Selection Bias and Utilization of the Dual Eligibles in Medicare and Medicaid HMOs

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Objective. To examine the existence of selection bias in the first 3 years of the Minnesota Senior Health Options (MSHO) demonstration and to estimate the MSHO effects on medical services utilization after adjusting for selection bias.

Data Sources. Monthly dual eligibility data and MSHO encounter data of March 1997–December 2000 and Medicaid encounter data of January 1995–December 2000 from the Minnesota Department of Human Services; Medicare fee-for-service claims data of January 1995–December 2000 from the Centers for Medicare and Medicaid Services.

Study Design. Quasi-experimental design comparing utilization between MSHO and control groups; multiple econometric and statistical models were estimated with time-invariant and time-varying covariates.

Principal Findings. Favorable MSHO selection was found in the nursing home (NH) and community populations, but selection bias did not substantially affect the findings. Enrollment in MSHO for more than 1 year reduced inpatient hospital admissions and days, emergency room and physician visits for NH residents, and lowered physician visits for community residents.

Conclusions. There was favorable selection in the first 3 years of the MSHO program. Enrollment in MSHO reduced several types of utilization for the NH group and physician visits for community enrollees.

Key Words. Elderly, program evaluation, nursing home, hospitalization, managed care

Medicare and Medicaid “dual eligibles” are among the frailest and costliest medical populations in the United States. Dual eligibles often are disadvantaged by the perverse payment mechanisms and fragmented care systems of the Medicare and Medicaid programs. They have been the target population in the Minnesota Senior Health Options (MSHO) demonstration, which pools Medicare and Medicaid payments to health maintenance organizations

(HMOs) to deliver Medicare and Medicaid-covered primary, acute, and long-term care services to voluntarily enrolled elderly dual eligibles (Kane, Homyak, and Rudolph 2004).

MSHO HMOs are required to be providers of the Prepaid Medical Assistant Program (PMAP), Minnesota's mandatory Medicaid-managed care program covering acute and ancillary services and 180 days of nursing home (NH) stays. PMAP dual eligibles can obtain home- and community-based services through the state fee-for-service (FFS) Elderly Waiver (EW) program. PMAP dual eligibles are qualified for MSHO enrollment, and thus, natural controls for MSHO dual eligibles. Compared with PMAP dual eligibles covered by Medicaid capitation and Medicare FFS arrangements, the MSHO program requires care coordination for each enrollee, for example, Evercare is contracted to provide a nurse practitioner model of primary care and care coordination to many MSHO NH residents. Evercare has been effective in lowering inpatient hospital utilization for Medicare+Choice (M+C) NH enrollees (Kane, Keckhafer et al. 2003).

MSHO HMOs may put marketing materials, audited and approved by the State and the Centers for Medicare and Medicaid Services (CMS), in NHs, hospitals, and clinics, but they are not permitted to send salespersons there. Dual eligibles also know about the MSHO enrollment option through county Medicaid workers, physicians, family members, and friends, as well as marketing mailings from MSHO HMOs. MSHO HMOs are prohibited to discriminate and deny qualified dual-eligible applicants.

A prior evaluation found that MSHO reduced inpatient hospital utilization, emergency room (ER) and physician visits for NH residents, and physician visits for community residents compared with controls during its first 3 years of operation (Kane, Homyak, Bershadsky et al. 2004). However, some variables that potentially affect both MSHO enrollment and medical utilization were omitted from the statistical models due to administrative data limitations, such as underreporting of diagnoses in encounter data and missing disability functional status in FFS claims data. Omission of such variables may raise concerns about possible selection bias in prior findings.

This study examined the existence and degree of selection bias from unobserved variables and the MSHO effects on utilization after adjusting for

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selection bias. Hereafter, "selection bias" refers to differences in unobserved characteristics between voluntary MSHO and PMAP enrollees that affect both program enrollment and medical care utilization.

Medicare HMO selection bias in the literature has been more often defined on observed variables than on unobserved variables (Hellinger 1987, 1995; Dowd et al. 1996; Hellinger and Wong 2000; Mello et al. 2003). The general findings are that Medicare HMOs reduce inpatient hospital utilization and also attract healthier Medicare beneficiaries compared with FFS Medicare (Luft 1998; Mello, Stearns, and Norton 2002). The samples in these studies were either Medicare-only populations or Medicare with only a small percentage eligible for Medicaid. Some studies did not control for NH status due to the small sample proportion of NH residents or data limitations. To our knowledge, this study is the first to focus exclusively on selection bias among elderly dual eligibles residing in both NH and the community.

