention, in which the actually managed cohort’s cost was compared with those eligible for disease management but not actually managed. This measurement methodology is susceptible to selection bias, in which the experience of the population electing to enroll is different to that of the nonenrolling population, absent intervention. Clearly, selection bias distorts and invalidates any DM savings calculations determined using this methodology. Over time, this pre/post methodology has tended to be replaced by a population methodology in which the experience of the entire Chronic population in the historic period is compared with that of the Chronic population in the intervention period, thereby eliminating the potentially distorting effect of selection.

A commonly used population method for estimating disease management financial outcomes is the actuarially adjusted historical control methodology,<sup>2</sup> in which a health care cost trend

factor is applied to historic Chronic member costs (preprogram) to predict the cost of the Chronic population in the absence of the program. These costs include all claims costs related to the care of members with specified chronic diseases, not just the costs related to care for the chronic diseases.

Cost trend factors are increasingly used in population studies. Because the Chronic population is subject to medical management, an estimate of health care trend from a source external to the chronic condition (Chronic) population is an essential component of this method. One source of this estimator of trend is the Nonchronic population.

Although the actuarially adjusted historical cost method has been used extensively, the relationship between Chronic and Nonchronic trends is not well understood by those who apply them nor by users of the studies. In particular, it is often assumed that the Chronic and Nonchronic trends are equal in the absence of intervention, allowing the latter to be a valid estimator of the former. Because many DM savings studies make the assumption that Chronic and Nonchronic trends are identical, this study seeks to examine these trends in a large data set of commercially insured members. We are not aware of the specific disease management programs (if any) that cover the employer groups included in the database.

### 1.2 Previous Studies

Existing health care cost trend literature is limited to the cost trends for populations (Strunk and Ginsburg, 2003), subpopulations (such as the obese; Thorpe, Florence, Howard, and Joski, 2004), or to costs related to specific diseases (Thorpe, Florence, and Joski, 2004) rather than to that of all payers’ costs related to care for populations with specific diseases. The absence of prior studies of health care cost trends in Chronic populations makes it difficult to benchmark the actual observations in DM studies. We include the Thorpe data because of the paucity of published data in this area. The study by Thorpe, Florence, and Joski compares data on chronic disease prevalence and spending from the National Medical Expenditure Survey (NMES) in 1987 and the 2000 Medical Expenditure Panel Survey, House-

<sup>1</sup> As defined by the Disease Management Association of America, (DMAA). See [www.dmaa.org](http://www.dmaa.org).

<sup>2</sup> See “An Actuarial Methodology for Evaluating Disease Management Outcomes,” Paper 6 of the series “An Introduction to Care Management Interventions and their Implications for Actuaries” (a study sponsored by the Society of Actuaries Health Section) by Henry Dove and Ian Duncan, available at [www.soa.org](http://www.soa.org).

hold Component (MEPS-HC). This study does not calculate trends according to the actuarial definition, but the authors provide the data, and we report the results of our analysis of the Thorpe, Florence, and Joski data in Table 1 as these results deserve to be better known by health actuaries.

The 1987 NMES surveyed 34,459 people (both Chronic and Nonchronic) and the 2000 MEPS-HC surveyed 25,096. The data used in Exhibit 2 of the Thorpe, Florence, and Joski paper are self-reported data from the 1987 NMES and the 2000 MEPS-HC and include health spending, demographics, use of services, and self-reported conditions. The data should be treated with some caution because they are self-reported by patients (rather than the more usual disease management methods of either clinician reporting or claims data analysis). Over time, it is possible that the increased awareness of and testing for chronic diseases in the population may have contributed to the increased prevalence observed. The data are easily summarized in a traditional actuarial trend form (Table 1). We have extracted only the cost and prevalence data associated with the traditional conditions managed by chronic disease programs and converted to an average annual trend over the 13-year period, 1987 to 2000.

The raw data provided from these two studies allow us to calculate rates of total expenditure, prevalence of chronic disease, and costs per member per year (PMPY) for the Chronic population. Having data at two points in time (1987 and 2000) allows us to also calculate an average trend in each of these metrics between 1987 and 2000.

Annual trends in the Chronic population range from 3.0% (diabetes) to 7.3% (hypertension), with an average annual trend of 4.6%.

Other studies of chronic prevalence trends include a Centers for Disease Control (CDC) study that predicts an annual growth in chronic prevalence between 1998 and 2020 of about 1% annually, somewhat lower than the 1.9% measured in the Thorpe, Florence, and Joski study between 1987 and 2002. The CDC study does not project future cost growth. In addition, these studies measured disease-specific cost trends for the entire population, as opposed to trends (as defined by actuaries) which are measured at the individual level. The actuarial definition of trend is provided below (Section 1.3).

