The Effects of HMO Penetration on Preventable Hospitalizations

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Objective. To examine the effects of health maintenance organization (HMO) penetration on preventable hospitalizations.

Data Source. Hospital inpatient discharge abstracts for 932 urban counties in 22 states from the Healthcare Cost and Utilization Project (HCUP) State Inpatient Databases (SID), hospital data from American Hospital Association (AHA) annual survey, and population characteristics and health care capacity data from Health Resources and Services Administration (HRSA) Area Resource File (ARF) for 1998.

Methods. Preventable hospitalizations due to 14 ambulatory care sensitive conditions were identified using the Agency for Healthcare Research and Quality (AHRQ) Prevention Quality Indicators. Multiple regressions were used to determine the association between preventable hospitalizations and HMO penetration while controlling for demographic and socioeconomic characteristics and health care capacity of the counties.

Principal Findings. A 10 percent increase in HMO penetration was associated with a 3.8 percent decrease in preventable hospitalizations (95 percent confidence interval, 2.0 percent–5.6 percent). Advanced age, female gender, poor health, poverty, more hospital beds, and fewer primary care physicians per capita were significantly associated with more preventable hospitalizations.

Conclusions. Our study suggests that HMO penetration has significant effects in reducing preventable hospitalizations due to some ambulatory care sensitive conditions.

Key Words. HMOs, preventable hospitalizations, quality of care

In the 1980s, health maintenance organizations (HMOs) were heralded as an important mechanism to control rising health care costs. Proponents believed that, under a capitated payment system, HMOs could achieve savings by promoting prevention and effectively managing acute and chronic conditions, thereby reducing the needs for care and costly hospitalizations among enrollees. However, the capitated payment system also creates a short-term incentive for restricting health care services, which, combined with traditional HMO methods such as limited provider networks, primary care gatekeeping of access to specialty services and medical necessity authorization, may adversely affect quality of care. The concern over withholding services by

HMOs to achieve savings became especially salient as the number of HMOs increased in the mid-1980s, resulting in more competition among HMOs and higher turnovers among HMO enrollees (Hellander 2001; Wholey et al. 1997). The growth of for-profit HMOs in the 1990s (Gabel 1997) and, more recently, the diversification of HMOs' products in response to consumer backlash and legislative pressure over restrictive care (Draper et al. 2002) further exacerbate the concern.

In general, empirical studies have shown positive effects of HMOs in containing health care costs (Frank and Welch 1985; Gaskin and Hadley 1997; McLaughlin 1987; Robinson 1991, 1996; Zwanziger, Melnick, and Bamezai 2000), although there were some conflicting findings (Frank and Welch 1985; McLaughlin 1987, 1988). Researchers have also observed a significant shift in patterns of care associated with HMOs, such as fewer hospitalizations and more preventive services used by HMO enrollees than their fee-for-service counterparts, and simultaneous increases in ambulatory care and decreases in hospitalizations accompanied by increased HMO penetration (Luft 1981; Manning et al. 1987; Wholey et al. 1997). However, the evidence of HMOs' impacts on quality of care and use of preventive services is limited and inconsistent (Decker and Hempstead 1999; Gordon, Rundall, and Parker 1998; Riley et al. 1999; Sullivan 1999). For example, increased cancer screenings were associated with HMO enrollment (Gordon, Rundall, and Parker 1998) and higher HMO penetration (Decker and Hempstead 1999). On the other hand, Medicare HMO enrollees were diagnosed at a later stage of breast cancer (Riley et al. 1999). More recent literature indicates that HMOs and fee-for-service plans provide roughly comparable quality of care. However, HMOs offer more comprehensive preventive services (Miller and Luft 2002).

Examination of the effects of HMOs on preventable or avoidable hospitalizations is a unique approach to understanding the degree to which HMOs succeed in prevention and outpatient management. The underlying theory is

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that timely and effective ambulatory care of certain conditions, called ambulatory care sensitive conditions (ACSCs), would prevent hospitalizations for these conditions. Excess admissions due to these conditions are thus considered indicators of either access barriers or ineffective, low-quality ambulatory care (Billings, Anderson, and Newman 1996; Bindman et al. 1995; Blustein, Hanson, and Shea 1998; UCSF-Stanford Evidence-based Practice Center 2001; Fleming 1995; Porell 2001; Weissman, Gatsonis, and Epstein 1992).