Social intervention studies are rarely randomized controlled trials and mainly rely on statistical adjustment to control or reduce selection bias on observed and unobserved variables. The former includes standard multivariate regressions and the propensity score (PS) method; the latter usually resorts to simultaneous equations methods, such as the instrumental variables (IVs) approach and sample selection models. The choice of methods to address selection bias may yield different results. The PS method can reduce overt bias from observed variables by matching, stratification or regression based on scalar PSs, which are treatment probabilities that are empirically predicted from the observed variables for the pooled treatment and control groups (Rosenbaum and Rubin 1983, 1984, 1985; D'Agostino 1998; D'Agostino and D'Agostino 2007). The PS method was not designed to adjust for hidden bias from unobservables, and frequently yields similar average treatment effects to the traditional multivariate regressions (Braitman and Rosenbaum 2002; Austin et al. 2005; Shah et al. 2005).

For the IV approach, e.g., two-stage least squares (2SLS) regressions, the endogeneity of treatment choice can be tested by Hausman's specification test (1978) between the 2SLS and ordinary least squares (OLS) estimators. A significant test result indicates biased selection. Favorable (adverse) treatment selection occurs if the 2SLS treatment effect is less than (greater than) the OLS estimate.

The biggest challenge for the IV approach lies in finding IVs that are highly correlated with treatment choice but uncorrelated with omitted variables that are correlated with treatment choice (Greene 2003). The selected IVs may be still questionable even though they pass some empirical tests because their correlation with the true errors cannot be tested. Furthermore,

when IVs are weak, the IV estimator may be biased in the same direction as the OLS estimator, and the standard error of the IV estimator may be too small (Zivot, Startz, and Nelson 1998).

The IV approach assumes that the treatment effects are homogeneous across people, or if the response to treatment is heterogeneous, people do not decide to participate in treatment based on their private unobserved information of potential treatment gains, i.e., the heterogeneous treatment effects are independent of treatment participation. If these strong assumptions are incorrect or if they fail, the IV estimator is still inconsistent for estimating the treatment effects on the treated even with good IVs (Heckman 1997). Furthermore, the instrument-dependent IV estimator that identifies the local or “marginal” average treatment effects on those whose treatment status is determined by the selected instruments does not generalize to persons even in the same study sample whose treatment enrollment is instrument independent (Imbens and Angrist 1994; Angrist, Imbens, and Rubin 1996; Moffitt 1996; Harris and Remler 1998).

Sample selection models usually have two equations, the equation of interest and the sample selection equation. Selection bias can be measured by the strength and direction of the correlation between the error terms of the two equations. However, few studies have applied sample selection models to Medicare HMO selection bias, because extra exogenous identifying variables (IVs) are needed for model identification; again, it has been very difficult to find good IVs (Heckman 1979; Dowd et al. 1996; Greene 2003).

Because good IVs were not available in this study due to administrative data limitations, we used a third approach. By modeling the constant person-level heterogeneity explicitly and assuming program enrollment or selection bias depends only upon constant unobservables such as chronic health and functional status, fixed effects (FE) models can deal with some of the problems of endogenous heterogeneous treatment effects. While random effects (RE) models may be suitable for modeling exogenous heterogeneous treatment effects. In this sense, FE/RE models explicitly control for unobserved individual heterogeneity by using each dual eligible as his/her own control. Selection bias was deduced from the strength and direction of the correlation between program choice and predicted person-heterogeneity from the FE models, as well as other supporting statistical and program evidences. In short, there is no single “best” method available yet for the tricky issue of selection bias. The goal of this study was to detect and correct possible selection bias through multiple methods.

METHODS

Data and Sample

Monthly eligibility data for all dual eligibles in the Twin Cities' metropolitan area and Medicare and Medicaid encounter data for all MSHO enrollees came from the Minnesota Department of Human Services (MDHS). These data ran from March 1997, the starting date of the MSHO program, through December 2000, the ending date of the MSHO demonstration evaluation. Medicaid encounter data for PMAP controls and those who later transferred to MSHO were obtained from MDHS, and their Medicare FFS claims data from CMS. These data ran from January 1995 through December 2000. M+C HMO encounter data were not available. Monthly enrollment data were cross-linked to utilization data based on predetermined data processing algorithms (Kane, Homyak, and Rudolph 2003).

The study sample included only those aged 65 and older, with at least 1 month of dual-eligible status, from Ramsey, Hennepin, Anoka, and Dakota counties, having at least a 6-month claims history of any utilization before their earliest observed dual-eligible month as their health status proxy and risk adjuster. Dual eligibles from Washington and Scott counties were excluded because of very late MSHO program enrollment. Those living outside the Twin Cities were not included because MSHO was not available to them. The community NH certifiable conversion group (persons who left NHs after more than 6-month stays) was dropped due to its very small sample size. Dual eligibles with end-stage renal disease and M+C status were excluded from the final sample. MSHO HMO NH residents who converted to MSHO from non-MSHO Medicare HMOs were also dropped because prior Medicare utilization data were not available.

Study Design

Health care utilization is conceptualized as a function of the dual eligibles' demographics, health and frailty status, MSHO program choice or exposure time, county characteristics, and unobserved relevant variables. MSHO program choice or exposure time is hypothesized to depend on the dual eligibles' demographics, health and frailty status, county characteristics, and unobserved relevant variables. The unobserved variables or error terms in the utilization equations and choice equations are assumed to be correlated because of common or correlated missing variables such as chronic health conditions and functional disability status, which might bias the estimated

coefficients of the utilization equations when these common omitted variables vary across MSHO and control groups (Heckman 1979).

