Medicare HMO Penetration and Mortality Outcomes of Ischemic Stroke

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Objective: To examine associations between Medicare health maintenance organization (HMO) penetration and stroke mortality outcomes among older persons.

Study Design: Panel analysis of nationally representative secondary data from 1993 to 1998.

Methods: The first analysis sample included ischemic stroke hospitalizations among older persons in the Nationwide Inpatient Sample; the second included county-level ischemic stroke deaths in the National Vital Statistics System. The 2 samples were merged with the HMO enrollment data and the 2001 Area Resource File. The 2 outcomes were inhospital death status and county-level population ischemic stroke death rates among older persons; the 2 utilization variables were length of hospital stay for ischemic stroke and proportion of ischemic stroke deaths occurring in hospitals. The 3 key explanatory variables were county-level Medicare total, independent practice association, and nonindependent practice association HMO penetration. Ordinary least squares analysis with hospital or county fixed effects was used in estimation.

Results: Medicare HMO penetration was not associated with the 2 ischemic stroke mortality outcomes ($P > .05$). Increases in Medicare total and independent practice association HMO penetration were associated with a significant shift in a higher proportion of stroke deaths from hospitals to nursing homes or residences ($P < .05$). Medicare HMO penetration was negatively associated with length of stay, although this was not statistically significant ($P > .05$).

Conclusions: Increased Medicare HMO penetration was associated with a shift in ischemic stroke deaths from hospitals to nonhospital settings. The effect of Medicare HMO penetration on quality of stroke care needs further research.

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Managed care organizations adopt various mechanisms (eg, utilization review, gatekeeping, and preauthorization) to control healthcare utilization.[1] These mechanisms could lead to lower intensity of care, which has raised concerns about quality of care in managed care.[2,3] One influential study[4] suggested that older persons with chronic illnesses had worse outcomes in managed care than their fee-for-service (FFS) counterparts, but empirical evidence on performance of managed care is limited overall. One methodological challenge has been that managed care practice styles may spill over to FFS settings as managed care penetration increases. This practice style convergence may blur differences in outcomes between managed care and FFS practices when comparing outcomes at an individual level within areas.[2,3,5] As a result, market-level studies[6-8] of the effect of managed care penetration on market-level outcomes should be a useful complement to the individual-level comparisons. Although there have been studies[9-15] of the effect of managed care market penetration on quality of care, few market-level studies[12,15-17] have examined the effect of managed care penetration on outcomes.

This study examined the effect of Medicare health maintenance organization (HMO) penetration on mortality outcomes among older persons. We might hypothesize ex ante that this penetration could have different outcome effects on different diseases. In this article, we focus on ischemic stroke (hereafter referred to as stroke) because stroke is one of the leading causes of morbidity and mortality in the United States[18] and because lower-intensity practice styles could be hypothesized to adversely affect stroke outcomes. Stroke requires intensive acute and postacute care that not only improves stroke survival but also prevents recurrent strokes, which have lower survival rates than initial strokes.[19] Medicare requires a 3-day hospitalization before reimbursing for postacute care. Some Medicare HMOs, not subject to this 3-day rule, might bypass or shorten the initial hospitalization and reduce the intensity of postacute care. Although a previous market-level study[20] showed that Medicare HMO penetration was not associated with stroke hospitalization rates, several studies[21-23] found that, compared with FFS stroke

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patients, managed care stroke patients received a lower intensity of acute and postacute care. Therefore, we postulated that increased Medicare HMO penetration could lead to higher mortality rates for stroke. However, the level of intensity and the quality of care may depend on the type of HMO.[14,24-26] One might expect that, in contrast to independent practice association (IPA) HMOs, transitions of care (eg, postacute care) may be better coordinated and less subject to the Medicare 3-day hospitalization rule in closed-network non-IPA (eg, staff or group) HMOs. We further postulated that the effects on stroke mortality may differ by Medicare IPA and non-IPA HMO penetration.

Using the Nationwide Inpatient Sample (NIS) and mortality data from the National Vital Statistics System from 1993 to 1998, we examined the associations between Medicare HMO penetration and inhospital and overall population mortality rates among older persons. Because of concern about the steady decreases in length of hospital stay (LOS) and the proportion of stroke deaths in hospitals during the past 2 decades in part due to the expansion of managed care,[27] we further examined the associations between Medicare HMO penetration and LOS and the proportion of stroke deaths occurring in hospitals (vs nursing homes or residences).

