What Will It Take for Disease Management to Demonstrate a Return on Investment? New Perspectives on an Old Theme

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Background: Disease management programs are expected (and usually contractually required) to reduce total costs in the diseases they manage.

Objectives: To discuss the appropriateness of using utilization indexes in lieu of cost and the importance of reviewing utilization trends to determine whether sufficient opportunity exists for a program to be financially effective; and to conduct an analysis to determine the number of admissions that must be reduced for a program to achieve various levels of return on investment.

Study Design: Descriptive.

Methods: Historical inpatient cost trends, discharges per 10 000 population, the mean length of stay, and emergency department visits per 10 000 population for acute myocardial infarction, congestive heart failure, asthma, and diabetes mellitus are presented. A "number-needed-to-decrease" analysis is performed to determine the number of admissions or emergency department visits that must be reduced to meet varying levels of return on investment.

Results: (1) Hospital days per 10 000 population for these conditions trended downward, while costs during the same period escalated. (2) Discharge and emergency department visit rates per 10 000 population were flat and low during the observation period, while the mean length of stay declined. Results of the number-needed-to-decrease analysis suggest that disease management programs will have to decrease admissions 10% to 30% to cover program fees alone.

Conclusion: A review of historical utilization trends and a number-needed-to-decrease analysis should be conducted before disease management program implementation to determine whether sufficient opportunity exists to reduce utilization to levels that will ensure a positive return on investment.

(Am J Manag Care. 2006;12:217-222)

Disease management (DM) programs have long been promoted as major medical cost-saving mechanisms, although the scant research that exists on the topic has provided conflicting results.[1-4] These inconsistencies are due in part to the varying evaluation designs used in measuring financial outcomes. As one would expect, most studies published in the peer-reviewed literature rely on randomized controlled trials to provide unbiased estimates of program effectiveness. Under these controlled conditions, financial outcomes tend toward small effect sizes at best. By contrast, for commercial purposes, DM programs almost universally evaluate program economic effectiveness using the total population pre-post study design,[5] a weak evaluation technique that is easily affected by many sources of bias[6] and, more often than not, tends to demonstrate overly positive program effects.

Given the uncertainty regarding the validity of findings from these evaluations, most contracts continue to include financial guarantees to ensure that the purchasers will at least break even if the program fails to demonstrate medical cost savings. However, using total costs as the primary outcome measure to demonstrate program effectiveness and return on investment (ROI) poses a significant threat to the validity of outcomes in the evaluation of DM.[6,7] Shifts in medical costs due to changes in provider reimbursement, insurance coverage, new technologies, and others are beyond the control of program interventions. In fact, DM programs have been unable to consistently control financially related outcomes beyond hospital admissions and emergency department (ED) visits. In a recent systematic review, Ofman et al[4] reported that reductions in outpatient utilization (eg, provider visits) were demonstrated in only 4 of 25 studies examined. This result is not surprising because physician encounters and pharmacy utilization are likely to increase as a result of successful DM interventions based on evidence-based practice guidelines.[1,8-14]

Because inpatient utilization represents the single largest health expenditure (30% in 2004),[15] it is logical to focus on reducing hospitalizations as a means of achieving large cost savings. Similarly, because approximately 14% of ED visits result in hospital admission,[16] it is reasonable to target ED utilization as well. That said, if hospital admission and ED visit rates in the population are too low to begin with, the program may be effective in saving money but not enough to demonstrate a positive ROI. Under this circumstance, it may be unreasonable to hold DM firms accountable for demonstrating effectiveness based on financial indicators alone.

This article highlights crucial issues central to the current controversy over DM program financial effectiveness. First, the appropriateness of using utilization

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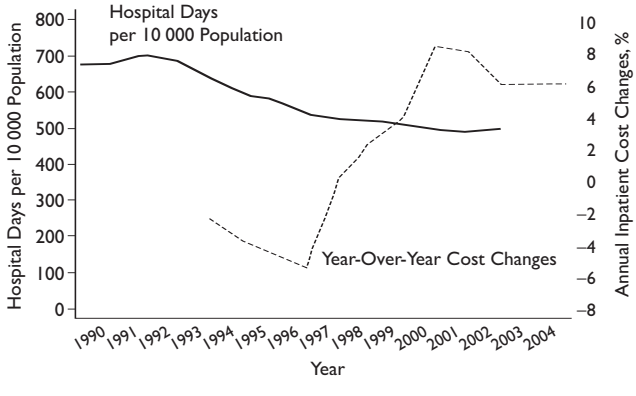
indexes in lieu of cost will be discussed. Second, the importance of reviewing historical utilization trends is addressed. Third, a modified "number-needed-to-decrease" (NND) analysis will be conducted to determine the number of admissions or ED visits that must be reduced for a program to break even or show a positive ROI.

