

Capitation payment: Using predictors of medical utilization to adjust rates

by Arnold M. Epstein and Edward J. Cumella

The current adjusted average per capita cost methodology has been strongly criticized because the subgroup classifications explain minimal interpatient variation in utilization, therefore providing incentives for biased selection. In this article, we review previous investigations of predictors of medical utilization that might be included in the adjusted average per capita cost: perceived health status, functional health status,

prior utilization, clinical descriptors, sociodemographic characteristics, and other miscellaneous patient characteristics. The existing data are analyzed to assess what is known about the relative strength of various predictors. Gaps in the available literature and the implications for future research and policy are discussed.

Introduction

Increasing enrollment of the elderly in health maintenance organizations (HMO's) has become a priority of the Medicare system. With this goal in mind, the Tax Equity and Fiscal Responsibility Act (TEFRA), passed by Congress in 1982, provided financial incentives for prepaid groups to enroll Medicare beneficiaries. TEFRA regulations stipulated that the capitation rate for HMO enrollees would equal 95 percent of the adjusted average per capita cost (AAPCC). Any surplus achieved by an HMO could be retained and used either to lower supplemental premiums paid to the HMO by enrolled Medicare beneficiaries or to expand the benefits offered to these beneficiaries.

To determine the AAPCC, the national average per capita cost for all Medicare beneficiaries is first multiplied by the ratio of per capita reimbursement in the counties in which an HMO operates to per capita reimbursement in the entire United States. This cost is then adjusted further for differences between characteristics of the HMO-enrolled and unenrolled beneficiaries who reside in the county. This latter adjustment is based on four factors, which are used to classify patients into 1 of 30 cells: age (65-69 years, 70-74 years, 75-79 years, 80-84 years, and 85 years or over); sex; institutional status (living in the community or not); and, if living in the community, eligibility for Medicaid. The extent of adjustment for the 30 different subgroups is based on a national survey of 5,000 Medicare enrollees performed in the years 1974-76 (Beebe, Lubitz, and Eggers, 1985; Gruenberg, 1982; Thomas et al., 1983).

As currently defined, the AAPCC methodology has come under strong criticism. Despite adjustment, substantial interpatient variation remains in the use of medical services within the 30 subgroups based on

age, sex, and welfare and institutional status. In several studies among elderly patients, the subgroup classifications of the AAPCC have been found to explain less than 1 percent of the interpatient variation in utilization (Anderson, 1983; Beebe, Lubitz, and Eggers, 1985; Lubitz, Beebe, and Riley, 1985).

Heterogeneity in utilization leads to important problems. First, by chance alone, HMO's could enroll a Medicare population that differs significantly from the average in long-term systematic utilization needs. In this case, HMO's would receive inappropriately high or low payment. This is more likely for HMO's that enroll only small numbers of Medicare beneficiaries and are not protected by the "law of large numbers" (McClure, 1984). If such HMO's are risk averse, they may have a strong disincentive to enroll Medicare patients. Probably a more significant problem is the strong incentive for providers to attempt biased selection, skimming out healthy patients by making access more difficult for sicker patients. HMO's might, for example, provide particular benefits (e.g., preventive health rather than homemaker services) or employ targeted advertising to attract a healthier population. Structuring benefits in particular ways, such as reducing coverage for home health services, might also encourage existing members who develop a chronic illness to disenroll from the plan. Unfortunately, sicker patients may be the ones who would benefit most from the type of coordinated care that can be offered through an HMO. Skimming not only leads to difficulties in access but may also increase Medicare costs, forcing the Government to overpay HMO's for the healthy patients who have enrolled while remaining responsible for the sicker population still under Medicare's direct purview. Such a situation would also raise the level of payment set by the AAPCC, as this would be based on the higher levels of utilization among the sicker population remaining in the fee-for-service sector.

One potential solution to the problem of heterogeneity is to find a group of factors that predict future utilization needs and can be used to define subgroups that are more homogeneous than the

This work was supported by the Department of Medicine (Division of General Medicine, Section on Health Services Research), Brigham and Women's Hospital, and the Department of Health Care Policy, Harvard Medical School; and the Department of Health Policy and Management, Harvard School of Public Health.

Reprint requests: Arnold M. Epstein, Department of Health Policy and Management, Harvard School of Public Health, 677 Huntington Avenue, Boston, Massachusetts 02115.

current AAPCC subgroups in their expected health care expenditures. Individual prepaid groups would then be more likely to receive appropriate payment for their enrollees, and incentives for adverse or favorable selection would be diminished.

Predictors of medical utilization that might be considered for inclusion in the AAPCC have been examined in more than 40 previous investigations. To our knowledge, no systematic and comprehensive review of this literature has been conducted to date. In this article, we first describe the general format of previous investigations and summarize their data on the predictive strength of the various factors. We then discuss practical considerations for modifying the AAPCC. Finally, we identify the most pressing gaps in the available information and consider the implications of the data for policy and future research.

Methods

Selection of studies

A systematic online bibliographic search of the National Library of Medicine's Medline files was performed to locate investigations of patient factors associated with medical utilization that were published from January 1, 1970, through December 31, 1985. We selected only studies that pertained to the utilization of services in an American or Canadian elderly population (at least 60 years of age) or contained separate analyses on an elderly subset of a broader population from these countries. By these means, we identified 34 investigations. In addition, we included eight related but unpublished investigations that were identified by tracing citations from the literature we located.

Measures and predictors of utilization

The different measures of medical utilization used in previous studies can be grouped into three categories: total dollars spent on medical care, use of hospital services, and use of ambulatory services. In most studies, total dollars spent have been measured as the amount of money reimbursed by the Medicare program during a particular year. Hospital services most commonly have been measured either by the number of hospital days or episodes in a particular period of time or by total dollars reimbursed under Part A of the Medicare program. Ambulatory services have been represented in most studies by the number of visits to a physician during a given period of time.

The sources of utilization data (detailed in Table 1) vary across studies. Of 45 data sets used in 42 studies, 49 percent (22 out of 45) were obtained from patient interviews (self-reports). Records from health care providers or third-party payers, which may be a more reliable source of data than patient interviews, were used in the remaining studies. Of these records, 31 percent were provided by the Medicare system and 20

percent by other third-party payers or health care providers.

In the 42 studies, numerous predictors of medical utilization were investigated. These predictors fall into six groups: perceived health status, functional health status, prior utilization, clinical descriptors, sociodemographic characteristics, and additional predictors. A detailed definition and discussion of predictors is provided later.

Availability and presentation of data

With the exception of data on prior utilization, most of the available data about predictors of utilization come from studies in which information about predictors was collected at the same time as information about utilization. Hence, the various measures are predictors only in a statistical sense. In examining predictors of medical utilization in previous investigations, both univariate and multivariate models have been employed. In the univariate models, predictors were examined for the strength of their uncontrolled association with measures of medical utilization (e.g., *t*-test and chi-square). In the multivariate models, a predictor was examined along with sociodemographic characteristics or indexes of health status as one of multiple predictors of utilization (e.g., ordinary least-squares regression analysis).

In the 42 studies, *t*-tests and multiple-regression analyses were the most widely used analytic techniques. Therefore, the only measure of predictive strength available in every study is the statistical significance of individual predictors (from either a regression coefficient or *t*-statistic). Use of statistical significance has substantial limitations, which are discussed later. However, because statistical significance is available for all studies, we focus on it in our initial review of the literature.