METHODS

Data Sources

The main data sources were the NIS, mortality data from the National Vital Statistics System, and HMO enrollment files (Medicare-specific enrollment and HMO enrollment for all ages) from 1993 to 1998. This study period, although dated, represented a period during which diagnostics and therapeutics for stroke care were stable. An additional data source was the 2001 Area Resource File, from which we extracted county-level information on the number of neurologists per 1000 older (≥ 65 years) persons and on population counts of older persons by demographics (ie, age and sex) from 1993 to 1998.

The NIS, part of the Agency for Healthcare Research and Quality's Healthcare Cost and Utilization Project, includes discharges from a sample of hospitals representing approximately 20% of all community hospitals in the United States. Although the Healthcare Cost and Utilization Project tried to sample the same hospitals over time, some hospitals were added, replaced, or deleted each year mainly because new states participated in the project. Available information in the NIS included primary and secondary discharge diagnoses with the *International Classification of Diseases, Ninth Revision (ICD-9-CM)* codes, inhospital death status, LOS, patient demographics, and state or county codes.

The mortality data comprised all death certificates in counties with populations of at least 100 000 based on the 1990 census. Available mortality data included place of death, underlying cause of death (*ICD-9-CM* code), demographics, and state and county of residence. The place of death variable was coded as (1) death during a hospital inpatient, outpatient, or emergency department visit; (2) death in a nursing home or residence; or (3) death in another or an unknown place (about 2%). A single cause of death was reported.

Two HMO enrollment files were used to measure HMO penetration. The first file was the Medicare HMO enrollment file from the Centers for Medicare & Medicaid Services, which summarized the total number of Medicare HMO enrollees by contract (eg, risk contract) and type of HMO (ie, IPA, group, or staff) in each county, the adjusted average per capita cost rates, and the number of older persons eligible for Medicare Part A. The second file was the overall HMO enrollment file, which reported the number of HMO enrollees at the county level. A county was considered a Medicare HMO market. A partial justification for this market definition was that adjusted average per capita cost rates depended on counties as key administrative market areas.

We constructed 3 county-level Medicare HMO penetration measurements. Only risk contract HMO enrollment data were used to measure the penetration because risk HMOs were capitated and bore full financial risk. The first measurement was the Medicare total HMO penetration, measured as a ratio of the total number of Medicare HMO enrollees regardless of the type of HMO to the Medicare Part A–eligible population at the county level. The other 2 Medicare HMO penetration measurements were calculated in a manner similar to that used for the Medicare total HMO penetration, using IPA or non-IPA HMO enrollees instead of the total number of Medicare HMO enrollees. An additional HMO penetration variable measured overall (all ages combined) HMO penetration, constructed from HMO enrollment data from the Group Health Association of America and Interstudy (previously reported by Laurence Baker[28]). We calculated overall HMO penetration as a ratio of the total number of HMO enrollees to the total population in each county. (For a general discussion about measuring the county-level HMO penetration, see the 1997 article by Baker.[28])

Analysis Samples

Using the NIS and mortality data, we created 2 analysis samples, which were merged with the 2 HMO penetration enrollment data files and the 2001 Area Resource File in the statistical analysis. The first sample (discharge level), constructed from the NIS, included stroke admissions with the primary diagnoses (*ICD-9*

code 434.xx or 436.xx), age at admission of 65 years or older, LOS of 180 days or less, and state and county codes. The key explanatory variables were the 3 Medicare HMO penetration measurements. Patient-level covariates included 2 dummy variables for age (65-74 as a reference, 75-84, and ≥ 85 years), sex, and 6 selected comorbidities.[29] Three county-level time-varying covariates were the overall HMO penetration, the number of neurologists per 1000 older persons, and the adjusted average per capita cost rates. The second sample (county level), constructed from the mortality data, included all stroke deaths among older persons.

Outcomes and Utilization Variables

We created 4 dependent variables in our analyses. The first 2 variables were inhospital mortality status (1 if an inhospital death vs 0 otherwise) and LOS in the discharge-level sample. The other 2 variables were the proportion of stroke deaths occurring in hospitals and the overall population stroke death rates among older persons in the county-level sample. For each of the 6 strata identified by the 3 age categories (65-74, 75-84, and ≥ 85 years) and sex at each county in each year, we defined the proportion as a ratio of the number of stroke deaths occurring in the hospital setting (ie, death during a hospital inpatient, outpatient, or emergency department visit) to the total number of stroke deaths, excluding stroke deaths in the other category or in an unknown place. For each of the same 6 demographic strata, the stroke death rate was calculated as the total number of stroke deaths divided by the total population in each stratum.

