A Comparative Analysis of Chronic and Non-Chronic Insured Commercial Member Cost Trends

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Abstract

Background

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 chronics in the absence of DM can be predicted by their pre-DM year cost (on a per-member–per-month (PMPM) basis) adjusted for the non-chronic population's cost trend. The assumption made, not previously tested, is that absent DM, the chronic and non-chronic trends are identical.

Methods

We calculated chronic and non-chronic trends over 1999–2002 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.

Data

We used a data set of 1.5 million commercially insured members.

Results

When chronic and non-chronic members are identified and included in the population prospectively, the average three-year trend over the study period for chronic and non-chronic members adjusted for high-cost outliers was 4.9 percent and 13.9 percent respectively. Adjusting the population experience for differences in service mix had little impact 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 percent; non-chronics 17.2 percent; total 16.0 percent). Using the original selection algorithm but risk-adjusting the populations annually also caused their trends to converge (chronics, 12.5 percent; non-chronics 11.9 percent).

Conclusions

Estimating DM program financial outcomes based on the assumption that, absent the program, the chronic population would have had the same trend as the non-chronic population can lead to erroneous conclusions. Identification of a chronic member and the point at which that member is re-classified from one sub-population to another can significantly impact the observed trends in both sub-populations, 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.

1. Disease Management

DM is "a system of coordinated health care interventions and communications for populations with (chronic) conditions in which patient self-care efforts are significant."[4] 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 outcome studies generally compared a cohort, pre- and post-intervention, in which the actually managed cohort's cost was compared with those eligible for DM, 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 non-enrolling population, absent intervention (see discussion in Paper 2[5]). 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

[4] As defined by the Disease Management Association of America (DMAA). See www.dmaa.org.

[5] See "Actuarial Issues in Care Management Interventions," by Ian Duncan and Henry Dove, Paper 2 of the series "Evaluating the Results of Care Management Interventions; Comparative Analysis of Different Outcomes Measures," sponsored by the SOA Health Section.

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 DM financial outcomes is the actuarially adjusted historical control methodology,[6] in which a health care cost trend factor is applied to historic chronic member costs (pre-program) 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 non-chronic population.

Although the actuarially adjusted historical cost method has been used extensively, the relationship between chronic and non-chronic trends is not well understood by those who apply them or by users of the studies. In particular it is often assumed that the chronic and non-chronic 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 non-chronic 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 DM programs (if any) that cover the employer groups included in the database.

2. Previous Studies

Existing health care cost trend literature is limited to the cost trends for populations (Strunk and Ginsburg, 2003), sub-populations (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

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[6] 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).

prevalence and spending from the National Medical Expenditure Survey (NMES) in 1987 and the 2000 Medical Expenditure Panel Survey, Household 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, et al., 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 non-chronic) and the 2000 MEPS-HC surveyed 25,096. The data used in Exhibit 2 of the 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 DM 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 for the chronic population. Having data at two points in time (1987 and 2000) allows us also to calculate an average trend in each of these metrics between 1987 and 2000. Annual trends in the chronic population range from 3.0 percent (diabetes) to 7.3 percent (hypertension), with an average annual trend of 4.6 percent.

TABLE 1

Total Healthcare Spending For Each Condition

Year	Pulmonary	Hypertension	Diabetes	Heart	TOTAL
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%

Number of Chronic Individuals Per 100,000 of the population

Year	Pulmonary	Hypertension	Diabetes	Heart	TOTAL
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%

Healthcare Cost Per Member Per Year

Year	Pulmonary	Hypertension	Diabetes	Heart	TOTAL
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%

Other studies of chronic prevalence trends include a CDC study that predicts an annual growth in chronic prevalence between 1998 and 2020 of about 1 percent annually, somewhat lower than the 1.9 percent 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) at the individual level (see below).