Many of the published studies examine just one chronic condition. Because of the prevalence of comorbidities in the chronic population, these studies can contribute to overestimation of prevalence of chronic disease(s) unless double counting is explicitly eliminated. Hoffman, Rice, and Sung (1996) report that 44% of all chronic patients have one or more chronic conditions. Hogan (2003), writing for the American Diabetes Association, estimates the total cost of care associated with diabetes to be \$92 billion in 2002. The historic rate of increase in diabetes expenditures per member per year is estimated by Hogan as 5.9% over the 1987–2000 period. The growth in prevalence of diabetes over this period is estimated as 2.8%. Hogan estimates growth of diabetes prevalence between 2000 and 2020 as 2% annually, somewhat lower than the historic experience. The estimated growth in expenditures

Table 1  
**Chronic Condition Prevalence Costs and Trends 1987–2000**

	Year	Pulmonary	Hypertension	Diabetes	Heart	Total
<b>Total Health Care Spending for Each Condition (\$'000)</b>	1987	\$11,685	\$8,008	\$8,661	\$30,450	\$58,804
	2000	36,477	23,395	18,288	56,679	134,839
	Increase in chronic spending	212.2%	192.1%	111.2%	86.1%	129.3%
	Annualized cost increase	9.2%	8.6%	5.9%	4.9%	6.6%
<b>Number of Chronic Individuals per 100,000 People</b>	1987	10,389	9,734	2,961	6,189	29,273
	2000	15,526	11,384	4,260	6,226	37,396
	Increase in chronic prevalence	49.4%	17.0%	43.9%	0.6%	27.7%
	Annualized prevalence increase	3.1%	1.2%	2.8%	0.0%	1.9%
<b>Health Care Cost per Member per Year</b>	1987	1,125	823	2,925	4,920	2,009
	2000	2,349	2,055	4,293	9,104	3,606
	Increase in chronic cost	108.9%	149.8%	46.8%	85.0%	79.5%
	Annualized PMPY increase	5.8%	7.3%	3.0%	4.8%	4.6%

is 50% (to \$138 billion) by 2020 in constant 2002 dollars. The implied annual trend is only 2.3% annually, to which we must add an estimate of future cost of living increases (we estimate 3%) to estimate future trend (5.3%).

### 1.3 Definition of Health Care Trend

“Health care trend” is the term applied to the empirical observation that most health care measures [such as utilization, unit cost, and per member per month (PMPM) costs] tend to change over time. Generally, but not always, trend results in increases in cost-related health care measures.

“Trend” is the rate of increase in PMPM cost, or the difference between year 2 and year 1 costs PMPM, divided by year 1 cost PMPM. Trend may be defined on a calendar year or any 12-month basis, and with appropriate adjustment, any non-12 month period. Trend from period  $t$  to period  $t + 1$  is defined as

$$\text{Trend} = \frac{\text{PMPM}_{t+1} - \text{PMPM}_t}{\text{PMPM}_t},$$

$$\text{PMPM}_t = \frac{\sum_{j=1}^{12} \sum_{i=1}^{n_j} C_{ij}}{\sum_{j=1}^{12} n_j},$$

where:  $C_{ij}$  = claims (or utilization, or other statistic being measured) of the  $i$ 'th member in the  $j$ 'th month; and

$n_j$  = number of members enrolled in the  $j$ 'th month

### 1.4 Measurement of Trend

For the purpose of the actuarially adjusted historical control design, it is important that trend be derived from a stable population (or from Chronic and Nonchronic populations that exhibit similar tendencies) that is not subject to changes in risk profile, such as age, gender, or morbidity. At the very least, the effect of changes in the underlying population must be isolated and an appropriate correction must be applied when the observed trend is used in a calculation. Otherwise, the effect of underlying population changes will contribute to the trend calculation. For example, if it is known that the average age of the population increased between year 1 and year 2,

the effect of this age increase could be calculated and deducted from the observed trend to estimate the underlying, or “stable population” trend. To the extent that equivalence with respect to risk factors is not achieved in the two periods over which trend is measured, their effect on trend will have to be estimated and an actuarial adjustment applied.

### 1.5 Factors That Affect Trend

As actuaries are aware, unit cost and PMPM cost trends are influenced by many factors: changes in the covered population's age, sex, geographic, or employment mix; underlying cost pressures; increases in intensity of services; actions taken as a result of cost shifting by some payers; provider contract changes; or leveraging due to the interaction between increasing charges and fixed plan design features such as co-pays or deductibles. Utilization trend, on the other hand, is influenced by intensity of services; the propensity of demand for services to be affected by supply, regulations, and changes in medical practice (such as increased use of defensive medicine or the introduction of a requirement for minimum length-of-stay for certain procedures); the effect of aging or “maturing” of the diseased population; and the introduction of new technologies and treatments.

When trends are calculated for a typical health plan, the overall experience of the population is tracked over time. Measurement of disease management outcomes, however, often introduces the need to analyze the experience of subpopulations. Three factors that have a potentially significant effect on trend are the migration of members between categories (such as Nonchronic, Chronic, or excluded members), catastrophic claims, and the mix of services used by members of different categories. We discuss each of these factors next.

### 1.6 Factors That Affect Selection of Measured Populations

While a health plan may apply its DM programs to all members identified as Chronic for the diseases of interest, members may choose not to participate. Measuring only the outcomes of volunteers introduces the possibility of selection bias. To avoid selection bias, studies now tend to

be done including the entire Chronic population, that is, considering all members who meet criteria for identification as Chronic, whether or not they choose to enroll in a DM program. The population methodology has the additional advantage of potentially avoiding bias due to regression to the mean, provided increases and decreases in costs in the population are random, that is, offset each other (Fetterolf, Wennberg, and DeVries, 2004). How members are selected into the measured Chronic population varies. For example, selection can be broader (one or two claims with ICD codes for the diagnosis) or narrower (scoring systems in which claims for encounters, drugs, procedures, and lab results are taken into account). Broad selection algorithms tend to have high sensitivity (identify most or nearly all members who have the disease) but lower specificity (some members are selected who do not actually have the disease). Narrow selection algorithms tend to have lower sensitivity but higher specificity.

