Can Disease Management Target Patients Most Likely to Generate High Costs? The Impact of Comorbidity

Mary Charlson, MD[1], Robert E. Charlson, MD[2], William Briggs, PhD[1], and James Hollenberg, MD[1]

[1]Division of General Internal Medicine, Executive Director, Center for Complementary and Integrative Medicine, Weill Medical College of Cornell University, 525 East 68th Street, Box 46, New York, NY 10021, USA; [2]Yale New Haven Hospital, New Haven, CT, USA.

CONTEXT: Disease management programs are increasingly used to manage costs of patients with chronic disease.

OBJECTIVE: We sought to examine the clinical characteristics and measure the health care expenditures of patients most likely to be targeted by disease management programs.

DESIGN: Retrospective analysis of prospectively obtained data.

SETTING: A general medicine practice with both faculty and residents at an urban academic medical center.

PARTICIPANTS: Five thousand eight hundred sixty-one patients enrolled in the practice for at least 1 year.

MAIN OUTCOMES: Annual cost of diseases targeted by disease management.

MEASUREMENTS: Patients' clinical and demographic information were collected from a computer system used to manage patients. Data included diagnostic information, medications, and resource usage over 1 year. We looked at 10 common diseases targeted by disease management programs.

RESULTS: Unadjusted annual median costs for chronic diseases ranged between $1,100 and $1,500. Congestive heart failure ($1,500), stroke ($1,500), diabetes ($1,500), and cancer ($1,400) were the most expensive. As comorbidity increased, annual adjusted costs increased exponentially. Those with comorbidity scores of 2 or more accounted for 26% of the population but 50% of the overall costs.

CONCLUSIONS: Costs for individual chronic conditions vary within a relatively narrow range. However, the costs for patients with multiple coexisting medical conditions increase rapidly. Reducing health care costs will require focusing on patients with multiple comorbid diseases, not just single diseases. The overwhelming impact of comorbidity on costs raises significant concerns about the potential ability of disease management programs to limit the costs of care.

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INTRODUCTION

In recent years, cost of caring for individuals with chronic disease has increasingly come to dominate health care expenditures in this country, with an estimated 78% of total health care resources soon to be devoted to individuals with chronic disease.[1] Among approaches to curtail rising health care costs, disease management programs have shown promise in improving outcomes and the quality of care for chronic illness. Disease management is a systematic, population-based approach to patient care that aims to curb utilization by optimizing the process of care, increasing efficiency and managing the "total" disease.[2–6] In practice, most disease management programs involve a combination of patient education and compliance programs, treatment guidelines, and other interventions to design a comprehensive approach to managing a patient's disease. These programs are frequently either outsourced to pharmaceutical benefits managers or other for profit organizations, or developed in-house as part of HMOs or other insurers. In recent years, these programs have grown rapidly, with revenues rising from $85M in 1997 to more than $600M in 2002,[7] while targeting specific chronic illnesses as congestive heart failure, diabetes, depression, and asthma, among others.

The goal of this paper is to use prospectively acquired data to determine characteristics of patients at risk for the highest utilization, focusing on chronic diseases commonly addressed by disease management programs. By determining the actual cost of such conditions, in both unadjusted and adjusted terms, such data will demonstrate whether targeting patients with single chronic conditions is an efficient strategy for reaching high cost patients or whether targeting of patients with multiple chronic illnesses is required.

METHODS

Overview

We conducted a cohort study of 5,861 patients cared for at an academic medical practice at New York-Presbyterian Hospital over a 1-year period. To be included in the study, these patients had to have been followed for 1-year or more by

physicians in the practice. The study involved the collection of demographic, clinical, and cost data from the hospital data systems. Though study patients could have any diagnosis, our analysis focused on 10 common diseases targeted by disease management programs: congestive heart failure, dementia, ischemic heart disease, stroke, diabetes, cancer, asthma, COPD, depression and hypertension. The study was approved by the hospital's institutional review board (IRB).