We define selection bias as bias in the estimated coefficients, rather than bias in the predicted expected means. This is one of the important reasons that many general linear models were applied in this study because the estimated coefficients would not be biased if the omitted variables were independent from the covariates, while the predicted expected means may or may not be biased. Even for bias or forecast precision of the expected means, general linear models, especially the much-attacked simple OLS models, are not always inferior to generalized linear models (GLMs) and two-part models (Buntin and Zaslavsky 2004; Ellis and McGuire 2007).

A quasi-experimental design was used to compare the MSHO NH and community enrollees with PMAP controls who lived in the same metropolitan area and were eligible for MSHO but chose not to enroll in MSHO. The MSHO treatment and PMAP control populations were defined by their monthly eligibility status, payment rate–cell categories, frailty status, living arrangements, and residence counties between March 1997 and December 2000. Specifically, the MSHO and PMAP enrollees were divided into three comparison groups: MSHO NH versus PMAP NH, MSHO Community NH Certifiable (CM NHC) versus PMAP Community EW (CM EW), and MSHO Community Non-NH Certifiable (CM non-NHC) versus PMAP Community Non-EW (CM non-EW).

Empirical Models and Measures

Five panel data models were estimated to test the MSHO effects on utilization: FE- and RE-reduced models, RE full models, generalized estimating equations (GEE) full models with unstructured working correlation, and OLS full models with cluster robust standard errors. The “reduced models” included only time-varying covariates: age, death and county indicators, adjusted average per capita cost (AAPCC) county rates, and MSHO enrollment status. The “full models” included both time-variant variables and time-invariant covariates: sex, race, original reasons for Medicare eligibility, and average yearly utilization before the earliest observed dually eligible months (inpatient hospital admissions and days, ER and physician visits, NH admissions and days). The dependent variables for both reduced and full models were current monthly utilization during the observed dually eligible period: inpatient hospital admissions and days, ER and physician visits.

The FE/RE-reduced models include not only observed time-invariant individual heterogeneity, but also unobserved time-invariant variables such as chronic health conditions and education, etc. The RE model assumes that individual heterogeneity is independent from the covariates, while the FE model does not have this strong assumption. If the RE-reduced model is not rejected by Hausman's specification test, it would be a strong indication of no significant selection bias from unobserved chronic health and functional status and other constant individual-specific characteristics. If the RE-reduced model is rejected, however, Hausman's test cannot tell explicitly if the correlation between the individual heterogeneity and the observed covariates is due to MSHO enrollment or other time-varying covariates.

To test if MSHO enrollment was selective on unobservables, the predicted values of the individual heterogeneity from the FE-reduced models were regressed on the MSHO enrollment monthly indicator and all observed time-invariant variables including sex, race, reasons for being eligible for Medicare, and prior utilization measures by the OLS regression with robust stand errors. The observed time-invariant variables were included in the predicted values because they are not estimable in FE models. By controlling for those time-invariant variables, the marginal selection effects of MSHO enrollment on the unobserved person-specific characteristics can be examined. The estimated coefficient for MSHO enrollment was the empirical measure for selection bias on unobserved person-specific variables like chronic health and functional status, the most important reason that the general linear FE models were applied, because the constant person-heterogeneity is not estimable in the conditional FE GLM models.

FE/RE models estimated the person-specific MSHO effects on utilization given a dual eligible's changing enrollment status from PMAP to MSHO by explicitly modeling individual heterogeneity as the only source of within-panel correlation of repeated measures. GEE models estimated the population-averaged (PA) MSHO effects on utilization by comparing the average MSHO and PMAP dual eligibles and explicitly modeling the within-panel correlation, regardless of its sources. FE/RE models are helpful in revealing possible sources of selection bias, while the PA MSHO effects on utilization are of interest, too. Note that the coefficients of the RE and OLS models are also the PA effects due to the identity link functions and assumptions of the expected values of the idiosyncratic errors as zeros (Zeger, Liang, and Albert 1988). Comparing the estimated coefficients of the GEE, OLS, and RE full models with those of the FE/RE-reduced models may give us some hints on the degree of selection bias. To be conservative, the conclusions would be

based on both OLS and GEE estimates if there was no significant selection bias, and on FE estimates if there was significant selection bias. FE/RE models with first-order autocorrelation errors AR(1) and conditional FE/RE Poisson models were also fitted for comparison.

Because the rates of MSHO enrollees' disenrollment to PMAP were very low, it is also reasonable to model MSHO choice as a once-and-for-all decision and sum the utilization within panels into one cross-sectional longitudinal data-set of MSHO exposure time. The goal was to check the effects of MSHO enrollment time on the total utilization of MSHO enrollees during their whole observed dually eligible months. The hypothesis is that total utilization of MSHO enrollees compared with controls will fall as exposure time increases.