COST TRENDS

The chief concern about using medical costs as the primary measure in evaluating DM program economic effectiveness is that costs are a function of unit pricing and utilization. Although the DM program can affect utilization (and, as illustrated herein, only the admission component of a hospital stay and ED visits), the program has no control over unit pricing of health services. **Figure 1** (in which data are plotted for 1990-2004) presents the medical cost trends for inpatient hospitalization taken from the Milliman Health Cost Index[17] compared with aggregated hospital days per 10 000 population.[18] As shown, the 2 variables have historically trended in opposite directions: hospital days decreased, while year-over-year inpatient hospital costs increased. Therefore, this divergence can only be explained by annual increases in the unit pricing of services. This assertion is further supported by a 2006 PricewaterhouseCoopers report which states: "Unlike other medical service categories, price increases in excess of inflation—not increased utilization—are disproportionately responsible for the increased spending on inpatient hospital services."[19] Because DM programs can only reasonably affect costs vis-à-vis reduced acute utilization or ED visits, those should be the measures by which program effectiveness is established.

Figure 1. Inpatient Medical Cost Trends From 1990 to 2004[17] Plotted Against Aggregated Hospital Days per 10 000 Population[18] for Acute Myocardial Infarction, Congestive Heart Failure, Asthma, and Diabetes



UTILIZATION TRENDS

Although DM can generally reduce hospital admissions and ED visits, these outcomes are not assured in every population or for every disease condition. Before offering DM services to a given population, a review of historical inpatient and ED utilization data should be conducted. This serves (1) to assess whether a historical trend exists and to develop future projections and (2) to determine if the level of recent utilization provides an opportunity for DM to have an effect. Time-series analysis[20] is the most suitable technique for providing meaningful insights as to what utilization trends would be expected in the absence of a DM program intervention. In addition, as presented herein, an economic analysis is recommended to address the issue of effect opportunity.

To demonstrate how a historical utilization review should be conducted, the following analysis is based on hospital data collected annually from the National Hospital Discharge Survey[18] and on ED data collected annually from the National Hospital Ambulatory Medical Care Survey.[21] The National Hospital Discharge Survey collects data from a sample of inpatient records acquired from a national sample of hospitals. In 2003 (the latest survey data available), 426 hospitals responded to the survey, and data were collected for approximately 320 000 discharges. The 2003 National Hospital Ambulatory Medical Care Survey collected data from 406 participating hospitals with an ED, representing 40 253 ED visits. The details regarding how these data are collected, quality is controlled, and national estimates are developed were previously published.[22]

Although this review can be conducted at the population-wide level or at the level of the chronically ill cohort, almost all DM programs are financed and evaluated at the population level (In conversation with Alfred Lewis, JD, president, Disease Management Purchasing Consortium International, Inc, January 2006). In other words, program fees are paid on a per-member-per-month (PMPM) basis, so that costs are spread across the entire population as opposed to across the diseased cohort only. Therefore, reviewing data at the population-wide level allows for a more direct application to current industry practices.

The review should begin with the examination of admission or discharge data. **Figure 2** presents the annual discharges per 10 000 population for 4 of the primary conditions traditionally managed by DM: acute myocardial infarction, congestive heart failure, asthma, and diabetes mellitus. Observations for each condition and for the aggregate were abstracted from annual reports and were plotted for the years 1990 to 2003. Two observations are immediately evident on visual inspection: (1) In contrast to costs, utilization for all 4

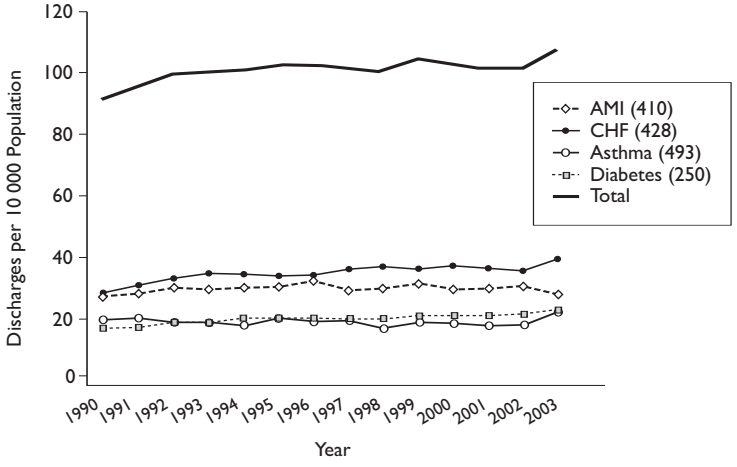
conditions appears flat over the 14-year period, and the levels of these rates remained low. (2) Even when all diseases are aggregated, the mean discharge rate during the 14-year period is 99.4 (95% confidence interval, 97.5-101.2) discharges per 10 000 population.