Many of the published studies examine just one chronic condition. Because of the prevalence of co-morbidities 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 percent of all chronic patients have one or more chronic conditions. Hogan, et al. (2003), writing for the American Diabetes Association, estimate 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, et al., as 5.9 percent over the period 1987-2000. The growth in prevalence of diabetes over this period is estimated as 2.8 percent. Hogan, et al., estimate growth of diabetes prevalence between 2000 and 2020 as 2 percent annually, somewhat lower than the historic experience. The estimated growth in expenditures is 50 percent (to $138 billion) by 2020 in constant 2002 dollars. The implied annual trend is only 2.3 percent annually, to which we must add an estimate of future cost-of-living increases (we estimate 3 percent) to estimate future trend (5.3 percent).

3. Definition of Healthcare Trend

"Healthcare trend" is the term applied to the empirical observation that most health care measures (such as utilization, unit cost and 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 two and year one costs PMPM, divided by year one 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} is the claims (or utilization, or other statistic being measured) of the i-th member in the j-th month; and

n_j is the number of members enrolled in the j-th month

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 non-chronic 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 one and year two, 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.

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) and the effect of aging or "maturing" of the diseased population or 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 DM outcomes, however, often introduces the need to analyze the experience of sub-populations. Three factors that have a potentially significant effect on trend are the migration of members between categories (such as non-chronic, chronic or excluded members), catastrophic claims and the mix of services used by members of different categories. We discuss each of these factors below.

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. In order to avoid selection bias, studies now tend to be done including the entire chronic population, that is, considering all members that 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.[7] 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 re-qualified as chronic year-to-year under the same set of criteria used to identify the member initially ("re-qualification") 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. However, we do not address the issue of re-qualification, which we will explore in Paper 8.[8]

[7] It may seem intuitively wrong for a "chronic" member to be re-classified as "non-chronic" after initially being identified as chronic. However, identification that is performed based on administrative data and chronic disease algorithms are not 100 percent infallible, and a percentage of "false positives" is to be expected with any algorithm. (See discussion in Paper 6 and practical application in Paper 8.)

[8] See "Testing Actuarial Methods for Evaluating Disease Management Savings Outcomes," forthcoming, by Ian Duncan, Rebecca Owen and Henry Dove, Paper 8 of the series "Evaluating the Results of Care Management Interventions; Comparative Analysis of Different Outcomes Measures," sponsored by the SOA Health Section.

7. 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.[9] No information about specific medical management or DM programs was included in the dataset, although the incidence of DM 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 focuses 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 non-chronic 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 DMAA (Duncan, ed., 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 non-chronic groups was tracked; incurred claims were associated with the corresponding membership and summed and expressed as PMPM. 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 non-chronic using the prospective "once chronic/always chronic" criterion. As an alternative, we varied the identification to attribute chronic conditions retrospectively as well.

[9] The Ingenix data set is used with permission of Ingenix Inc., Minneapolis, Minn.

8. 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 years 1999–2002. In 1999, although chronic individuals accounted for 4.1 percent of all covered members, they accounted for 14.5 percent of all costs. By 2002, chronic individuals had increased to 8.6 percent of the population and accounted for 23.1 percent 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: in order 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).[10]

[10] Members identified in 1999 are identified through claims incurred in one year of historic claims data. When the population is not re-qualified 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.

8.1 Chronic and Non-Chronic Members and Costs

TABLE 2
Costs and Trends Using the "Prospective Identification" Methodology

Year	Chronic Member Months	Chronic Prevalence	Chronic Cost PMPM	Chronic Cost Trend	Total Chronic Cost ($'000)	Chronic Cost as % of Total
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%
3-Year Annualized				5.6%		

Year	Non-Chronic Member Months	Non-Chronic Cost PMPM	Non-Chronic Cost Trend	Total Non-Chronic Cost ($'000)	Non- Chronic Cost as % of Total
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%
3-Year Annualized			13.8%		

Year	Total Member Months	Total Cost PMPM	Total 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
3-Year Annualized			16.0%	

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 exist to identify chronic members than were available for 1999.