MSHO enrollment time may be endogenous, however. Because good IVs were not available, only MSHO selection on observables was examined and predicted propensity scores were used as extra adjustors in all longitudinal data models. Probit models were applied to determine MSHO selection on individual observed variables. The dependent variable was binary MSHO enrollment. The covariates were age, AAPCC rate and county indicator at the observed starting dually eligible month, sex, race, original reasons for Medicare eligibility, prior average yearly utilization, and a vector of binary total dually eligible months observed. The propensity scores predicted from the probit models were grouped by deciles and then compared between MSHO and PMAP. Significant differences in the propensity scores in many deciles would indicate strong MSHO selection on observed variables. OLS models with robust standard errors were also fitted to check MSHO selection on observables and address the concerns on applying OLS models for binary and count data.

Zero-inflated negative binomial (ZINB) models and zero-inflated Poisson (ZIP) models were applied to model the excess zeros and count data nature of the utilization measures for the MSHO exposure time longitudinal data (Lambert 1992). The dependent variables for the negative binomial or Poisson models were total utilization. The dependent variables for the zero-inflation logistic models were binary utilization, with positive utilization as the reference. The covariates for all models included age, AAPCC rate, county indicator, sex, race, original reasons for Medicare eligibility, death indicator, prior utilization, a vector of binary total dually eligible months observed, a vector of binary total MSHO enrollment months, and a vector of binary PS quintiles to further balance the observables between MSHO and PMAP. For comparison, OLS, log linear OLS (LogOLS), and GLM with gamma distribution and log link models (Gamma GLM) were also fitted.

RESULTS

Descriptive statistics for the panel data are shown in Table 1 and those for the longitudinal data are shown in supplementary material Appendix SA2. The final samples included 10,524 dual eligibles (192,809 total observed dually eligible person months) for the NH group; 1,792 (24,271) for the CM NHC/EW group; and 8,149 (195,530) for the CM non-NHC/EW group. The average ages were about 84, 78, and 74.5 years for the NH, CM NHC, and CM non-NHC enrollees, respectively, during the evaluation period. Female enrollees accounted for about 70–80 percent of the three populations. The percentage of whites dropped from 92 percent for NH to 72 percent for CM NHC and to 54 percent for CM non-NHC, while the percentage of Asians jumped from <1 percent for NH to about 6 percent for CM NHC and to nearly 13 percent for CM non-NHC. Blacks accounted for about 5 percent of NH, 13 percent of CM NHC, and 11 percent of CM non-NHC enrollees. About 46 percent of NH residents died during the 46-month MSHO study window, while the overall death rates for community residents fell between 6 and 9 percent. The average known claims history before the first observed dually eligible month was around 2.5 years for all groups. MSHO enrollees generally had lower unadjusted prior utilization and death rates than PMAP enrollees, indicating possible favorable MSHO selection on observed health status measures.

The estimated coefficients or marginal effects of MSHO enrollment on utilization from different general linear panel data models are summarized in Table 2. The Hausman tests for all comparisons of FE/RE-reduced models rejected the null hypothesis that unobserved person-heterogeneity was uncorrelated with the covariates, a key assumption of the RE models. However, the similar signs, magnitudes, and significance levels of the MSHO effects on most utilization measures across the various models indicate that possible MSHO selection bias was not strong, which generally agreed with the results from the OLS regressions based on the results of the FE-reduced models.

For the NH population, there was significant favorable MSHO selection on unobserved health status indexed by inpatient hospital admissions and days. However, MSHO enrollment still significantly reduced all utilization measures compared with controls after adjusting for favorable selection. Significant favorable MSHO selection was also found for the CM NHC population (indexed only by physician visits), and MSHO significantly reduced physician encounters only. For the CM non-NHC group, there was no significant selection bias, and MSHO was significant in lowering physician and

Table 1: Descriptive Statistics for Panel Data

Variable	NH Group (n = 192,809)		CM NHC/EW (n = 24,271)		CM Non-NHC/EW (n = 195,530)	
	Mean/Frequency	Standard Deviation/Percent	Mean/Frequency	Standard Deviation/Percent	Mean/Frequency	Standard Deviation/Percent
<i>Current monthly utilization</i>						
Inpatient admissions	0.0373	0.2007	0.0808	0.2977	0.0375	0.2058
Inpatient days	0.2078	1.7533	0.4719	4.1002	0.1934	1.5413
ER visits	0.0559	0.2688	0.1219	0.4051	0.0647	0.3024
Physician visits	1.2589	1.4754	1.6146	2.2222	1.1534	1.9591
<i>Demographics</i>						
Age	83,9924	8.6354	78,0314	7.5539	74,5728	6.7159
Age ²	7,129,2960	1,440.7050	6,145,9580	1,204.0290	5,606,2040	1,040.1530
Female	147,128	76.31%	19,322	79.61%	140,668	71.94%
Male	45,681	23.69%	4,949	20.39%	54,862	28.06%
White	177,292	91.95%	17,452	71.90%	103,965	53.17%
Black	9,353	4.85%	3,330	13.72%	20,607	10.54%
Asian	853	0.44%	1,337	5.51%	28,656	14.66%
Other race	5,311	2.76%	2,152	8.87%	42,302	21.63%
Aged	162,100	84.07%	20,135	82.96%	169,496	86.69%
Disabled	30,709	15.93%	4,136	17.04%	26,034	13.31%
Alive	187,959	97.48%	24,149	99.50%	194,843	99.65%
Dead	4,850	2.52%	122	0.50%	687	0.35%
<i>Prior yearly utilization</i>						
Inpatient admissions	0.6200	0.8460	0.6020	0.8223	0.3326	0.6669
Inpatient days	4.0769	7.8021	3.5186	6.2322	1.5752	4.0951
ER visits	0.9814	1.3324	1.0391	1.5645	0.6735	1.3472
Physician visits	6.7364	6.0490	10.1732	8.5272	6.9876	6.3701

