# Social/Health Maintenance Organization and Fee-for-Service Health Outcomes Over Time

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*Evaluating the performance of long-term care (LTC) demonstrations requires longitudinal assessment of multiple outcomes where selective mortality and disenrollment, if not accounted for, can give the appearance of reduced (or enhanced) efficacy. We assessed outcomes in social/health maintenance organizations (S/HMOs) and Medicare fee-for-service (FFS) care using a multivariate model to estimate active life expectancy (ALE). S/HMO enrollees and samples of FFS clients in four sites were analyzed and outcome differences assessed for a 3-year period. Results provide insights into S/HMO performance under different conditions and, more generally, into evaluating LTC demonstrations without randomized client and control groups.*

## INTRODUCTION

The utility of LTC for functionally impaired, community dwelling elderly is well documented. In-home services (for meal preparation, shopping, laundry, grooming, and dressing) and out-of-home services (such as adult day care, recreational, physical, and occupational therapy) improve client and caregiver lives (e.g., Kemper, 1988). The value of case management (i.e., needs assessment, care planning, coordinating and monitoring of services) is also evident. Though improving client and caregiver outcomes, however, these services do not appear to reduce costs—possibly due to methodological factors (e.g., defining their cost effectiveness relative to institutional care) (Kemper, 1988; Weissert, Cready, and Pawelak, 1988; Zawadski, 1984). Institutional costs are limited by State Medicaid programs and may be insufficient to bring about therapeutic innovations or to prevent quality-of-care problems (e.g., decubitus ulcer, malnutrition, pneumonia, or urinary tract infection [UTI]) (Brandeis et al. 1990; Braun, 1991; Dontas et al., 1991; Fiatarone et al. 1990; Gloth et al., 1991; Gross, 1988; Pinchcofsky-Devin and Kaminski, 1987).

Consequently, an alternative model for delivering LTC to community populations, the S/HMO, was developed. It was hoped that LTC, provided in a capitated system (as it is in a S/HMO), might improve cost effectiveness and outcomes. A Health Care Financing Administration (HCFA) demonstration of S/HMOs started in January 1985. S/HMOs were to:

- Provide hospital, physician, home health, extended benefit (e.g., eye glasses, hearing aids, drugs) and LTC services (e.g., nursing home, home-

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maker, and transport) to voluntarily enrolled clients paying a monthly premium.

- Use case managers to determine eligibility for, and select, LTC services. Access is limited by disability criteria and coverage limits.
- Serve both impaired and unimpaired elderly to maintain health and function.
- Be reimbursed by capitation payments from pooled Medicare, Medicaid (for eligible enrollees), and member premiums. S/HMOs assumed risk for all costs after 30 months. Integrated funding and financial risk are incentives for cost control and service flexibility (Leutz et al., 1985).

Some S/HMO features complicate the evaluation process. Because enrollment is voluntary, and marketability important, persons with specific health attributes can self-select into S/HMOs. Thus, a randomized study design could not be used. Statistical controls for health differences between S/HMO enrollees and members of comparison FFS samples are necessary. Additionally, the LTC provided by S/HMOs is available to persons in FFS. That is, the intervention depends on the degree to which S/HMOs make LTC accessible and not on its presence or absence. Variation in interventions makes comparisons of S/HMO and FFS outcomes complex. Here we focus on one outcome—the effect of being in a S/HMO on a person's functioning, relative to being in Medicare FFS, controlling for initial health and mortality. In this analysis we do not deal with cost issues, as they are treated in other reports.

Comparing outcomes longitudinally between S/HMO enrollees and FFS samples is difficult because of systematic health changes, mortality, and sample loss. For example, in the National Long-Term Care Channeling demonstration, the effect of increased access to case management (both with and without payments for additional services) was evaluated in 10 sites during an 18-month period. Persons with impairments were selected for the study and randomized into one of four groups (i.e., case and control groups defined for two interventions). Differences were found on baseline interviews in case and control response rates (10 percent higher for cases), response times (cases responded 5.4 days faster), and willingness (cases, on average, required 29 percent fewer contacts). Timing was important in assessing hospitalized or institutionalized persons (Brown and Mossel, 1984).

In S/HMOs, the content of interventions (i.e., services offered) also changes with time. LTC demonstrations are often designed as if impairments are progressive with little potential for improvement. LTC is viewed as "palliative." Analyses of national longitudinal surveys, however, show that many elderly, frail persons regain function (Manton, Corder, and Stallard, 1993; Suzman et al., 1992). Thus, outcomes involve improvements as well as decrements in function. Finally, for the elderly, impairment is a matter of degree. At 85 years of age, most persons may have an activities of daily living (ADL) or instrumental activities of daily living (IADL) dysfunction, though the proportion losing social autonomy, i.e., those who are wholly incapable of performing any self-care, is small (Manton et al., to be published). Assessments cannot simply be made of transitions into or out of discrete impairment states. The degree of impairment on multiple dimensions (e.g., mobility versus cognitive functioning versus manual dexterity) must be assessed to compare outcomes of different care delivery systems over time. In this article, we examine whether the integration of acute and LTC services offered by the S/HMOs produced higher ALEs—periods free of impairment (Katz et al., 1983) —than for persons receiving customary and usual Medicare FFS care, controlling for differences in health at enrollment.

## PRIOR STUDIES OF HMOs

Except for the 1985 HCFA S/HMO demonstrations, there have been no prior S/HMO demonstrations. There are multiple studies of the care of elderly persons in capitated health systems (i.e., HMOs) that do not provide LTC. The following criteria have been used to assess HMO outcomes.

Most studies of Medicare HMOs examine enrollment and attrition. Riley, Rabey, and Kasper (1989) compared mortality rates for 3 HMOs with FFS for 6 years following enrollment, controlling for age, gender, and Medicaid and institutional status. HMO mortality was lower in the first year, implying favorable selection. Mortality increased to FFS levels by the second year in two plans. The third approached FFS levels over 5 years due to favorable attrition, i.e., mortality 2 years after disenrollment was higher than for continuing members. Two other studies found HMO mortality rates lower than FFS mortality rates. One examined mortality for 2 years following enrollment (U.S. General Accounting Office, 1986). In the other study, mortality in an Oregon HMO was compared with State mortality rates over 6 years—adjusted for age, gender, and smoking or non-smoking status (McFarland et al., 1986). These studies did not control for functional status. Therefore, mortality findings are ambiguous because they can be interpreted as either an indirect cost measure (i.e., high terminal care costs) or a health measure.

In the Medicare competition evaluation, the service use of HMO and FFS clients were compared for 2 years pre-enrollment and mortality rates were compared for 2 years post-enrollment. Prior use was lower in 13 of 14 HMOs; mortality lower in 12 of 17 HMOs; both results suggest favorable selection for HMOs. Disabled persons disenrolled from HMOs at higher rates (Brown, 1988). In addition, quality of care was assessed (Langwell and Hadley, 1989). Care access (controlled for self-reported symptoms) was measured by whether a health professional was seen, and baseline and followup health status were compared for all clients. No significant differences were found between HMOs and FFS regarding care access or health change. HMO records were more complete, and contained more reports on tests and immunizations. There were few differences in drugs prescribed, history taking, or exams for those with congestive heart failure. Some practice patterns varied (e.g., HMO physicians hospitalized unstable angina cases more often). Though an improvement over assessing mortality differences, the quality of care indexes are partly confounded with service use. None of the HMO studies examined functional change as an outcome.

## CASE SELECTION

Our analysis included all enrollees in 4 S/HMOs ($n$ = 10,838) in June 1986 (in Long Beach, California and Portland, Oregon) or December 1986 (in Brooklyn, New York and Minneapolis, Minnesota), and samples ($n$ = 16,664) of non-institutionalized Medicare FFS clients 65 years of age or over living in those 4 areas. FFS clients enrolling in HMOs during the study were followed. This HMO group of clients (i.e., persons self-selected after 1986) differs from 3 HMO samples of 1,000 persons each enrolling in HMOs from Medicare FFS in 1985 and 1986. Data collected on the HMO samples included a health screening form (HSF), prior costs (Manton et al., 1994), reasons for enrollment (Newcomer, Harrington, and Friedlob, 1990), and mortality and disenrollment (Manton et al., unpublished), but did not include health changes or post-enrollment service use. Those data were obtained for all members in the FFS samples—including persons entering HMOs during the study. Thus, the HMO samples were not analyzed, but FFS clients shifting to HMOs during the study were.

This evaluation is designed to assess the differences between S/HMOs and standard FFS care, and not those between S/HMOs and HMOs. During the demonstration, the benefits which distinguish S/HMOs from HMOs which provide extended care were reduced (Newcomer, Preston, and Harrington, 1991). Nonetheless, S/HMOs provide LTC services which are not reimbursed in extended care Medicare HMOs. Thus, changes in S/HMO benefits were not structural, but specific management decisions as service costs became clear. Data were collected to assess how S/HMO services changed relative to HMO services.

Persons applying to a S/HMO could be nursing home certifiable under State Medicaid criteria, but could not be in a nursing home. They may have previously been in a nursing home, or be considering entering a home. Consequently, nursing home residents are also out of scope for FFS samples. This exclusion's effect varies by age and gender. Nursing home residence is about 25 percent for persons 85 years of age or over, according to the 1985 National Nursing Home Survey (Hing, Sekscenski, and Strahan, 1989). Rates are higher for females and the oldest-old, and vary by health (e.g., about 45 percent of nursing home residents in 1985 had "dementia"). Thus, the exclusion differentially affects females, the very old, and persons with specific medical problems.

### Response Rates and Biases

Non-response in the FFS sample can bias estimates of case-mix distributions. The FFS response rate for the HSF was 80.5 percent. The HSF response rate was 98.3 percent for S/HMOs because plans were required to screen persons before enrollment, though small numbers of enrollees initially received a comprehensive assessment form (CAF) if impairments were known to exist. Several persons died while applying. Thus, instead of defining S/HMO enrollees as only those with HSFs, persons were counted if they had received CAFs, had Medicare service use data, and were identified on Medicare records as a S/HMO enrollee.

Studies of health surveys (National Center for Health Statistics, 1966; Manton, Stallard, and Woodbury, 1991) find that elderly non-respondents are frailer and use more services than respondents. This is assessed in the evaluation by comparing the average costs of all Medicare-eligible persons in the catchment area to the average costs of FFS sample respondents. The average costs for the Medicare population (after institutionalized persons are removed) are 15 percent higher than those for sample respondents. Because Medicare costs are correlated with health and functional status, this suggests that FFS sample respondents are, on average, healthier and less impaired than the total Medicare population in each site (Manton et al., 1994). This bias should be against demonstrating favorable enrollment in S/HMOs. In addition, there is a "guaranteed" time bias in that terminally ill persons (those with an average of 3 months to live) are unlikely to change care providers, i.e., enroll in S/HMOs. To eliminate the comparable group from the FFS sample, we identified persons who died before the end of the interview period from Medicare records and divided them into two groups. FFS nonrespondents dying before the median interview date (about 6 months; $n = 765$) in a site were excluded as terminal cases. Persons dying after that date are included and their characteristics imputed from the characteristics of respondents. This adjustment is most important for prior cost analyses (Manton et al., 1994). The vital status of all persons was determined from Medicare records. S/HMO and HMO enrollment and disenrollment dates were determined from group health membership files mapped to Medicare Automated Data Retrieval System files containing data on Medicare Part A and B service use.