We attempted to utilize as much of the available information as possible. To avoid overrepresenting the information on statistical significance from the several studies in which the same predictors or measures of outcome were examined in multiple models, we adhered to several conventions. For studies in which multiple models of the same outcome were presented, the statistical significance of any predictor that was used in more than one model came from the model that explained the greatest proportion of variance. For example, if age and sex were used as predictors of hospital services in one multiple-regression model, and age and prior hospital charges were used as predictors of hospital services in a second multiple-regression model, the statistical significance of age as a predictor of hospital services was taken from whichever of these two models explained the greatest proportion of variance (R^2). In the few cases in which the proportion of variance explained was not given, statistical significance came from the model with the greatest number of predictors. In addition, different versions of the same outcome measure presented in any one study (e.g., number of physician visits scaled

Table 1
Summary of studies of predictors of medical utilization among the elderly

Study	Sample size	Patient population and source of data	Case-mix adjustment	Utilization examined	Predictors used
(1) Anderson and Knickman, 1984a	236,964	20-percent random sample from the 1974-77 Medicare History File	—	Mean 1976 and 1977 Medicare expenditures	Prior total expenditures; age, sex, Medicaid eligibility, extent of Medicare coverage, race
(2) Anderson and Knickman, 1984b	204,917	Same as (1)	Individuals with renal failure and those who died or left the program during 1974-77 were eliminated	1974-77 total Medicare expenditures standardized to 1974 dollars	Prior total expenditures, any prior hospitalization
(3) Anderson and Steinberg, 1984	270,266	1-percent national random sample of all Medicare beneficiaries enrolled at any time during 1974-77; American Hospital Association Annual Survey of Hospitals	Patients with end stage renal disease were excluded	Whether or not a patient was readmitted to the hospital during 60 days after discharge from an acute care hospital	Disability status; number of prior hospitalizations; surgery performed while in hospital; age, sex, urban residence, Medicaid eligibility
(4) Anderson and Steinberg, 1985	21,043	Same as (3), using every 20th data record	Same as (3)	Same as (3)	Disability status; number of readmissions for same diagnosis, having hospitalization for acute illness, surgery performed while in hospital; age, sex, Medicaid eligibility, race
(5) Anderson, 1983	11,970	Randomly selected subset of California, Texas, and Massachusetts beneficiaries from the 1974-77 Medicare History File	—	Relative Medicare cost factors for 1975 and 1976; number of hospitalizations	Limited activity; no prior use, number of prior hospitalizations, number of prior days in hospital, Part B use only; readmission for chronic illness; age, sex, urban residence
(6) Anderson et al., 1982	15,536	Subset of 1974 Los Angeles County residents from the 1-percent Medicare History File, 1974-77	Deceased, health maintenance organization enrollees, and those hospitalized for unknown diagnoses were excluded	1975 and 1976 total Medicare reimbursements	Prior Medicare Parts A and B payment, prior Medicare payment for physicians' services, skilled nursing, and home health, number of prior hospitalizations, number of prior days in hospital; hospitalization for simple diagnosis, hospitalization for complex diagnosis; age, sex, Medicaid eligibility
(7) Ash, 1985	22,727	Approximately 5-percent random sample from the 1979-80 Medicare History File	Deceased, those with chronic renal disease, those under 65 years of age, and those not eligible for both Parts A and B of Medicare were eliminated	1980 Medicare reimbursed costs	Disability status; prior total expenditures, prior Medicare Parts A and B payment, number of prior hospitalizations; age, sex, Medicaid eligibility

Table 1—Continued
Summary of studies of predictors of medical utilization among the elderly

Study	Sample size	Patient population and source of data	Case-mix adjustment	Utilization examined	Predictors used
(8) Beebe, Lubitz, and Eggers, 1985	20,773	0.1-percent sample of the Health Insurance Master Accretions File for October 1974 through September 1975; 1976 Medicare Person Summary File	Deceased, those under 65 years of age, and those not eligible for both Parts A and B of Medicare were eliminated	Total 1976 Medicare reimbursement	Any prior hospitalization, number of prior hospitalizations, Part B deductible met; age, sex, extent of Medicare coverage
(9) Branch et al., 1981	1,625	1974 Massachusetts Department of Health Survey of noninstitutionalized State residents 65 years of age or over	—	Numbers of hospital days, physician contacts, and ambulatory services used	Perceived health; activities of daily living, Rosow-Breslau physical activities index, ability to climb stairs, ability to walk 1/2 mile; existence of acute or chronic problem; age, sex, education, Medicaid eligibility, race, marital status, living alone, employment status, private insurance coverage, having regular doctor, income; transportation barriers
(10) Cantor and Mayer, 1976	1,552	New York City Office for the Aging 1970 survey of persons 60 years of age or over living in the 26 poorest inner-city neighborhoods	—	Numbers of hospitalizations and physician visits	Perceived health; sex, income, minority status
(11) Coulton and Frost, 1982	1,519	Cluster sample of noninstitutionalized Cleveland residents 65 years of age or over eligible for Medicare and Supplemental Security Income, 1975-76	—	Number of physician visits	Perceived health; age, sex, education, race, income, extent of Medicare coverage; psychic distress, social isolation, receiving case management
(12) Davis, 1975	Approximately 12,000	Sample of respondents 65 years of age or over from the National Center for Health Statistics 1969 Health Interview Survey	—	Numbers of hospitalizations, hospital days, and physician visits	Limited activity, restricted-activity days; existence of acute or chronic problem; age, sex, education, urban residence, Medicaid eligibility, race, employment status, income, family size
(13) Davis, 1976	Approximately 44 million	Subset of persons 65 years of age or over from National Center for Health Statistics data for July 1963 through June 1964; 1969 Medicaid data from 24 States	—	Total Medicaid expenditures, number of physician visits	Medicaid eligibility, race, income
(14) Davis and Reynolds, 1975	10,573	Subset of persons 65 years of age or over from the National Center for Health Statistics 1969 Health Interview Survey	Those for whom family income or education were unknown were excluded	Numbers of hospital days and hospitalizations, mean length of stay, numbers of physician visits in past 2 weeks and in past year	Limited activity, restricted-activity days; number of chronic problems; age, sex, education, Medicaid eligibility, race, income, family size

Table 1—Continued
Summary of studies of predictors of medical utilization among the elderly

Study	Sample size	Patient population and source of data	Case-mix adjustment	Utilization examined	Predictors used
(15) Eggers, 1981	13,634	5-percent random sample of aged Medicare beneficiaries living in 10 U.S. counties, 1978-79, from the Medicare Statistical System	—	1979 total Medicare reimbursements	Prior total expenditures; age, sex
(16) Evashwick et al., 1984	1,317	Massachusetts Health Care Panel Study, 1974-76, a statewide area probability sample of household residents 65 years of age or over	—	Whether hospitalized in past 15 months, numbers of physician visits and ambulatory services used in past 15 months	Perceived health; ability to walk 1/2 mile, ability to climb stairs, activities of daily living; existence of acute or chronic problem, having preventive physician visits; age, sex, education, Medicaid eligibility, race, marital status, living alone, income, private insurance coverage, having regular doctor, white-collar status; transportation barriers
(17) Eve and Friedsam, 1980	5,065	Proportionate quota sample of Texans 60 years of age or over in 13 areas of State	Those with any missing data were eliminated	Numbers of hospitalizations and physician visits	Perceived health; age, sex, education, urban residence, Medicaid eligibility, race, marital status, employment status, income, private insurance coverage, family size; transportation barriers
(18) Ferguson, Lee, and Wallace, 1976	1,384,816	Discharge information collected from 1965 through 1971 by 66 short-term voluntary non-Federal hospitals in Missouri; unit of analysis is the discharge	Those 65 years of age or over within 20 disease categories were retained	Percents of discharges and of total patient days, average length of stay	Relative severity of admission diagnosis, risk of dying from admission diagnosis; age
(19) Freeborn et al., 1977	708	Household interviews of a subset of a 5-percent sample of Oregon Region Kaiser-Permanente Medical Care Program members, continuously enrolled from January 1, 1969, through December 31, 1970	—	Number of outpatient contacts	Perceived health; index of physical symptoms; education, income, perceived social class; mental health status
(20) German, Skinner, and Shapiro, 1976	352	Random sample of households in 12 census tracts surrounding the Johns Hopkins Hospital in East Baltimore; survey conducted from March 1 through June 30, 1974	—	Percent seeing a health provider at least once in 6-month period	Age, sex, living alone, living in public housing

Table 1—Continued
Summary of studies of predictors of medical utilization among the elderly

Study	Sample size	Patient population and source of data	Case-mix adjustment	Utilization examined	Predictors used
(21) Gornick, 1977	Approximated: 33,788,667	20-percent sample of discharge records for Medicare population enrolled for Part A, 1967-73; unit of analysis is the discharge	—	Mean length of stay, number of discharges per 1,000 enrollees	Surgery performed while in hospital; age, sex, race
(22) Gruenberg, 1982	22,266	Persons 65 years of age or over from the 1977 Health Interview Survey	—	Numbers of acute hospital days and physician visits	Limited activity; age
(23) Hassinger and Hobbs, 1973	465	Interview data from 4 random cluster samples of households in 4 rural central Missouri communities	—	Numbers of persons hospitalized and physician visits	Income
(24) Haug, 1981	625	Persons 60 years of age or over interviewed in a national random sample by the National Opinion Research Center in 1978	—	Number of physician visits	Perceived health; existence of acute or chronic problem; age, sex, race, marital status, perceived social class; challenge of physician's authority
(25) Kasper and McCombs, 1985	43,612	Health maintenance organization (HMO) data for all Medicare enrollees in the Greater Marshfield Community Health Plan and the Fallon Community Health Plan, Massachusetts; Medicare data on a sample of nonenrollees in the market areas of these HMO's, 1980-83	Disabled and those under 65 years of age were excluded	Percent with hospital admission, number of days per admission, hospital charges	Age, sex
(26) Link, Long, and Settle, 1980	8,239	Persons 65 years of age or over from the 1976 Health Interview Survey	Those with missing data for income, education, or physician visits were excluded	Numbers of hospital days and physician visits	Existence of acute or chronic problem; Medicaid eligibility, private insurance coverage
(27) Link, Long, and Settle, 1982	Approximately 30,000	Persons 65 years of age or over from the 1969, 1974, and 1976 Health Interview Surveys	Those with missing data for income, education, or physician visits and those reporting noneligibility for Medicare were excluded	Numbers of hospital days and physician visits	Existence of acute or chronic problem; income
(28) Long and Settle, 1984	4,303; several thousand	1977 Current Medicare Survey; 1963-66 Health Interview Surveys	Those not reporting essential information were excluded	Annual numbers of physician visits and hospital days	Perceived health, existence of acute or chronic problem; age, urban residence, race, lives alone, income