Collection of Data

Patients were identified and cost data was compiled through CLIMACS©, a practice management system developed by 1 of the authors (JPH), for a 1-year period beginning December 1, 1993. Among 15,186 patients who had at least 1 physician visit during that 1-year period, 7,041 were excluded because they were new to the practice. Another 2,284 patients were excluded because they had received care for less than a year prior to the beginning of the study. To be included, patients had to be established patients of the practice, receiving care for at least 1 year before December 1, 1993. This ensured the longitudinal capture of clinical information. This data provided the basis for previous papers about resident versus attending and about depression in primary care practices.[8,9]

In total, 5,861 patients met these criteria, and the data on diagnoses and comorbidity was accumulated from all of the patient's visits to the practice over at least a 1-year period. Patients who did not meet criteria tended to be younger and were more often male. Data on the 0.4% of patients who died during the year were included. The clinical data collected includes appointments, laboratory tests, radiology tests, consultations, procedures, prescriptions, outpatient diagnoses, and patient billing. ICD-9 codes were assigned in this system by physicians at the conclusion of each visit for billing purposes. Diagnoses were cumulative, unlimited in number and new diagnoses were added as they occurred. Therefore, CLIMACS© provides a prospectively collected database of demographics, appointments, ICD-9 diagnoses, medications, and resource utilization.

Clinical and Demographic Characteristics

Patients' clinical and demographic characteristics were collected from the above data system. Patient age was based on the age on the date of study data collection, defined as December1, 1993. The Charlson comorbidity index was used to measure the burden of comorbid illness.[10] This comorbidity index assigns a weight of 1 to myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic pulmonary disease, ulcer disease, mild liver disease, and diabetes (whether type I or type II). However, diabetes (type I or II) with end organ damage (neuropathy, nephropathy, or retinopathy), any tumor, leukemia, and lymphoma all have a weight of 2, while moderate or severe liver disease has a weight of 3. Metastatic solid tumor and AIDS have a weight of 6. The score is calculated by adding weights for each patient disease, with possible scores ranging from 0 to 32; higher scores are associated with poorer prognosis. The Deyo adaptation for ICD-9 data was used to identify the presence of specific comorbid diseases.[11] Comorbidity was assessed from ambulatory records; hence, the discharge-related group coding did not affect the comorbidity. We previously reported that comparing the CLIMACS data to patient records regarding diabetes mellitus, asthma, and chronic obstructive pulmonary disease showed an undercoding rate of 0.8% for diabetes, and 7.7% for asthma and COPD.[8]

Resource Utilization

Cost data was collected for inpatient and outpatient events. The total cost includes the cost of ambulatory visits, laboratory tests, radiographic tests, consultations, and hospital charges. The New York Hospital cost accounting system (Transition Systems Inc, Boston Mass) tracked inpatient costs, and converted charges to costs by using specific cost-to-charge ratios. Each department had a specific cost-to-charge ratio, i.e., radiology and microbiology. Cost-to-charge ratios did not vary by payer or plan. CLIMACS data allowed for the assessment of the number of ambulatory visits, laboratory and radiology tests, specialty consultations, and other miscellaneous services such as vaccinations or procedures. Data on ambulatory resource utilization was converted from charges to cost using the specific ratio of cost-to-charges for each category of service. Services such as skilled nursing, home health, outpatient pharmaceutical, were not offered by the hospital or included in the charges.

Not all costs of care were able to be captured; external providers, including visits to physicians outside the practice and tests ordered and performed in outside laboratories, were not part of this analysis. Similarly, hospital costs include only those costs at New York-Presbyterian Hospital; if patients were hospitalized elsewhere, the costs were not captured. To assess the rate of undercoding, a 1% random sample of patients was contacted, and rate of hospitalization at other facilities was 6.3% among the 158 patients interviewed by telephone.