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

TABLE 3
Average Cost PMPM without the Effect of Prevalence Creep

Year	Chronic Member Months	Non-chronic 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 (re-stated)	469,760	11,112,055	11,581,815	4.1%	$298.99

The chronic and non-chronic trend results may at first appear counter-intuitive. First, the chronic trend is lower than either the total or non-chronic trend, which appears anomalous, given that chronic members are high cost (their cost PMPM is between three and four times that of non-chronic members). Second, the overall population trend is higher than that of either sub-population. These apparent anomalies, however, are accounted for by migration in membership between the relatively low-cost non-chronic population, as newly identified chronic members transfer to the relatively high-cost chronic population. The members who leave the non-chronic 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 percent) is reasonably consistent with the trend observed for similar chronic conditions (4.6 percent) between 1987 and 2002 by Thorpe et al. (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 non-chronic pool. Newly identified chronic members tend to be lower cost than the remainder of the chronic pool, but higher cost than the non-chronic pool, effectively reducing the trends observed in each sub-population. Some more recently introduced savings methodologies attempt to adjust for duration since chronic diagnosis, but this method is hampered by the availability of data. However, the lack of a long series of historical data makes it difficult to apply methods that introduce a true duration adjustment.

8.2 Decomposition by Service Sector

To further explore the gap between chronic and non-chronic trends, we explored 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 decomposing trend into its utilization and unit cost components. An example of such service category decomposition is shown in Figure 1.

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

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 non-chronic population) using weights appropriate for the chronic population.

Table 4 compares the composition of overall (total) PMPM claims of each of the chronic, non-chronic and all member populations by major service category. For example, over the three-year period, inpatient hospital claims amount to $67.32 PMPM for the non-chronic 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 one would expect, the composition of the claims dollar is different for each population, with non-chronic members using relatively fewer inpatient hospitalization services (29.5 percent of their total expense) and relatively more physician office services (17.9 percent) than chronic members (36.2 percent and 12.2 percent, respectively). The differences in service sector trends (hospital expenses growing relatively more slowly than certain outpatient expenses) when combined with these utilization differentials could result in different overall trends in each sub-population. 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

Comparison of Chronic and Non-Chronic Service Cost PMPM and Service Mix

	ALL YEARS Mem Mons	Claims PMPM Inpatient	Outpatient	Presc Drug	Emerg Rm	Laboratory	Phys Ofc	Rehab	Other	ALL SERVICES TOTAL
NON-CHRONIC	10,964,214	$ 67.32	$ 68.53	$ 33.47	$ 5.24	$ 4.46	$ 40.90	$ 0.91	$ 7.58	$ 228.40
CHRONIC	750,281	$ 294.02	$ 197.69	$ 158.37	$ 9.69	$ 10.64	$ 99.34	$ 6.29	$ 35.10	$ 811.15
ALL	11,714,495	$ 81.84	$ 76.80	$ 41.47	$ 5.52	$ 4.86	$ 44.64	$ 1.25	$ 9.34	$ 265.72

	ALL YEARS Mem Mons	Service Category Weights Inpatient	Outpatient	Presc Drug	Emerg Rm	Laboratory	Phys Ofc	Rehab	Other	ALL SERVICES TOTAL
NON-CHRONIC	10,964,214	29.5%	30.0%	14.7%	2.3%	2.0%	17.9%	0.4%	3.3%	100.0%
CHRONIC	750,281	36.2%	24.4%	19.5%	1.2%	1.3%	12.2%	0.8%	4.3%	100.0%
ALL	11,714,495	30.8%	28.9%	15.6%	2.1%	1.8%	16.8%	0.5%	3.5%	100.0%

Table 4 shows that the PMPM cost and relative service category utilization of chronic and non-chronic 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 non-chronic 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 sub-population and in the population as a whole, with non-chronic member trends generally higher than those of chronic members.