Table 1—Continued

Summary of studies of predictors of medical utilization among the elderly

Study	Sample size	Patient population and source of data	Case-mix adjustment	Utilization examined	Predictors used
(29) Lopez-Aqueres et al., 1984	704	Comprehensive Assessment and Referral Evaluation Survey of Hispanic persons 60 years of age or over residing in Los Angeles County from Sept. 14, 1981, through April 30, 1982	—	Whether a physician was visited in past year	Age, sex, income, non-English speaking, uninsured
(30) Lubitz, Beebe, and Riley, 1985	20,773; 3,753	Same as (8); Current Medicare Survey, 1977	Same as (8)	Total 1976 Medicare reimbursements	Disability status, limited activity; any prior hospitalization, number of prior days in hospital, Part B deductible met; having hospitalization for chronic illness, repeated hospitalization for cancer, cardiac, or musculoskeletal problems; age sex, Medicaid eligibility
(31) Markides, Levin, and Ray, 1985	327	Household interview data from 1981-82 area probability sample of Mexican-Americans 65-80 years of age living in the San Antonio area	—	Number of physician visits in past year	Perceived health, number of chronic problems, index of physical symptoms; age, sex, education, private insurance coverage, marital status, employment status, income; worry over health
(32) McCall and Wai, 1983	72,576	Blue Cross/Blue Shield of Colorado Medicare claims data on aged continuously enrolled from October 1974 through December 1978; Health Care Financing Administration data on Medicare eligibility; Colorado Medicaid program data on Medicaid/Medicare coverage	Deceased and those not continuously enrolled in Parts A and B were excluded	Numbers of inpatient days, medical office visits, and medical relative value units	Prior total expenditures, numbers of prior days in hospital and prior physician visits, medical relative value units; age, sex, urban residence, Medicaid eligibility, race
(33) Pope, 1979	468	Medical record data for persons 65 years of age or over from subsample of adults from 5-percent random sample of families continuously enrolled in the Oregon component of the Kaiser-Permanente Medical Care Program during 1969 and 1970	—	Number of annual physician visits	Physician visit for emotion-related illness

Table 1—Continued

Summary of studies of predictors of medical utilization among the elderly

Study	Sample size	Patient population and source of data	Case-mix adjustment	Utilization examined	Predictors used
(34) Roos and Shapiro, 1981	2,526	1971 Manitoba Longitudinal Study on Aging interview data for various sizes of random samples of the elderly living in the community and in institutions; government data files on service utilization	Elderly in acute care hospitals and those with incomplete Health Insurance Commission Registry data were excluded	Numbers of days in hospital and physician visits	Perceived health; numbers of prior days in hospital and prior physician visits; numbers of acute and chronic problems; age, sex, income, type of residence
(35) Shapiro and Roos, 1985	2,422	Same as (38)	Deceased and those admitted to nursing home or hospital in 1970-71 were excluded	Number of physician visits	Perceived health, disability status; numbers of acute and chronic problems; age, sex, education, urban residence, marital status, income, income adequacy, has relatives living nearby; mental health status, interviewer-judged state of mind, proxy needed to complete interview
(36) Steel et al., 1982	150	Review of medical records of enrollees 65 years of age or over active in Home Medical Service, Boston, from March through May 1980	Institutionalized elderly were excluded	Number of home medical service contacts	Numbers of diseases diagnosed and prescription medications; age, race, lives alone, lives in public housing; whether various social support services were received
(37) Thomas et al., 1985	2,122	Medicare claims and 1982-83 survey data on Michigan Medicare beneficiaries	—	Standardized total Medicare charges, numbers of acute inpatient days and Part B claims	Perceived health, activities of daily living and instrumental activities of daily living scores; prior total expenditures, number of prior hospitalizations, number of prior emergency room visits, number of Part B claims; existence of specific chronic conditions, number of reported chronic conditions, hospitalization for simple or complex diagnosis; age, sex, education, Medicaid eligibility, income, institutional status, marital status
(38) Wan, 1982	1,987	Interview data from National Center for Health Services Research Community Survey of a multistage probability sample of occupied dwelling units in 5 U.S. low-income areas	—	Numbers of days in short-term hospitals and physician visits	Limited activity; number of acute health problems, number of episodic illnesses; race, income, uninsured, has regular doctor

Table 1—Continued
Summary of studies of predictors of medical utilization among the elderly

Study	Sample size	Patient population and source of data	Case-mix adjustment	Utilization examined	Predictors used
(39) Wan and Odell, 1981	1,182	1978 Baltimore City Department of Aging interview data from neighborhood canvassing and quota sampling of Baltimore County residents 60 years of age or over	—	Whether there was a hospitalization, numbers of hospital days and annual physician visits	Instrumental activities of daily living score, bed disability days; age, sex, education, Medicaid eligibility, marital status, lives alone, employment status, economic dependency, extent of Medicare coverage; depression, has social support, knowledge of services available, transportation barriers
(40) Wolinsky and Coe, 1984	15,899	Noninstitutionalized persons 60 years of age or over from the 1978 Health Interview Survey	—	Numbers of nights in hospital and physician visits	Perceived health, limited activity; body-mass ratio; age, sex, education, urban residence, Medicaid eligibility, race, employment status, income, private insurance coverage, has regular doctor, has telephone in home, lives alone, marital status
(41) Wolinsky et al., 1983	401	Interview data from a 2-stage random sample of noninstitutionalized persons 65 years of age or over living in south-central Metropolitan St. Louis	—	Any hospital episodes, numbers of emergency room visits and physician visits	Perceived health, activities of daily living and instrumental activities of daily living scores; nutritional risk, level of sensory functioning; age, sex, race, marital status, lives alone, income, private insurance coverage, has regular doctor, Duncan socioeconomic index; mental health status, mental limitations, locus of control, nutritional knowledge
(42) Wright, Berg, and Creecy, 1980	414	Interview data from random sample of low-income elderly residing in public housing in Milwaukee	—	Number of physician visits	Perceived health; bed disability days; numbers of acute or chronic problems; age, sex, education, race, marital status, has regular doctor, uninsured; morale

continuously and a binary measure coded 0 for no physician visits and 1 for one visit or more) were considered as one outcome. The statistical significance of predictors examined in relation to both versions of such outcomes again was taken from the model that explained the greatest proportion of variance. In some studies, more than one model were considered, each model having a different outcome measure but the

same predictors (e.g., age and sex as predictors of hospital services in one model and age and sex as predictors of ambulatory services in a second model). In such cases, the relationship of a predictor to one outcome measure was considered independent of the relationship of that predictor to the other outcome measure or measures, and the statistical significance of each relationship was therefore analyzed separately.

Finally, interaction terms were examined in only two studies. Therefore, they were excluded from the predictors reviewed.

Although emphasis on statistical significance enabled us to include the majority of results available from previous studies, it also had important limitations. First, levels of statistical significance depend on sample size, which varied across studies. (Sample size data are provided in Table 1.) This could bias the results against those predictors that were examined chiefly in smaller data sets, as the likelihood of a predictor reaching statistical significance is reduced in such cases. Second, with large data sets, predictors may reach statistical significance but explain only minimal amounts of interpatient variation. Reduction of variance, however, is a primary issue (from a statistical point of view) in reducing heterogeneity in the levels of utilization within groups of patients. Hence, models that incorporate statistically significant predictors can still make inaccurate predictions for subgroups of patients that are selected with bias. Third, levels of statistical significance depend on the number of predictors used in a model. This could bias the results against those predictors used primarily in larger multivariate models rather than in smaller multivariate or univariate models. Fourth, our inclusion of multiple outcomes from individual studies also introduced potential limitations, as some of the results were based on the same data and were therefore not statistically independent.