Continued

Table 1: Continued

Variable	NH Group (n = 192,809)			CM NHC/EW (n = 24,271)			CM Non-NHC/EW (n = 195,530)		
	Mean/Frequency	Standard Deviation/Percent		Mean/Frequency	Standard Deviation/Percent		Mean/Frequency	Standard Deviation/Percent	
NH admissions	0.4041	0.4336		0.1032	0.2414		0.0331	0.1507	
NH days	174.9723	169.5296		6.8901	28.2029		2.3092	20.1832	
Prior total months	26.1810	10.5238		29.7564	12.3762		26.8091	10.7571	
<i>County characteristics</i>									
Anoka	9,432	4.89%		2,077	8.56%		11,379	5.82%	
Dakota	18,049	9.36%		2,004	8.26%		14,171	7.25%	
Hennepin	109,297	56.69%		13,790	56.82%		107,747	55.11%	
Ramsey	56,031	29.06%		6,400	26.37%		62,233	31.83%	
AAPCC rates	428.4464	23.2314		438.6527	23.6316		429.6262	22.9057	
<i>Enrollment months</i>									
PMAP control	139,654	72.43%		18,327	75.51%		179,422	91.76%	
MSHO	53,155	27.57%		5,944	24.49%		16,108	8.24%	

NH, nursing home; CM NHC/EW, Community NH Certifiable/Elderly Waiver; CM non-NHC/EW, Community Non-NH Certifiable/Elderly Waiver; ER, emergency room; AAPCC, adjusted average per capita cost; PMAP, Prepaid Medical Assistant Program; MSHO, Minnesota Senior Health Options.

Table 2: MSHO Treatment Effects and Selection Effects by Groups and Models

Utilization	MSHO Treatment Effects					MSHO Selection Effects
	FE Reduced Model	RE Reduced Model	RE Full Model	GEE Full Model	OLS Full Model	FE/OLS Reduced Model
<i>NH group (n = 192,809)</i>						
Inpatient admissions	-0.0112***	-0.0096***	-0.0089***	-0.0085***	-0.0083***	-0.0043**
Inpatient days	-0.0567**	-0.0564***	-0.0509***	-0.0584***	-0.0561***	-0.0241*
ER visits	-0.0224***	-0.0205***	-0.0197***	-0.0186***	-0.0181***	-0.0019
Physician visits	-0.5385***	-0.5198***	-0.5083***	-0.4489***	-0.5045***	0.0141
<i>CM NHC/EW group (n = 24,271)</i>						
Inpatient admissions	0.0057	-0.009	-0.0087	-0.0095	-0.0104	-0.0018
Inpatient days	0.0259	-0.1436*	-0.1413*	-0.1332	-0.1409	-0.0992
ER visits	-0.0129	-0.0164	-0.0157	-0.0174	-0.0203*	0.019
Physician visits	-0.5231***	-0.7577***	-0.7150***	-0.7156***	-0.7801***	-0.2553***
<i>CM non-NHC/EW group (n = 195,530)</i>						
Inpatient admissions	-0.0017	-0.0008	-0.0012	-0.0038	-0.0044*	0.0006
Inpatient days	-0.0165	-0.0076	-0.0088	-0.0231	-0.0272*	0.0128
ER visits	-0.0042	-0.0024	-0.0035	-0.0076*	-0.0108*	-0.0004
Physician visits	-0.3908***	-0.3656***	-0.3746***	-0.3543***	-0.4344***	-0.0178

* $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$.

For MSHO treatment effects: -, MSHO reduced utilization; +, MSHO increased utilization compared with PMAP.

For MSHO selection effects: -, favorable MSHO selection or MSHO enrollees had better unobserved health status indexed by utilization than PMAP; +, adverse MSHO selection.