Statistical Models

We ran 4 sets of models, 1 for each dependent variable. In each set of models, we estimated the effects of the 3 Medicare HMO penetration measurements separately. The main concern about estimating the effects of Medicare HMO penetration was that uncontrolled heterogeneity, particularly at the market level, could yield biased estimates.

With this concern in mind, we first regressed inhospital mortality status and LOS (log transformed) on Medicare HMO penetration, using the discharge-level sample. To minimize Medicare HMO selection biases, we used a hospital fixed-effects specification to control for any hospital and county-level time-invariant heterogeneity (eg, the "stroke belt" in the southeastern United States). Other covariates included patient-level demographics and 6 comorbidities, 3 county-level time-varying variables, and year dummy variables. To examine whether Medicare HMO penetration might have affected the place of stroke death and consequently negatively affected overall population stroke death rates, we then regressed the proportion of stroke deaths occurring in hospitals and overall population stroke death rates on Medicare HMO penetration with county fixed effects, weighted with county populations of older persons stratified by age categories (65-74, 75-84, and ≥ 85 years) and sex. Except for the 6 comorbidities, the same covariates were used in the latter analysis.

We conducted 2 sensitivity analyses. First, the exclusion of counties with populations of less than 100 000 in the county-level sample might limit the comparability of the results from the 2 samples, and using a county as a Medicare HMO market might not be appropriate in counties with sparse populations in the discharge-level sample. Therefore, we reran the analysis of the discharge-level sample, restricting the sample to counties with populations of at least 100 000 and tested the robustness of the estimates from the full discharge-level sample. Second, multicollinearity problems may lead to insignificant estimates of the effects of Medicare HMO penetration because of potential correlations of Medicare HMO penetration and overall HMO penetration. We reran all the analyses by removing the overall HMO penetration variable. Ordinary least squares models (or linear probability models for the inhospital mortality status variable) were used for all estimates. Standard errors were adjusted via Huber-clustered (hospital) standard errors correction in the analysis of the discharge-level sample and via Huber standard errors correction in the county-level sample.[30,31] We used STATA[32] statistical software for all statistical analyses.

RESULTS

Characteristics of the Samples

The discharge-level sample included 365 479 stroke hospitalizations in 1327 hospitals, located in 585 counties from 17 states. The mean descriptive statistics of the discharge-level sample are summarized in **Table 1**. The mean inhospital mortality dropped from 9.8% in 1993 to 7.6% in 1998, while the mean LOS decreased from 9.2 to 6.4 days. Medicare total HMO penetration grew from 8.0% in 1993 to 18.5% in 1997 and dipped to 13.9% in 1998. During the same period, Medicare IPA HMO penetration grew at a pace similar to that of the Medicare total HMO penetration, but Medicare non-IPA HMO penetration grew at a slower pace. Overall HMO penetration rose steadily from 1993 to 1998. The comorbidities remained unchanged during the period (data not shown).

Table 2 summarizes the mean descriptive statistics of the county-level sample, comprising 16 003 observa-

Table 1. Mean Statistics of Key Variables in the Discharge-level Sample Created From the National Inpatient Sample (NIS)*

Variable	1993 (n = 62 162)	1994 (n = 60 322)	1995 (n = 62 389)	1996 (n = 63 211)	1997 (n = 60 669)	1998 (n = 56 726)
Dependent variables						
Inhospital death rate, per 100 hospitalizations	9.765	9.539	8.742	8.014	7.630	7.566
Length of stay, d	9.230	8.400	7.930	7.180	6.860	6.430
Independent variables						
Medicare total HMO penetration	0.080	0.092	0.115	0.152	0.185	0.139
Medicare IPA HMO penetration	0.032	0.041	0.064	0.089	0.112	0.086
Medicare non-IPA HMO penetration	0.049	0.051	0.051	0.063	0.073	0.053
Overall HMO penetration	0.205	0.215	0.230	0.260	0.288	0.288
No. of neurologists, per 1000 older persons	0.121	0.160	0.142	0.135	0.171	0.227
Adjusted average per capita costs, in $1000	0.406	0.427	0.466	0.491	0.493	0.504
No. of unique hospitals	761	759	756	730	711	683
No. of unique counties	393	399	410	407	405	412

*Discharges from Georgia, Hawaii, Kansas, South Carolina, and Tennessee in the NIS had missing state or county codes and were excluded from this sample. HMO indicates health maintenance organization; IPA, independent practice association.

tions in 452 unique counties during the study period. The proportion of stroke deaths occurring in the hospital setting decreased from 64.0% in 1993 to 58.4% in 1998, but the overall population stroke death rate among older persons remained stable at 2.6 per 10 000 people. The mean descriptive statistics of Medicare HMO penetration variables and other county-level covariates were similar to those described in the discharge-level sample.