### Health Assessments

The initial assessment was a telephone-delivered HSF for the FFS sample and a self-completed mail-back HSF for S/HMO applicants. The HSF is based on the National Long-Term Care Survey (NLTCS) screening instrument (Durako, 1987). HSFs measure ADLs (e.g., toileting, dressing, bathing [Katz and Akpom, 1976]), IADLs (e.g., preparing meals, laundry, housework [Lawton and Brody, 1969]), and health conditions (e.g., diabetes, hypertension). Persons having two or more IADL (or one or more ADL) limitations received a CAF, administered by social workers or nurses to verify self-reported impairment.

FFS cases with no ADL and fewer than two IADL impairments were contacted annually by phone. S/HMO enrollees were contacted by mail-back questionnaires. S/HMO disenrollees were interviewed over the phone by evaluation staff. Persons reporting two or more IADL limitations at baseline or in the annual re-HSF were contacted semiannually. Those with two or more IADL, but no ADL, limitations were given a re-HSF. Those ever reporting an ADL impairment are given a re-CAF—usually by phone. CAFs were conducted for 3,234 (11.8 percent) of 27,482 FFS and S/HMO members. In 3 years, 8,506 CAFs were administered—an average of 2.63 extra contacts per interviewee. S/HMOs could identify health changes in clinical encounters. In FFS, clinical encounters did not trigger a CAF—the identification of health changes depended on a periodic, but complete, screening. In S/HMOs, screening after enrollment started about 6 months late and relied on mail-back instruments. Thus, it is less likely to be complete than the followup screening of FFS members by phone. CAFs may affect S/HMO service eligibility, which might cause bias toward recording less impairment (or more improvement).

## Case-Mix Scores

Case-mix scores are calculated using grade of membership (GoM), a generalization of log linear (Bishop, Fienberg, and Holland, 1975) and latent class membership (LCM) (Lazarsfeld and Henry, 1968) analyses for categorical data. In log linear models, the membership of each person denoted by $i$ in K independent groups is observed. That is, K group membership variables, $g_{ik}$ (= 1 or 0), are observed, where $g_{ik}$ describes whether individuals' observed characteristics relate to group Ks. For the K groups, cell probabilities for J-way tables, $\lambda_{kjl}$, are calculated from observed frequencies; thus, the $\lambda_{kjl}$s define the groups. In LCM, group membership is not observed, so the probability of being in a group ($\hat{P}_{ik} = \text{Prob}[g_{ik} = 1.0]$) is estimated jointly with the $\lambda_{kjl}$s. In GoM, not only is group membership unobserved, but persons may be "partial" members of groups. The $g_{ik}$s in GoM representing partial membership are estimated such that $\sum_k g_{ik} = 1.0$, and $0.0 \leq g_{ik} \leq 1.0$, so that multiplying $\lambda_{kjl}$s by $g_{ik}$s reproduces the observed frequencies. Thus, GoM is used in this analysis to define a set of K case-mix classes from a series of health and functioning variables. The relation of person $_i$s health characteristics to the K classes is summarized in the K scores $g_{ik}$. The $g_{ik}$s in GoM define within-group heterogeneity not represented in the LCM. The significance of this heterogeneity can be tested by determining if the GoM fits the data better because the models are parametrically nested.

GoM was applied to pooled HSF and CAF data so that $g_{ik}$s could be updated for health changes. The updated scores ($g_{ik \cdot t}$) control for health variation, over individuals and time ($t$), in comparing S/HMO and FFS outcomes. In "pre-post" analyses, interventions are made at fixed times and do not describe systems with voluntary enrollment or disenrollment (such as S/HMOs) well, where interventions are of variable content, duration, and timing. Variables affecting choice interact with outcome—the decision to stay enrolled is made daily, and reflects the degree of satisfaction with services and outcomes.

In GoM, J multinomial variables for each of I persons ($x_{ij}$) are each coded as $L_j$ binary (0, 1) variables, $y_{ijl}$. Continuous variables are divided into $L_j$ intervals and then coded in binary form. The probability of $y_{ijl}$ occurring is (site and coverage indexes suppressed),

$$\hat{p}_{ijl \cdot t} = \text{Prob}(y_{ijl \cdot t} = 1.0) = \sum_k (g_{ik \cdot t} \cdot \lambda_{kjl}). \quad (1)$$

Both the $\lambda_{kjl}$ and the $g_{ik}$ are uniquely identified if J >2K (Woodbury, Manton, and Tolley, to be published), because selecting J variables determines the space, M, of all possible responses, $y_{ijl}$. The solution, B, is the intersection of the probability space, $L_B$, defined by the $p_{ijl \cdot t}$ estimated in equation 1, with the a priori determined M. Extreme points of B define the $\lambda_{kjl}$. The $g_{ik}$s are the linear functions joining $\lambda_{kjl}$s. The $\lambda_{kjl}$ are assumed time invariant; time is represented in $g_{ik \cdot t}$.

To assure $g_{ik \cdot t}$s are comparable between FFS and S/HMO and over time, the K profiles ($\lambda_{kjl}$) are estimated from HSF and CAF data pooled over time, site, and coverage. The likelihood for the combined data is (+ indicates a index for which data is combined),

$$L = \prod_i \prod_j \prod_l \prod_t \prod_c \prod_s (g_{ik \cdot t++} \cdot \lambda_{kjl++})^{y_{ijl \cdot tcs}}, \quad (2)$$

where measurement is at time $t$, $c$ refers to coverage (e.g., S/HMO or FFS), and $s$ to site (Manton et al., 1986; 1987). A person is given a CAF when a health change is detected in an annual re-HSF, semiannual monitoring of impaired persons, or in an S/HMO clinical visit. Because scores change at variable times, we divided each record into months (i.e., $t = 1, 2, ..., 36$). If a CAF is administered at $t+1$, new $g_{ik \cdot t+1}$s are calculated if health changed. Otherwise the $g_{ik \cdot t}$ are assumed constant. By using monthly histories we can estimate the time spent in specific health states (i.e., having specific $g_{ik \cdot t}$ values). This deals with the variable assessment times, because how long a person remains in a case-mix class is decribed by the $g_{ik \cdot t}$.

The GoM likelihood in equation 2 (suppressing indexes for coverage, time, and site) is evaluated by iteratively solving two functions (Woodbury and Clive, 1974),

$$\frac{\partial L}{\partial g_{ik}} = \frac{1}{y_{i++}} \sum_{j=1}^{J} \sum_{l=1}^{L_j} y_{ijl} \left( \frac{g_{ik} \cdot \lambda_{kjl}}{\sum_h g_{ih} \cdot \lambda_{hjl}} \right) \quad (3)$$

and

$$\frac{\partial L}{\partial \lambda_{kjl}} = \frac{\sum_{i=1}^{I} y_{ijl} \dfrac{(g_{ik} \cdot \lambda_{kjl})}{\sum_h g_{ih} \cdot \lambda_{hjl}}}{\sum_{i=1}^{I} \sum_{l=1}^{L_j} y_{ijl} \dfrac{(g_{ik} \cdot \lambda_{kjl})}{(\sum_h g_{ih} \cdot \lambda_{hjl})}}. \quad (4)$$

Normally, terms in a likelihood for individuals are collected in an independent factor and only structural parameters (i.e., those not involving $i$) are estimated (Cox and Hinkley, 1974). To factor individual from structural parameters, assumptions are made about the distribution of individual parameters so that the information in structural parameters is restricted to a "small" number of data moments (e.g., the $[J \times (J+1)]/2$ unique elements in a covariance matrix for J variables in factor analysis). In equation 3, estimation of $g_{ik}$ involves $\lambda_{kjl}$. In equation 4 estimation of $\lambda_{kjl}$ involves $g_{ik}$. Thus, the sets of parameters are jointly estimated. This makes $\lambda_{kjl}$ estimates robust to individual variation because they are conditioned on the $g_{ik}$ distribution. Estimates of $g_{ik}$s do not have a prespecified distribution but produce unbiased estimates of up to the Jth order moments of the $g_{ik}$ distribution (Woodbury, Manton, and Tolley, to be published). The $\lambda_{kjl}$ estimates are consistent because equation 3 implicitly constrains the moments of the $g_{ik}$ distribution across individuals.

To estimate parameters for external variables (for validation), or transition rates, two steps are needed. First, equations 3 and 4 are maximized for J health variables. Then, the parameters for the J variables in equations 3 and 4 are fixed to hold constant the definition of the K classes (i.e., $\lambda_{kjl}$) and individual scores (i.e., $g_{ik}$). Then equation 4 is maximized to produce conditional (on case mix) maximum likelihood estimation of $\lambda_{knl}$ for the N added variables. Likelihood ratio tests can be formed to determine if external variables contain significant information not represented in case-mix groups. Mortality and coverage change probabilities may be estimated by defining transition variables for each case-mix group, i.e., $\lambda_{kN(l_1 \cdot l_2)}$ ($l_1$ are time intervals, and $l_2$ changes in status). Transition rates are estimated in a second maximum likelihood step again with the definition of case-mix groups fixed. The $\lambda_{kN(l_1 \cdot l_2)}$ describe discrete changes (e.g., death, coverage change) over 3 years of followup. They do not describe cohort changes.

### Active Life Expectancy

The $g_{ik \cdot t}$ and $\lambda_{kjl}$ describe all information on health and mortality in 3 years of followup of an initially non-institutionalized population. They do not describe age-specific survival and disability changes for a cohort of such persons. This requires solving systems of difference equations for monthly intervals, to approximate life table differential (continuous time) equations. In those calculations, two additional equations are needed. The first describes health changes among survivors $t$ to $t+1$:

$$g_{ik(t+1)} = \{Age \bullet \beta_{kk}\}(g_{ik \cdot t}) + e_{ik}, \quad (5)$$

where $\{Age \bullet \beta_{kk}\}$ is a matrix of age-dependent transition rates between K case-mix groups. Four $\beta_{kk}$ matrices are estimated, one each for FFS and S/HMO males and females. The definition of $g_{ik \cdot t}$s in equation 2 ensures their comparability over gender, coverage, and site (Manton, Woodbury, and Tolley, 1994).

The second describes mortality as an age-dependent quadratic function of the $g_{ik \cdot t}$,

$$\mu(g_{ik \cdot t}) = (g^T_{ik \cdot t}\, Q\, g_{ik \cdot t})\{e^{\theta t}\} = (g^T_{ik \cdot t}\, Q_t\, g_{ik \cdot t}). \quad (6)$$

In equation 6 all coefficients in Q are multiplied by $e^{\theta t}$. $\theta$ is the percent per year of age increase in mortality. In equation 6, a person's risk changes as $g_{ik \cdot t}$ changes according to equation 5. The performance of S/HMOs and FFS in maintaining function is described by $\beta_{kk}$; and for survival by $Q_t$. $\theta$ is the age-related, average effect of unobserved variables for FFS and S/HMO males and females. As information in $g_{ik \cdot t}$ increases, $\theta \rightarrow 0.0$ (Manton et al., to be published).