Statistical Analysis

We calculated the unadjusted annual costs associated with 10 chronic diseases often targeted by disease management programs. These included congestive heart failure, dementia, ischemic heart disease, stroke, diabetes, cancer, asthma, COPD, depression, and hypertension. These costs were compared to the unadjusted annual costs of the remainder of the study population without that specific disease. The percentage of total costs represented by those patients with each individual comorbidity score was then calculated, and compared to the percentage of the total population represented by each comorbidity score. We then calculated adjusted annual costs for each specific disease, using the statistical software R[12] to perform regression modeling. The multivariate model determining adjusted costs considered age, sex, specific chronic diseases, and the Charlson comorbidity index. The adjusted annual costs for each illness were then calculated for each comorbidity index score.

Adjusted Costs of Chronic Diseases

A regression model was built to predict the log of total cost adjusting for age, sex, individual diseases, and Charlson comorbidity index. The log of total cost was necessary to bring this response in line with typical regression assumptions. Because the relation between age and cost was not linear and the nonlinearity had a significant impact on cost, a restricted cubic spline (with 4 knots chosen dynamically) was used to

allow nonlinear effects for age. This, again, is fairly standard practice for data of this type. Also, we primarily sought to control for age and were not, per se, interested in estimating a simplified functional dependence on age.

Nonlinearities were unneeded for the comorbidity index. Interactions of sex and age, sex and comorbidity, and (linear) age and comorbidity were included in each model. Interactions of age and comorbidity were found unnecessary.

RESULTS

Total Unadjusted Costs

The average age was 56. Typical of many primary care practices, significantly more patients were women.[13,14] As shown in Table 1, 32% had Medicare; 30%, Medicaid; 12%, managed care (mainly PPO plans); and 8%, employee plans. Unadjusted median costs and their interquartile range for various chronic diseases commonly addressed by disease management programs are listed in Table 2. The percent of patients with each condition is also shown. The most expensive diseases were congestive heart failure ($1,500; in annual unadjusted costs), stroke ($1,500), diabetes ($1,500), and cancer ($1,400). Dementia ($1,100), COPD ($1,200), and hypertension ($1,200) were least expensive. The overall median annual cost for a random patient in this study was $810. Mean charges, often reported, are much higher reflecting the skewed nature of cost data. There were no gender differences in cost or comorbidity. The cost outcomes were not significantly related to plan type, after adjusting for age, sex, and comorbidity.

Higher comorbid burden of illness was associated with a larger percentage of overall costs (Table 2). The proportion of overall costs attributed to increasing comorbidity is detailed in Table 3. Though accounting for more than 43% of the study population, individuals with a comorbidity score of 0 accounted for just 23% of the cost. Likewise, patients with a comorbidity score of 1 accounted for 30% of the population and 27% of the cost. However, those individuals with comorbidity scores of 2 or more accounted for just 26% of the population, but slightly more than 50% of the overall cost of care. In unadjusted terms, costs for individuals with higher comorbidity increased steeply, ranging from $1,300 for a score of 2 to $1,600 for a score of 3 to $3,000 with scores of 6.

Figure 1 shows the modeled mean annual costs of various chronic diseases calculated for a female of median age (57) with the stated disease (the effect of sex was small; the modeled average was exponentiated to produce numbers in real dollars. Thus, the adjusted cost—for each disease—was calculated by inputing the values of adjusted comorbidity and the median sex (f) and age, and computing the result). The horizontal axis is the adjusted comorbidity index, which is found by subtracting the weighting of each stated disease from the patient's comorbidity score for just those patients with the stated disease. Thus, adjusted comorbidity scores of 0 are for patients who had the stated disease but no other (except possibly for those diseases that do not contribute weights to the comorbidity index). Calculating the adjusted comorbidity allows us to remove the effect of each disease while still showing that costs increase by adding to a patient's comorbid burden.