In addition, the literature cites several methods of determining whether a member, once identified, *remains* in the Chronic pool in succeeding periods.<sup>3</sup> A member may be identified as Chronic either prospectively, implying that the member is included in the Chronic population from the month of first identification onward, or retrospectively, in which case the member is retrospectively classified to the Chronic population from the beginning of the study (also referred to as “ever/never Chronic”). In addition, an investigator must decide whether Chronic members must be requalified as Chronic year-to-year under the same set of criteria used to identify the member initially (Requalification) or not. A third method that is used in some studies is the cohort methodology, which measures outcomes only on a cohort of (Chronic) members over all measurement periods, with no continuing eligible members allowed in or out across all periods. We explore some of these ideas in this paper.

<sup>3</sup> It may seem intuitively wrong for a “Chronic” member to be reclassified as “Nonchronic” after initially being identified as Chronic. However, identification that is performed based on administrative data and chronic disease algorithms are not 100% infallible, and a percentage of “false positives” is to be expected with any algorithm.

## 2. POPULATION AND METHODS

The population used for this analysis consisted of a total of 1.5 million covered lives enrolled under employer health plans from January 1998 to February 2003.<sup>4</sup> No information about specific medical management or disease management programs was included in the data set, although the incidence of disease management programs in the commercial population is believed to be minor for the years for which we have data. Retired members whose coverage is complementary to Medicare (Medicare Supplemental) were excluded, and the analysis focused on the active employer-insured (commercial) population. Risk-bearing payers (generally employer groups) without continuous enrollment over the study period were excluded (although members of continuously eligible employer groups were allowed to enter and leave the study). Total membership for analysis was slightly lower than 1 million lives each year.

No minimum eligibility requirements were imposed on individual members within payer groups. Claims for members who did not appear in the eligibility file for the month incurred were eliminated from analysis. The population was divided annually into several groups, resulting in each member being counted as either Chronic or Nonchronic for one of the five assessed chronic diseases (coronary artery disease, heart failure, diabetes mellitus, asthma, or chronic obstructive lung disease) for each year based on the following criteria: A single admission with primary diagnosis for one of the diseases; or at least two face-to-face encounter claims on separate days for one of the diseases; or, in the case of diabetes or asthma, a prescription fill for a drug specific for that disease could substitute for one or both of the encounter claims. The diagnostic (ICD-9-CM) and drug (NDC) codes used were consistent with disease codes recommended by the Disease Management Association of America (Duncan, 2004).

Claims costs were analyzed as allowed charges, that is, billed charges for allowed health plan benefits before negotiated discounts and before cost sharing with the insured. The per-capita claims experience of the Chronic and Nonchronic groups

<sup>4</sup> The Ingenix data set is used with permission of Ingenix Inc., Minneapolis, MN.

was tracked; incurred claims were associated with the corresponding membership and summed and expressed as per member per month. Trends were calculated based on PMPM costs (allowed charges). We did not separate the prevalence, costs, or trends of members with different conditions.

All members were identified as Chronic or Nonchronic using the prospective “once Chronic/always Chronic” criterion. As an alternative, we varied the identification to attribute Chronic conditions retrospectively as well.

### 3. RESULTS

Table 2 shows costs and trends using the prospective identification methodology and illustrates the contribution of Chronic individuals to total cost over the four-year period 1999–2002. In 1999, although Chronic individuals accounted for 4.1% of all covered members, they accounted for 14.5% of all costs. By 2002, Chronic individuals had increased to 8.6% of the population and accounted for 23.1% of costs. This increase in Chronic prevalence arises in part because we analyze prevalence using the once Chronic/always Chronic methodology. It also points out an issue with commercial studies of chronic disease: For chronic identification to be consistent year to

year, we would require as many historic years of claim data for the first year of the study (in this case, 1999) as we have for the last (2002).<sup>5</sup>

#### Chronic and Nonchronic Members and Costs

Effectively, the combination of once Chronic/always Chronic and four historical years of data (in the case of 2002) means that the Chronic population is identified based on a total of five years of claims data. To replicate this identification protocol in each year would require that data be available from 1995 to 1998 to identify 1999 chronic members with the same number of historical years of claims. To analyze trends we need as many years of PMPM costs as we can assemble, which requires us to use all available years of claims. The consequence of this constraint, however, is that by 2002, more years of historic data

<sup>5</sup> Members identified in 1999 are identified through claims incurred in one year of historic claims data. When the population is not requalified annually, members identified in subsequent years could have incurred their identifying claims several years previously. For example, a member counted as Chronic in 2002 could have been identified through claims incurred in 1998 and have had no subsequent claims. Symmetry in claims-based identification would require that the 1999 Chronic population be identified by claims back to 1995.