Calculating cohort life tables requires using parameters in equations 5 and 6 to solve monthly difference equations. The proportion of a cohort, $l$, surviving to $t+1$, is,

$$l_{t+1} = l_t |I + V_t Q_t|^{-1/2} \exp \left\{ \frac{\mu_t(\bar{\underset{\sim}{g}}(t)) + \mu_t(\bar{\underset{\sim}{g}}^*(t))}{2} - 2\mu_t \left( \frac{\bar{\underset{\sim}{g}}(t) + \bar{\underset{\sim}{g}}^*(t)}{2} \right) \right\}, \quad (7)$$

where $\bar{\underset{\sim}{g}}(t)$ is a vector of means of $g_{ik \cdot t}$ and $V_t$ their covariance matrix. Equations 8 and 9 show that $\bar{\underset{\sim}{g}}^*(t)$ and $(V^*_t)$ are functions of mortality $(Q_t)$ and case mix heterogeneity $(V_t)$ or,

$$\bar{\underset{\sim}{g}}^*(t) = \left(\bar{\underset{\sim}{g}}(t) - V^*_t\, Q_t\, \bar{\underset{\sim}{g}}(t)\right) / \sum_k \langle \bar{\underset{\sim}{g}}(t) - V^*_t\, Q_t\, \bar{\underset{\sim}{g}}(t) \rangle_k \quad (8)$$

and

$$V^*_t = (I + V_t\, Q_t)^{-1}\, V_t. \quad (9)$$

Mortality depends on $\bar{g}(t)$ and $V_t$. $V_t$ has deterministic (i.e., Age $\bullet$ $\beta_{kk}$) and stochastic components. Diffusion increases, and mortality reduces, $V_t$. Diffusion must reflect the 0,1 bounds on the $g_{ik \cdot t}$s. We assume that $V_t$ has, at most, Bernoulli variance, $(\bar{\underset{\sim}{g}}_k(t+1) \bullet (1 - \bar{\underset{\sim}{g}}(t+1)))$, and that correlations of $g_{ik \cdot t}$s are constant from $t$ to $t+1$. The correlation matrix R is estimated from $V_t$ after conditioning on age. In the diagonal matrix, S, elements are square roots of the ratios of $g_{ik \cdot t}$ variances to Bernoulli limits. S projects the $g_{ik \cdot t}$ to a high dimensional spherical space so that, in computations, $g_{ik \cdot t}$s are not "trapped" on "faces" of B. $W_{t+1}$ is a diagonal matrix with elements

$$\sqrt{\bar{g}_k}(t+1) \cdot (1\text{-}\bar{g}_k(t+1)).$$

The new "constrained" variance is

$$V_{t+1} = W_{t+1} S R S W_{t+1}, \qquad (10)$$

which can be used to estimate a constrained diffusion matrix,

$$\Sigma_{t+1} = V_{t+1}\text{-}C_t V^*_t C, \qquad (11)$$

where $C_t$ = Age • $\beta_{kk}$ from equation 5. Changes in the means ($\underset{\sim}{\bar{g}}(t)$) of $g_{ik \cdot t}$ for survivors are

$$\bar{g}_{\sim}(t+1) = (\text{Age} \cdot \beta) \cdot \underset{\sim}{\bar{g}}^*(t). \qquad (12)$$

Equations 7 through 12 are used to calculate cohort life tables for K case-mix groups. Cohort life tables differ from transition variables estimated in equation 2 because the 3-year experience of initially non-institutionalized persons of different ages is used to construct disability dynamics and mortality for the life of a cohort. Thus, there are three distinct sets of calculations. One generates the $g_{ik \cdot t}$, describing cases from the pooled data using equation 2. In those calculations we may estimate 3-year transition rates. Second, $g_{ik \cdot t}$s are used to generate parameters for disability dynamics (in equation 5) and mortality (in equation 6). Those parameters are used in difference equations 7 through 12 to calculate cohort life tables. The individual components of cohort dynamics can be examined by fixing selected parameters in equations 7 through 12.

In a hazard model, the risk of an event is estimated for fixed covariates (Cupples et al., 1988). The difference equations use time-varying covariates. Thus, the difference equations produce insights about cohort dynamics that cannot be made using only a hazard function. The quadratic in equation 6, one component of the cohort calculations, is a hazard function. It is estimated by maximum likelihood and, because μ (the mortality rate) is estimated directly, there are no problems of interpreting coefficients as in Cox or logistic functions (e.g., including quadratic terms in a Cox model makes the hazard scale dependent)—the function changes as risk factor levels change.

## RESULTS

To assess FFS or S/HMO outcomes, health variation over persons and time must be described. This requires defining multiple "Profiles" to characterize a person's health. The six profiles in Table 1 are described by comparing $\lambda_{kjl}$s to the overall frequency of an attribute—e.g., 27.1 percent need help with meals. Someone who "fits" Profile 3, 4, or 6 (i.e., has a high $g_{ik \cdot t}$) requires assistance. Individuals matching Profiles 1, 2, or 5 do not. The $\lambda_{kjl}$ can be discussed both as a profile of J attributes and as groups of cases characterized by a profile.

The profiles in Table 1 are defined by their association ($\lambda_{kjl}$) with health variables:

- "Healthy"—Individual is unimpaired but has diabetes, hypertension, and joint disease. This profile is "healthy" relative to other case-mix groups.
- "Acutely Ill"—Individual has cancer (100 percent), cardiopulmonary problems, and hypertension, but no impairment.
- "Impaired"—Individual has IADL impairments suggesting early dementia but few other neurological problems. Medical conditions (e.g., diabetes) may be present.

### Table 1

**Multivariate Values for 30 Health and Functioning Measures From Social/Health Maintenance Organization (S/HMO) Demonstrations: 1986-89**

| | | Case-Mix Group | | | | | |
|---|---|---|---|---|---|---|---|
| Health and Functioning Measures | Frequency | Healthy | Acutely Ill | Impaired | Pulmonary | Cardiac | Frail |
| **Functional Ability** | | | | Percent | | | |
| Requires Assistance With: | | | | | | | |
| 1. Preparing Meals | 27.1 | 0.0 | 0.0 | 100.0 | 100.0 | 0.0 | 100.0 |
| 2. Laundry | 19.9 | 0.0 | 0.0 | 100.0 | 0.0 | 0.0 | 100.0 |
| 3. Light Housework | 16.3 | 0.0 | 0.0 | 100.0 | 0.0 | 0.0 | 100.0 |
| 4. Grocery Shopping | 15.8 | 0.0 | 0.0 | 100.0 | 0.0 | 0.0 | 100.0 |
| 5. Managing Money | 21.2 | 0.0 | 0.0 | 100.0 | 42.1 | 0.0 | 100.0 |
| 6. Taking Medicine | 14.8 | 0.0 | 0.0 | 100.0 | 0.0 | 0.0 | 100.0 |
| 7. Making Phone Calls | 11.4 | 0.0 | 0.0 | 86.5 | 0.0 | 0.0 | 100.0 |
| 8. Eating | 7.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| 9. Getting In and Out of Chairs or Bed | 22.2 | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | 100.0 |
| 10. Walking Around Inside | 15.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| 11. Driving or Using Public Transportation | 32.3 | 0.0 | 0.0 | 100.0 | 100.0 | 0.0 | 89.2 |
| 12. Toileting | 20.3 | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | 75.9 |
| 13. Dressing | 16.2 | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | 100.0 |
| 14. Bathing | 20.9 | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | 100.0 |
| Individual: | | | | | | | |
| 15. Uses a Wheelchair or Walker | 6.7 | 0.0 | 0.0 | 38.5 | 0.0 | 0.0 | 46.2 |
| 16. Uses a Cane | 18.0 | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 17. Is Bedfast | 13.2 | 0.0 | 0.0 | 0.0 | 42.2 | 0.0 | 100.0 |
| **Medical Conditions** | | | | | | | |
| 18. Diabetes Mellitus | 17.6 | 100.0 | 100.0 | 100.0 | 0.0 | 100.0 | 0.0 |
| 19. Hypertension | 31.7 | 27.6 | 100.0 | 29.7 | 0.0 | 100.0 | 0.0 |
| 20. Heart Trouble | 18.6 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 |
| 21. Neurological Problems | 11.2 | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | 40.8 |
| 22. Stroke | 17.0 | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | 47.7 |
| 23. Lung or Breathing Problems | 18.9 | 0.0 | 0.0 | 0.0 | 80.8 | 100.0 | 0.0 |
| 24. Chronic Cough | 6.8 | 0.0 | 0.0 | 0.0 | 0.0 | 73.5 | 0.0 |
| 25. Cancer | 16.3 | 0.0 | 100.0 | 0.0 | 49.8 | 0.0 | 10.0 |
| 26. Hardening of the Arteries | 14.6 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 |
| 27. Stomach or Bowel Problems | 20.9 | 0.0 | 100.0 | 0.0 | 0.0 | 100.0 | 38.6 |
| 28. Bladder Problems | 15.5 | 0.0 | 0.0 | 0.0 | 44.4 | 100.0 | 0.0 |
| 29. Rheumatism or Arthritis | 56.7 | 41.0 | 100.0 | 0.0 | 53.5 | 100.0 | 63.9 |
| 30. Other Health Problems | 25.2 | 11.6 | 96.5 | 26.4 | 30.8 | 71.6 | 36.5 |
| $g_k$ (weighted prevalence) | — | 52.2 | 7.0 | 9.8 | 11.7 | 11.5 | 7.8 |

SOURCES: Data derived from health screening forms (HSFs) and comprehensive assessment forms (CAFs) administered by the authors. HSF data were collected from fee-for-service beneficiaries at baseline and from S/HMO enrollees upon application. Total HSF sample size is 27,503 cases. CAFs were completed semiannually by persons who identified functional disabilities on the HSF.

- "Pulmonary"—Individual has ADL impairments (42.2 percent bedfast), pulmonary problems (80.8 percent), and cancer (49.8 percent).
- "Cardiac"—Individual is not impaired, but has multiple medical problems—including cardiopulmonary conditions (no stroke) and arteriosclerosis.
- "Frail"—Individual is bedfast (100 percent) and limited on all ADLs and IADLs. Medical problems include stroke, cancer, neurological, stomach, and bowel problems. A person with a high score on this dimension, unless having excellent social and economic resources, would be at risk of institutionalization because he or she is 88.9 percent impaired on the 17 functional items. Thus, as the population ages, movement into the frail category serves as a measure of persons potentially needing institutionalization—because

institutional residents were excluded at the study's start and are not represented in baseline health measures.

The predictive validity of the $g_{ik \cdot t}$ was examined on sociodemographics and service use (Reuben, Siu, and Kimpau, 1992). The $\lambda_{kNl}$s describing these relations (calculated conditionally on case-mix scores) are presented in Table 2.

Approximately 93.6 percent of the "healthy" group report good or excellent health; 100 percent of the "acutely ill" group report fair or poor health. Persons in the "impaired" group (48.9 percent reporting fair or poor health) are similar to those in the "pulmonary" group (38.3 percent), while the "cardiac" (65.2 percent fair or poor) and "frail" (60.1 percent fair or poor) groups are similar. Case mix is not strongly associated with age because health changes ($g_{ik \cdot t}$) estimated from the combined HSF and CAF data, represent most age effects. Healthy individuals are young—a mean age of 71.7. The frail group members are the oldest, with a mean age of 83.2. Acutely ill persons are older (77.5) than the healthy, but are little different than the two chronically ill groups.

There are also large differences in service use. Acutely ill individuals use the most acute care (e.g., oxygen, 10.6 percent; visiting nurses, 11.2 percent; home health aides, 22.7 percent), and 100 percent had prior hospital stays. Prior hospital use for the impaired and pulmonary groups is similar—and three times that of the healthy group. Hospital use in the cardiac and frail groups is similar; the frail group used the most nursing homes, visiting nurses, home health, and transport services. These groups are similar to those produced from the baseline HSF data (Manton et al., 1994). In the combined HSF and CAF data, the pulmonary group is more impaired and the cardiac group has more medical problems—as does the acutely ill group. Because new health problems are recorded on CAFs, the number of disabilities and medical problems generally increased.

## Health Status, Mortality, and Disenrollment

One-year probabilities of change in coverage and mortality for case-mix groups estimated from transition variables $\lambda_{kN}(l_1 \cdot l_2)$ are in Table 3. The HMO category represents the experience of FFS clients ($n$ = 900) entering an HMO during the study.