Three studies have investigated the association between HMOs and hospitalizations due to certain preventable hospitalizations. Porell (2001) found that discharge rates for asthma and dehydration were higher for Medicaid HMO enrollees than Medicaid non-HMO enrollees in Massachusetts, suggesting potential access to or quality of care problems in HMO enrollees. However, Friedman and Basu (2001) reported that a 20 percent increase in HMO penetration in a county led to a 1.8 percent reduction in hospitalizations due to 10 ACSCs among children in New York State. Backus et al. (2002) showed that a 10 percent increase in HMO/PPO (preferred provider organization) penetration resulted in a 3.1 percent decrease in hospitalizations due to five chronic conditions in California from 1990 to 1997. While these studies have their own limitations, they shed some light on the relationship between HMO penetration and preventable hospitalizations.

This study extends the literature in the following ways. First, while earlier studies used data from a single state, our study includes 932 urban counties in 22 states, making our study more generalizable. Second, we use 14 more vigorously validated preventable hospitalization indicators, including both acute and chronic conditions that afflict both adults and children. Third, our study includes all hospitalized patients in the community, not a subset of patients (e.g., only Medicaid patients). And finally, our measure of HMO penetration is population-based and created at the community-level. Consequently, we are able to estimate the effect of HMO penetration as it affects preventable hospitalizations for an entire community, both HMO enrollees (i.e., direct effect) and non-enrollees (i.e., spillover effect).

Conceptual Framework

The Anderson and Aday framework of access (Anderson and Aday 1978) naturally extends to theorize how HMO penetration affects ACSC admissions. The distribution of predisposing demographic and socioeconomic factors determines the demand for health care in a region, and the availability of health care providers and facilities measures the supply of health care at the region. Previous studies suggest that socioeconomic characteristics of a population, health status measured by mortality and low birth rate, and local supply of physicians and hospitals affect hospital use in general (Alexander et al. 1999; Carr-Hill et al. 2002; Hofer et al. 1998). More specifically, previous studies suggest that hospitalization rates due to ACSCs are higher among persons who are less educated, minority, elderly, and female (Billings, Anderson, and Newman 1996; Blustein, Hanson, and Shea 1998; Gaskin and Hoffman 2000), low-income (Cable 2002), and with Medicaid or uninsured (Porell 2001; Weissman, Gatsonis, and Epstein 1992), and in regions with lower availability of primary care physicians (Parchman and Culler 1994) and public clinics (Epstein 2001) and with higher per capita hospital beds (Schreiber and Zielinski 1997). Managed care interacts with and alters both demand and supply, and consequently affects hospital admissions in a community. As Landon, Wilson, and Cleary (1998) recognized, an HMO could affect care by (1) determining the nature and capacity of its providers, (2) interacting with enrollees through methods such as patient education and copayment policy, (3) influencing physician behavior, and (4) adopting broader population-focused programs aimed at the larger community.

While there are many hypotheses that can be generated from this framework to explain how HMO penetration may affect ACSC hospitalizations, we highlight two opposing hypotheses. With integrated comprehensive systems of providers and services and preventive orientation, HMOs have the potential to be more effective in managing certain ACSCs at primary care settings, thus avoiding hospitalizations (i.e., direct effect). Non-HMO providers could follow the HMOs' example to reduce ACSC hospitalizations (i.e., spillover effect). As a result, areas with higher concentration of HMOs would have fewer admissions due to ACSCs. Alternatively, there is an incentive under HMO capitated risk contracts to restrict services, and inadequate care of ACSCs may lead to increased hospitalizations. Our overall approach is to use multiple regression analyses to determine the association between measures of preventable hospitalizations and HMO penetration while controlling for confounding factors discussed above.

METHODS

Data Sources

The primary source of data for this study was the 1998 Healthcare Cost and Utilization Project (HCUP) State Inpatient Databases (SID), maintained by the

Agency for Healthcare Research and Quality (AHRQ). The 1998 SID files contained uniform hospital discharge data on all inpatient stays from all 2,814 short-term acute care general hospitals in 932 urban counties across 22 states (AZ, CA, CO, CT, FL, GA, HI, IA, IL, KS, MA, MD, MO, NJ, OR, PA, NY, SC, TN, UT, WA, WI). Data on population characteristics, health care capacity, county-level HMO penetration rates, and MSA-level HMO competition index were obtained from the 2000 Health Resources and Services Administration's (HRSA) Area Resource File (ARF) (2000). The HMO penetration rates reported in ARF were calculated by dividing HMO enrollment data from the InterStudy County Surveyor Database by the U.S. population estimates. Unlike earlier versions of these HMO enrollment data, the 1998 HMO enrollment data have been adjusted for enrollee residence and do not rely upon HMO headquarters location (Health Resources and Services Administration 2000).

We created a Herfindahl-Hirschmann index from the American Hospital Association (AHA) Annual Survey to measure the intensity of hospital competition in a county. The index is the sum of squared market shares of discharges by hospitals in each county.