Another important component of the hospitalization event is the length of stay for that given episode of care. Although it would be advantageous for a DM program to have control over what occurs in the inpatient setting, it is beyond the scope of their operations. **Figure 3** presents the mean length of stay for the 4 conditions in Figure 2.[18] As illustrated individually and at the aggregate level, the mean length of stay decreased annually for these conditions. At the aggregate level, the decrease is from 7.4 days in 1990 to 4.8 days in 2003.

ED utilization is the other major financially related indicator that DM is thought to affect. **Figure 4** presents the ED visits per 10 000 population for asthma, heart disease (including congestive heart failure but excluding ischemia), and all endocrine system–related illnesses.[21] Similar to the hospitalization rates, the ED visit rates over the 12-year period are flat. When all diseases are aggregated for 1995 to 2003, the mean ED visit rate is 182.5 (95% confidence interval, 175.3-189.7) visits per 10 000 population.

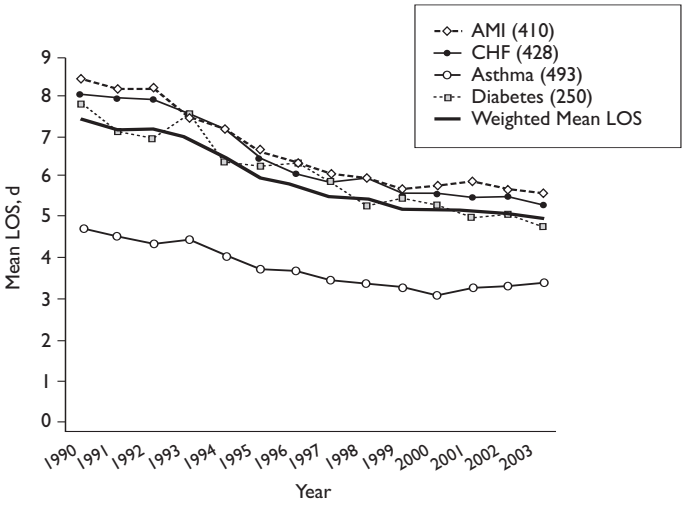
As suggested by these data, there is good cause for vendors and purchasers of DM services to assess whether there is sufficient opportunity to realistically affect hospitalization and ED visit rates in the target population. Historical trends for these are flat and low at the national level.

Figure 2. Hospital Discharges per 10 000 Population



AMI indicates acute myocardial infarction; CHF, congestive heart failure; and Total, the aggregate of all 4 conditions.[18] The numbers in parentheses are *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* codes.

Figure 3. Mean Length of Stay (LOS) for 4 Conditions



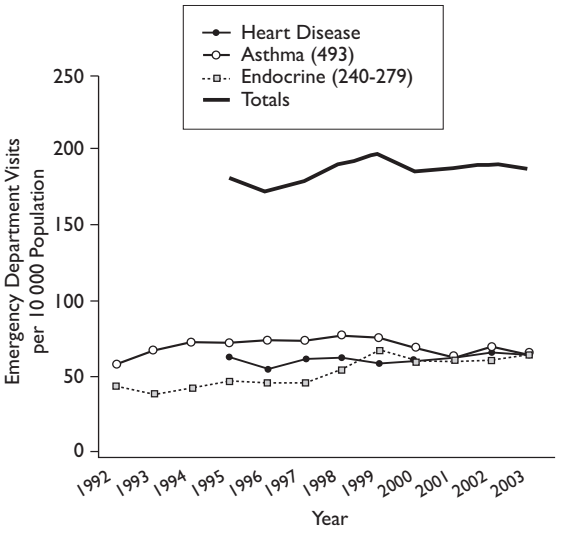
AMI indicates acute myocardial infarction; CHF, congestive heart failure; and Weighted Mean LOS, the aggregate of all 4 conditions.[18] The numbers in parentheses are *ICD-9-CM* codes.