Table 2  
Costs and Trends Using the Prospective Identification Methodology

Year	Member Months	Chronic Prevalence	Cost PMPM	Cost Trend	Total Cost (\$'000)	Cost as % of Total
<b>Chronic</b>						
1999	463,196	4.1%	\$745.87	—	\$ 345,483	14.5%
2000	701,398	6.0%	\$746.42	0.1%	\$ 523,538	18.3%
2001	845,883	7.0%	\$820.27	9.9%	\$ 693,856	20.3%
2002	990,646	8.6%	\$879.71	7.2%	\$ 871,485	23.1%
<b>3-year annualized</b>				5.6%		
<b>Nonchronic</b>						
1999	10,956,779		\$186.26	—	\$2,040,836	85.5%
2000	11,067,274		\$211.41	13.5%	\$2,339,693	81.7%
2001	11,241,633		\$242.83	14.9%	\$2,729,790	79.7%
2002	10,591,169		\$274.44	13.0%	\$2,906,654	76.9%
<b>3-year annualized</b>				13.8%		
<b>Total</b>						
Year	Member Months		Cost PMPM	Cost Trend	Total Cost (\$'000)	
1999	11,419,975		\$208.96	—	\$2,386,319	
2000	11,768,672		\$243.29	16.4%	\$2,863,231	
2001	12,087,516		\$283.24	16.4%	\$3,423,646	
2002	11,581,815		\$326.21	15.2%	\$3,778,138	
<b>3-year annualized</b>				16.0%		

exist to identify chronic members than were available for 1999.

For the entire population, PMPM cost increased at an annualized rate of 16.0% over this period. If Chronic prevalence remained at 4.1% throughout the study period, the average annualized increase would have been only 12.7%, implying that approximately 3.3% of the annual increase was due to the increase in chronic prevalence. This observation is derived from Table 3.

The relative Chronic and Nonchronic trend results in Table 2 may at first appear counterintuitive. First, the Chronic trend is lower than either the total or Nonchronic trend, which appears anomalous, given that Chronic members are high cost (their cost PMPM is between three and four times that of Nonchronic members). Second, the overall population trend is higher than that of either subpopulation. These apparent anomalies, however, are accounted for by migration in membership between the relatively low-cost Nonchronic population, as newly identified Chronic members transfer to the relatively high-cost Chronic population. The members who leave the Nonchronic are relatively high cost, while they are relatively low-cost members of the Chronic population. In each case the trend of the respective populations is reduced below the underlying rate. Finally, we note that the observed Chronic trend (5.6%) is reasonably consistent with the trend observed for similar Chronic conditions (4.6%) between 1987 and 2002 by Thorpe, Florence, and Joski (2004).

The growth in the Chronic member population (more than doubling between 1999 and 2002) results from increasing identification of Chronic members or increased measured prevalence. Because the overall population is almost constant, the increase in Chronic membership is matched

by a decrease in the Nonchronic pool. Newly identified Chronic members tend to be lower cost than the remainder of the Chronic pool, but higher cost than the Nonchronic pool, effectively reducing the trends observed in each subpopulation. Some more recently introduced savings methodologies attempt to adjust for duration since chronic diagnosis. However, the lack of a long series of historical data makes it difficult to apply methods that introduce a true duration adjustment.

### Decomposition by Service Sector

To further explore the gap between Chronic and Nonchronic trends, we examined whether this divergence could be accounted for by differences in service mix between the populations. Certain applications of the actuarially adjusted methodology apply a single trend to baseline costs. As actuaries are aware, trend is particularly susceptible to factors such as leveraging of plan design, change in mix of services, and covered population. If this is a concern, a refinement to the simple, single-composite-trend approach may be applied that decomposes the calculation into service categories and further decomposes the trend into its utilization and unit cost components. An example of such service category decomposition is shown in Figure 1. An advantage of this decomposition by service line category is the ability to calculate a weighted average of the individual service line trends (derived from the Nonchronic population) using weights appropriate for the Chronic population.

Table 4 compares the composition of overall (total) PMPM claims of each of the Chronic, Nonchronic, and all-member populations by major service category. For example, over the three-year period, inpatient hospital claims amount to

Table 3  
Average Cost PMPM without the Effect of Prevalence Creep

Year	Chronic Member Months	Nonchronic Member Months	Total Member Months	Chronic Prevalence	Cost PMPM
1999	463,196	10,956,779	11,419,975	4.1%	\$208.96
2002	990,646	10,591,169	11,581,815	8.6%	\$326.21
2002 (restated)	469,760	11,112,055	11,581,815	4.1%	\$298.99

Figure 1  
**Service Categories for Decomposition of Savings Calculation**

- Inpatient hospital (including ICU, SNF)
- Emergency room
- Outpatient surgery
- Professional charges
- Outpatient office visits
- Rehabilitation facility
- Professional office visits
- X-ray/lab
- Prescription drugs (non-inpatient)
- Other medical

\$67.32 PMPM for the Nonchronic population, compared with \$294.02 for the Chronic population and \$81.84 for the population as a whole. Data are annualized averages over the four-year period 1999–2002. As expected, the composition of the claims dollar is different for each population, with Nonchronic members using relatively fewer inpatient hospitalization services (29.5% of their total expense) and relatively more physician office services (17.9%) than Chronic members (36.2% and 12.2%, respectively). The differences in service sector trends (hospital expenses grow-

ing relatively more slowly than certain outpatient expenses) when combined with these utilization differentials could result in different overall trends in each subpopulation. While some trends were discernible within each service category (inpatient services generally fell over the four-year period, while outpatient services generally increased), there was relatively little variation in the service category percentages over time.

Table 4 shows that the PMPM cost and relative service category utilization of Chronic and Nonchronic members is different, with Chronic members being heavier utilizers of inpatient hospital, prescription drug, and rehabilitation services. These are all service categories that, for Chronic members, have relatively low trends.

Table 5 compares the trends in Chronic and Nonchronic populations by major service category. Trends are three-year average annualized rates, calculated over the four-year period. Different trends by service are observed in each subpopulation and in the population as a whole, with Nonchronic member trends generally higher than those of Chronic members.