As (adjusted) comorbidity rises, regardless of the disease, total yearly adjusted mean cost increases rapidly, as the shape of the curve reveals. Yearly costs were especially high among those patients with comorbidity scores of 2 or more. Disease was still important to predict costs, however. For example, patients with cancer and an adjusted comorbidity score of 6 had very high costs, while patients with hypertension had lowest costs of all patients with an adjusted comorbidity score of 6. Although hypertension is lowest and cancer is highest, the mean costs are remarkably similar at lower levels of

Table 1. Demographics of the Population

Parameters	Percentage
<20	0.3 (0.9)
20–29	7.6 (14.8)
30–39	13.5 (20.2)
40–49	15.3 (17.3)
50–59	17.2 (16.2)
60–69	18.6 (14.3)
70–79	16.9 (10.7)
80–89	8.9 (4.9)
>90	1.7 (0.8)
Female	72
Medicare	32
Medicaid	29.5
Self-pay	16.5
Employee	8.4
Managed	11.9

Table 2. The Yearly Unadjusted Median Costs of Patients with and without Specific Chronic Diseases

Chronic diseases	Percentage of population with disease	Median unadjusted annual cost with specific disease (inner-quartile range)	Median unadjusted annual cost without specific disease (inner-quartile range)
Congestive Heart Failure	8	$1,500 ($3,500)	$770 ($1,100)
Dementia	2	$1,100 ($2,500)	$800 ($1,200)
Ischemic heart disease	4	$1,300 ($2,100)	$790 ($1,200)
Stroke	3	$1,500 ($1,900)	$800 ($1,200)
Diabetes	18	$1,500 ($1,900)	$700 ($1,000)
Cancer	8	$1,400 ($1,800)	$760 ($1,200)
Asthma	15	$1,300 ($1,600)	$760 ($1,100)
COPD	10	$1,200 ($1,300)	$770 ($1,200)
Depression	10	$1,300 ($1,600)	$770 ($1,200)
Hypertension	45	$1,200 ($1,400)	$550 ($900)
AIDS	1	$1,800 ($4,300)	$800 ($1,200)

Note that the patients in the second column did not have the specified disease but may have had other diseases; these numbers are averages across all other diseases patients may have had, so not too much should be read in the differences between these numbers.

Table 3. Distribution of Costs and Patients According to Total Comorbidity

Charlson comorbidity scale	Percentage of total cost	Percentage of patients	Median cost ($)
0	21	43	$500
1	25	30	$870
2	23	14	$1,300
3	15	7	$1,600
4	7	3	$1,600
5	3.4	1.4	$2,200
6	2.5	0.85	$3,000
≥7	1.4	0.25	$2,400

(N=5,861)