To address the limitations of the data based on statistical significance and to assess their accuracy, we considered two types of additional information. Before suggesting that a particular variable is a poor predictor of utilization because it did not often reach statistical significance in the studies we reviewed, we examined the sample size of the investigations that included this predictor. More importantly, we directly compared the explanatory power of different predictors through a second analysis focused only on the 13 investigations that included measures of univariate association between predictors and outcome measures. We examined correlation coefficients and chi-squares converted into correlation coefficients using standard methods (Rosenthal, 1984). These indicators of effect size have three important advantages: they are independent of sample size; they

are not influenced by the presence of differing numbers of additional variables, as in the multivariate models; and they can be directly equated with reduction in variance. We compared these latter results, based on effect size, with the results of the larger analysis based on statistical significance.

Results

Perceived health status

Perceived health status was examined in 15 studies. Information on this measure was commonly derived from the answer to a single question, such as, "Compared to other people your age, would you say that your health is excellent, good, fair, or poor?" The number of response categories given in this question varied across studies from two (e.g., good versus poor) to four. In addition, in two investigations (Coulton and Frost, 1982; Thomas et al., 1985), a rating of perceived health was based on answers to more than one question.

Information presented in Table 2 suggests that perceived health is generally a predictor of medical utilization. Of 27 predictive instances, perceived health reached statistical significance ($p < .05$) in 23 cases (85 percent). Although the predictive power of perceived health is evident for both hospital utilization and ambulatory utilization, it may be greater for the latter (67 percent versus 94 percent). This makes intuitive sense because the patient may have a larger role in the decision to see a physician than in the decision to be hospitalized. Not enough data exist to consider perceived health as a predictor of total medical costs.

In 25 of the 27 instances examined, perceived health was measured with a single question: in 16 instances, four rating choices were offered (excellent, good, fair, or poor), and in 9 instances, two or three choices were offered. Based on the data in Table 2, there appears to be little difference among questions with different numbers of response categories. In studies with a four-choice question, perceived health reached statistical significance 81 percent of the time (in 13 out of 16 studies). In studies that used a two- or three-choice question, statistical significance was reached 89 percent of the time (in eight out of nine studies).

Table 2
Summary of results in studies of perceived health

Specific predictors used	Total medical costs ¹	Hospital utilization ¹	Ambulatory utilization ¹	Maximum size of insignificant study ²	Summary of studies ³
Total	2/2	6/9	15/16	—	—
Single question: 2 choices	—	—	3/3	—	24, 35, 42
Single question: 3 choices	—	2/3	3/3	4,303	10, 17, 28
Single question: 4 choices	1/1	4/6	8/9	1,625	9, 16, 19, 31, 34, 40, 41
Series of questions	1/1	—	1/1	—	11, 37

¹Values represent the number of statistically significant ($p < .05$) results for a predictor over the number of instances in which it was tested.

²Numbers indicate sample size of the largest study in which a predictor was statistically insignificant ($p > .05$).

³See studies listed by number in Table 1.

Because it was used in only two investigations, there are limited data with which to compare the multiple-question approach to measuring perceived health with the single-question approach. In one investigation (Thomas et al., 1985), this comparison was examined directly by testing the predictive strength of a single-question four-choice measure with the strength of a measure based on nine questions. The single-question measure explained 2.4 percent of the variance in utilization, and the multiple measure explained roughly the same percentage (2.3 percent). In a second investigation (Coulton and Frost, 1982), also, a measure of perceived health based on a series of questions was used and found to be a significant predictor, but there is insufficient published information to contrast its predictive power with that of the single-question measures used in other studies.

Functional health status

Nine specific indexes of functional health status were examined in 17 studies. These nine measures can be grouped into three conceptual categories:

- Global, or single-question, measures of impaired function, such as whether the individual is disabled or limited in usual activities or mobility.
- Measures of impairment in specific functions or groups of specific functions, such as ability to climb stairs, to walk one-half of a mile, to perform physical activity, or to perform activities of daily living (ADL) and instrumental activities of daily living (IADL).
- Measures of the number of days in a specified period of time during which some limitation of activity was present, such as number of days with restricted activity or with bed disability.

An overall evaluation of Table 3 indicates that measures of functional health are fairly consistent predictors of medical utilization. In the 76 instances of prediction tested, functional health reached statistical significance 47 times (62 percent). Predictive ability seems to be comparable for hospital utilization (22 out of 35, or 63 percent) and ambulatory utilization (20 out of 34, or 59 percent). Functional health also reached significance five out of seven times (71 percent) when used to predict total medical expenditures.

Although all measures of functional health generally have been strong predictors of medical utilization, some differences may exist among the three categories of measures. For example, global measures of functional health reached significance in 21 out of 22 instances in which they were tested (95 percent). Measures of impairment to specific functions or groups of functions reached significance only 39 percent of the time (16 out of 41), and numbers of limited-activity days reached significance 77 percent of the time (10 out of 13).

It is interesting that single-question global measures of functional health seem to have predictive power that may be superior to that of two widely used measures in which multiple questions are employed—ADL and IADL. One explanation for this finding may be statistical artifact. Studies in which ADL and IADL were examined generally had smaller sample sizes. Another possible explanation relates to the purposes for which the various instruments were created. The Katz ADL (Katz et al., 1963) and the Older American Resources and Services Questionnaire (OARS) IADL (Duke University Center for the Study of Aging and Human Development, 1978), for example, were designed to measure change in specific

Table 3
Summary of results in studies of functional health

Specific predictors used	Total medical costs ¹	Hospital utilization ¹	Ambulatory utilization ¹	Maximum size of insignificant study ²	Summary of studies ³
Total	5/7	22/35	20/34	—	—
Global measures					
Disability status	2/2	1/2	1/1	21,043	3, 4, 7, 30, 35
Limited activity	1/1	10/10	6/6	—	5, 12, 14, 22, 30, 38, 40
Activity Impairment					
Ability to climb stairs	—	0/2	3/4	1,625	9, 16
Ability to walk 1/2 mile	—	2/2	0/4	1,625	9, 16
Activities of daily living scale	1/2	2/5	3/7	2,122	9, 16, 35, 37, 39, 41
Instrumental activities of daily living scale	1/2	1/5	1/4	2,122	16, 37, 39, 41
Rosow-Breslau physical activities Index	—	1/2	1/2	1,625	9, 16
Limited days					
Restricted-activity days	—	3/5	2/3	10,573	12, 14
Bed-disability days	—	2/2	3/3	—	39, 42

¹Values represent the number of statistically significant ($p < .05$) results for a predictor over the number of instances in which it was tested.

²Numbers indicate sample size of the largest study in which a predictor was statistically insignificant ($p > .05$).

³See studies listed by number in Table 1.

functions over time. These scales are likely to be especially sensitive for gauging outcomes such as the efficacy of therapy for a specific disability. Yet, as predictors of a general outcome such as medical utilization, the more encompassing, or global, measures of functional health might more effectively cover areas of personal health and health-related behaviors that are missed when using measures relying on questions about specific areas of function. The available literature does not enable us to clarify the relative importance of these explanations.

Prior utilization

Prior utilization was examined in 12 studies. It is considered to be an indirect measure of health status as well as other characteristics of individuals that contribute to their use of health services. Seventeen different measures of prior utilization were examined. Six were measures of prior medical costs (e.g., total dollars reimbursed under the Medicare program) and 11 were measures of the intensity of prior utilization (e.g., numbers of Medicare claims filed, hospitalizations, hospital days, or physician visits).

As shown in Table 4, prior utilization is a consistent predictor of subsequent utilization. In 12 investigations, measures of prior utilization reached statistical significance in 46 out of 51 instances (90 percent). Based on the available data, predictive ability appears to be consistent for total medical costs (38 out of 43, or 88 percent), hospital utilization (5 out of 5, or 100 percent), and ambulatory utilization (3 out of 3, or 100 percent). In addition, in multiple-regression models that included as many as four

measures of prior use, three of the four measures remained statistically significant (Ash, 1985). This suggests that the several indexes of prior utilization may measure different and independently predictive patient characteristics. Predictive ability also appears to hold regardless of whether prior utilization is measured in terms of medical costs (13 out of 16, or 81 percent) or intensity (33 out of 35, or 94 percent).