To test the effect of service category mix on trend, we applied the Chronic service category utilization percentages to the Nonchronic service category trends. Table 6 shows the unadjusted Nonchronic trend, compared with the Nonchronic trend adjusted for the Chronic population service distribution. The difference in service utilization accounts for relatively little of the difference in trends between subpopulations (between 0.3% and 0.8%, depending on the year, and 0.6% on average over the three-year period).

Table 4  
**Comparison of Chronic and NonChronic Service Cost PMPM and Service Mix**

	All Years Mem Mons	Inpatient	Outpatient	Prescription Drug	Emergency Room	Laboratory	Physician's Office	Rehab	Other	All Services Total
<b>Claims PMPM</b>										
<b>Nonchronic</b>	10,964,214	\$67.32	\$68.53	\$33.47	\$5.24	\$4.46	\$40.90	\$0.91	\$7.58	\$228.40
<b>Chronic</b>	750,281	\$294.02	\$197.69	\$158.37	\$9.69	\$10.64	\$99.34	\$6.29	\$35.10	\$811.15
<b>All</b>	11,714,495	\$81.84	\$76.80	\$41.47	\$5.52	\$4.86	\$44.64	\$1.25	\$9.34	\$265.72
<b>Service Category Weights</b>										
<b>Nonchronic</b>	10,964,214	29.5%	30.0%	14.7%	2.3%	2.0%	17.9%	0.4%	3.3%	100.0%
<b>Chronic</b>	750,281	36.2%	24.4%	19.5%	1.2%	1.3%	12.2%	0.8%	4.3%	100.0%
<b>All</b>	11,714,495	30.8%	28.9%	15.6%	2.1%	1.8%	16.8%	0.5%	3.5%	100.0%

Table 5  
**Comparison of Chronic and NonChronic Trends by Service Category**

	3-Year Annualized Mem Mons	Service Category Trends								All Services Total
		Inpatient	Outpatient	Prescription Drug	Emergency Room	Laboratory	Physician's Office	Rehab	Other	
<b>Nonchronic</b>	10,964,214	12.3%	15.4%	11.0%	19.4%	10.8%	16.5%	12.8%	9.0%	13.8%
<b>Chronic</b>	750,281	6.6%	8.3%	1.1%	12.1%	0.6%	8.9%	-9.5%	-1.7%	5.7%
<b>All</b>	11,714,495	15.8%	17.2%	13.7%	20.0%	11.4%	17.7%	12.6%	11.3%	16.0%

**Effect of Exclusions on Trend**

In DM applications, exclusions (both from the measured population and from the claims associated with the population) are often made to reduce potential confounding. Examples of exclusions of members are members with HIV/AIDS and members who have a diagnosis of end-stage renal disease. Examples of exclusions of claims are claims above a catastrophic limit (outliers) or claims for certain diagnoses (such as maternity or mental health).

We tested the effect of applying both member and claim exclusions on the Chronic and Nonchronic trends. Sample results are provided in Table 7. Excluding members and claims does not change the average three-year trend for the Nonchronic or total population (16.2% versus 16.0%; 13.9% versus 13.8%). However, the Chronic trend is reduced (5.6% versus 4.9%) and, at the same time, is more subject to variation year-to-year. This result suggests that the large claims in the Chronic population have been growing at a faster rate than corresponding large claims in the Nonchronic population. One important objective in commercial DM evaluations is to avoid incorrect conclusions due to random variation. This analysis suggests that including the full amount of

high-dollar claims makes the PMPM claims and trend of the Chronic population more variable. If the objective of a study is to avoid potential confounding due to variability, exclusion of large claims in excess of a stop-loss limit (also called "top-coding") appears to be justified.

**Effect of Migration between Chronic and Nonchronic Populations**

Migration from the Nonchronic to the Chronic population causes divergence between the trends of each group. We tested this effect by assigning members to a group (Chronic or Nonchronic) retrospectively to the beginning of the first measurement period, irrespective of the period in which they met the Chronic condition identification criteria. Thus, for example, in the results reported in Table 2, a member who is Nonchronic in 1999 and 2000 but meets the Chronic test at January 1, 2001, will be classified in the Nonchronic group in 1999 and 2000 and reclassified to the Chronic group in 2001 and 2002. For the comparison in Table 8, this same member will be classified as Chronic for all four years of analysis.

When trend is measured on members assigned retrospectively from the beginning of the period, Chronic, Nonchronic, and total trends are much closer: The Nonchronic group trend is at a slightly higher rate using the retrospective method (17.2%) versus prospective (13.8%). The chronic trend is 16.3% using the retrospective method, considerably higher than the trend using the prospective method (5.6%). More important for commercial applications, either the Nonchronic or total trend appears to be usable as a proxy for the Chronic trend measured on the retrospective basis.