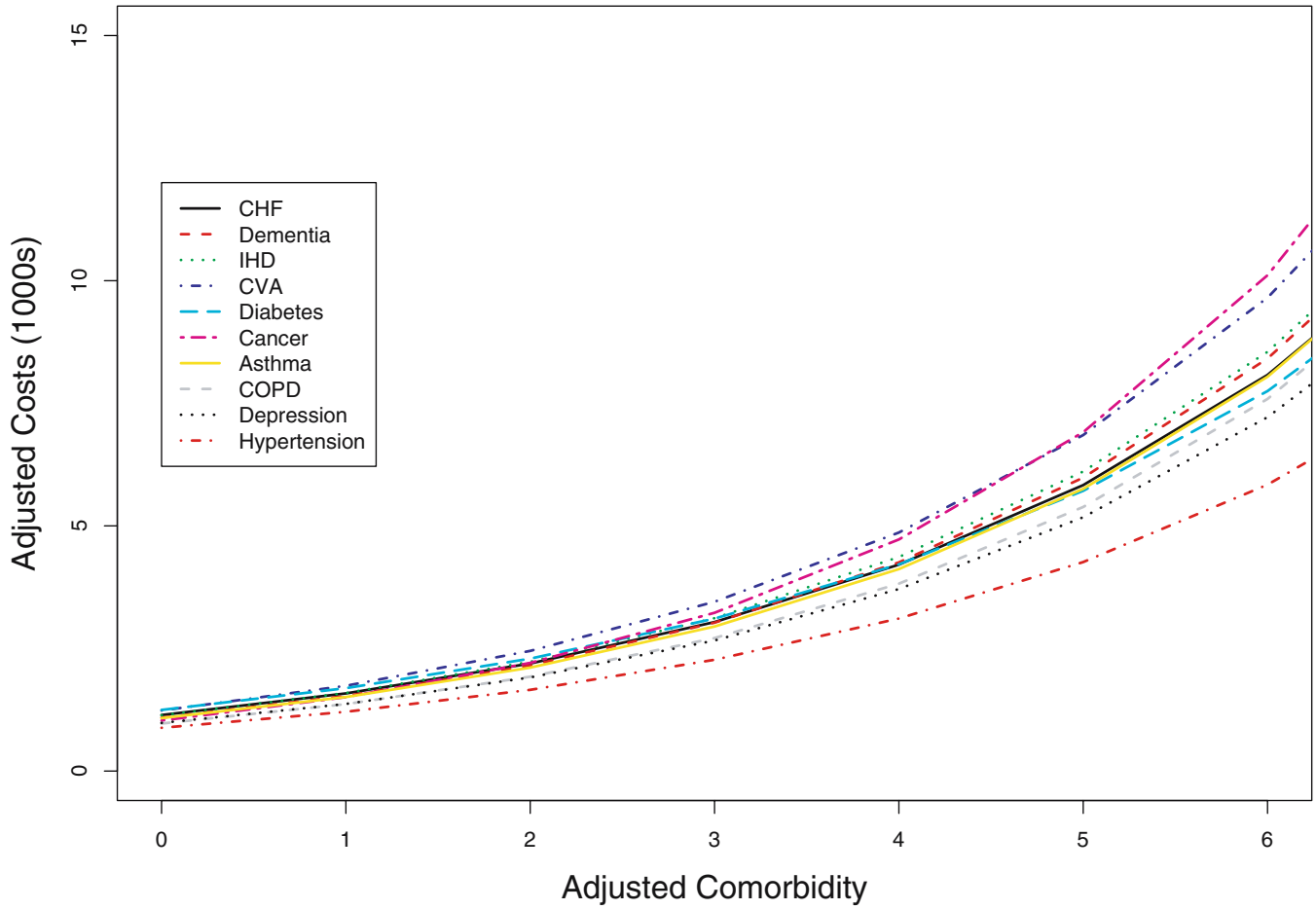

Figure 1. The adjusted cost of each chronic condition according the adjusted level of comorbidity (for a female of median age).

comorbidity. Nonetheless, patients with lower comorbidity scores (2 to 4) had similar adjusted costs, regardless of disease. Overall cost escalation follows a remarkably similar pattern with increasing comorbidity.

Figure 2 shows the distribution of patients' adjusted comorbidity scores conditioned on each disease. For the 478 patients with congestive heart failure, 129 (27%) had an adjusted comorbidity score of 0 (as follows from the definition of this score); 92 patients (19%) had an adjusted comorbidity score of 1, which means that each patient had some other disease with a weight of 1. The same trend occurred in patients with diabetes. Of a total population of 1,030 patients with diabetes, 355 (34%) had an adjusted comorbidity score of 0, while 189 (18%) had an adjusted comorbidity score of 1. Though significantly less in number, patients with higher levels of comorbidity accounted for a notable fraction of the overall costs of care, as noted above. The interesting thing to note is that the distribution of comorbidity scores remains essentially the same regardless of the base disease (see Fig. 2). In effect, the data suggests that higher costs are driven by the aggregate comorbidity burden, regardless of the specific diseases.

DISCUSSION

The goal of this study has been to examine the annual costs of chronic diseases often targeted by disease management programs. In this study, we found that unadjusted costs varied within a relatively narrow range ($1,100 to $1,600). There were only small differences between patients who had only 1 of the following conditions: congestive heart failure, dementia, ischemic heart disease, stroke, COPD, depression, and hypertension. The costs increased rapidly when patients had 2, 3, or 4 different comorbid conditions. The cost of care increased rapidly with increasing comorbidity, with a small percentage of patients (26%) with comorbidity $\geq$ 2 accounting for half (50%) the total costs.

Several other recent studies of the cost of various chronic diseases have shown some divergence in the actual cost figures.[15–17] Many reasons for such discrepancies exist including differences in the populations, and differences in cost-to-charge ratios. The cost of care at an academic institution such as ours may be different from other centers,[18,19] and medical services and their costs have been shown to exhibit geographic variation.[20,21] Because we did not use claims data, our study undoubtedly missed costs incurred outside New York Hospital, and our data also did not include expenditures related to prescription drugs or emergency room visits more easily captured in a claims-based system.