Identifying Preventable Hospitalizations Due to ACSCs

Preventable hospitalizations due to ACSCs have been considered indicators of quality of preventive and ambulatory care by many researchers for years (Billings, Anderson, and Newman 1996; Bindman et al. 1995; Blustein, Hanson, and Shea 1998; Center 2001; Fleming 1995; Porell 2001; Weissman, Gatsonis, and Epstein 1992). A unique feature of our study is the use of the recently developed AHRQ Prevention Quality Indicators (PQIs) to create our preventable hospitalization measures (Agency for Healthcare Research and Quality 2002a). The PQIs are one set in a series of tools developed at AHRQ that make use of readily available hospital inpatient administrative data to measure health care quality. Specifically, the AHRQ PQI software uses the ICD-9-CM codes on the inpatient stay records and identifies hospital admissions that evidence suggests could have been avoided, at least in part, through high-quality outpatient care. A research team at the University of California at San Francisco (UCSF)-Stanford University Evidence-Based Practice Center (2001), under contract with the AHRQ, conducted extensive literature research, expert consensus and empirical testing, and validations on potential PQIs. They recommended 14 PQIs, each found to show construct validity, reasonable precision and bias, and potential for fostering quality improvement. The details of these ACSC indicators, including ICD-9-CM codes used to identify each condition, can be found in the full report from UCSF-Stanford Evidence-based Practice Center (2001).

Data Analysis

Preventable hospitalizations are rare, with the number of preventable hospitalizations per 100 population for each of the 14 ACSCs less than 1 and the sum of all 14 ACSCs less than 2. Following Alexander et al. (1999) and Hofer et al. (1998), we used Poisson regressions to estimate the effect of HMO penetration on preventable hospitalizations. The simplified form of the model is defined as:

$$\log(ACSC_i) = \beta_0 + \beta_1 HMO + \beta_2 D_i + \beta_3 H_i + \beta_4 S_i + \beta_5 P_i + \log(POP_i)$$

where $ACSC_i$ is the expected ACSC discharges in county *i*; *HMO, D, H, S, P* and *POP* denote HMO penetration rate (*HMO*), demographic and socioeconomic variables (*D*), health status measures (*H*), supply of hospital beds and physicians excluding primary care physicians (*S*), supply of primary care physician (*P*), and total population (*POP*), respectively; and the βs are the regression coefficients. Log(*POP*) was included and its coefficient was forced to be 1 to account for the different population sizes across counties (Alexander et al. 1999; Hofer et al. 1998; Selvin 1996; Wolfe et al. 1991). Initial analysis of the data revealed that the variance was larger than the mean of numbers of preventable hospitalizations across counties, indicating an overdispersion of the data and a violation of Poisson assumption. Following Long (1997), a negative binomial estimation process was used to account for the overdisperssion. *STATA* was used to obtained robust estimates of the coefficients (StataCorp 1999).

One of our methodological concerns is that the HMO penetration measure could be endogenous. Health maintenance organization penetration and preventable hospitalizations in a county could be simultaneously determined or impacted by common factors. This concern is common for studies examining the effects of HMO penetration on hospital costs because high hospital costs could induce HMO expansion in a market (Dranove, Simon, and White 1998; McLaughlin 1987). Similar arguments could be made regarding preventable hospitalizations.

The bias due to endogenous regressors, the use of instrumental variables (IV) to correct this bias and the difficulty in finding good IVs are well elucidated by the December 2000 special issue of *Health Services Research,* edited by McClelland and Newhouse (2000). Based on recent work by Wong and Encinosa (2002), we postulate that local market conditions, as measured by competition between HMOs and between hospitals, along with local demand and supply factors described earlier, have a direct effect on HMO penetration. However, competition between HMOs and between hospitals may have no direct effect on quality of care or preventable hospitalizations. We therefore used an HMO competition measure and a hospital competition measure as instrument variables in a two-stage analysis to correct for endogeneity bias. In the first stage, HMO penetration was regressed on all demand and supply factors as well as on indexes of HMO competition and hospital competition. The predicted HMO penetration from the first stage was entered into the negative binomial regressions in the second stage to estimate the effects of HMO penetration on preventable hospitalizations.

Admittedly our IVs are not ideal. One could argue that competition could force HMOs and hospitals to focus on short-term profits and consequently affect their behavior and provision of ambulatory care. In other words, competition may have direct effects on preventable hospitalizations, violating a critical IV requirement. In the absence of ideal IVs, our IV estimates, in comparison with the ordinary estimates, provide insight in the robustness of our estimated effects.

RESULTS

Table 1 presents the descriptive statistics of the variables in our analytic file. These statistics are similar to national estimates (U.S. Census Bureau 2001). Table 2 presents the prevalence of preventable hospitalizations. The total number of preventable hospitalizations in counties varied from 0 to 159 per 1,000 population, averaging about 18. The mean discharge rates for the 14 ACSCs varied from 0.23 per 1,000 population for lower extremity amputation to 4.80 per 1,000 population for bacterial pneumonia. These 14 ACSC rates were highly correlated with each other, with a Cronbach's alpha of 0.83.