TABLE 5

Comparison of Chronic and Non-Chronic Trends by Service Category

	3- Year Annualized Mem Mons	Service Category Trends Inpatient	Outpatient	Presc Drug	Emerg Rm	Laboratory	Phys Ofc	Rehab	Other	ALL SERVICES TOTAL
NON-CHRONIC	10,964,214	12.3%	15.4%	11.0%	19.4%	10.8%	16.5%	12.8%	9.0%	13.8%
CHRONIC	750,281	6.6%	8.3%	1.1%	12.1%	0.6%	8.9%	-9.5%	-1.7%	5.7%
ALL	11,714,495	15.8%	17.2%	13.7%	20.0%	11.4%	17.7%	12.6%	11.3%	16.0%

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

TABLE 6
Effect of Chronic Service Mix on Non-Chronic Trends

Year	Non-chronic Trend	Adjusted Non-Chronic Trend	Difference
2000	13.5%	12.7%	0.8%
2001	14.9%	14.6%	0.3%
2002	13.0%	12.4%	0.6%
Three-year average	13.8%	13.2%	0.6%

8.3 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). More detail on this issue may be found in Paper 6.[11]

We tested the effect of applying both member and claim exclusions on the chronic and non-chronic trends. Sample results are provided in Table 7.

[11] 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).

TABLE 7
Effect of Excluding High-Cost Outliers on Trend

Year	Non-chronic cost PMPM	Non-chronic 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%
3-year Annualized		13.9%		4.9%		16.2%

Excluding members and claims does not change the average three-year trend for the non-chronic or total population (16.2 percent vs. 16.0 percent; 13.9 percent vs. 13.8 percent). However, the chronic trend is reduced (5.6 percent vs. 4.9 percent) 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 non-chronic 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.

8.4 Effect of Migration between Chronic and Non-Chronic Populations

Migration from the non-chronic to the chronic population causes divergence between the trends of each group. We tested this effect by assigning members to a group (chronic or non-chronic) 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 non-chronic in 1999 and 2000, but meets the chronic test at January 1, 2001 will be classified in the non-chronic group in 1999 and 2000 and re-classified to the chronic group in 2001 and 2002. For the comparison below, this same member will be classified as chronic for all four years of analysis. The analysis uses the member exclusion and claims exclusions, as in the previous section.

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

TRENDS	3-year annualized	RETROSPECTIVE IDENTIFICATION				
Year	Chronic Member Months	Chronic Trend	Non-Chronic Member Months	Non-Chronic Trend	Total Member Months	Total Trend
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%
Three year	annualized	16.3%	annualized	17.2%	annualized	16.0%
		PROSPECTIVE IDENTIFICATION				
Three year	annualized	5.6%	annualized	13.8%	annualized	16.0%

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

The fact that both chronic and non-chronic trends are higher than overall trend in the case of the retrospectively identified population may appear to be anomalous. However, the lower trend in the overall population results from the relative growth rates of non-chronic members (0.8 percent per year) and chronic members (-2.2 percent per year) over the four years. During the four-year period, non-chronic members increase from 63.0 percent of the total population to 65.6 percent of the total population. The lower PMPM cost of the non-chronic population, combined with their relatively faster growth, depresses the overall trend in the population.

8.5 Effect of Changes in the Population Risk Profiles

One possible source of difference between chronic and non-chronic trends is diffential 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 population) based on risk factors in the individual member's risk profile. We applied a commonly used and commercially available grouper[12] to the chronic and non-chronic populations defined above. 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. Results are shown in Table 9 for the chronic and non-chronic populations identified by the "once chronic/always chronic" methodology.

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

	Prospective Chronic Identification							
	CHRONIC				NON-CHRONIC			
Year	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%
3-Year annualized		-6.1%	5.6%	12.5%		1.7%	13.8%	11.9%

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.