It should be noted, however, that in 5 of the 12 investigations in which the predictive power of prior utilization was examined (Anderson and Knickman, 1984a; Anderson and Knickman, 1984b; Anderson and Steinberg, 1984; Anderson, 1983; Anderson et al., 1982), data from the same source, the Medicare History File, were used. Therefore, the predictive power of prior utilization was demonstrated for only eight different data bases.

Clinical descriptors

Routine clinical and diagnostic information was considered in 25 investigations of medical utilization. The predictive information examined included direct measures of health problems (e.g., the existence of an acute or chronic health problem or numbers of specific acute or chronic problems) and indirect measures based on hospitalizations for specific diagnoses (e.g., whether there were any hospitalizations for chronic illness or complex diagnoses). Although the latter measures are similar to measures of prior utilization, they are classified here because the emphasis is on the existence of a particular clinical condition rather than on utilization alone.

Table 4
Summary of results in studies of prior utilization

Specific predictors used	Total medical costs ¹	Hospital utilization ¹	Ambulatory utilization ¹	Maximum size of insignificant study ²	Summary of studies ³
Total	38/43	5/5	3/3	—	—
Prior costs					
Total expenditures	9/9	—	—	—	1, 2, 7, 15, 32, 37
Medicare Part A costs	2/2	—	—	—	6,7
Medicare Part B costs	2/2	—	—	—	6,7
Medicare costs for physicians' services	0/1	—	—	15,536	6
Medicare home health costs	0/1	—	—	15,536	6
Medicare costs for skilled nursing facility services	0/1	—	—	15,536	6
Intensity of prior use					
No use	1/1	—	—	—	5
Any hospitalization	2/2	3/3	—	—	2, 8, 30
Number of hospitalizations	8/8	—	—	—	3, 5, 6, 7, 8, 37
Number of days in hospital	5/6	2/2	—	72,576	5, 6, 7, 30, 32, 34
Number of emergency room visits	1/1	—	—	—	37
Part B use only	5/5	—	—	—	5, 6
Part B deductible met	2/2	—	—	—	8, 30
Number of Medicare Part B claims	1/1	—	—	—	37
Number of prior home health visits	0/1	—	—	22,727	7
Number of prior physician visits	—	—	2/2	—	32, 34
Medical relative value units	—	—	1/1	—	32

¹Values represent the number of statistically significant ($p < .05$) results for a predictor over the number of instances in which it was tested.

²Numbers indicate sample size of the largest study in which a predictor was statistically insignificant ($p > .05$).

³See studies listed by number in Table 1.

In the 25 studies, clinical descriptors were tested as predictors of utilization in 69 instances (Table 5). They reached statistical significance in 57 of these instances (83 percent). The predictive patterns were similar for the three outcomes, with clinical descriptors reaching statistical significance 94 percent of the time as predictors of total medical expenditures, 83 percent of the time for hospital utilization, and 75 percent of the time for ambulatory utilization. In addition, this consistent predictive ability appears to hold for both types of clinical descriptors, with information on health problems reaching significance in 40 out of 51 instances (78 percent) and information on specific hospital incidents reaching significance in 17 out of 18 instances (94 percent).

Sociodemographic characteristics

Investigations of medical utilization have commonly included patients' sociodemographic characteristics as predictors. Of the 42 studies reviewed in this article, the effect of sociodemographic factors on utilization was examined in all but 2 (95 percent). Altogether, 25 different measures of patient sociodemographic characteristics were considered, including 7 basic

demographic categories (age, sex, race, educational attainment, institutional status, primary language, and urban versus suburban residence), 14 measures related to economic standing (e.g., income, welfare status, and perceived social class), and 4 related to family structure (e.g., marital status and family size).

As shown in Table 6, sociodemographic characteristics were statistically significant predictors of medical utilization in 44 percent of the instances examined (185 out of 419). The individual predictive categories vary somewhat, with sociodemographic characteristics reaching statistical significance 69 percent of the time (31 out of 45) as predictors of total medical costs, 38 percent of the time (68 out of 180) as predictors of hospital utilization, and 44 percent of the time (86 out of 194) when predicting ambulatory utilization. Basic demographic characteristics reached statistical significance 50 percent of the time (106 out of 212); measures of economic standing, 43 percent of the time (68 out of 157); and measures of family structure, only 22 percent of the time (11 out of 50).

A separate examination of the four sociodemographic characteristics currently used in the AAPCC (i.e., age, sex, institutional status, and eligibility for Medicaid) suggests that, as predictors of

Table 5
Summary of results in studies of clinical descriptors

Specific predictors used	Total medical costs ¹	Hospital utilization ¹	Ambulatory utilization ¹	Maximum size of insignificant study ²	Summary of studies ³
Total	16/17	20/24	21/28	—	—
Conditions					
Acute or chronic problem	3/4	4/4	10/12	2,122	9, 12, 16, 24, 26, 27, 28, 35, 37
Number of acute and chronic problems	—	1/1	2/3	2,422	34, 35, 42
Number of acute problems	—	1/1	1/1	—	38
Number of chronic problems	1/1	2/3	2/3	10,573	14, 31, 37
Number of diseases diagnosed	—	—	1/1	—	36
Number of episodic illnesses	—	1/1	1/1	—	38
Number of prescription medications	—	—	1/1	—	36
Index of physical symptoms	—	—	1/2	708	19, 31
Level of sensory functioning	—	0/2	0/1	401	41
Body-mass ratio	—	1/1	—	—	40
Nutritional risk	—	2/2	1/1	—	41
Preventive physician visits	—	1/1	1/2	1,317	16
Relative severity of admission diagnosis	—	1/1	—	—	18
Risk of dying from admission diagnosis	—	1/1	—	—	18
Hospitalizations					
Hospitalization for acute illness	—	1/1	—	—	4
Hospitalization for chronic illness	3/3	—	—	—	5, 30
Readmission for chronic diagnosis	4/4	—	—	—	5
Hospitalization for simple diagnosis	2/2	—	—	—	6, 37
Hospitalization for complex diagnosis	2/2	—	—	—	6, 37
Readmission for cancer, cardiac, or musculoskeletal problems	1/1	—	—	—	30
Number of readmissions for same diagnosis	—	0/1	—	21,043	4
Surgery performed while in hospital	—	4/4	—	—	3, 4, 21

¹Values represent the number of statistically significant ($p < .05$) results for a predictor over the number of instances in which it was tested.

²Numbers indicate sample size of the largest study in which a predictor was statistically insignificant ($p > .05$).

³See studies listed by number in Table 1.

health services utilization, these variables fare about as well as sociodemographic characteristics in general. The four AAPCC factors reached statistical significance 50 percent of the time, compared with 44 percent of the time for all sociodemographic characteristics taken together.

Additional predictors

Several other predictors of medical utilization were used in a small number of studies. These include measures of psychological or mental status (e.g., scales of depression, psychic distress, general mental health), use or existence of social supports (e.g., receipt of Visiting Nurse Association or homemaker assistance, degree of social isolation), and other variables presumed to influence an individual's utilization of medical services (existence of transportation barriers, knowledge of community services or nutrition).

Overall, 21 different predictors were considered in 12 studies (Table 7). Statistical significance was

reached by these predictors in 16 out of 48 instances (33 percent). Taken as a group, these predictors seem to fare better in relation to ambulatory services (reaching significance 48 percent of the time) than in relation to hospital services (reaching significance twice in 19 instances). The data for the prediction of hospital services are limited, however, as they are based on only three investigations (Branch et al., 1981; Wan and Odell, 1981; Wolinsky et al., 1983), none with a large sample size. In no studies in the group were total medical expenditures predicted.

Comparison of predictor groups

Comparing the explanatory power of the six groups of predictors is not straightforward. We attempted to do this in two ways.