### *Health Assessment*

A CAF is used to assess health changes. For S/HMO members this may occur after a clinical encounter. In the FFS evaluation, data were not collected on clinical encounters. Instead, a re-HSF or re-CAF is given every 6 months to impaired persons, and everyone is screened annually. It is unlikely that changes in chronic disabilities are missed in a 6-month interval (Manton, Vertrees, and Clark, 1993).

Healthy (3.6 percent) and acutely ill (6.6 percent) S/HMO enrollees have a greater (but still relatively insignificant) chance of receiving a CAF than FFS sample members. S/HMO and FFS CAF rates are similar for impaired groups. Frail HMO members have CAF rates similar to FFS and S/HMOs. The largest S/HMO and FFS differences are for chronically ill groups. Though S/HMOs have a higher case-mix adjusted probability of a CAF than FFS (i.e., 38 percent versus 21.8 percent), the

## Table 2

**Multivariate Values for Sociodemographic and Health Service Use Variables From Social/Health Maintenance Organization (S/HMO) Demonstrations: 1986-89**

| Variables | Frequency | Healthy | Acutely Ill | Impaired | Pulmonary | Cardiac | Frail |
|---|---|---|---|---|---|---|---|
| | | Case-Mix Group | | | | | |
| **Sociodemographic Variables** | | | | Percent | | | |
| Gender: | | | | | | | |
| Male | 37.4 | 43.1 | 34.9 | 40.4 | 25.3 | 28.0 | 29.4 |
| Female | 62.6 | 57.0 | 65.1 | 59.7 | 74.7 | 72.0 | 70.6 |
| Age: | | | | | | | |
| 64-69 Years | 33.4 | 54.0 | 0.0 | 5.0 | 10.2 | 16.5 | 11.0 |
| 70-74 Years | 22.1 | 22.8 | 0.0 | 66.1 | 11.5 | 14.7 | 10.0 |
| 75-79 Years | 17.4 | 13.3 | 100.0 | 7.0 | 7.4 | 13.2 | 13.3 |
| 80-84 Years | 14.2 | 7.6 | 0.0 | 9.4 | 55.5 | 12.6 | 16.8 |
| 85-89 Years | 8.9 | 1.9 | 0.0 | 6.5 | 11.0 | 42.5 | 17.0 |
| 90 Years or More | 4.0 | 0.5 | 0.0 | 6.1 | 4.5 | 0.5 | 31.9 |
| Mean Age | 75.3 | 71.7 | 77.5 | 75.8 | 80.5 | 80.1 | 83.2 |
| Marital Status: | | | | | | | |
| Married | 51.3 | 58.7 | 12.5 | 43.9 | 36.0 | 41.1 | 55.7 |
| Not Married | 48.7 | 41.3 | 87.5 | 56.1 | 64.1 | 58.9 | 44.3 |
| Living Arrangements: | | | | | | | |
| Lives Alone | 36.0 | 33.5 | 69.3 | 24.5 | 47.0 | 51.4 | 1.3 |
| With Spouse | 50.6 | 57.8 | 11.5 | 42.8 | 36.8 | 40.1 | 55.1 |
| With Child | 7.0 | 4.5 | 12.7 | 18.4 | 7.2 | 4.3 | 16.0 |
| With Relative | 3.4 | 2.7 | 5.4 | 5.6 | 5.1 | 1.7 | 6.0 |
| With Unrelated Person | 3.1 | 1.5 | 1.0 | 8.7 | 3.9 | 2.5 | 10.8 |
| Type of Housing: | | | | | | | |
| Group Care | 1.4 | 0.3 | 0.0 | 6.4 | 4.5 | 0.1 | 4.4 |
| Senior Housing | 4.5 | 2.7 | 17.9 | 4.8 | 5.1 | 9.4 | 3.0 |
| Other's Home | 4.4 | 2.1 | 7.3 | 20.4 | 6.1 | 2.3 | 8.3 |
| Own Home | 88.5 | 93.8 | 72.1 | 67.0 | 83.7 | 86.4 | 82.1 |
| Other | 1.3 | 1.1 | 2.7 | 1.5 | 0.6 | 1.8 | 2.3 |
| Self-Rated Health: | | | | | | | |
| Excellent | 23.4 | 36.8 | 0.0 | 10.4 | 11.5 | 0.1 | 7.5 |
| Good | 46.8 | 56.8 | 0.0 | 40.7 | 50.3 | 34.7 | 32.4 |
| Fair | 23.0 | 6.5 | 73.9 | 31.6 | 29.7 | 57.4 | 30.7 |
| Poor | 6.8 | 0.0 | 26.1 | 17.3 | 8.5 | 7.8 | 29.4 |
| **Health Service Use Variables** | | | | | | | |
| Oxygen Equipment | 1.8 | 0.0 | 10.6 | 6.6 | 3.2 | 4.2 | 2.9 |
| Visiting Nurse Services | 3.5 | 0.1 | 11.2 | 9.5 | 8.9 | 0.6 | 17.5 |
| Therapist Services | 1.4 | 0.3 | 8.7 | 2.9 | 2.2 | 0.9 | 5.2 |
| Home Health Aide Services | 5.0 | 0.2 | 22.7 | 12.6 | 12.8 | 1.5 | 22.5 |
| Social Worker Services | 2.3 | 0.1 | 17.3 | 4.9 | 4.3 | 0.7 | 9.8 |
| Adult Day Health Services | 1.1 | 0.2 | 1.6 | 3.1 | 1.6 | 0.9 | 5.2 |
| Transportation Assistance | 7.1 | 0.5 | 58.1 | 20.2 | 17.4 | 4.9 | 13.1 |
| Meals Delivered to Home | 3.4 | 0.4 | 16.6 | 11.8 | 9.2 | 3.0 | 7.1 |
| Hospital Admissions in Past Year: | | | | | | | |
| None | 76.8 | 89.1 | 0.0 | 67.9 | 71.8 | 60.7 | 65.2 |
| 1-3 | 22.0 | 10.8 | 90.0 | 30.0 | 27.1 | 36.9 | 32.3 |
| 4 or More | 1.2 | 0.1 | 10.0 | 2.1 | 1.1 | 2.5 | 2.6 |
| Nursing Home Use: | | | | | | | |
| None | 99.1 | 99.9 | 96.5 | 97.7 | 99.1 | 99.7 | 94.5 |
| 1-30 Days | 0.4 | 0.1 | 3.3 | 0.8 | 0.4 | 0.2 | 1.4 |
| 31 Days or More | 0.5 | 0.0 | 0.3 | 1.5 | 0.5 | 0.1 | 4.1 |
| Considering Applying to Nursing Home | 1.2 | 0.3 | 3.6 | 4.5 | 1.4 | 0.6 | 5.1 |

SOURCES: Data derived from health screening forms (HSFs) and comprehensive assessment forms (CAFs) administered by the authors. HSF data were collected from fee-for-service beneficiaries at baseline and from S/HMO enrollees upon application. Total HSF sample size is 27,503 cases. CAFs were completed semiannually by persons who identified functional disabilities on the HSF.

case-mix weighted time between CAFs is 38.4 days shorter in FFS.

CAF rates for S/HMOs may be higher in the healthy, acutely and chronically ill groups because of a greater likelihood of clinical encounters for acute conditions. A CAF, however, is needed to qualify for LTC. Frail cases enrolled in S/HMOs, at baseline, were more severely ill and younger than in FFS. Though not likely to stay frail (i.e., to recover or die), they had high initial costs (Manton et al., unpublished). Thus, despite the higher S/HMO CAF rates, it is unclear that clinical encounters uncover more chronic disability than the periodic and comprehensive FFS screening.

### *Changes in Coverage*

This category includes persons who moved from: FFS to an HMO; an S/HMO (or HMO) to another HMO; an S/HMO (or HMO) to FFS. Annually, 15.2 percent of FFS clients enroll in HMOs; 10.6 percent

**Table 3**

**Annual Functional Impairment, Coverage Change, and Mortality Probabilities, by Case-Mix Group and Health Coverage: 1986-89**

| Case-Mix Group and Health Coverage | Health Assessment[1] | Change in Coverage S/HMO | Change in Coverage HMO | Change in Coverage FFS | Death |
|---|---|---|---|---|---|
| | | | Percent | | |
| **Case-Mix Standardized Rate** | | | | | |
| S/HMO | 38.0 | — | 3.9 | 9.4 | 10.1 |
| FFS | 21.8 | 0.9 | 15.2 | — | 10.2 |
| HMO[2] | 18.4 | 0.4 | 31.9 | 10.6 | 8.1 |
| **Healthy** | | | | | |
| S/HMO | 3.6 | — | 5.8 | 10.7 | 3.0 |
| FFS | 1.2 | 1.2 | 20.7 | — | 3.7 |
| HMO[2] | 0.5 | 0.2 | 36.8 | 9.8 | 3.0 |
| **Acutely Ill** | | | | | |
| S/HMO | 6.6 | — | 1.8 | 27.2 | 6.4 |
| FFS | 1.0 | 1.6 | 14.4 | — | 9.5 |
| HMO[2] | 1.2 | 0.9 | 34.6 | 16.5 | 9.0 |
| **Impaired** | | | | | |
| S/HMO | 75.4 | — | 3.4 | 11.5 | 22.1 |
| FFS | 76.1 | 0.7 | 11.2 | — | 14.4 |
| HMO[2] | 28.2 | 0.2 | 43.7 | 10.8 | 12.3 |
| **Pulmonary** | | | | | |
| S/HMO | 80.9 | — | 1.2 | 4.9 | 7.4 |
| FFS | 56.9 | 0.3 | 6.6 | — | 12.1 |
| HMO[2] | 46.7 | 2.4 | 21.2 | 12.6 | 9.3 |
| **Cardiac** | | | | | |
| S/HMO | 40.1 | — | 4.1 | 8.8 | 8.6 |
| FFS | 7.6 | 0.7 | 16.4 | — | 22.4 |
| HMO[2] | 6.9 | 0.3 | 32.8 | 13.1 | 10.9 |
| **Frail** | | | | | |
| S/HMO | 78.8 | — | 0.6 | 3.4 | 51.7 |
| FFS | 70.2 | 0.3 | 3.2 | — | 28.2 |
| HMO[2] | 78.9 | 0.8 | 5.2 | 9.5 | 30.3 |

[1]This column refers to the annual probability of receiving a comprehensive assessment form (CAF), issued when a change in health or a functional impairment was reported. After initial issuance, a CAF was refiled every 6 months.

[2]This refers to persons in either FFS or S/HMOs who entered HMOs after the start of the study.

NOTES: S/HMO is social/health maintenance organization. HMO is health maintenance organization. FFS is fee-for-service. Probabilities are annualized and may not sum to 100 percent.

SOURCES: Data derived from health screening forms (HSFs) and CAFs administered by the authors. HSF data were collected from FFS beneficiaries at baseline and from S/HMO enrollees upon application. Total HSF sample size is 27,503 cases. CAFs were completed semiannually by persons who identified functional disabilities on the HSF.

return to FFS. Approximately 3.9 percent and 9.4 percent of S/HMO members (case-mix adjusted) enroll in HMOs and return to FFS, respectively. Healthy FFS cases are more likely to join HMOs (20.7 percent) than the acutely ill (14.4 percent). The FFS impaired (11.2 percent) and cardiac (16.4 percent) groups are also likely to enter HMOs. The FFS pulmonary group is less likely (6.6 percent) , and the frail least likely (3.2 percent) to enter HMOs.