The trend in risk score of the chronic population indicates that the chronic population becomes less risky over time. Conversely, the non-chronic population becomes slightly riskier over time. Making a simple adjustment to the PMPM Trend observed in each population, (by dividing PMPM trend by the effect of population risk-score change), the adjusted 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 non-chronic 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 non-chronic population) is associated

[12] The DxCG grouper, used with permission of DxCG Inc., Boston. More information about groupers and alternative products may be found in Cumming et al. (2002).

with a differential change in risk score. The practical application of this technique is illustrated below.

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 (for typical inclusion and exclusion criteria, see Paper 6[13]). As is the case in many calculations, the baseline cost PMPM is trended forward using the non-chronic 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 non-chronic trend, and then the effect of change in the chronic population risk-profile, allowing the (adjusted) non-chronic trend to be used as a potentially unbiased estimate.

[13] 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).

TABLE 10
Application of a Risk-Adjusted Trend Model

Basic Data

The standard adjusted historical control savings calculation uses the unadjusted trends and cost PMPM, as follows:

Baseline Chronic Cost PMPM	$300
Trend (non-chronic)	1.10
Trended Baseline Chronic Cost	$330
Actual Cost	$305
Estimated Savings	$ 25 PMPM

Risk-adjusted historical control savings calculation uses the adjusted trends and cost PMPM, as follows:

Population	Baseline Period	Intervention Period	Trend
Non-chronic Cost PMPM	$100	$110	10.0%
Non-chronic Risk Score	1.0	1.02	2.0%
Non-chronic Cost PMPM, adjusted for Risk trend		$110/1.02 = $107.84	
Risk-adjusted Non-Chronic Cost Trend, PMPM	$100	$107.84	7.84%
Chronic Cost PMPM	$300	$305	1.67%
Chronic Risk Score	3.0	2.90	(3.33%)

Baseline Chronic Cost PMPM	$300
Risk-adjusted Trend (non-chronic)	1.0784
Trended Baseline Chronic Cost	$323.52
Actual Cost	$305
Risk-adjusted Actual Cost	$305/.967 = $315.41
Estimated Savings	$8.11 PMPM

Using the risk-adjusted trend as our estimate of chronic trend gives a lower but more credible estimate of savings.

9. 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 non-chronic trend in the absence of intervention, this assumption has not been proven.

This study showed that at least 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 non-chronic trend. This conclusion was unaffected by readjusting the non-chronic trend to the chronic population's service mix. Because this divergence in trends may be due to the prospective method of classifying chronics, we applied a second (retrospective) methodology, which assumed that over the four-year span all members were either chronic or non-chronic. 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 either 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 non-chronic 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.

10. 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 above 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.

We did not explore a third frequently used chronic selection methodology, that of annual reselection. This method has been promoted as avoiding some of the effects of migration (because members can migrate both into and out of the chronic pool). It is possible that the risk-adjusted "once/always" and "reselect annually" methods accomplish the same end—adjusting the chronic populations' risk to avoid a decline in its trend due to dilution from lower-risk cases. This is an area where further data analysis is warranted.

11. Conclusions and Implications for DM Purchasers

1. When chronics are identified using a prospective "once chronic/always chronic" algorithm, unadjusted non-chronic (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 (i.e., 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 non-chronic trend as calculated in this article (13.8 percent) 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 percent, 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 non-chronic), the chronic and non-chronic trends are closer to convergence. However, this methodology is difficult to justify on clinical grounds.

5. Adjusting the non-chronic trend for service mix has little effect on trend.

6. Adjusting both the non-chronic and chronic populations for the effect of change in population risk results in an adjusted non-chronic 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. The above 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, non-chronic trend may be more or less close to the true underlying chronic trend.

Operationally, the non-chronic 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-adjustment methodology may be applied to a prospective analysis. To do so, the non-chronic trend would first be adjusted by dividing the non-chronic PMPM trend by the trend in non-chronic 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.

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