Results based on statistical significance

Clearly, based on the percentage of statistically significant results, perceived health, functional health,

Table 6
Summary of results in studies of sociodemographic characteristics

Specific predictors used	Total medical costs ¹	Hospital utilization ¹	Ambulatory utilization ¹	Maximum size of insignificant study ²	Summary of studies ³
Total	31/45	68/180	86/194	—	—
Basic sociodemographic characteristics					
Age	11/11	16/28	11/24	72,576	1, 3-9, 11, 12, 14, 15-18, 20, 21, 24, 25, 28-32, 34-37, 39, 40-42
Sex	8/11	9/24	9/21	236,904	1, 3-12, 14, 15-17, 20, 21, 24, 25, 29-32, 34, 35, 37, 39, 40-42
Educational attainment	0/1	1/11	5/15	15,899	9, 11, 12, 14, 16, 17, 27, 31, 35, 37, 39, 40, 42
Institutional status	0/1	0/1	1/1	2,526	34, 37
Urban residence	3/4	3/8	3/8	72,576	3, 5, 12, 13, 17, 28, 32, 35, 40
Race	2/3	12/18	12/20	236,964	1, 4, 9-14, 16, 17, 21, 24, 28, 32, 36, 38, 40, 42
Non-English speaking	—	0/1	0/1	704	29
Economic standing					
Income	1/2	13/23	13/28	15,899	9-14, 16, 17, 19, 23, 27-29, 31, 34, 35, 37, 38, 40, 41
Welfare status/Medicaid	2/7	4/15	8/13	72,576	1, 3, 4, 6, 7, 9, 12, 14, 16, 17, 26, 30, 32, 37, 39, 40
Income adequacy	—	—	0/1	2,422	35
Economic dependency	—	0/2	0/1	1,182	39
Lives in public housing	—	—	0/2	352	20, 36
Uninsured	2/2	0/2	2/3	1,987	29, 38, 42
Extent of Medicare coverage	1/2	0/1	1/1	236,964	1, 8, 11, 39
Has private insurance	—	1/6	2/8	15,899	9, 11, 16, 17, 26, 31, 40, 41
Has regular doctor	—	3/6	6/8	1,625	9, 16, 38, 41, 42
Has telephone in home	—	1/1	1/1	—	40
Unemployed	—	3/7	3/7	15,899	9, 12, 17, 31, 39, 40
Occupational prestige	—	0/2	0/1	401	41
White collar	—	0/1	0/2	1,317	16
Perceived social class	—	—	1/2	708	19, 24
Family support					
Family size	—	0/6	2/4	5,065	12, 14, 17
Lives alone	—	1/9	2/9	15,899	9, 16, 20, 28, 36, 39, 40, 41
Marital status	1/1	1/8	4/12	15,899	9, 16, 17, 24, 31, 35, 37, 39, 40-42
Has relatives living nearby	—	—	0/1	2,422	35

¹Values represent the number of statistically significant ($p < .05$) results for a predictor over the number of instances in which it was tested.

²Numbers indicate sample size of the largest study in which a predictor was statistically insignificant ($p > .05$).

³See studies listed by number in Table 1.

prior utilization, and clinical descriptors appear to be strong predictors of utilization. In each group, statistical significance was reached approximately two-thirds of the time or more. On the other hand, sociodemographic characteristics and additional predictors reached statistical significance in less than one-half of the instances examined. The poorer predictive power of the sociodemographic variables does not appear to be related to sample size, as these predictors were examined in many of the larger studies and nevertheless failed to reach statistical significance. (Note the relatively large sample sizes in the last column of Table 6.) To more accurately compare the six predictor groups, we performed a second analysis.

Results based on correlational data

Because the previous results depend in part on sample size, on the number of predictors included in multivariate models, and on the number of outcome measures examined in individual studies, all of which vary, we compared the explanatory power of the predictor groups in a more direct way. We examined the magnitude of association between predictors and outcome measures using correlation coefficients, which are independent of both sample size and the number of predictors in a model. Reduction of variance (R^2) can be calculated directly from such data.

In Table 8, we present correlation coefficients from 13 studies for which they were available (Anderson, 1983; Ash, 1985; Freeborn et al., 1977; Gruenberg, 1982; Hassinger and Hobbs, 1973; Haug, 1981; Kasper and McCombs, 1985; Lopez-Agueres et al., 1984; Markides, Levin, and Ray, 1985; Roos and Shapiro, 1981; Shapiro and Roos, 1985; Thomas et al., 1985; Wright, Berg, and Creecy, 1980). These data reflect a pattern that is roughly similar to the pattern of results based on statistical significance. Prior utilization was the strongest predictor, with mean correlations ranging from .24 to .40, depending on the outcome examined. This is equivalent to a reduction in variance of approximately 6-16 percent. Perceived health, functional health, and clinical descriptors also generally predicted utilization well. Sociodemographic characteristics again generally predicted utilization poorly, with mean correlations ranging from .02 to .05, depending on the outcome examined. Although 9 out of 58 correlations between sociodemographic characteristics and medical utilization were greater than .10, the predictive strength of individual characteristics was variable and did not suggest that any particular sociodemographic characteristic was a strong predictor. Although the data are sparse, the four sociodemographic factors that are currently used in the AAPCC appeared to correlate with utilization no better than all sociodemographic characteristics taken together. Finally, when taken as a group, additional predictors

Table 7
Summary of results in studies of additional predictors

Specific predictors used	Hospital utilization ¹	Ambulatory utilization ¹	Maximum size of insignificant study ²	Summary of studies ³
Total	2/19	14/29	—	—
Mental health				
Depression	1/2	1/1	1,182	39
Poor mental health	0/2	2/3	401	19, 35, 41
Mental limitations	0/2	0/1	401	41
Psychic distress	—	0/1	1,519	11
Interviewer-judged state of mind	—	1/1	—	35
Proxy needed to complete interview	—	0/1	2,422	35
Morale	—	0/1	2,422	35
Has physician visit for emotional diagnosis	—	1/1	—	33
Challenges physician authority	—	1/1	—	24
Locus of control	0/2	0/1	401	41
Worry over health	—	0/1	327	31
Social support				
Social isolation	—	1/2	2,422	11, 35
Received case management	—	1/1	—	11
Received social support services	—	1/1	—	36
Received Visiting Nurse Association assistance	—	1/1	—	36
Received home health aid services	—	1/1	—	36
Received homemaker services	—	0/1	150	36
Has social support	0/2	0/1	1,182	39
Other				
Knowledge of services available	0/2	0/1	1,182	39
Nutritional knowledge	0/2	0/1	401	41
Transportation barriers	1/5	3/6	5,065	9, 16, 17, 39

¹Values represent the number of statistically significant ($p < .05$) results for a predictor over the number of instances in which it was tested.

²Numbers indicate sample size of the largest study in which a predictor was statistically insignificant ($p > .05$).

³See studies listed by number in Table 1.

again appeared to be rather weakly associated with medical utilization. However, in four studies (Freeborn et al., 1977; Hassinger and Hobbs, 1973; Shapiro and Roos, 1985; Wright, Berg, and Creecy, 1980) that included correlations of indexes of mental health and ambulatory utilization, several of the associations were of moderate strength (poor mental health—.06, .24, .37; worry over health—.13; morale—.06). No information is available about the univariate association of these predictors with hospital utilization or total medical costs.

Potential modifiers, practical considerations

Based on the comparison of predictors, it appears that the AAPCC formula could be improved by including new factors. In the current AAPCC, only four sociodemographic characteristics, which predict total medical utilization relatively poorly, are used. It is therefore of interest to consider the possibility of modifying the AAPCC to include factors from the groups of predictors that are more strongly associated with total medical utilization.

Characteristics of predictors that might facilitate their use as modifiers of the AAPCC have previously been delineated (Lubitz, 1985; McCall and Wai, 1983; Thomas et al., 1983; Welch, 1985).

- They should strongly predict utilization and so define a system of adjustment in which the cells are relatively homogeneous.
- Data on predictors should be easy to collect and not entail significant financial expense or administrative difficulty.
- Predictors should be easy to monitor and difficult to manipulate by providers who have an incentive to influence capitation rates.
- They should not provide incentives for inefficient care.

Thus far, we have considered the predictive strength of the various types of factors. Because measures of perceived health, measures of functional health, and prior utilization and clinical descriptors appear to be the strongest predictors of those reviewed, we will

consider these four predictors in terms of the other characteristics.

In terms of ease of collection, all four predictor groups have drawbacks. No information on perceived health status is currently available in Medicare data bases. To collect such information, a new administrative framework would need to be established for interviewing Medicare beneficiaries. However, because perceived health status can probably be ascertained from the answer to a single question, patient interviews would not be lengthy. Information on functional health status is also not available in current Medicare data bases, with the exception of one datum on whether an elderly beneficiary previously received disability payments. Because other measures of functional health status may be more powerful predictors of utilization, the incorporation of functional health measures in the AAPCC would also likely require beneficiary interviews and so entail a new administrative framework. In addition, questionnaires used to determine functional health might be more complex and lengthy than those used for perceived health. Although data on prior utilization are available for beneficiaries who have been enrolled in Medicare for more than 1 year, no data are available for new elderly enrollees (i.e., patients just reaching 65 years of age) or those receiving care through an HMO. Collecting such data would entail new administrative expenses, and it might be especially difficult to collect data on new enrollees. Finally, clinical and diagnostic data (9th Revision International Classification of Diseases, or ICD-9, codes) are easily available only for beneficiaries who have been hospitalized. Other useful data, such as data on the existence of a chronic condition requiring ongoing ambulatory care, might need to be collected at additional administrative cost. Collecting new data of any sort, however, need not be undertaken for all Medicare beneficiaries; predictive data collected for a representative subset of the Medicare population could be used to determine adjustments to the AAPCC for different HMO's.