Estimates of Multivariate Analyses

The main regression estimates of Medicare HMO penetration from the multivariate analyses are summarized in **Table 3**. The estimates showed that none of the 3 Medicare HMO penetration variables was associated with inhospital stroke mortality rates or with overall population stroke mortality rates ($P > .05$ for both). Only increased Medicare IPA HMO penetration was associated with a moderate decrease in LOS at $P < .001$ (2279/365 479 observations, or 0.6%, were dropped because of zero days of LOS). Medicare HMO penetration was negatively associated with length of stay, although this was not statistically significant ($P > .05$). Additional analysis suggested that Medicare HMO penetration was associated with the proportion of stroke deaths in hospitals. Increased Medicare total HMO penetration was statistically significantly associated with a shift in a higher proportion of stroke deaths from hospitals to nursing homes or residences ($P < .01$), and we saw a similar shift associated with Medicare IPA HMO penetration ($P < .05$). All other things equal, a 10-percentage-point increase in Medicare total or IPA HMO penetration was associated with a 1.0-percentage-point decrease in the proportion of stroke deaths occurring in hospitals. However, there was no association between Medicare non-IPA HMO penetration and the place of stroke death.

The estimates of other covariates (data not shown) suggested that demographics and comorbidities (only available in the discharge-level sample) were significantly correlated with the 4 dependent variables in all models ($P < .01$). The county-level time-varying covariate estimates were not statistically significant at $P < .05$ except for the number of neurologists per 1000 older persons, which was associated with a decrease in the proportion of stroke deaths occurring in hospitals ($P < .01$). In addition, our sensitivity analysis demonstrated the robustness of the key estimates of Medicare HMO penetration.

Table 2. Mean Statistics of Key Variables in the County-level Sample Created From the Mortality Data*

Variable	1993 (n = 2610)	1994 (n = 2669)	1995 (n = 2668)	1996 (n = 2678)	1997 (n = 2695)	1998 (n = 2683)
Dependent variables						
Proportion of stroke deaths in hospitals	0.640	0.617	0.603	0.593	0.586	0.584
Stroke death rate, per 1000 older persons	0.265	0.265	0.269	0.266	0.258	0.251
Independent variables						
Medicare total HMO penetration	0.076	0.092	0.122	0.156	0.186	0.146
Medicare IPA HMO penetration	0.039	0.050	0.072	0.097	0.121	0.095
Medicare non-IPA HMO penetration	0.039	0.044	0.050	0.059	0.065	0.051
Overall HMO penetration	0.211	0.213	0.230	0.258	0.280	0.290
No. of neurologists, per 1000 older persons	0.127	0.136	0.132	0.131	0.129	0.127
Adjusted average per capita costs, in $1000	0.417	0.436	0.477	0.502	0.501	0.513

*The mean statistics were weighted by the county-level older populations, stratified by 3 age categories (65-74, 75-84, and ≥ 85 years) and by sex. There were 452 unique counties represented during each year of the study period.
HMO indicates health maintenance organization; IPA, independent practice association.

Table 3. Estimates of Medicare HMO Penetration From the Hospital or County Fixed-effects Models

Variable	Inhospital Death Status*	Stroke Death Rate	Length of Stay	Proportion of Stroke Deaths in Hospitals
Medicare total HMO penetration	–0.017	0.033	–0.069	–0.101†
Medicare IPA HMO penetration	–0.022	0.012	–0.016‡	–0.090§
Medicare non-IPA HMO penetration	–0.010	0.061	0.083	–0.106‡
Fixed effects	Hospital	County	Hospital	County

HMO indicates health maintenance organization; IPA, independent practice association.
*Scored as 1 if an inhospital death vs 0 otherwise.
†Statistically significant at $P < .01$.
‡Statistically significant at $P < .10$.
§Statistically significant at $P < .05$.