In our study, a small percentage of the patients accounted for a large percentage of the costs, a result that agrees with other studies on the costs of chronic illness. In some studies, perhaps as little as 10–20% of patients have accounted for more than 70–80% of the resources,[4,22] a result has been repeated in other studies that assess the costs of chronic illness.[16] Though not often specified, our results suggest that

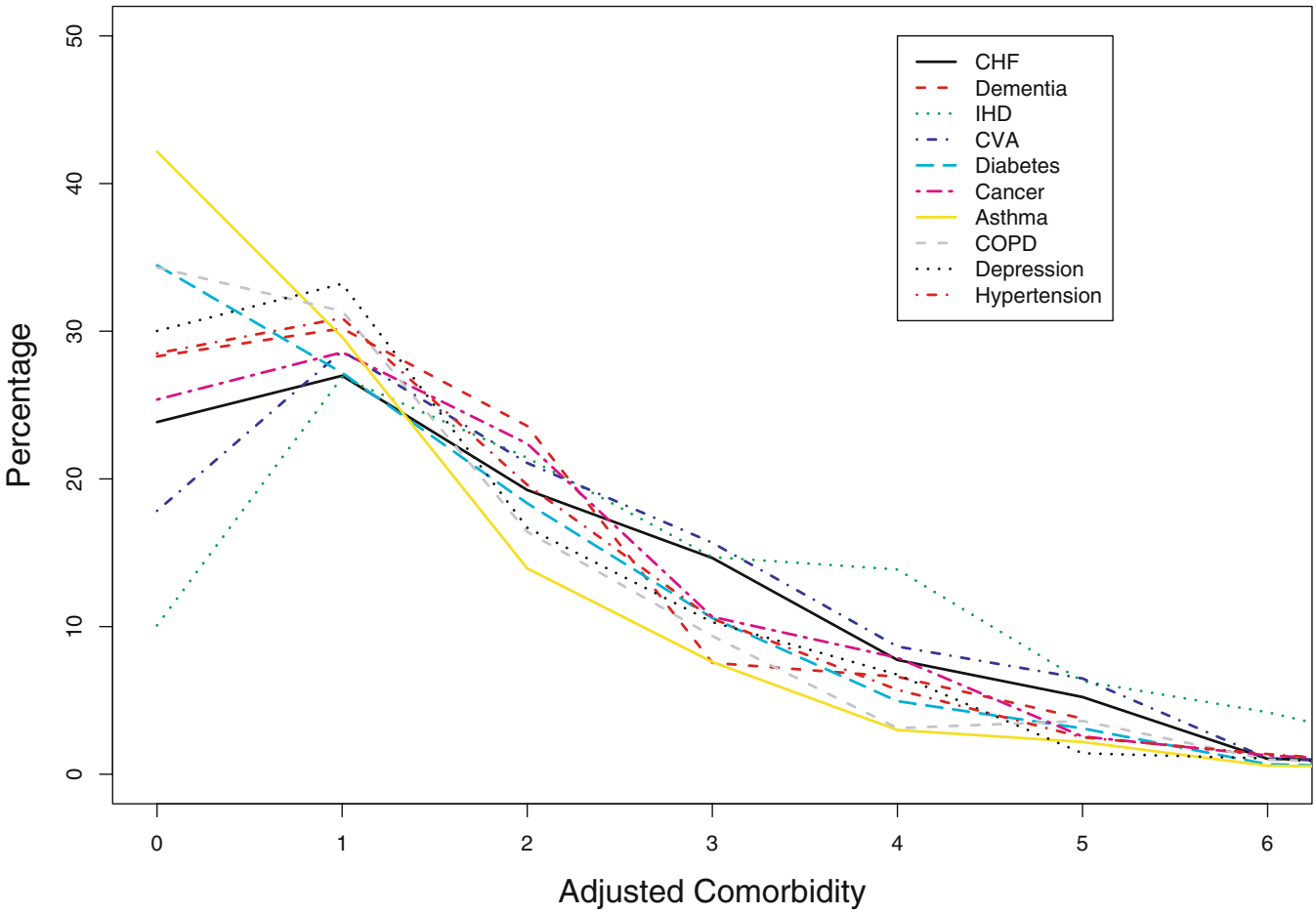

Figure 2. The distribution of patients' adjusted comorbidity scores for each disease. An adjusted comorbidity score of 0 always means the percent of patients with the stated disease only. Adjusted comorbidity scores greater than 0 indicate the percent of patients with a disease or diseases in additional to the stated disease.

patients with multiple coexisting conditions may represent that group of patients responsible for the lion's share of the overall costs of care.

The importance of measuring the cost of chronic disease in different settings bears directly on the future of disease management. Though evolving, disease management programs continue to be driven by the fundamental principle of providing quality health care at a reduced cost.[2,5,6] There is more evidence about improving outcomes than reducing costs.[23–27] Disease management has not shown consistent cost savings in randomized trials.[28,29] In fact, surprisingly few studies have actually evaluated the effect of disease management programs on health care utilization, and those that did, often reported modest or inconsistent findings.[30,31] Further complicating the picture of disease management, encouraging findings are often short term (within a 1-year window), and usually do not include the administrative costs of the disease management programs themselves.

It has been suggested that explanation for such contradictory results, at least in part, lies in the different populations enrolled in disease management programs mean to target.[2,3,32] To reduce costs, programs must target high-risk patient populations, where interventions targeted at reducing hospitalizations, emergency room visits, and the like, can theoretically lead to reduced resource utilization over a defined window. Enrollment of low risk patients in such programs is unlikely to show benefits. This emphasis on profitable subsets of the larger insured population has led several authors to raise questions concerning disease management's ability to focus on general disease prevention in relatively well patients, instead of short-term cost savings involving relatively sick ones.[2]