The fact that both Chronic and Nonchronic trends are higher than overall trend in the case of the retrospectively identified population may

Table 6  
**Effect of Chronic Service Mix on Nonchronic Trends**

Year	Nonchronic Trend	Adjusted Nonchronic Trend	Difference
2000	13.5%	12.7%	0.8%
2001	14.9	14.6	0.3
2002	13.0	12.4	0.6
<b>Three-year average</b>	13.8%	13.2%	0.6%

Table 7  
Effect of Excluding High-Cost Outliers on Trend

Year	Nonchronic cost PMPM	Nonchronic Trend	Chronic Cost PMPM	Chronic Trend	Total Cost PMPM	Total Trend
1999	\$148.08	—	\$650.87	—	\$168.47	—
2000	162.89	10.0%	625.12	-4.0%	190.44	13.0%
2001	192.47	18.2	706.81	13.1	228.46	20.0
2002	218.61	13.6	751.95	6.4	264.23	15.7
<b>3-year Annualized</b>		13.9%		4.9%		16.2%

appear to be anomalous. However, the lower trend in the overall population results from the relative growth rates of Nonchronic members (0.8% per year) and Chronic members (-2.2% per year) over the four years. During the four-year period, Nonchronic members increase from 63.0% of the total population to 65.6% of the total population. The lower PMPM cost of the Nonchronic population, combined with their relatively faster growth, depresses the overall trend in the population.

**Effect of Changes in the Population Risk Profiles**

One possible source of difference between Chronic and Nonchronic trends is differential changes in population risk over time. One commonly used method for estimating member (and population) risk is the use of groupers or predictive models, which provide a single numerical value, at the individual member level. Each member is assigned a numerical “score” (which may also be aggregated to assess the risk of a popu-

lation) based on risk factors in the individual member’s risk profile. We applied a commonly used and commercially available grouper<sup>6</sup> to the Chronic and Nonchronic populations defined earlier. The DxCG model was applied prospectively; that is, a risk score was predicted, based on the prior year’s claims history, for each individual member for the following year. Results are shown in Table 9 for the populations identified by the Prospective methodology and for the Chronic and Nonchronic populations identified by the Once Chronic/always Chronic methodology.

The trend in risk score indicates that the Chronic population becomes less risky over time. Conversely, the Nonchronic population becomes slightly more risky over time. Making a simple adjustment to the PMPM trend by the effect of population risk score change, the adjusted

<sup>6</sup> The DxCG grouper, used with permission of DxCG Inc., Boston. More information about groupers and alternative products may be found in Cumming, Knutson, Cameron, and Derrick (2002).

Table 8  
Effect of Applying Retrospective (Ever/Never Chronic) Identification Methodology

Year	3-Year Annualized Chronic Member Months	Chronic Trend	Nonchronic Member Months	Nonchronic Trend	Total Member Months	Total Trend
<b>Retrospective Identification</b>						
1999	1,410,116	0.0%	10,009,859	0.0%	11,419,975	0.0%
2000	1,440,371	15.5%	10,328,301	17.8%	11,768,672	16.7%
2001	1,437,872	17.2%	10,649,644	17.0%	12,087,516	16.2%
2002	1,317,536	16.3%	10,264,279	16.8%	11,581,815	15.3%
<b>3-year annualized Prospective Identification</b>		16.3%		17.2%		16.0%
<b>3-year annualized</b>		5.6%		13.8%		16.0%

Table 9  
**Effect on Trend of Applying Risk Adjustment to the Prospective Methodology**

Year	Prospective Chronic Identification							
	Chronic				Nonchronic			
	Risk Score	Risk Score Trend	PMPM Trend	Risk-Adjusted PMPM Trend	Risk Score	Risk Score Trend	PMPM Trend	Risk-Adjusted PMPM Trend
1999	3.162				0.878			
2000	2.814	-11.0%	0.1%	12.5%	0.870	-0.9%	13.5%	14.6%
2001	2.686	-4.5%	9.9%	15.1%	0.894	2.8%	14.9%	11.7%
2002	2.622	-2.4%	7.2%	9.9%	0.922	3.1%	13.0%	9.6%
<b>3-year annualized</b>		-6.1%	5.6%	12.5%		1.7%	13.8%	11.9%

Note: A risk score of 1.0 is the prediction that an individual or group will have the same PMPM cost as the mean of the entire insured population used for validating the risk adjustment model.

trends become closer. The adjusted trends are not significantly different.

The implication of this analysis may not be immediately obvious, so we remind the reader that unadjusted Nonchronic trend is often used as an estimator for Chronic trend in the absence of a program. This analysis indicates that the lower trend in the chronic population (when compared with the Nonchronic population) is associated with a differential change in risk score. The practical application of this technique is illustrated below in Table 10.

Table 10 contains some basic (hypothetical) data and a typical DM program savings estimate. The baseline cost PMPM represents the average cost during a period prior to the initiation of a program for all included services per Chronic member per month for members who meet the inclusion criteria. As is the case in many calculations, the baseline cost PMPM is trended forward using the Nonchronic population experience as an estimate of that which would have been experienced by the Chronic population, absent the intervention program. The difference between the projected baseline cost and actual cost of the Chronic population is our estimate of program-savings PMPM. The remainder of the calculation applies a risk adjuster to these numbers to determine a more accurate estimate, firstly of Nonchronic trend and then the effect of change in the Chronic population risk profile, allowing the (adjusted) Nonchronic trend to be used as a potentially unbiased estimate. Using the risk-adjusted trend as our estimate of Chronic trend gives a lower but more credible estimate of savings.