"NUMBER-NEEDED-TO-DECREASE" ANALYSIS

To establish if an opportunity exists to affect financial outcomes, a preliminary analysis of current (preprogram) hospitalization and ED data is warranted. The concept of the "number needed to treat" is used in research to assess the effect of treatment in relation to the number of patients needed to be treated with a particular therapy to prevent one adverse event.[23] In this article, the number-needed-to-treat concept is applied to DM in a similar fashion. Herein, we determine the number of admissions or ED visits that must be reduced from the current level for the DM program to demonstrate various levels of ROI. This analysis will be referred to as the "number needed to decrease."

Table 1 and **Table 2** give the results of an NND analysis with multiple scenarios for hospitalizations based on 5 assumptions. These include (1) a general population of 100 000 persons, (2) discharge rates derived from the 2003 aggregate data presented in Figure 2 (1045 discharges per 100 000 population), (3) the mean length of stay (4.8 days) derived from the aggregate data present-

Figure 4. Emergency Department Visits per 10 000 Population[20]



Missing values for Heart Disease (1992-1994 and 2001) indicate that these diagnoses were not among the top 20 most frequently recorded diagnoses. Heart Disease includes congestive heart failure but excludes ischemic conditions; Endocrine includes diabetes; and Totals is the aggregate of all 3 conditions except during periods in which there are missing values for Heart Disease. The numbers in parentheses are *ICD-9-CM* codes.

ed in Figure 3, (4) program fees for 4 diseases (acute myocardial infarction, congestive heart failure, asthma, and diabetes) range from a low of $0.90 PMPM to a high of $1.20 PMPM (In conversation with Alfred Lewis, JD, president, Disease Management Purchasing Consortium International, Inc, January 2006), and (5) cost-per-day rates of $1000 (based on Medicare Provider Analysis and Review data) and $2000 (based on data provided by the Maryland Health Services Cost Review Commission).

To illustrate how the NND is calculated in this analysis, one possible scenario using these assumptions is an ROI of 1.0 and the hospitalization cost per day of $1000, found in the top left of Table 1. The annual fees charged for DM services in this population are $1 080 000 ($0.90 PMPM ≥ 12 months × 100 000 population). Given that each hospitalization, on average, is 4.8 days and costs $4800, the program will have to reduce the number of admissions by 225 to break even ($1 080 000/$4800). This represents a 21.5% decrease from the current hospitalization rate of 1045 admissions per 100 000 population. The lowest breakeven target (ROI, 1.0) can be achieved by eliminating 113 admissions (10.8% of 1045). For this to occur, the DM program must charge $0.90 PMPM, and the mean cost per day must equal $2000. The highest breakeven target (NND, 300 [28.7% reduction from 1045]) can be achieved with fees of $1.20 PMPM and a hospitalization cost per day of $1000 (Table 2).

There is little need to perform a comprehensive NND analysis for ED visits because the visit rates in the population and the cost per visit are typically low. For example, by extrapolating the 2003 total visit rate (all conditions) from Figure 4 to the hypothetical population, there are 1843 ED visits per 100 000 population. Assuming a (high) cost of $500 per visit, the annual costs for total visits will be $921 500.

A logical approach would be to combine the 2 utilization measures in the NND to provide a more accurate picture of what is needed under various scenarios to break even. For example, if the DM vendor assumes that the total ED visits can be reduced by 30%, the savings from ED visits alone would be $276 450 (1843 visits × 30% × $500/visit). This would necessitate a reduction of 167 hospital admissions (16% from current levels) just to break even (assuming a $1000 cost per hospital day and program fees of $0.90 PMPM).

On analysis, it becomes readily apparent that a significant number of admissions or ED visits must be avoided for the DM program to claim a positive ROI. This may be feasible by changing some of the assumptions. For example, if a given population has a much higher average cost per hospital day or ED visit, the target is easier to reach. Similarly, the DM vendor could lower their fees in an effort to achieve a positive ROI. In addition, the more diseases or conditions that are included in the DM program intervention, the higher the baseline admission or ED visit rate and the better the chances are to reduce hospital stays and ED visits.