MSHO, Minnesota Senior Health Options; NH, nursing home; FE, fixed effects; RE, random effects; GEE, generalized estimating equations; OLS, ordinary least squares; ER, emergency room; CM NHC/EW, Community NH Certifiable/Elderly Waiver; CM Non-NHC/EW, Community Non-NH Certifiable/Elderly Waiver; PMAP, Prepaid Medical Assistant Program.

ER visits. The FE/RE AR(1) and FE/RE Poisson models returned very similar conclusions (supplementary material Appendix SA3).

The probit model results are reported in Table 3. For all three comparison groups, the longer the observed dually eligible months, the more likely the MSHO enrollment. For NH residents, whites and blacks were more likely to enroll in MSHO compared with the reference group who were not white, black, or Asian. Dual eligibles from Dakota and Ramsey counties were less likely to enroll in MSHO than those in Hennepin county. Higher AAPCC

Table 3: Probit Model Results for MSHO Selection on Observed Variables by Groups

<i>Observed Covariates</i>	<i>NH (n = 10,524)</i>		<i>CM NHC/EW (n = 1,792)</i>		<i>CM Non-NHC/EW (n = 8,149)</i>	
	<i>Marginal Effect</i>	<i>Robust SE</i>	<i>Marginal Effect</i>	<i>Robust SE</i>	<i>Marginal Effect</i>	<i>Robust SE</i>
<i>Demographics</i>						
Age	0.0211	0.0094*	−0.0055	0.0251	0.0066	0.0098
Age ²	−0.0001	0.0001	0.0000	0.0002	0.0000	0.0001
Male versus female	−0.0064	0.0114	−0.0059	0.0261	−0.0122	0.0078
White versus other	0.0760	0.0261**	−0.1471	0.0385***	−0.0090	0.0096
Black versus other	0.1302	0.0384***	−0.0379	0.0400	0.0308	0.0146*
Asian versus other	0.0017	0.0781	0.2169	0.0638***	0.0362	0.0143**
Disabled versus aged	0.0069	0.0156	0.0441	0.0305	−0.0143	0.0105
<i>County characteristics</i>						
AAPCC rates	0.0076	0.0003***	0.0015	0.0007*	−0.0001	0.0003
Anoka versus Hennepin	−0.0271	0.0213	−0.0696	0.0357	−0.0494	0.0126***
Dakota versus Hennepin	−0.0456	0.0189*	−0.1245	0.0335*	−0.0794	0.0108***
Ramsey versus Hennepin	−0.2732	0.0094***	−0.0495	0.0267	−0.0131	0.0091
<i>Prior yearly utilization</i>						
Inpatient admissions	−0.0089	0.0113	0.0358	0.0226	0.0140	0.0090
Inpatient days	−0.0007	0.0011	−0.0045	0.0029	−0.0016	0.0012
ER visits	0.0008	0.0054	−0.0005	0.0092	−0.0005	0.0032
Physician visits	−0.0020	0.0008*	−0.0023	0.0013	0.0003	0.0006
NH admissions	−0.0192	0.0159	−0.0506	0.0609	−0.0542	0.0268*
NH days	0.0003	0.0000***	0.0001	0.0004	0.0000	0.0001
<i>Dually eligible months</i>						
Dual months (13–24 versus 1–12)	0.2394	0.0142***	0.0171	0.0306	0.0634	0.0136***
Dual months (25–36 versus 1–12)	0.2999	0.0174***	0.0680	0.0436	0.0623	0.0156***
Dual months (37–46 versus 1–12)	0.3591	0.0166***	0.1196	0.0648*	0.0953	0.0146***

* $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$.

MSHO, Minnesota Senior Health Options; NH, nursing home; CM NHC/EW, Community NH Certifiable/Elderly Waiver; CM Non-NHC/EW, Community Non-NH Certifiable/Elderly Waiver; SE, standard error; AAPCC, adjusted average per capita cost; ER, emergency room.

rates, older age, and longer prior NH stays increased the likelihood of MSHO enrollment. However, more prior physician visits reduced the likelihood of MSHO enrollment. For CM NHC population, higher AAPCC payments increased the likelihood of MSHO enrollment. Whites were less likely and Asians were more likely to enroll in MSHO. Dakota residents were less likely to enroll in MSHO than Hennepin residents. There was no significant biased

MSHO selection on all prior utilization measures. For CM non-NHC population, blacks and Asians were more likely to choose MSHO. Dual eligibles from Anoka and Dakota counties were less likely to enroll in MSHO than those from Hennepin county. Prior NH admissions reduced the chances to enroll in MSHO. Note that the OLS models returned exactly or nearly exactly same conclusions as the probit models (supplementary material Appendix SA4).

Comparisons of propensity scores by deciles are presented in supplementary material Appendix SA5. For the NH population, the propensity scores for MSHO and PMAP were different only in the first, third, and tenth deciles. For the CM NHC population, the propensity scores were different only in the tenth deciles. For the CM non-NHC population, the propensity scores were different in the first, second, sixth, and eighth deciles.