DISCUSSION

Although our analysis suggests no association between Medicare HMO penetration and LOS of older persons hospitalized for stroke, we found a significant shift in a higher proportion of stroke deaths from hospitals to nursing homes or residences associated with increased Medicare HMO penetration, likely driven by increased IPA HMO penetration. Despite this significant shift in the place of stroke death, there was little evidence indicating that Medicare HMO penetration was associated with inhospital or overall population stroke mortality rates among older persons.

In contrast to our results of stroke outcomes, few studies examining the direct effects of HMO penetration on health outcomes have had mixed results. There is little evidence available on the market-level effects of IPA or non-IPA HMO penetration on health outcomes. In a study[17] of the effect of the penetration of the Medicare + Choice program on population mortality rates, increased enrollment rates in the Medicare + Choice program without drug benefits was associated with higher mortality rates. A suggested reason was the life-extending benefit of pharmaceutical products. Using cross-sectional data, 3 other studies[12,15,16] found that survival rates of older FFS acute myocardial infarction patients were not associated

with HMO penetration. Two additional studies[11,13] indirectly assessed the effects of HMO penetration on health outcomes and did not demonstrate associations between HMO penetration and outcomes.

We chose stroke as the focus of this study because frail older HMO enrollees have been shown to fare significantly worse than their FFS counterparts and because HMO practice styles of stroke care might undermine quality of care.[4,21-23] Contrary to our hypotheses, we found no association between Medicare HMO penetration and the inhospital or the overall population stroke mortality rates. It is possible that increased Medicare HMO penetration did not have any detrimental effect on stroke outcomes. For example, HMOs, particularly IPA HMOs, may use selective contracting as their strategy for cost savings rather than restricting utilization. While restricting utilization might lower quality of care, selective contracting might not affect outcomes. In addition, HMO practice patterns might be irrelevant to stroke outcomes in a market in which at low levels of penetration there were disproportionately few patients at risk of stroke in HMOs.

This study had 4 limitations. First, because of the use of inpatient claims data with limited clinical detail, we were unable to assess whether increased Medicare HMO penetration affected the severity of hospitalized stroke patients. We could not rule out that higher Medicare HMO penetration could have led to hospitalization only of patients with lower severity of stroke and at a lower risk of death. Second, we were concerned about the accuracy of using *ICD-9-CM* codes to identify strokes. Measurement errors in using secondary data for stroke studies have been reported.[33] In addition, some hospitals in the NIS may be fully owned by regional HMO plans (eg, Kaiser Health Plans) that are staff-model HMOs with sizable Medicare risk contracts. The diagnoses in claims generated from this type of hospital that are not used for any billing purposes may be less accurate than those from community hospitals that treated predominately FFS patients. Although measurement errors represent a concern about the precision of the estimates, there has been no evidence suggesting correlation of HMO penetration and this type of measurement error. Therefore, the estimates in our study would not be biased by this type of error. Furthermore, if we assumed that this type of measurement error was systematic within a hospital or a county over time, the hospital or county fixed-effects models used for estimation could actually purge this type of error. Third, increased Medicare HMO penetration might adversely affect inhospital stroke mortality rates, but the data and methods in our study might impede this inference. Although our hospital or county fixed-effects analysis may minimize biases resulting from market-level time-invariant heterogeneity, we are concerned about biases caused by unmeasured time-varying hospital or county factors correlated with Medicare HMO penetration and stroke outcomes. Fourth, our findings might not be generalizable to the period after the introduction of the Medicare + Choice program, which began to offer other managed care plans in 1999. Therefore, the effect of Medicare managed care penetration on health outcomes in the future remains unclear.

A shift in the place of stroke death associated with increased Medicare HMO penetration raises important policy questions, including whether Medicare HMOs may be detrimental as opposed to being appropriate or, indeed, desirable. On the one hand, HMOs may affect practice by discouraging hospitalization for individuals who are likely to survive but who nonetheless may benefit from various services such as aggressive treatment of conditions that may lead to a recurrent stroke or stroke complication. On the other hand, HMOs may encourage providers to avoid hospitalizing patients who are unlikely to do well with acute care (such as severely demented individuals with another stroke in a series of strokes) and to discharge them faster when they are admitted. Death out of hospital could reflect greater appreciation of patient preference. As Medicare policy makers continue to expand managed care programs to older persons, more research is needed to understand how the shift in the place of stroke death from the hospital to nonhospital settings may affect quality of care.

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