Approximately one-third (31.9 percent) of the 900 HMO enrollees switch plans annually—more than in baseline HMO samples. S/HMO members, partly because a large proportion in two sites (40 percent and 60 percent) enrolled from the parent HMO, are stable (Harrington, Newcomer, and Preston, 1993; Newcomer, Preston, and Harrington, 1991). Among recent HMO enrollees, only the pulmonary (21.2 percent) and frail (5.2 percent) groups do not switch often. Less than 6 percent of S/HMO members in any group switch to HMOs. For the acutely ill or frail, the rate is less than 2 percent. This is consistent with HMO joiners adjusting to new plans and S/HMO members having stable plan relations.

Acutely ill S/HMO enrollees are more likely than HMO members to return to FFS (27.2 percent versus 16.5 percent), as are the healthy and the impaired enrollees. Disenrollment varies by site. The two new plans disenroll more acutely ill persons than S/HMOs in mature HMOs. There is little difference between S/HMO and HMO enrollees with respect to healthy and impaired groups. S/HMO members in the chronically ill or frail groups are less likely than HMO joiners to return to FFS.

*Mortality*

FFS mortality (gender and age combined) is higher for the healthy, acutely and chronically ill and lower for the impaired groups. "Case-mix standardized" values are weighted to the pooled case mix of the S/HMO and FFS populations. FFS clients enrolling in HMOs had the lowest mortality (8.1 percent). S/HMO (10.1 percent) and FFS (10.2 percent) rates are similar. Case-mix measures estimated from the pooled HSF/CAF data explain most S/HMO and FFS mortality differences. The HSF data alone explain only 82 percent of mortality differences.

## STOCHASTIC HEALTH CHANGES AND MODALITY

The number of factors that can be simultaneously controlled by stratification is limited. Consequently we used a multivariate model to control for health inputs, gender, age, and coverage in examining what happens in a cohort simultaneously subjected to mortality and disability dynamics. From data available for 3 years, the difference equations were used to construct S/HMO or FFS cohort life tables. Cohort estimates reflect differences in initial case-mix distributions as well as age-dependent dynamics. To examine how disability and mortality interact in FFS and S/HMOs, we calculated three types of life tables. Table 5 presents the age-specific life expectancies and number of years expected to be lived in each case-mix group. In Tables 6 and 7, cohort health changes, mortality, and the proportion expected to be active at specific ages are calculated—starting from specific groups to adjust for initial case-mix differences. In Table 8, the effects of case-mix dynamics are removed by starting cohorts at specific ages and, holding case-mix constant, identifying S/HMO and FFS differences in mortality over age (rather than just at 75 years of age, as in Table 4).

## MORTALITY FUNCTIONS

Table 4 presents gender-specific estimates of FFS and S/HMO mortality (i.e., the $Q_t$). All four have significant $\chi^2$. Each is estimated with its own θ to adjust for different unobserved age-related risk factors (i.e., bias). The coefficients represent the annual probability of death ( × 100) at 75 years of age. Diagonal coefficients are the probability of death for a person in a case-mix group (e.g., the probability of death for a male whose $g_{ik} = 1.0$ in an S/HMO is 57.1 percent; in the healthy group, 2.9 percent). The relative risk of frail to healthy groups is 19.7 to 1 (compared with Table 3, 19.8 to 1.0; in baseline data the ratio is 10.5 to 1). If a person is represented by multiple profiles, off-diagonal (interaction) terms are used. For example, the mortality for a person whose health status is a mixture of the attributes of the frail and healthy groups is the weighted sum of the diagonal and interaction coefficients for the two groups.

Impaired and frail males have significantly higher mortality in S/HMOs (Table 3). FFS mortality is higher for the acutely ill, cardiac, and pulmonary groups, except if sharing attributes with an impaired group, due to interactions. Because impairment increases with age, this gives FFS males a mortality advantage at later ages—along with two other factors. The first is that θ, representing unobserved age-related factors, raises mortality 2.7 percent per year for FFS males, and 3.8 percent per year for S/HMO males. For each year of age, mortality rises 40.7 percent faster for S/HMO males because of non-health factors. Second, the mortality ratio of frail to healthy groups is greater in S/HMOs (19.7 to 1) than in FFS (7.1 to 1). Thus, as disability dynamics move persons into frail groups with age, mortality increases more rapidly for S/HMO males.

For females, there are no significant mortality differences for the healthy, acutely ill, or impaired groups. Two differences for the pulmonary group are marginally significant. Significant differences exist for the cardiac and frail groups. S/HMO females in the cardiac and pulmonary groups are advantaged. FFS females in the frail group, including its interactions with all other groups (except the cardiac), are advantaged. The interaction involving the frail and pulmonary groups is significant, and shows a favorable effect for FFS females. Because the cardiac group is younger (mean age 80.1 years) and the frail older (83.2 years), FFS females will be advantaged at later ages. The θ shows mortality increases 12.8 percent less per year as S/HMO females age. This is counterbalanced by disability dynamics moving more females with age into the frail group, where FFS females have better survival. The effects of greater heterogeneity (i.e., a frail-to-healthy relative risk of 20.8 to 1 versus 8.9 to 1 in FFS) also favors FFS female survival.

## ACTIVE LIFE EXPECTANCY ESTIMATES

We used equations 7 through 12 to estimate cohort life tables using parameters from equations 6 and 7. At the left of Table 5 we list age and coverage. Next are age-specific life expectancies and then six columns containing the years expected to be lived at age $x$ in a case-mix group ($e_{kx}$)—underneath each $e_{kx}$ is the

## Table 4
## Mortality Functions, by Case-Mix Group and Health Coverage, by Gender, at 75 Years of Age

| Case-Mix Group and Health Coverage | Case-Mix Group: Healthy | Acutely Ill | Impaired | Pulmonary | Cardiac | Frail |
|---|---|---|---|---|---|---|
| **Males*** | | | | | | |
| Healthy: | | | | | | |
| FFS | 3.2 (±0.40) | [1]5.7 (±0.60) | [1]5.1 (±0.63) | 6.3 (±0.68) | [1]6.6 (±0.64) | [1]8.6 (±1.04) |
| S/HMO | 2.9 (±0.40) | 4.3 (±0.85) | 6.5 (±1.54) | 6.3 (±1.08) | 5.0 (±0.80) | 12.9 (±1.57) |
| Acutely Ill: | | | | | | |
| FFS | | [1]9.9 (±1.78) | 8.8 (±1.26) | [1]11.0 (±1.38) | [1]11.5 (±1.43) | [1]15.0 (±1.96) |
| S/HMO | | 6.2 (±2.42) | 9.6 (±2.74) | 9.2 (±2.14) | 7.4 (±1.66) | 18.9 (±3.8) |
| Impaired: | | | | | | |
| FFS | | | [1]7.9 (±1.78) | [1]9.8 (±1.41) | [1]10.3 (±1.46) | [1]13.4 (±1.97) |
| S/HMO | | | 14.7 (±6.80) | 14.2 (±3.72) | 11.3 (±3.04) | 29.0 (±6.9) |
| Pulmonary: | | | | | | |
| FFS | | | | 12.2 (±2.20) | [1]12.8 (±1.62) | [1]16.6 (±2.20) |
| S/HMO | | | | 13.7 (±4.24) | 10.9 (±2.30) | 28.0 (±4.9) |
| Cardiac: | | | | | | |
| FFS | | | | | [1]13.4 (±2.4) | [1]17.4 (±2.30) |
| S/HMO | | | | | 8.7 (±2.81) | 22.3 (±4.2) |
| Frail: | | | | | | |
| FFS | | | | | | [1]22.6 (±4.60) |
| S/HMO | | | | | | 57.1 (±11.4) |
| **Females**** | | | | | | |
| Healthy: | | | | | | |
| FFS | 1.7 (±0.23) | 2.8 (±0.36) | 3.2 (±0.34) | [1]3.5 (±0.33) | [1]4.0 (±0.32) | [1]5.1 (±0.45) |
| S/HMO | 1.6 (±0.25) | 2.7 (±0.51) | 3.2 (±0.85) | 3.1 (±0.51) | 2.5 (±0.43) | 7.2 (±0.85) |
| Acutely Ill: | | | | | | |
| FFS | | 4.7 (±0.94) | 5.4 (±0.69) | 5.9 (±0.69) | [1]6.6 (±0.75) | [1]8.5 (±0.96) |
| S/HMO | | 4.6 (±1.60) | 5.4 (±1.66) | 5.4 (±1.17) | 4.2 (±0.96) | 12.4 (±2.32) |
| Impaired: | | | | | | |
| FFS | | | 6.1 (±1.02) | 6.7 (±0.70) | [1]7.5 (±0.76) | [1]9.7 (±0.97) |
| S/HMO | | | 6.4 (±3.38) | 6.4 (±1.74) | 5.0 (±1.50) | 14.6 (±3.86) |
| Pulmonary: | | | | | | |
| FFS | | | | [1]7.3 (±0.96) | [1]8.2 (±0.71) | [1]10.6 (±0.91) |
| S/HMO | | | | 6.3 (±1.75) | 4.9 (±1.04) | 14.4 (±2.24) |
| Cardiac: | | | | | | |
| FFS | | | | | [1]9.2 (±1.06) | 11.8 (±0.96) |
| S/HMO | | | | | 3.9 (±1.36) | 11.3 (±2.22) |
| Frail: | | | | | | |
| FFS | | | | | | [1]15.2 (±1.77) |
| S/HMO | | | | | | 33.2 (±5.66) |

*$\theta_{FFS} = 0.027$, $\chi^2 = 587.6$, Ratio (6/1) = 7.1
$\theta_{S/HMO} = 0.038$, $\chi^2 = 643.9$, RR = 19.7
**$\theta_{FFS} = 0.034$, $\chi^2 = 1334.3$, RR = 8.9
$\theta_{S/HMO} = 0.030$, $\chi^2 = 736.8$, RR = 20.8

[1]*FFS two standard deviation bound for coefficient does not contain S/HMO estimate.*

NOTES: FFS is fee-for-service. S/HMO is social/health maintenance organization. Underlined rates indicate the higher of the two rates in the S/HMO and FFS comparison.

SOURCES: Data derived from health screening forms (HSFs) and comprehensive assessment forms (CAFs) administered by the authors. HSF data were collected from FFS beneficiaries at baseline and from S/HMO enrollees upon application. Total HSF sample size is 27,503 cases. CAFs were completed semiannually by persons who identified functional disabilities on the HSF.