ZINB/ZIP models estimates are reported in Table 4. Vuong (1989) tests and overdispersion tests showed that ZINB models generally fitted the data better than negative binomial models and ZIP models. Compared with PMAP controls who never enrolled in MSHO, exposure to MSHO between 1 and 2 years reduced inpatient hospital days and ER visits for NH and CM non-NHC groups, and lowered inpatient hospital admissions for the CM non-NHC group. However, longer MSHO enrollment generally did not further decrease inpatient hospital and ER utilization. Exposure to MSHO generally increased the chances of seeing physicians, but reduced the total number of seeing physicians in all three groups, and the MSHO effects on physician visits generally increased with longer MSHO enrollment. LogOLS models returned significant results very similar to FE/RE models, and OLS and Gamma GLM models returned conclusions very similar to ZINB models and the OLS models for panel data (supplementary material Appendix SA6).

DISCUSSION

The FE models control for selection bias from chronic health conditions, but not for unobserved acute health conditions. The chronic health conditions refer to those at the beginning of the observed dually eligible period, which were probably correlated with the chronic health conditions added later on. There is no reason to believe that dual eligibles who died during the MSHO evaluation had stable health status, and, thus, there may be selection bias on unobserved changing health status leading to death. However, when examining the MSHO effects on utilization, a death indicator was included to

Table 4: ZINB Model Results for MSHO Exposure Time Effects on Utilization by Groups

	NH (n = 10,524)				CM NHC/EW (n = 1,792)				CM Non-NHC/EW (n = 8,149)			
	Negative Binomials		Logistic		Negative Binomials		Logistic		Negative Binomials		Logistic	
	Robust	SE	Coefficient	Robust SE	RR	Robust SE	Coefficient	Robust SE	RR	Robust SE	Coefficient	Robust SE
<i>Utilization-MSHO Exposure Time</i>												
<i>Inpatient hospital admissions</i>												
1-12 months	0.9833	0.0590	-0.0761	0.3927	1.0368	0.1572	-0.1802	0.3183	0.9501	0.0823	-0.4071	0.3671
13-24 months	0.7561	0.1426	-0.5404	2.6669	0.8873	0.1233	-0.0543	0.3786	0.7863	0.0749*	-0.5695	0.5078
25-46 months	0.9130	0.0860	-0.2533	0.8259	0.8823	0.1383	0.0647	0.4187	0.9224	0.1034	-0.2489	0.3982
<i>Inpatient hospital days</i>												
1-12 months	0.9439	0.0690	-0.0489	0.0727	0.8828	0.1181	-0.1224	0.1911	0.8552	0.0758	-0.1066	0.1313
13-24 months	0.8564	0.0638*	0.2100	0.0902*	0.8282	0.1384	-0.0132	0.2942	0.7809	0.0935*	-0.1802	0.1815
25-46 months	0.9493	0.0802	0.0263	0.1066	0.7236	0.1354	0.0572	0.4069	0.9135	0.1028	-0.0957	0.1674
<i>ER visits</i>												
1-12 months	0.9670	0.0541	0.1684	0.4384	1.0541	0.1342	0.0074	0.2649	0.9028	0.0638	-0.2957	0.3216
13-24 months	0.7999	0.0465***	0.5907	0.5102	0.9390	0.1154	0.2057	0.3409	0.7494	0.0788**	-1.6662	1.7297
25-46 months	0.9036	0.0580	0.9056	0.7237	0.8378	0.1090	0.2730	0.3786	0.8602	0.0868	-0.0913	0.5103
<i>Physician visits</i>												
1-12 months	0.9405	0.0186**	-0.6002	0.1586***	0.6576	0.0437***	-0.1013	0.3906	0.8877	0.0338**	-0.6295	0.3019*
13-24 months	0.7504	0.0146***	0.0845	0.9027	0.5954	0.0496***	-10.3996	3.4380***	0.7749	0.0389***	-0.8033	0.9129
25-46 months	0.6745	0.0135***	-10.6382	0.4801***	0.5641	0.0453***	-0.4944	0.2425*	0.6656	0.0261***	-1.2948	1.3022

* $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$.

For negative binomial regressions, relative risk (RR) < 1, which means MSHO exposure time decreased utilization; RR > 1 means MSHO exposure time increased utilization compared with the PMAP controls whose MSHO exposure time was 0 months.

For logistic regressions: -, MSHO exposure time increased the likelihood of utilization; +, MSHO exposure time decreased the likelihood of utilization compared with PMAP controls.

ZINB, zero-inflated negative binomial; MSHO, Minnesota Senior Health Options; NH, nursing home; CM NHC/EW, Community NH Certifiable/Elderly Waiver; CM Non-NHC/EW, Community Non-NH Certifiable/Elderly Waiver; RR, relative risk; SE, standard error; ER, emergency room; PMAP, Prepaid Medical Assistant Program.

control for the death and death-related effects on utilization. Those alive in MSHO were compared only with those alive in the control groups; those who died in MSHO were compared only with those who died in the control groups. Therefore, the unobserved death-related changing health conditions should not be a big concern even though there was likely biased selection on propensity to die. Death, also as an outcome and quality of care measure, was reported by using survival analysis in the prior MSHO evaluation.