DISCUSSION

This article highlights several critical issues with which DM vendors must contend before implementing a program when cost savings are expected. First, it has been demonstrated that using cost as the primary outcome in determining the financial effectiveness of DM is fundamentally flawed, given that unit cost has historically been the primary driver of increasing hospital costs, not utilization. Because DM does not affect unit pricing of healthcare services, the more appropriate financially related outcome measures are hospital admissions and ED visits. In view of the fact that purchasers are likely to continue to demand that DM programs demonstrate cost savings, the most reasonable solution is that each unit of utilization be equated with a standardized cost. Accordingly, period-over-period changes in total costs would then be associated with changes in utilization and not unit pricing of those services.[7,20]

Second, a review of historical utilization is recommended to assess whether a DM program has sufficient opportunity to reduce hospitalization and ED visit rates in a population to a level that will demonstrate a positive ROI. The data presented herein indicate that the national rates of hospital admissions and ED visits for those chronic illnesses typically managed by DM have been flat since before the advent of DM. Moreover, these admission rates are sufficiently low to warrant the question of whether they can be reduced any further.

Third, the mean length of stay has decreased annually for these conditions due primarily to changes to hospital reimbursement and increased efficiencies. Therefore, it is imperative that program outcomes be subjected to a rigorous analysis to ensure that a reduction in hospital days is causally associated with the intervention and not a result of externalities, such as the secular trend occurring at the national level.

Given that the data used for these reviews are representative of the entire US population and are not specific to any one purchaser's population, it is recommended that an NND analysis be conducted before each program implementation so that providers and purchasers of DM services can jointly determine (1) whether there is sufficient opportunity to reduce admissions or ED visits in the target population and, if not, (2) whether program fees should be adjusted accordingly. The results of the NND analysis conducted herein suggest that DM programs will have to decrease admissions 10% to 30% just to break even. This holds true even if ED visits are reduced by sizable amounts.

Table 1. Number-Needed-to-Decrease (NND) Analysis of the Number of Hospitalizations That Must Be Reduced to Meet Varying Levels of Return on Investment (ROI), Assuming a $0.90 Per-Member-Per-Month Program Fee*

	Cost per Day, $†			
	1000		2000	
ROI	NND	% Decrease‡	NND	% Decrease‡
1.0§	225	21.5	113	10.8
1.5	338	32.3	170	16.3
2.0	450	43.1	226	21.6
2.5	563	53.9	283	27.1
3.0	675	64.6	339	32.4

*See the text for 5 assumptions on which the analysis is based.
†The mean cost per hospital day ($1000 per Medicare Provider Analysis and Review data and $2000 per Maryland Health Services Cost Review Commission data).
‡From the current discharge rate.
§1.0 Indicates that program fees equal current hospital costs.

Table 2. Number-Needed-to-Decrease (NND) Analysis of the Number of Hospitalizations That Must Be Reduced to Meet Varying Levels of Return on Investment (ROI), Assuming a $1.20 Per-Member-Per-Month Program Fee*

	Cost per Day, $†			
	1000		2000	
ROI	NND	% Decrease‡	NND	% Decrease‡
1.0§	300	28.7	150	14.4
1.5	450	43.1	225	21.5
2.0	600	57.4	300	28.7
2.5	750	71.8	375	35.9
3.0	900	86.1	450	43.1

*See the text for 5 assumptions on which the analysis is based.
†The mean cost per hospital day ($1000 per Medicare Provider Analysis and Review data and $2000 per Maryland Health Services Cost Review Commission data).
‡From the current discharge rate.
§1.0 Indicates that program fees equal current hospital costs.

CONCLUSIONS

Based on national healthcare data, cost savings that DM companies offer purchasers can only be achieved via significant reductions in hospitalizations or ED visits. The results of the analyses conducted herein suggest that admissions must be reduced from 10% to 30% to cover program fees alone. However, even if a program has the capability of reducing utilization by that magnitude, the question is whether the opportunity exists in the population for which DM services will be offered. To answer this question fully, an NND analysis should be conducted before program implementation. Finally, although cost savings can only be achieved via reduced utilization, purchasers will likely continue to expect that DM programs demonstrate total cost savings. Therefore, the most equitable solution for both parties may be to issue a standard cost for each unit of utilization and to track period-over-period changes in utilization, holding unit costs constant.

REFERENCES

1. Congressional Budget Office. *An Analysis of the Literature on Disease Management Programs.* Washington, DC: Congressional Budget Office. October 13, 2004. Available at: http://www.cbo.gov/showdoc.cfm?index=5909&sequence=0. Accessed November 4, 2005.

2. Goetzel RZ, Ozminkowski RJ, Villagra VG, Duffy J. Return on investment on disease management: a review. *Health Care Fin Rev.* 2005;26:1-19.