## Table 5

**Life Expectancy and Active Life Expectancy by Age, Health Coverage, and Case-Mix Group, by Gender**

| Gender, Age, and Health Coverage | Life Expectancy | Case-Mix Group[1] Healthy | Acutely Ill | Impaired | Pulmonary | Cardiac | Frail |
|---|---|---|---|---|---|---|---|
| **Males** | | | | | | | |
| 65 Years: | | | | | | | |
| FFS | 15.2 | 10.7 | 0.2 | 0.1 | 1.4 | 2.3 | 0.3 |
| | | (70.8) | (1.6) | (0.8) | (9.4) | (15.2) | (2.2) |
| S/HMO | 14.9 | 13.2 | 0.4 | 0.1 | 0.1 | 0.9 | 0.1 |
| | | (88.8) | (2.6) | (1.0) | (1.0) | (6.0) | (0.7) |
| 75 Years: | | | | | | | |
| FFS | 11.3 | 8.5 | 0.4 | 0.5 | 0.6 | 1.2 | 0.1 |
| | | (75.3) | (3.2) | (4.0) | (5.0) | (11.0) | (1.0) |
| S/HMO | 9.6 | 8.0 | 0.3 | 0.1 | 0.4 | 0.6 | 0.2 |
| | | (83.2) | (2.8) | (1.5) | (4.0) | (6.0) | (2.5) |
| 85 Years: | | | | | | | |
| FFS | 7.1 | 4.6 | 0.2 | 0.5 | 1.0 | 0.4 | 0.2 |
| | | (65.4) | (2.9) | (7.7) | (14.3) | (6.3) | (3.5) |
| S/HMO | 5.6 | 4.1 | 0.2 | 0.1 | 0.5 | 0.3 | 0.3 |
| | | (73.4) | (4.0) | (2.3) | (9.5) | (5.5) | (5.4) |
| 95 Years: | | | | | | | |
| FFS | 3.6 | 1.4 | 0.3 | 0.2 | 0.7 | 0.4 | 0.6 |
| | | (40.3) | (8.6) | (5.6) | (18.2) | (10.2) | (17.1) |
| S/HMO | 2.7 | 1.8 | 0.2 | 0.1 | 0.1 | 0.2 | 0.4 |
| | | (63.9) | (7.3) | (2.1) | (4.3) | (6.6) | (15.8) |
| **Females** | | | | | | | |
| 65 Years: | | | | | | | |
| FFS | 21.4 | 18.7 | 0.5 | 0.4 | 0.2 | 1.4 | 0.1 |
| | | (87.2) | (2.3) | (2.0) | (1.1) | (6.6) | (0.7) |
| S/HMO | 18.4 | 16.1 | 0.5 | 0.3 | 0.1 | 1.3 | 0.1 |
| | | (87.4) | (2.8) | (1.6) | (0.3) | (7.3) | (0.6) |
| 75 Years: | | | | | | | |
| FFS | 15.1 | 13.0 | 0.2 | 0.3 | 0.6 | 0.6 | 0.3 |
| | | (86.2) | (1.6) | (2.2) | (4.0) | (4.2) | (1.9) |
| S/HMO | 11.9 | 9.2 | 0.3 | 0.2 | 0.9 | 1.0 | 0.3 |
| | | (77.6) | (2.3) | (2.1) | (7.5) | (8.3) | (2.2) |
| 85 Years: | | | | | | | |
| FFS | 9.2 | 6.3 | 0.2 | 0.6 | 1.5 | 0.3 | 0.3 |
| | | (69.1) | (1.9) | (6.1) | (15.9) | (3.6) | (3.5) |
| S/HMO | 6.5 | 3.6 | 0.2 | 0.3 | 1.3 | 0.6 | 0.5 |
| | | (56.0) | (3.1) | (4.8) | (19.8) | (8.7) | (7.6) |
| 95 Years: | | | | | | | |
| FFS | 4.6 | 1.7 | 0.3 | 0.2 | 0.9 | 0.4 | 1.1 |
| | | (36.5) | (6.0) | (5.2) | (19.1) | (8.5) | (24.7) |
| S/HMO | 3.4 | 1.1 | 0.3 | 0.2 | 0.9 | 0.2 | 0.7 |
| | | (32.8) | (7.4) | (6.9) | (26.7) | (5.0) | (20.4) |

[1]Years of life expectancy at age X and proportion surviving.

NOTES: FFS is fee-for-service. S/HMO is social/health maintenance organization. Numbers in parentheses are in percent.

SOURCE: Data derived from health screening forms (HSFs) and comprehensive assessment forms (CAFs) adminstered by the authors. HSF data were collected from FFS beneficiaries at baseline and from S/HMO enrollees upon application. Total HSF sample size is 27,503 cases. CAFs were completed semiannually by persons who identified functional disabilities on the HSF.

## Table 6
## Health and Mortality Variables for Males at 75 and 85 Years of Age, by Case-Mix Group at 65 Years of Age

| Age at Evaluation | Case-Mix Group at 65 Years of Age | Health Coverage | Life Expectancy | Proportion Surviving in Percent | Case-Mix Group at Evaluation Age | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Healthy | Acutely Ill | Impaired | Pulmonary | Cardiac | Frail |
| 75 Years | Healthy | FFS | 12.5 | 73.9 | 94.3 | 1.1 | 0.8 | 1.8 | 1.5 | 0.6 |
| | | S/HMO | 9.8 | 71.0 | 88.3 | 2.2 | 1.1 | 3.5 | 2.9 | 2.2 |
| | Acutely Ill | FFS | 9.9 | 46.2 | 47.3 | 6.7 | 14.9 | 9.9 | 17.7 | 3.5 |
| | | S/HMO | 8.3 | 41.0 | 56.9 | 14.8 | 3.8 | 9.6 | 9.4 | 5.6 |
| | Impaired | FFS | 10.9 | 57.2 | 66.2 | 4.7 | 11.4 | 6.6 | 8.8 | 2.4 |
| | | S/HMO | 7.8 | 25.9 | 49.9 | 6.3 | 23.0 | 6.8 | 10.0 | 4.0 |
| | Pulmonary | FFS | 9.3 | 38.1 | 37.6 | 7.9 | 11.3 | 14.0 | 24.7 | 4.4 |
| | | S/HMO | 8.5 | 33.3 | 61.7 | 6.2 | 3.6 | 11.0 | 11.9 | 5.6 |
| | Cardiac | FFS | 8.5 | 35.1 | 25.3 | 5.9 | 7.9 | 10.4 | 47.4 | 3.2 |
| | | S/HMO | 7.5 | 40.2 | 22.8 | 3.9 | 3.4 | 6.7 | 59.7 | 3.6 |
| | Frail | FFS | 9.3 | 31.7 | 37.3 | 8.1 | 11.6 | 14.4 | 24.1 | 4.6 |
| | | S/HMO | 8.4 | 15.5 | 57.9 | 8.5 | 3.3 | 8.8 | 16.4 | 5.1 |
| 85 Years | Healthy | FFS | 7.4 | 44.2 | 75.2 | 2.2 | 5.0 | 12.4 | 2.5 | 2.8 |
| | | S/HMO | 5.6 | 32.0 | 74.5 | 3.8 | 2.2 | 9.4 | 4.9 | 5.3 |
| | Acutely Ill | FFS | 6.7 | 20.4 | 53.7 | 3.6 | 12.2 | 16.5 | 9.6 | 4.4 |
| | | S/HMO | 5.5 | 14.5 | 69.8 | 4.8 | 2.6 | 10.2 | 6.9 | 5.8 |
| | Impaired | FFS | 7.0 | 28.9 | 62.1 | 3.1 | 9.9 | 14.9 | 6.1 | 3.8 |
| | | S/HMO | 5.5 | 8.4 | 69.3 | 4.7 | 2.9 | 10.1 | 7.2 | 5.8 |
| | Pulmonary | FFS | 6.6 | 15.4 | 49.5 | 3.9 | 12.4 | 17.6 | 12.0 | 4.6 |
| | | S/HMO | 5.5 | 12.1 | 70.3 | 4.5 | 2.5 | 10.0 | 7.1 | 5.7 |
| | Cardiac | FFS | 6.4 | 12.4 | 42.0 | 4.3 | 12.2 | 18.0 | 18.8 | 4.7 |
| | | S/HMO | 5.3 | 11.8 | 58.8 | 5.4 | 3.3 | 10.8 | 15.6 | 6.2 |
| | Frail | FFS | 6.6 | 12.8 | 49.5 | 3.9 | 12.5 | 17.7 | 11.9 | 4.6 |
| | | S/HMO | 5.5 | 5.6 | 69.1 | 4.6 | 2.6 | 10.1 | 7.8 | 5.8 |

NOTES: FFS is fee-for-service. S/HMO is social/health maintenance organization.

SOURCES: Data derived from health screening forms (HSFs) and comprehensive assessment forms (CAFs) administered by the authors. HSF data were collected from FFS beneficiaries at baseline and from S/HMO enrollees upon application. Total HSF sample size is 27,503 cases. CAFs were completed semiannually by persons who identified functional limitations on the HSF.

## Table 7
## Health and Mortality Variables for Females at 75 and 85 Years of Age, by Case-Mix Group at 65 Years of Age

| Age at Evaluation | Case-Mix Group at 65 Years of Age | Health Coverage | Life Expectancy | Proportion Surviving in Percent | Case-Mix Group at Evaluation Age | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Healthy | Acutely Ill | Impaired | Pulmonary | Cardiac | Frail |
| **75 Years** | Healthy | FFS | 15.7 | 85.4 | 94.1 | 0.7 | 0.8 | 2.3 | 1.1 | 1.0 |
| | | S/HMO | 12.1 | 81.7 | 84.5 | 1.6 | 1.4 | 6.3 | 4.4 | 1.8 |
| | Acutely Ill | FFS | 12.1 | 52.5 | 38.6 | 8.4 | 10.1 | 16.1 | 18.7 | 8.1 |
| | | S/HMO | 10.1 | 50.1 | 36.3 | 15.8 | 6.1 | 17.8 | 18.2 | 5.9 |
| | Impaired | FFS | 12.5 | 59.8 | 43.7 | 7.5 | 17.0 | 12.5 | 12.2 | 7.2 |
| | | S/HMO | 10.0 | 49.0 | 31.9 | 7.6 | 20.5 | 15.4 | 19.6 | 5.0 |
| | Pulmonary | FFS | 11.5 | 48.7 | 31.1 | 6.7 | 8.6 | 14.6 | 31.8 | 7.2 |
| | | S/HMO | 10.2 | 45.7 | 36.6 | 6.7 | 6.2 | 18.7 | 25.9 | 6.1 |
| | Cardiac | FFS | 11.4 | 48.1 | 29.6 | 6.5 | 8.3 | 14.4 | 34.2 | 7.0 |
| | | S/HMO | 10.1 | 61.1 | 20.7 | 4.1 | 4.9 | 13.6 | 53.0 | 3.6 |
| | Frail | FFS | 12.5 | 52.8 | 43.8 | 8.7 | 10.4 | 16.2 | 12.7 | 8.3 |
| | | S/HMO | 10.6 | 26.6 | 47.6 | 6.6 | 5.9 | 15.5 | 18.1 | 6.2 |
| **85 Years** | Healthy | FFS | 9.3 | 62.9 | 73.4 | 1.6 | 4.7 | 14.6 | 2.6 | 3.2 |
| | | S/HMO | 6.5 | 49.2 | 57.6 | 3.0 | 4.5 | 19.4 | 8.0 | 7.5 |
| | Acutely Ill | FFS | 8.3 | 28.6 | 46.5 | 3.5 | 13.6 | 23.2 | 8.1 | 5.1 |
| | | S/HMO | 6.3 | 23.4 | 47.5 | 3.9 | 6.2 | 22.4 | 11.6 | 8.4 |
| | Impaired | FFS | 8.4 | 34.0 | 48.9 | 3.3 | 14.3 | 21.6 | 7.0 | 4.9 |
| | | S/HMO | 6.3 | 22.3 | 46.6 | 3.8 | 7.1 | 22.2 | 11.9 | 8.3 |
| | Pulmonary | FFS | 8.2 | 24.8 | 42.9 | 3.6 | 14.0 | 24.1 | 10.1 | 5.3 |
| | | S/HMO | 6.3 | 21.6 | 47.1 | 3.7 | 6.3 | 22.2 | 12.4 | 8.3 |
| | Cardiac | FFS | 8.2 | 24.1 | 42.6 | 3.6 | 14.1 | 24.3 | 10.5 | 5.3 |
| | | S/HMO | 6.2 | 27.9 | 41.8 | 3.9 | 6.9 | 23.1 | 15.9 | 8.4 |
| | Frail | FFS | 8.4 | 29.9 | 48.9 | 3.4 | 13.1 | 22.5 | 7.1 | 5.0 |
| | | S/HMO | 6.4 | 13.3 | 49.8 | 3.6 | 5.9 | 21.6 | 11.1 | 8.1 |

NOTES: FFS is fee-for-service. S/HMO is social/health maintenance organization.