This study found MSHO selection on few prior utilization measures and no serious MSHO selection on unobserved constant person heterogeneity. In some respects, this result is not too surprising. MSHO enrollees are assessed for level of care needs by using the same preadmission screening tools, criteria, and methodology for PMAP enrollees. The total dually eligible population was classified into NH, community NHC, and non-NHC groups by their living arrangements and level of care needs. Such grouping is an important character of the MSHO program payment methods to reduce MSHO HMOs' risk skimming. This study and the prior MSHO evaluation borrowed the MSHO payment grouping to assemble the comparison groups. Such grouping makes the dual eligibles within each comparison group more like each other. The relative within-group homogeneity can reduce the chances and effects of selection bias and regression to the (population) mean (Beebe 1988), so that multiyear prior utilization may be a good indicator for the chronic health status of dual eligibles. Consequently, MSHO selection on residual unobserved chronic health status that was not measured by the observed multiyear prior utilization, death, demographics, reasons for being eligible for Medicare, AAPCC rates, and counties was likely not serious.

In short, selection bias on unobserved acute or transitory health status that was not correlated with death or chronic conditions was not a big concern for this study, although it potentially existed. Utilization caused by pure transitory health status or an acute event is highly unpredictable for both dual eligibles and health plans, and risk selection based only on it is more likely random than systematic. Some working people and Medicare beneficiaries changed their health plans to take advantage of the big differences in out-of-pocket cost-sharing and/or benefits coverage between health plans or between Medicare FFS and M+C products (Luft 1998; Atherly, Dowd, and Feldman 2004), which seems likely not the case for the chronic condition-ridden dual eligibles and the much similar MSHO and PMAP programs. Furthermore, the Medicaid managed care mandate, the requirement that MSHO HMOs be PMAP providers, MSHO overpayments

to HMOs, and marketing regulations by CMS and MDHS also played important roles in alleviating, but not eliminating, favorable MSHO HMO risk selection. The fact that MSHO care coordination was not far superior to PMAP reduced the chances of adverse selection into MSHO (Malone et al. 2004).

Selection bias on unobservables is more difficult to correct than selection bias on observables because the latter usually can be statistically controlled. However, because of the relative relationship between the observed and unobserved variables, the importance of selection bias on unobservables likely depends on the quality and quantity of measurement of relevant and important observables, study designs, statistical methods, differences between the treatment and control programs, and heterogeneity of the target populations.

CONCLUSIONS

This study found favorable MSHO selection in the NH and community populations. Enrollment in MSHO for more than 1 year reduced inpatient hospital admissions and days, ER and physician visits for NH residents, and lowered physician contacts for community residents compared with controls. The very similar conclusions on MSHO program effects on selected utilization measures from the multiple methods and models of this study and the prior MSHO evaluation indicate MSHO selection bias generally was not strong.

This study also found that the MSHO program effects on inpatient hospital and ER utilization did not significantly increase with longer MSHO enrollment during the evaluation period. One possible reason for the lack of greater effects is that MSHO care coordination was not sufficiently proactive in providing effective care to frail dual eligibles by incorporating innovative geriatric care models and changing the practice styles of PCPs effectively (Kane 1998, 2002a, b; Kane et al. 2005).

Simply pooling Medicare and Medicaid payments to HMOs and extending case management to all enrollees is not enough to build efficient and effective integrated care systems for elderly dual eligibles (Challis 1993; Pacala et al. 1995; Boulton, Kane, and Brown 2000). We believe that innovative integration of appropriate financial incentives and effective health care services are indispensable in designing and implementing program initiatives to produce optimal population health among the frail elderly.

ACKNOWLEDGMENTS

This study was mainly performed when the first author worked in the University of Minnesota. The original research was supported by Contract #HCFA 500-96-0008, Task Order #3 with the Centers for Medicare and Medicaid Services. The authors thank three anonymous referees for helpful comments on an earlier draft. All remaining errors are ours.

Disclaimers: The results and conclusions are solely those of the authors and should not be interpreted as those of the federal government, the University of Minnesota, or current employers.

Disclosures: No conflicts of interest. An abstract prior to the initial draft was presented at the 2006 AcademyHealth Annual Research Meeting in Seattle, and the presentation material was not published on AcademyHealth website and conference prints.

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SUPPLEMENTARY MATERIAL

The following material is available for this article online:

Appendix SA1: Author matrix.

Appendix SA2: Descriptive Statistics for Longitudinal Data.

Appendix SA3: MSHO Treatment Effects and Selection Effects by Groups and Models.

Appendix SA4: OLS Model Results for MSHO Selection on Observed Variables by Groups.

Appendix SA5: Comparison of Propensity Scores between MSHO and PMAP by Groups.

Appendix SA6: OLS, LogOLS, and Gamma GLM Models Results for MSHO Exposure Time Effects on Utilization by Groups.

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