**Effect of Requalification on Chronic Population and Trend**

It has been suggested that applying an annual requalification requirement will eliminate those members (false positives) who satisfy the Chronic

Table 10  
**Application of a Risk-Adjusted Trend Model**

Standard adjusted historical control savings calculation			
Baseline Chronic cost PMPM		\$300	
Trend (Nonchronic)		1.10	
Trended baseline Chronic cost		\$330	
Actual cost		\$305	
Estimated savings		\$ 25 PMPM	
Risk-adjusted historical control savings calculation			
Baseline Chronic cost PMPM		\$300	
Risk-adjusted trend (Nonchronic)		1.0784	
Trended baseline Chronic cost		\$323.52	
Actual cost		\$305	
Risk-adjusted actual cost		\$305/0.967 = \$315.41	
Population	Baseline Period	Intervention Period	Trend
Nonchronic cost PMPM	\$100	\$110	10.0%
Nonchronic risk score	1.0	1.02	2.0%
Non-chronic cost PMPM, adjusted for risk trend		\$110/1.02 = \$107.84	
Risk-adjusted Nonchronic cost trend, PMPM	\$100	\$107.84	7.84%
Chronic cost PMPM	\$300	\$305	1.67%
Chronic risk score	3.0	2.90	(3.33%)
<b>Estimated savings</b>		\$8.11 PMPM	

Table 11

Year	Chronic Prevalence, Original	Chronic Prevalence, with Requalification
1999	4.1%	4.2%
2000	6.0%	4.6%
2001	7.0%	4.7%
2002	8.0%	5.3%

identification algorithms in the initial year but not the subsequent years. These members contribute to the prevalence creep observed earlier, as well as reduce the PMPM costs and trend in the Chronic population. (Because these members, by definition, do not qualify as Chronic in later years, their claims are lower than those members who continue to be Chronic and experience Chronic costs.)

We applied a requirement that a member be included in the next-year Chronic population only if the member experiences qualifying chronic claims in the prior year. This is a different requirement to that in the base case, in which members are added continuously throughout the year when they meet Chronic identification criteria. We applied this algorithm for computational ease. Chronic prevalence is reduced, compared with the base case (see Table 11). Chronic prevalence in the case of requalification is calculated based on the beginning-of-the-year population. As expected the application of requalification reduces the prevalence creep.

Table 12 compares Chronic and Nonchronic trends under the original assumptions and with requalification. Chronic trends with requalification are closer to Nonchronic (and overall) trends, although differences remain. As the ratio column shows, the three-year average ratio of Chronic to Nonchronic trend with requalification is 75.7%. However, this number varies between

57.8% and 90.9%, making it difficult to implement a “standard” adjustment to the Nonchronic trend to account for the observed difference. One factor that appears to be driving some of the difference is changes in observed Chronic prevalence: When there is a large year-on-year change in Chronic prevalence (as in 2000 and 2002), the ratio of Chronic to Nonchronic trends is relatively low. When the change in Chronic prevalence is large (as in 2001), the Chronic and Nonchronic trends are closer.

#### 4. DISCUSSION

Those who pay for DM programs want to understand whether they are receiving value for their money. Answering the value question means comparing the actual results to what would have been predicted absent the intervention. However, apart from a randomized controlled clinical trial (in which it can be assumed that the control or comparison group’s actual costs would answer the “in the absence of” question), the health care cost for the intervened group must be predicted from its cost in the “pre” year, adjusted by a suitable trend. While it is commonly assumed that the cost trend for the Chronic group (who receive the intervention) would be identical to the Nonchronic trend in the absence of intervention, this assumption has not been proven.

This study showed that if Chronics are identified using a once Chronic/always Chronic methodology, this assumption may not be true. We found that in a large, commercially insured population over four years, the Chronic trend was far lower than the Nonchronic trend. This conclusion was unaffected by readjusting the Nonchronic trend to the Chronic population’s service mix. Because this divergence in trends may be due to the prospective method of classifying Chronics, we

Table 12

Year	Base Trend			Requalification Trend		
	Chronic	Nonchronic	Total	Chronic	Nonchronic	Ratio Chronic/Nonchronic
1999	—	—	—	—	—	—
2000	0.1%	13.5%	16.4%	9.4%	12.2%	77.1%
2001	9.9%	14.9%	16.4%	14.6%	16.0%	90.9%
2002	7.2%	13.0%	15.2%	8.1%	14.1%	57.8%
<b>3-year average</b>	5.6%	13.8%	16.0%	10.7%	14.1%	75.7%

applied a second (retrospective) methodology, which assumed that over the four-year span, all members were either Chronic or Nonchronic. While this methodology resulted in convergence of the trends, it may not be clinically defensible because people are first identified with chronic diseases at a specific point in time, when qualifying tests (or the claims proxy used in DM analyses) are satisfied. The once Chronic/always Chronic methodology has greater clinical appeal—people do not become cured of their chronic diseases.

Because migration of members from the Nonchronic to the Chronic pool may change the case (risk) mix in the pools, we applied a commonly used and validated risk adjustment methodology. This resulted in the trends becoming almost identical.

## 5. LIMITATIONS

Because we used a commercially available data set, we had no information about the specific medical interventions, if any, present in the population. We expect that DM programs were limited during the time period represented by the data, given the relative recent development of large-scale DM programs.

The results that we reproduce in this paper represent a single, specific sample and may not be reproduced in other data. We encourage actuaries to follow our methods, however, to publish detailed trend analyses in other populations.