SOURCES: Data derived from health screening forms (HSFs) and comprehensive assessment forms (CAFs) administered by the authors. HSF data were collected from FFS beneficiaries at baseline and from S/HMO enrollees upon application. Total HSF sample size is 27,503 cases. CAFs were completed semiannually by persons who identified functional limitations on the HSF.

proportion that those years represent of life expectancy at that age. Male life expectancy at 65 years of age is 15.2 years in FFS and 14.9 years in S/HMO. The proportion of ALE (13.2 years; 88.8 percent) in S/HMOs is higher than in FFS (10.7 years; 70.8 percent), despite a lower life expectancy. Male life expectancy is higher in FFS to 95 years of age with absolute ALE differences becoming small by 75 years of age (i.e., 8.5 years in FFS; 8.0 years in S/HMO).

For females, life expectancy at 65 years of age is 3 years higher in FFS (21.4 years) than in S/HMOs (18.4 years). The ALE proportion is similar (87.2 percent versus 87.4 percent) at 65 years of age, though the absolute difference is 2.6 years because of higher FFS life expectancy. At 75 years of age, ALE is absolutely and proportionately higher in FFS (e.g., 86.2 percent versus 77.6 percent).

For both genders the proportion of life lived frail is modestly higher in FFS at 65 years of age and 95 years of age. It is higher in S/HMOs at 75 years of age and 85 years of age. Because the frail have a high risk of institutionalization, it may be that the frail's greater prevalence in FFS at 95 years of age reflects nursing home restrictions in certifiable S/HMOs.

## AGE-SPECIFIC PROPORTIONS IN CASE-MIX STATES

The life tables in Table 5 reflect the case-mix distribution at enrollment (i.e., initial conditions for the different equations), which is favorably biased for S/HMOs. To control for this, Tables 6 and 7 present case-mix distributions for 10- and 20-year survivors of cohorts starting in the Kth case-mix group at 65 years of age—specific to gender and coverage. These provide, for each group, estimates of the expected number of remaining years of life at a given age (e.g., 75 years of age and 85 years of age), the proportion surviving a period, and the likelihood of changing case mix.

Healthy males 65 years of age have a life expectancy at 75 years of age of 12.5 years (FFS) and 9.8 years (S/HMO), with 73.9 percent (FFS) and 71.0 percent (S/HMO) surviving 10 years. Males who are frail at 65 years of age have a life expectancy at 75 years of age of 9.3 years (FFS) and 8.4 years (S/HMO), with 37.3 percent and 57.9 percent becoming healthy after 10 years. By 85 years of age, 44.2 percent of healthy FFS males are alive; 32 percent in S/HMOs. Similar proportions of surviving males stay healthy (75.2 percent versus 74.5 percent). Of the frail, only 12.8 percent (FFS) and 5.6 percent (S/HMO) survive 20 years. Of frail survivors, 49.5 percent in FFS and 69.1 percent in S/HMOs become healthy by 85 years of age. The higher proportions becoming healthy in S/HMOs may be because of attrition (i.e., a smaller proportion of the frail survive in S/HMOs).

In Table 7, life expectancy is higher for FFS females at 75 years of age and 85 years of age. FFS has more healthy females (62.9 percent) surviving to 85 years of age than S/HMOs (49.2 percent). Survival is greater in FFS in all groups except the cardiac. S/HMO females in the cardiac group had better survival at both 75 years of age and 85 years of age. The frail group shows the greatest differences—more than one-half (52.8 percent) of frail FFS females survive 10 years (i.e., to 75 years of age), compared with 26.6 percent of frail S/HMO females. S/HMOs, by restricting nursing home certifiable cases, may attract acutely ill and frail persons.

**Table 8**
**Life Expectancy, by Age, Health Coverage, and Case-Mix Group, by Gender**

| Gender, Age, and Health Coverage | Case-Mix Group[1] Healthy | Acutely Ill | Impaired | Pulmonary | Cardiac | Frail |
|---|---|---|---|---|---|---|
| **Males** | | | | | | |
| 65 Years: | | | | | | |
| FFS | 23.6 | 10.3 | 12.3 | 8.7 | 8.0 | 5.1 |
| S/HMO | 23.7 | 14.5 | 7.6 | 8.1 | 11.4 | 2.4 |
| 75 Years: | | | | | | |
| FFS | 19.7 | 8.2 | 9.9 | 6.9 | 6.3 | 4.0 |
| S/HMO | 18.8 | 11.0 | 5.6 | 5.9 | 8.6 | 1.7 |
| 85 Years: | | | | | | |
| FFS | 16.3 | 6.5 | 7.9 | 5.4 | 5.0 | 3.1 |
| S/HMO | 14.6 | 8.2 | 4.0 | 4.3 | 6.3 | 1.1 |
| 95 Years: | | | | | | |
| FFS | 13.5 | 5.2 | 6.3 | 4.3 | 3.9 | 2.4 |
| S/HMO | 11.2 | 6.0 | 2.8 | 3.0 | 4.5 | 0.8 |
| **Females** | | | | | | |
| 65 Years: | | | | | | |
| FFS | 33.4 | 17.7 | 14.8 | 13.0 | 10.9 | 7.4 |
| S/HMO | 37.1 | 18.2 | 14.3 | 14.6 | 20.6 | 3.7 |
| 75 Years: | | | | | | |
| FFS | 27.9 | 13.9 | 11.5 | 10.0 | 8.4 | 5.5 |
| S/HMO | 31.7 | 14.7 | 11.4 | 11.6 | 16.8 | 2.8 |
| 85 Years: | | | | | | |
| FFS | 23.0 | 10.8 | 8.8 | 7.6 | 6.3 | 4.1 |
| S/HMO | 27.0 | 11.7 | 9.0 | 9.2 | 13.5 | 2.1 |
| 95 Years: | | | | | | |
| FFS | 19.0 | 8.3 | 6.7 | 5.7 | 4.7 | 3.0 |
| S/HMO | 23.2 | 9.3 | 7.0 | 7.2 | 10.8 | 1.6 |

[1]Years of remaining life after age X in each case-mix group.

NOTES: FFS is fee-for-service. S/HMO is social/health maintenance organization.

SOURCES: Data derived from health screening forms (HSFs) and comprehensive assessment forms (CAFs) administered by the authors. HSF data were collected from FFS beneficiaries at baseline and from S/HMO enrollees upon application. Total HSF sample size is 27,503 cases. CAFs were completed semiannually by persons who identified functional limitations on the HSF.

By 75 years of age, one-half the frail female survivors in both types of coverage return to the healthy group.

In Table 8 we set auto-regressive coefficients to 1.0 ($\beta_{kk} = 1$) and diffusion $\Sigma = 0$ to remove the effects of health changes. Comparing Table 8 with Tables 6 and 7 identifies the effects of health changes. Table 8, for example, shows that frail males have a life expectancy at 65 years of age of 5.1 years in FFS and 2.4 years in S/HMOs. Life expectancy at 65 years of age in Tables 6 and 7 is higher because persons can either die or change health status. In Table 8, FFS healthy, impaired, and frail males live longer past 75 years of age. S/HMO males live longer only in the acutely ill and cardiac groups. S/HMO females are advantaged in the cardiac, healthy, acutely ill, and impaired groups. A survival advantage exists for FFS females manifesting attributes of the frail. Because the prevalence of frailty increases with age, this mortality advantage increased in Table 7, where disability dynamics were operating.

A comparison of Tables 5 through 8 isolates gender differences between outcomes in the two types of coverage attributable to initial conditions, health change, and mortality. For example, while FFS males have modestly better survival but worse ALE than S/HMO males in Table 5 because of better initial conditions in S/HMOs, this changes in Table 6, with initial condition differences eliminated, where the proportion active stays higher for FFS males. For FFS females, life expectancy at 65 years of age is greater (3 years) because groups where mortality differences favor FFS females are those into which disability dynamics, identified in Table 7, move females with age. Table 8 describes the pure effects of mortality free of disability dynamics—one component of the cohort experience.

Gender differences between FFS and S/HMO, because θs are non-zero and differ in size, may reflect differences in unobserved factors (e.g., widowhood). Without estimating θ, this effect would be subsumed in Q, causing those coefficients to be biased. The $Q_t$ include these effects but are evaluated at specific ages. Females have higher institutional risks above 85 years of age. For the elderly, the prevalence of dementia above 85 years of age could be as high as 47 percent (Evans et al., 1992) with 10 percent severely demented. Though having high disability, Alzheimer's cases can have near normal life spans with good care. The initial exclusion of institutionalized persons at all ages, given a high prevalence of dementia in institutions, removes many elderly, demented persons from S/HMO eligibility. However, one could expect moderately demented elderly to be disproportionately FFS clients (i.e., impaired groups tend to re-enter FFS).

## OUTCOME DIFFERENCES BY SITE AND GENDER

To ascertain whether outcome differences are related to site, or to whether a S/HMO was established in a pre-existing HMO or a LTC organization, we calculated life tables for total and site-specific populations. The results are presented in Table 9.

There are differences in life expectancy at 65 years of age (1.01 years) and 85 years of age (0.89 year) that favor FFS. Likewise, the proportion of individuals active at 75 years of age is higher in FFS (2.0 percent), with the difference increasing with age (at 85 years of age it is 6.7 percent).

Site-specific results show that FFS life expectancy is higher in all sites at 65 years of age and 85 years of age. The difference at 85 years of age is slightly larger than at 65 years of age, suggesting that it increases with time. The proportion of active individuals is higher in FFS at 75 years of age (reflecting a population that was enrolled in FFS for 10 years; a comparison at 65 years of age reflects only initial conditions) and increases at 85 years of age. The differences are similar across sites and do not vary by whether the S/HMO was started by an HMO or a LTC provider. There is a slight advantage at 85 years of age in the proportion of enrollees active in the two LTC organization-based S/HMOs (6.4 percent and 5.9 percent) over the differences relative to FFS in the two HMO-based S/HMOs (6.6 percent and 7.1 percent).