Three predictor groups probably would have shortcomings in terms of ease of monitoring and the potential for manipulation. If perceived or functional

Table 8
Magnitude of association between predictor groups and outcomes

Predictor group	Total medical costs			Hospital utilization			Ambulatory utilization		
	Mean correlation	Minimum and maximum correlations	Number of correlations	Mean correlation	Minimum and maximum correlations	Number of correlations	Mean correlation	Minimum and maximum correlations	Number of correlations
Perceived health	.15	(.15,.15)	2	.15	(.15,.15)	1	.21	(.05,.34)	6
Functional health	.12	(.01,.18)	4	.14	(.14,.14)	1	.10	(.01,.24)	3
Prior utilization	.24	(.19,.32)	6	.28	(.28,.28)	1	.40	(.40,.40)	1
Clinical descriptors	.14	(.10,.19)	3	.14	(.10,.17)	2	.20	(.06,.35)	6
Sociodemographic characteristics	.02	(.00,.03)	3	.05	(.01,.15)	13	.05	(.001,.17)	42
Additional predictors	—	—	—	—	—	—	.11	(.01,.37)	9

health status were included in the AAPCC, providers would have an incentive to influence members to report poorer health in response to Medicare interview questions. If clinical information were included in the AAPCC, more extensive and opportunistic coding of diagnoses might take place, similar to the phenomenon seen with hospital payment based on diagnosis-related groups ("DRG creep"). Only prior utilization appears to be relatively free of these problems. Prior utilization data based on Medicare claims or HMO records would be accurate, and we doubt that there would be sufficient incentive to induce provider manipulation.

In terms of incentives for inefficient care, all four predictor groups might present problems. Payments based on ratings of perceived or functional health status and even possibly those based on clinical indicators might ironically reward providers that offer poorer quality care because capitation rates for patients receiving poorer quality care would be higher if such care led to diminished health status. If payments were based on prior utilization data, those HMO's that provided greater numbers of services with less efficiency would receive higher capitation payments in subsequent years and therefore have less incentive to modify this practice. However, we doubt that the incentive here is substantial enough to affect behavior, especially if use of hospital services or total cost of care is the index by which payment is modified. On the other hand, the use of clinical information in the AAPCC could produce an incentive for providers to diagnose more illnesses. This could be medically advantageous to Medicare beneficiaries.

The relative importance of the administrative strengths and weaknesses of the four predictor groups needs to be evaluated carefully, especially in relation to the explanatory power of specific predictors.

Future research and policy implications

Because most of the investigations of medical utilization were not specifically directed toward modifying the AAPCC, the literature has several important gaps. It appears that individual predictors explain only limited amounts of interpatient variation. Our ability to improve on the current formulation of the AAPCC may be minimal; however, several strategies could be explored. Because the strength of individual predictors appears to be small, it is probably important to use them in combination. Although, in some studies, the cumulative explanatory power of predictors from several predictor groups was examined in relation to total medical costs, this has not been done systematically. In none of the studies was the combined explanatory power of measures from the four predictor groups that have performed best examined.

Interaction effects have also received too little attention. In promising work, Ash and colleagues are now examining the combination of prior hospital

utilization and specific medical conditions that might be especially predictive of subsequent utilization (Ash et al., 1987). Conceivably, this approach could be expanded profitably across other predictors. Another related approach, published subsequent to the period of this review, involves the combination of prior utilization and discretionary versus nondiscretionary medical conditions. The concept is that hospitalizations for a particular condition in which the decision to hospitalize is relatively nondiscretionary may be a more accurate gauge of patient health status and future resource needs than discretionary hospitalizations are (Anderson et al., 1986). Finally as noted earlier, it was suggested in some previous studies that indexes of mental health may be strongly correlated with ambulatory utilization. We should obtain similar information on the association of such indexes with total medical costs.

Because most of the previous studies were performed for purposes other than developing a reimbursement formula, the analytic information available is of limited use. The statistical significance of a predictor is the measure most generally available from previous studies. Less often is there information about reduction in variance, and only a few researchers (Beebe, Lubitz, and Eggers, 1985; Ash et al., 1987) have employed simulations to evaluate the ability of predictive models to make accurate predictions for subgroups of patients who might elect to join an HMO or be otherwise biased.

Questions about the reliability of available information also exist. We know of only one U.S. investigation (Thomas et al., 1985) in which data on perceived or functional health status obtained from patient interviews was examined in relation to hard data on utilization (e.g., data provided by third-party payers). In most studies, the predictors and utilization data examined were obtained from the same patient interview. Conceivably, this may have led to a positive bias in the assessment of explanatory power for perceived and functional health status.

Little information is available on the extent of administrative difficulty likely to be incurred in collecting information on alternative predictors. For example, no information is available on the cost of obtaining prior utilization data for patients in HMO's relative to the cost of interviewing Medicare beneficiaries to determine their health status. In addition, little information is available on the tradeoffs between multi-item health status instruments and simpler instruments in terms of predictive power and interview costs.

We also lack knowledge of the predictive stability of most health status measures. As we noted earlier, in most of the studies providing information on perceived and functional health status, data on patients' status and utilization were collected during the same interview. Hence, the analyses really provide information about explanatory power rather than predictive power. Although it seems likely that the predictive power of any measure will decay over time, some measures may be much more stable than others.

Clearly, it would be useful to have information about the relative stability of various measures, both for guiding the choice among alternatives and for estimating how frequently a particular measure should be updated.

Finally, only three studies (Freeborn et al., 1977; Kasper and McCombs, 1985; Pope, 1979) have been focused on HMO settings. Because a modified AAPCC would be used to pay for beneficiaries enrolled in prepaid groups, understanding the relationship of the various predictors to utilization in HMO settings is critical. We know that patterns of care, particularly rates of hospitalization, differ substantially between prepaid groups and fee-for-service settings. The relationships of various predictors with utilization may also differ between HMO's and fee-for-service settings. The current method of payment, based on what beneficiaries would have cost in the fee-for-service sector, has legislative sanction. However, one might posit an alternative model, namely, that the standard for payment be based on the cost of caring for beneficiaries (appropriately adjusted for their need characteristics) in an HMO rather than in the fee-for-service sector.

Based on this review, it appears that our ability to evaluate predictors as potential modifiers of the AAPCC would be enhanced if future studies of medical utilization were to include several elements. To the extent possible, investigations should include multiple predictors examined in both HMO and fee-for-service populations. Long-term followup should also be attempted. Analysis should include statistical considerations, such as determining the strength of individual predictors, their interaction effects, their cumulative ability to explain interpatient variance in medical utilization, and their ability to predict accurately future costs for groups of patients that are nonrandomly selected. Finally, the cost of data collection and the reliability of measures that eventually might be used to modify the AAPCC should be examined.

References

- Anderson, G., and Knickman, J.: Adverse selection under a voucher system: Grouping Medicare recipients by level of expenditure. *Inquiry* 21(2):135-143, Summer 1984a.
- Anderson, G., and Knickman, J.: Patterns of expenditures among high utilizers of medical care services. *Medical Care* 22(2):143-149, Feb. 1984b.
- Anderson, G., and Steinberg, E.: Hospital readmissions in the Medicare population. *New England Journal of Medicine* 311(21):1349-1353, Nov. 22, 1984.
- Anderson, G., and Steinberg, E.: Predicting hospital readmissions in the Medicare population. *Inquiry* 22(3):251-258, Fall 1985.
- Anderson, G. F., Cantor, J. C., Steinberg, E. P., and Holloway, J.: Capitation pricing: Adjusting for prior utilization and physician discretion. *Health Care Financing Review*. Vol. 8, No. 2. HCFA Pub. No. 03226. Office of Research and Demonstrations, Health Care Financing

Administration. Washington. U.S. Government Printing Office, Winter 1986.

Anderson, J.: Use of Medicare History in Designing Medicare Capitation. Paper presented at the Annual Meeting of the American Public Health Association. Dallas. Nov. 13-17, 1983.

Anderson, J., Resnick, A., English, P., and Gertman, P.: Prediction of Subsequent Year Reimbursement Using the Medicare History File: Results from the Preliminary Model. Paper presented at the Adjusted Average Per Capita Cost Advisory Meeting of the Health Care Financing Administration. Washington, D.C. May 7, 1982.