3. Krause DS. Economic effectiveness of disease management programs: a meta-analysis. *Dis Manag.* 2005;8:114-134.

4. Ofman JJ, Badamgarav E, Henning JM, et al. Does disease management improve clinical and economic outcomes in patients with chronic diseases? A systematic review. *Am J Med.* 2004;117:182-192.

5. American Healthways and Johns Hopkins Consensus Conference. Standard outcome metrics and evaluation methodology for disease management programs. *Dis Manag.* 2003;6:121-138.

6. Linden A, Adams JL, Roberts N. An assessment of the total population approach for evaluating disease management program effectiveness. *Dis Manag.* 2003;6:93-102.

7. Linden A, Adams J, Roberts N. *Evaluation Methods in Disease Management: Determining Program Effectiveness: Position Paper for the Disease Management Association of America (DMAA).* Washington, DC: Disease Management Association of America; October 2003.

8. Villagra VG, Ahmed T. Effectiveness of a disease management program for patients with diabetes. *Health Aff (Millwood).* 2004;23:255-266.

9. Oddone EZ, Weinberger M, Giobbie-Hurder A, et al; Veterans Affairs Cooperative Study Group on Primary Care and Hospital Readmission. Enhanced access to primary care for patients with congestive heart failure. *Eff Clin Pract.* 1999;2:201-209.

10. Gattis WA, Hasselblad V, Whellan DJ, O'Connor CM. Reduction in heart failure events by the addition of a clinical pharmacist to the heart failure management team: results of the Pharmacist in Heart Failure Assessment Recommendation and Monitoring (PHARM) study. *Arch Intern Med.* 1999;159:1939-1945.

11. Heller RF, D'Este C, Lim LL, et al. Randomised controlled trial to change the hospital management of unstable angina. *Med J Aust.* 2001;174:217-221.

12. Bogden PE, Koontz LM, Williamson P, Abbott RD. The physician and pharmacist team: an effective approach to cholesterol reduction. *J Gen Intern Med.* 1997; 12:158-164.

13. Browner WS, Baron RB, Solkowitz S, et al. Physician management of hypercholesterolemia: a randomized trial of continuing medical education. *West J Med.* 1994;161:572-578.

14. Montgomery AA, Fahey T, Peters TJ, MacIntosh C, Sharp DJ. Evaluation of computer based clinical decision support system and risk chart for management of hypertension in primary care: randomised controlled trial. *BMJ.* 2000;320: 686-690.

15. Centers for Medicare & Medicaid Services, Office of the Actuary, National Health Statistics Group. National health expenditure data: historical and projected. Available at: http://new.cms.hhs.gov/NationalHealthExpendData/02_National HealthAccountsHistorical.asp. Accessed November 4, 2005.

16. McCaig LF, Burt CW. *National Hospital Ambulatory Medical Care Survey: 2003 Emergency Department Summary: Advance Data From Vital and Health Statistics: No. 358.* Hyattsville, Md: National Center for Health Statistics; 2005.

17. Strunk BC, Ginsburg PB, Cookson JP. Tracking health care costs: declining growth trend pauses in 2004. *Health Aff (Millwood).* Jan-Jun 2005;Suppl Web Exclusives:W5-286-W5-295.

18. National Center for Health Statistics. Centers for Disease Control and Prevention. National Hospital Discharge Survey. 1990-2003. Available at: www.cdc.gov/nchs/datawh/ftpserv/ftpdata/ftpdata.htm-nhds. Accessed March 17, 2006.

19. PricewaterhouseCoopers. The factors fueling rising healthcare costs 2006. Available at: http://www.pwchealth.com/cgi-local/hcregister.cgi?link=reg/fuel.pdf. Accessed February 2, 2006.

20. Linden A, Adams JL, Roberts N. Evaluating disease management program effectiveness: an introduction to time-series analysis. *Dis Manag.* 2003;6:243-255.

21. National Center for Health Statistics. *National Hospital Ambulatory Medical Care Survey: Emergency Department Summary: Advance Data From Vital and Health Statistics: No. 245, 271, 275, 285, 293, 304, 313, 320, 326, 335, 340, 358.* Hyattsville, Md: National Center for Health Statistics; 1992-2003.

22. Dennison CF, Pokras R; National Center for Health Statistics. Design and operation of the National Hospital Discharge Survey: 1988 redesign. Available at: http://www.cdc.gov/nchs/data/series/sr_01/sr01_039.pdf. Accessed November 4, 2005.

23. Laupacis A, Sackett DL, Roberts RS. An assessment of clinically useful measures of the consequences of treatment. *N Engl J Med.* 1988;318:1728-1733.