Our study, however, questions the ultimate ability of disease management programs to target patients most likely to drive overall resource utilization. Patients with multiple coexisting conditions present a major challenge to disease management, as they are not immediately suited to having a single protocol manage their care. Yet these same patients are the ones that, in our study, accounted for the majority of overall costs. As comorbidity score increased, cost of care increased exponentially; put intuitively, the more complex a patient, the more expensive the cost of care. Though some authors have suggested that disease management programs expand "horizontally", providing services for comorbid conditions in addition to primary disease,[6] there is currently no simple way to stack disease management programs for such complex patients. Recently, limitations and potential risks of applying clinical practice guidelines to patients with multiple comorbid diseases has been highlighted.[33] However, there is evidence that chronic disease self-management programs, developed by Lorig and colleagues and designed to enhance self-efficacy, may reduce utilization.[34–37]

Our study was limited by several factors. First, for each patient in the practice, not all costs were captured. Patients could have seen providers and undergone hospitalization outside of our practice and New York-Presbyterian Hospital. Second, certain disease groups, notably cancer, have cost data that is probably underrepresented. Specifically, the cost of cancer chemotherapy was not tracked by our cost accounting system, accounting for the relatively low cost of cancer patients in our study.

Ultimately, disease management programs have much to offer patients regarding empowering patients through education, improving medication management, and encouraging them to become active members in management of their disease. Indeed, the literature continues to show quality improvements with many disease-specific management programs. However, whether they offer significant promise to a changing health care payment system remains to be seen. To make a significant impact on health care costs, programs need to focus on the highest cost drivers in the system: patients with multiple coexisting conditions. Efforts to reduce cost must focus on patients with the highest aggregate comorbidity burden; our data suggests that specific combination for diseases matters less.

Conflict of Interest: *None disclosed*

Corresponding Author: *Mary Charlson, MD; Division of General Internal Medicine, Executive Director, Center for Complementary and Integrative Medicine, Weill Medical College of Cornell University, 525 East 68th Street, Box 46, New York, NY 10021, USA (e-mail: mecharl@med.cornell.edu).*

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