Ash, A.: Predicting Costs for Non-Randomly Selected Medicare Populations: Doing Better with Prior Utilization Data. Draft report. Health Care Research Unit, Boston University Medical School. Boston. 1985.

Ash, A., Porell, F., Gruenberg, L., et al.: *Adjusting Medicare Capitation Payments Using Prior Hospitalization*. Contract No. 18-C-98526-1-032. Prepared for Health Care Financing Administration. Boston. Health Policy Consortium, 1987.

Beebe, J., Lubitz, J., and Eggers, P.: Using prior utilization to determine payments for Medicare enrollees in health maintenance organizations. *Health Care Financing Review*. Vol. 6, No. 3. HCFA Pub. No. 03198. Office of Research and Demonstrations, Health Care Financing Administration. Washington. U.S. Government Printing Office, Spring 1985.

Branch, L., Jette, A., Evashwick, C., et al.: Toward understanding elders' health service utilization. *Journal of Community Health* 7(2):80-92, Winter 1981.

Cantor, M., and Mayer, M.: Health and the inner city elderly. *The Gerontologist* 16(1):17-25, Feb. 1976.

Coulton, C., and Frost, A.: Use of social and health services by the elderly. *Journal of Health and Social Behavior* 23(4):330-339, Dec. 1982.

Davis, K.: Equal treatment and unequal benefits: The Medicare program. *Health and Society* 53(4):449-489, Fall 1975.

Davis, K.: Medicaid payments and utilization of medical services by the poor. *Inquiry* 13(12):122-135, June 1976.

Davis, K., and Reynolds, R.: Medicare and the utilization of health care services by the elderly. *Journal of Human Resources* 10(3):361-377, Mar. 1975.

Duke University Center for the Study of Aging and Human Development: *Multidimensional Functional Assessment: The OARS Methodology*. 2d ed. Durham, N.C. Duke University, 1978.

Eggers, P.: Analysis of the Relationship Between Reimbursements in One Year and Reimbursements in a Subsequent Year. Working Paper OR-33. Study from the Work Group on the Adjusted Average Per Capita Cost. Health Care Financing Administration. Baltimore, Md. 1981.

Evashwick, C., Rowe, G., Diehr, P., and Branch, L.: Factors explaining the use of health care services by the elderly. *Health Services Research* 19(3):357-382, Aug. 1984.

Eve, S., and Friedsam, H.: Multivariate analysis of health care services utilization among older Texans. *Journal of Health and Human Resources Administration* 3(6):169-191, Nov. 1980.

Ferguson, C., Lee, M., and Wallace, R.: Effects of Medicare on hospital use: A disease-specific study. *Medical Care* 14(7):574-589, July 1976.

- Freeborn, D., Pope, C., Maradee, D., and Mallooly, J.: Health status, socioeconomic status, and utilization of outpatient services for members of a prepaid group practice. *Medical Care* 15(2):115-128, Feb. 1977.
- German, P., Skinner, E., and Shapiro, S.: Ambulatory care for chronic conditions in an inner-city elderly population. *American Journal of Public Health* 66(7):660-666, July 1976.
- Gornick, M.: Medicare patients: Geographic differences in hospital discharge rates and multiple stays. *Social Security Bulletin*. Vol. 40, No. 6. Office of Research and Statistics, Social Security Administration. Washington. U.S. Government Printing Office, June 1977.
- Gruenberg, L.: The AAPCC—a Preliminary Examination of the Issues. Working paper. Center for Health Policy Research and Analysis. Waltham, Mass. 1982.
- Hassinger, E., and Hobbs, D.: The relation of community context to utilization of health services in a rural area. *Medical Care* 11(6):509-522, Nov.-Dec. 1973.
- Haug, M.: Age and medical care utilization patterns. *Journal of Gerontology* 36(1):103-111, Jan. 1981.
- Kasper, J., and McCombs, J.: The Use and Costs of Services for Medicare Beneficiaries in Capitated Systems. Paper presented at the Annual Conference of the American Public Health Association. Washington, D.C. Nov. 1985.
- Katz, S., Ford, A. B., Moskowitz, R. W., et al.: Studies of illness in the aged. The index of ADL: A standardized measure of biological and psychosocial function. *Journal of the American Medical Association* 185(2):94-99, July 13, 1963.
- Link, C., Long, S., and Settle, R.: Cost sharing, supplementary insurance, and health services utilization among the Medicare elderly. *Health Care Financing Review*. Vol. 2, No. 2. HCFA Pub. No. 03068. Office of Research, Demonstrations, and Statistics, Health Care Financing Administration. Washington. U.S. Government Printing Office, Fall 1980.
- Link, C., Long, S., and Settle, R.: Equity and the utilization of health care services by the Medicare elderly. *Journal of Human Resources* 17(2):195-212, Feb. 1982.
- Long, S., and Settle, R.: Medicare and the disadvantaged elderly: Objectives and outcomes. *Health and Society* 62(4):609-656, Apr. 1984.
- Lopez-Aqueres, W., Kemp, B., Staples, F., and Brummel-Smith, K.: Use of health care services by older Hispanics. *Journal of the American Geriatrics Society* 32(6):435-440, June 1984.
- Lubitz, J.: Health Status Adjustments for Medicare Capitation. Unpublished paper. Health Care Financing Administration, Baltimore. 1985.
- Lubitz, J., Beebe, J., and Riley, G.: Improving the Medicare HMO payment formula to deal with biased selection. In Scheffler, R. M., and Rossiter, L. F., eds. *Advances in Health Economics and Health Services Research*. Greenwich, Conn. JAI Press, Inc., 1985.
- Markides, K., Levin, J., and Ray, L.: Determinants of physician utilization among Mexican-Americans. *Medical Care* 23(3):236-246, Mar. 1985.
- McCall, N., and Wai, H.: An analysis of the use of Medicare services by the continuously enrolled aged. *Medical Care* 21(6):567-585, June 1983.
- McClure, W.: On the research status of risk-adjusted capitation rates. *Inquiry* 21(3):205-213, Fall 1984.
- Pope, C.: Illness with a high emotional component and the use of medical services. *Medical Care* 17(12):1182-1195, Dec. 1979.
- Roos, N., and Shapiro, E.: The Manitoba longitudinal study on aging. *Medical Care* 19(6):644-657, June 1981.
- Rosenthal, R.: *Meta-Analytic Procedures for Social Science Research*. Beverly Hills. Sage Publications, 1984.
- Shapiro, E., and Roos, N.: Elderly nonusers of health care services. *Medical Care* 23(3):247-257, Mar. 1985.
- Steel, K., Markson, E., Crescenzi, C., et al.: An analysis of types and costs of health care services provided to an elderly inner-city population. *Medical Care* 20(11):1090-1100, Nov. 1982.
- Thomas, J. W., Berki, S., Lichtenstein, R., and Wyszewianski, L.: A Health Status Measure for Adjusting the HMO Capitation Rates of Medicare Beneficiaries. Grant No. 18-P-98179/5-01. Prepared for Health Care Financing Administration. Ann Arbor, Mich. Department of Medical Care Organization, University of Michigan, 1985.
- Thomas, J. W., Lichtenstein, R., Wyszewianski, L., and Berki, S. E.: Increasing Medicare enrollment in HMOs: The need for capitation rates adjusted for health status. *Inquiry* 20(3):227-239, Fall 1983.
- Wan, T.: Use of health services by the elderly in low-income communities. *Health and Society* 60(1):82-107, Jan. 1982.
- Wan, T., and Odell, B.: Factors affecting the use of social and health services among the elderly. *Aging and Society* 1(3):95-115, Mar. 1981.
- Welch, W. P.: Medicare Capitation Payments in HMOs in Light of Regression Toward the Mean in Health Care Costs. Paper presented at Conference on Biased Selection in Health Care Markets. University of California, Berkeley, Calif. Apr. 11, 1985.
- Wolinsky, F., and Coe, R.: Physician and hospital utilization among noninstitutionalized elderly adults: An analysis of the Health Interview Survey. *Journal of Gerontology* 39(3):334-341, May 1984.
- Wolinsky, F., Coe, R., Miller, D., et al.: Health services utilization among the noninstitutionalized elderly. *Journal of Health and Social Behavior* 24(12):325-337, Dec. 1983.
- Wright, R., Berg, W., and Creecy, R.: Health care utilization among the elderly: A causal analysis. *Journal of Social Service Research* 3(3):253-265, Spring 1980.