## DISCUSSION AND CONCLUSION

S/HMOs integrate medical, health, and social services which, with financial risk, are designed to improve services and control costs. The issue addressed here

## Table 9

**Comparison of Life Expectancy and Active Life Expectancy, by Site and Type of Health Coverage, by Age and Gender**

| Health Coverage and Site | Life Expectancy at Age 65 | Male | Female | 85 | Male | Female | Proportion Active at Age 75 | Male | Female | 85 | Male | Female |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Percent | | | | | |
| S/HMO | 16.85 | 14.9 | 18.4 | 6.09 | 5.6 | 6.5 | 79.7 | — | — | 62.3 | — | — |
| FFS | 17.83 | 15.2 | 21.4 | 6.98 | 7.1 | 9.2 | 81.7 | — | — | 69.0 | — | — |
| Δ | 1.01 | | | 0.89 | | | 2.0 | | | 6.7 | | |
| **Established in HMOs** | | | | | | | | | | | | |
| Minneapolis: | | | | | | | | | | | | |
| S/HMO | 17.83 | 15.8 | 19.2 | 6.37 | 5.7 | 7.0 | 80.1 | 82.6 | 79.3 | 63.0 | 68.1 | 60.9 |
| FFS | 18.35 | 16.3 | 21.7 | 7.36 | 7.7 | 10.1 | 82.1 | 84.3 | 81.4 | 69.6 | 73.7 | 67.7 |
| Δ | 0.52 | 0.5 | 2.5 | 1.02 | 2.0 | 3.1 | 2.0 | 1.7 | 2.1 | 6.6 | 5.6 | 6.8 |
| Portland: | | | | | | | | | | | | |
| S/HMO | 16.71 | 14.2 | 18.4 | 5.86 | 5.6 | 6.5 | 79.2 | 80.5 | 78.6 | 61.4 | 64.8 | 59.7 |
| FFS | 16.96 | 14.4 | 18.7 | 6.67 | 6.3 | 8.2 | 81.5 | 82.8 | 80.8 | 68.5 | 71.6 | 66.8 |
| Δ | 0.25 | 0.2 | 0.3 | 0.81 | 0.7 | 1.7 | 2.3 | 2.3 | 2.2 | 7.1 | 7.2 | 7.1 |
| **Established in LTC Organizations** | | | | | | | | | | | | |
| Brooklyn: | | | | | | | | | | | | |
| S/HMO | 16.61 | 14.0 | 19.2 | 6.37 | 5.0 | 7.7 | 80.4 | 82.4 | 79.2 | 63.2 | 68.4 | 60.0 |
| FFS | 17.14 | 14.4 | 19.9 | 7.39 | 5.9 | 8.9 | 82.3 | 84.3 | 81.1 | 69.6 | 74.1 | 66.6 |
| Δ | 0.53 | 0.4 | 0.7 | 1.02 | 0.9 | 1.2 | 1.9 | 1.9 | 1.9 | 6.4 | 5.7 | 6.6 |
| Long Beach: | | | | | | | | | | | | |
| S/HMO | 16.49 | 13.8 | 18.1 | 6.24 | 5.2 | 6.7 | 80.9 | 83.7 | 79.6 | 64.1 | 70.5 | 61.3 |
| FFS | 16.96 | 14.4 | 18.5 | 7.22 | 6.3 | 7.7 | 82.9 | 85.1 | 81.7 | 70.6 | 75.2 | 68.4 |
| Δ | 0.47 | 0.6 | 0.4 | 0.98 | 1.1 | 1.0 | 2.0 | 1.4 | 2.1 | 5.9 | 4.9 | 7.1 |

NOTES: S/HMO is social/health maintenance organization. FFS is fee-for-service. LTC is long-term care. Delta represents difference between S/HMO and FFS.

SOURCES: Data derived from health screening forms (HSFs) and comprehensive assessment forms (CAFs) administered by the authors. HSF data were collected from FFS beneficiaries at baseline and from S/HMO enrollees upon application. Total HSF sample size is 27,503 cases. CAFs were completed semiannually by persons who identified functional limitations on the HSF.

is whether S/HMOs improved for members, over that for comparable FFS clients, age and gender-specific functional status, and mortality. To describe functional status, 30 items from the HSF and CAF were used to define 6 case-mix groups ranging from healthy to frail using a multivariate procedure. Groups were updated when a health change was measured in a CAF.

The case-mix groups are used to control health variation in two analyses. The first describes time to events within the 3-year study period. The second uses parameters estimated from the study to calculate cohort life tables, specific to gender and coverage. In cohort life tables, disability dynamics and mortality interact, though, by adjusting the coefficients in the difference equations, specific features of the health and mortality processes can be isolated. In the analysis of the 36 months of followup, lifetime implications of the differences between S/HMO and FFS experiences cannot be estimated. Differences in health changes past 36 months are not observed, so even censoring and "length biased" sampling will affect standard statistical analyses. The difference equations for the life table calculations allow the partial (i.e., 36 month) experience of persons at different ages to be composed to extrapolate the lifetime experience of specific cohorts using a multidimensional stochastic process model. Such calculations, though requiring assumptions about the form of the difference equations, allow estimates to be made for lifetime behavior—estimates impossible to make directly without bias with only 36 months of observation. Also, the difference equations reflect the dynamic interaction of health changes and mortality—this cannot be estimated as coefficients in a regression function. Thus, it is necessary to manipulate the difference equations, as done in Tables 5 through 8, to isolate the effects of initial conditions, health dynamics, and mortality selection for subgroups in the study. The problems of limited followup and the interaction of health changes and mortality, are found in many longitudinal observational and demonstration studies.

In Table 5, total life expectancy differed little for males, even though S/HMO males had an early ALE advantage reflecting an initially favorable case mix. For FFS females, in contrast, there is a life expectancy of 3 more years at 65 years of age; 2.6 years more of ALE. FFS life expectancy is high, relative to U.S. cross-sectional life tables (National Center for Health Statistics, 1989). However, institutionalized persons at all ages are initially "out of scope" for the FFS sample and S/HMOs. Thus, the life expectancy estimate should reflect the survival of persons of all ages initially non-institutionalized. This would have greater effects on females, persons of advanced age, and persons with dementia—all groups with high institutionalization rates. An effect of the anticipated direction and size is found in FFS but not in S/HMOs (Branch et al., 1991; Lew and Garfinkel, 1984, 1987).

Initial differences in case mix are adjusted in Tables 6 through 8 by analyzing survival and disability changes within case-mix groups. Non-response affects the proportion of cases initially in a group, but not its dynamics. Adjusting for the initial case mix (as in Tables 6 and 7) improves the relative performance of FFS clients in terms of the proportion active at specific ages. Healthy FFS clients are more likely to stay so at 75 years of age and 85 years of age. S/HMO males and females are likely to become relatively more healthy—but because of higher attrition rates in impaired groups. FFS survival is better for the impaired. Thus, while more surviving S/HMO male members are healthy, survival is worse for impaired groups, or for those with both acute illness and impairment (i.e., persons jointly in acutely ill, impaired, or frail groups). For females a mortality advantage occurs for the impaired and frail groups.

In considering outcome differences, several factors are relevant. First, it is difficult to demonstrate effects in community trials because innovation may affect controls (Brown and Mossell, 1984). If innovation is rapid, FFS clients may have access to new forms of care, while S/HMO members are restricted to a fixed set of services. The National Long-Term Care Channeling demonstration showed that controls often obtained LTC on their own (Manton, Vertrees, and Clark, 1993). Thus, what is usual and customary FFS care may change over the study, e.g., growth in the use of post-acute and home health services in the 1980s by Medicare-eligible persons (Manton et al., 1993). The out-of-pocket purchase of equipment and supplemental LTC services is further facilitated as the average income and education of new elderly cohorts increase. Therefore, S/HMO services (and their definition of and approach to "high risk" chronic care cases) have to be as adaptive as the private LTC market available for controls—especially for females—a general problem in the U.S. health care system (Ayanian and Epstein, 1991; Khan et al., 1990; Maynard et al., 1992; Steingart et al., 1991).

Second, S/HMOs are intended to allocate resources efficiently. Plans operate within benefit guidelines and LTC screening criteria, but vary in emphasis on rehabilitation or prevention. S/HMO interventions were not fixed over time, in contrast to standard clinical trials (e.g., geriatric evaluation units, where procedures for improving function and survival in the frail elderly were tested in randomized designs with fixed case and control groups [Rubenstein and Josephson, 1989]). A number of interventions have been shown in such trials to improve the health and functioning of the elderly, e.g., physical activity (Fiatarone et al., 1990), nutritional supplementation (Bastow, 1983a, 1983b; Gerster, 1991; Larsson et al., 1990; Penn et al., 1991a, 1991b; Tilyard et al., 1992), improved medical and surgical treatments (Gold et al., 1991; Hosking et al., 1989; SHEP Cooperative Research Group, 1991). S/HMO health outcomes might have improved had they adopted recently proven geriatric evaluation and treatment innovations.

This analysis, in addition to illustrating a general methodology for analyzing longitudinal studies of capitated plans, where randomization into case and control groups is inconsistent with study goals, identifies several features of S/HMO performance relative to FFS care with health policy implications.

First, it is clear, because of the large initial case-mix differences between the FFS population and those electing to enter S/HMOs, that capitation-based systems providing extended and LTC services can be more effective if rates are adjusted for detailed case-mix measures—and not just for the four average annual per capita cost factors (i.e., age, gender, Medicaid, and institutional status) that are known not to predict individual service costs. If this were done, then the problems of persons with high institutional risks and LTC needs (e.g., those with dementia, the oldest-old, females with specific health problems) could be directly addressed in capitated organization.

Second, little difference in outcome is found between S/HMOs started in established HMOs versus those started by LTC providers. In both cases acute care seems to be adequate. Neither appears to perform especially well in providing LTC—though S/HMOs started by LTC providers may do marginally better. This may be because of the restrictions placed on LTC eligibility and benefits which limit the provision of necessary LTC services.

Third, S/HMOs seem to perform HMO functions well, as indicated by the relative health success of the healthy and acutely ill. This is confirmed by the similarity of outcomes for specific case-mix groups between S/HMO enrollees and those FFS members entering HMOs during the study. However, S/HMOs perform less well for impaired persons, or for acutely ill persons with chronic impairments. Thus, LTC services provided by the S/HMOs, and their integration with acute care, do not seem effective.

This is illustrated by major gender difference in outcomes. Males, who have a lower disability prevalence, and are impaired for shorter periods of time, have similar life expectancy outcomes as seen in Table 5. FFS females have large advantages. Because females have higher disability prevalence, are disabled for longer periods of time, and, because of widowhood, are at greater risk of institutionalization, this suggests that LTC services provided in S/HMOs were not effective in improving their functional status—especially among elderly females who have the greatest LTC needs.

Gender differences are explored in a series of analyses in Tables 5 through 8. In Table 5, large differences in total life expectancy and ALE for FFS females were found even with favorable S/HMO enrollment. In Table 7, we removed the effects of favorable enrollment and still found advantages for FFS females. In Table 6, with the favorable enrollment for S/HMO males eliminated, FFS males had better outcomes. In Table 8 all disability dynamics (i.e., case-mix changes) are eliminated to generate life expectancy estimates for persons who remain in specific case-mix groups from 65 years of age. In this case, FFS males do well in all but the acutely ill and cardiac group, while only the frail do better for FFS females. Thus, the advantages observed in Tables 5 and 7 for FFS females are because of disability transitions over time and age. When disability dynamics are eliminated, the mortality patterns for each case-mix group are less favorable for FFS females (except for the frail). Thus, much of the disadvantage for S/HMO females may be because of a failure to keep persons from moving into impaired categories where FFS females are advantaged. For males, in contrast, because the age dependence of mortality (i.e., $\theta$ is smaller) is favorable for FFS, there are still improvements with age in Table 8.

Thus, the different tables isolate the effects of initial conditions (i.e., case mix at enrollment), disability changes, and mortality. FFS females have advantages in terms of disability changes. FFS males have mortality advantages at latter ages. S/HMOs start with an advantaged initial case mix. Thus, there is a need to re-evaluate the LTC provided by S/HMOs to determine how to better serve the chronically disabled elderly female population and to slow their rate of disability onset. This is now more feasible than when the S/HMO demonstrations started, because a number of innovative therapies and procedures have recently been demonstrated to be effective in improving function and survival (physical therapy [Rubenstein and Josephson, 1989]; nutritional supplementation [Fiatarone et al., 1990]). Furthermore, results from national surveys (Manton, Corder, and Stallard, 1993) show that rates of disability onset have declined nationally from 1984 to 1990. Even without intervention, the general U.S. elderly population shows declines in disability. Presumably S/HMO enrollees should do better than the general population without specialized integrated care. The method of reimbursing capitated systems to provide necessary LTC services to impaired elderly must be redesigned before capitated plans can deal effectively with this portion of the health service needs of the U.S. elderly population.

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