## 6. CONCLUSIONS AND IMPLICATIONS FOR DISEASE MANAGEMENT PURCHASERS

1. When Chronics are identified using a prospective once Chronic/always Chronic algorithm, the unadjusted Nonchronic (or total population) trend is a poor proxy for chronic trend in DM evaluations.
2. Using trends calculated in this way introduces a bias into estimates of savings outcomes. Based on our analysis, the bias is upward (that is, savings are overstated as a result of the bias). This effect, which has not previously been described or discussed in the literature, may be called a migration bias.
3. As an example of the effect of migration bias, consider a DM evaluation in which the baseline cost of the Chronic population is \$100 PMPM. Projecting this cost to the next period using a Nonchronic trend as calculated in this article (13.8%) would result in a projected cost of \$113.80 PMPM. Savings would be estimated as the difference between the observed cost PMPM and the actual cost PMPM. However, our results show that the actual Chronic trend that should have been used, in this example, is 5.6%, giving a projected cost PMPM of \$105.60. The difference in projected baseline costs PMPM (\$8.20) would be included in savings by a study that uses the trend projection and prospective Chronic identification methodology.
4. While using Chronic population identification algorithms that retrospectively classify members as never or always Chronic (or Nonchronic), the Chronic and Nonchronic trends are closer to convergence. However, this methodology is difficult to justify on clinical grounds.
5. Adjusting the Nonchronic trend for service mix has little effect on trend.
6. Adjusting both the Nonchronic and Chronic populations for the effect of change in population risk results in an adjusted Nonchronic trend that closely approximates adjusted Chronic trend.
7. When using a prospective once Chronic/always Chronic selection algorithm, the bias in trends can be corrected by using a risk adjuster to account for risk change in each population over time.
8. These conclusions about trend relativities hold when several years of trend are averaged. However, the results for individual years are less consistent because trend (particularly within the Chronic population) is volatile. In a particular savings calculation, Nonchronic trend may be more or less close to the true underlying Chronic trend.

Operationally, the Nonchronic trend as estimated using a retrospective (ever/never Chronic) method may be used to assess the effect of DM interventions without adjustment. However, the methodology may be rejected by some analysts on clinical grounds. As an alternative, a risk adjust-

ment methodology may be applied to a prospective analysis. To do so, the Nonchronic trend would first be adjusted by dividing the Nonchronic PMPM trend by the trend in Nonchronic risk score trend. An estimate would have to be made of the trend in Chronic risk score, which will require sufficient data series to estimate the risk score. There is also a potential for confounding because the risk score post-implementation of DM will be affected (reduced) by the intervention. However, this effect is expected to be relatively small in a Chronic population, which is permanently subject to its conditions, making this a potentially practical method for trend correction in applications.

### REFERENCES

- BROWN, M. 1990. The National Economic Burden of Cancer: An Update. *Journal of the National Cancer Institute*. 82: 1811–14.
- CUMMING, ROBERT B., DAVID KNUTSON, BRIAN A. CAMERON, AND BRIAN DERRICK. 2002. *A Comparative Analysis of Claims-Based Methods of Health Risk Assessment for Commercial Populations*. Schaumburg, IL: Society of Actuaries.
- DAVILA, F. 2002. Understanding Health and Healthcare Total Costs: A Novel Perspective. *American Journal of Managed Care*, Suppl: 6–8.
- DUNCAN, I. (ed). 2004. *Dictionary of Disease Management Terminology*. Washington, DC: Disease Management Association of America.
- FETTEROLF, D., D. WENNBERG, A. DEVRIES. 2004. Estimating the Return on Investment in Disease Management Programs Using a Pre-Post Analysis. *Disease Management* 7: 5–23.
- GARIS, R. I., K. C. FARMER. 2002. “Examining costs of chronic conditions in a Medicaid population”. *Managed Care*. 11(8): 43–50.
- GRUBER, W., T. LANDER, B. LEESE, T. SONGER, AND R. WILLIAMS. 1998. *The Economics of Diabetes and Diabetes Care*. Brussels, International Diabetes Federation.
- HOFFMAN, C., D. RICE, H. Y. SUNG. November 1996. Persons with Chronic Conditions. Their Prevalence and Costs. *Journal of the American Medical Association*, 13;276(18): 1473–9.
- HOGAN, PAUL (for the American Diabetes Association). 2003. *Economic Costs of Diabetes in the US*. Diabetes Care.
- RUBIN, R. J., W. M. ALTMAN, AND D. N. MENDELSON. 1992. Health Care Expenditures for People with Diabetes Mellitus. *Journal of Clinical Endocrinology and Metabolism* 78: 809A–809F.
- STRUNK, B. C., AND P. B. GINSBURG. January–June 2003. Tracking Health Care Costs: Trends Stabilize but Remain High in 2002. *Health Aff (Millwood)*. Suppl Web Exclusives: W3-266-74.
- THORPE, K. E., C. S. FLORENCE, D. H. HOWARD, AND P. JOSKI. October 20, 2004. Trends: The Impact of Obesity on Rising Medical Spending. *Health Affairs* (e-published ahead of print).
- THORPE, K. E., C. S. FLORENCE, AND P. JOSKI. August 25, 2004. Which Medical Conditions Account for the Rise in Health Care Spending? *Health Affairs* (e-published ahead of print).
- YU, W. 2003. Prevalence and Costs of Chronic Conditions in the VA HC System. *Medical Care Research and Review*. 60(3): 146S–167S.
- YU, W., A. RAVELO, T. H. WAGNER, AND P. G. BARNETT. December 2004. The Relationships Among Age, Chronic Conditions, and Healthcare Costs. *American Journal of Managed Care*. 10(12): 909–16.
- ZHANG, P., M. ENGELAU, S. NORRIS, E. GREGG, AND V. NARAYAN. 2004. “Application of Economic Analysis to Diabetes and Diabetes Care”. *Annals of Internal Medicine*, 140: 972–77.

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