Table 3 presents the estimates from Poisson regressions with and without IVs. It shows that advanced age, female, poverty, and poor health are associated with significantly more preventable hospitalizations. It also shows that more hospital beds per capita[1] and fewer primary care physicians per capita are significantly associated with more preventable hospitalizations. Health maintenance organization penetration is inversely associated with preventable hospitalizations. Our non-IV model produced a coefficient of

Table 1: Population Characteristics of Counties ($N = 932$)

Variable	*Mean (SD)*
HMO penetration, %	17.87 (16.58)
Demographic and Socioeconomic Variables	
Total population, millions	1.70 (0.45)
Age 14 or younger, %	20.21 (2.88)
Age 15–34, %	27.56 (4.63)
Age 35–64, %	31.09 (3.48)
Age 65 or older, %	14.47 (4.05)
Female, %	50.85 (1.52)
Whites, %	88.19 (14.60)
Blacks, %	9.05 (13.79)
Asian Americans and Pacific Islanders, %	1.81 (4.72)
Native Americans, %	0.96 (3.91)
Below poverty line, %	13.19 (5.14)
With 4+ year college, %	9.08 (4.26)
Unemployed, %	2.52 (1.15)
Health Status Measures (H)	
Five-year (1993–1998) average infant deaths, per 1,000	0.24 (0.30)
Three-year (1996–1998) average malignant neoplasm deaths, per 1,000	2.22 (0.57)
Three-year (1996–1998) average COPD deaths, per 1,000	0.47 (0.17)
Three-year (1996–1998) average IHD deaths, per 1,000	2.06 (0.79)
Three-year (1996–1998) average other cardiovascular deaths, per 1,000	1.34 (0.52)
Three-year (1996–1998) average cerebrovascular disease deaths, per 1,000	0.73 (0.28)
Three-year (1996–1998) average AIDS deaths, per 1,000	0.06 (0.09)
Three-year (1996–1998) average diabetes deaths, per 1,000	0.24 (0.10)
Three-year (1996–1998) average chronic liver/cirrhosis deaths, per 1,000	0.09 (0.05)
Three-year (1996–1998) average influenza/pneumonia deaths, per 1,000	0.37 (0.16)
Supply (S)	
Hospital beds, per 1,000	3.70 (2.75)
MDs/DO/physician assistants, per 1,000	1.60 (1.31)
Primary Care Physician (S)	
Primary care physicians, %	41.44 (15.04)
Instrumental Variables (IV)	
HMO competition index	0.49 (0.27)
Hospital competition index	0.75 (0.35)

Note: COPD = chronic obstructive pulmonary disease; IHD = ischemic heart disease.

-0.0038, indicating that a 10 percent increase in HMO penetration is associated with a 3.8 percent decrease in preventable hospitalizations (95 percent confidence interval, 2.0–5.6 percent).

Table 4 summarizes the estimated effects of HMO penetration on individual categories of preventable hospitalizations, controlling for all factors included in model 4. HMO penetration coefficients are negative for all models and statistically significant in 9 of the 14 ACSC categories, with the largest

Table 2: Rate of Preventable Hospitalizations per 1,000 population in Counties ($N = 932$)

Ambulatory Care Sensitive Condition	*Mean (SD)*
Diabetes, short-term complications	0.29 (0.21)
Diabetes, long-term complications	0.68 (0.55)
Pediatric asthma	0.36 (0.42)
COPD	2.34 (1.83)
Pediatric gastroenteritis	0.33 (0.48)
Hypertension	0.30 (0.28)
Congestive heart failure	3.75 (2.38)
Dehydration	1.31 (0.94)
Bacterial pneumonia	4.80 (3.31)
Urinary infection	1.52 (0.99)
Angina	0.78 (0.78)
Diabetes, uncontrolled	0.24 (0.24)
Adult asthma	0.74 (0.57)
Lower extremity amputation	0.23 (0.26)
Total	17.71 (10.52)

Note: COPD = chronic obstructive pulmonary disease.

estimate for pediatric gastroenteritis. Table 4 also presents the IV estimates. While the estimate for overall effect is similar (0.38 versus 0.43, both $p < .01$), estimates on some individual indicators (e.g., hospitalizations due to pediatric and adult asthma and hypertension) differ substantially. The F-value for the set of IVs in the first stage regression is 285.61, indicating that the IVs are reasonably strong (Staiger and Stock 1997). To address whether IVs have direct effects on preventable hospitalizations, we regressed the residuals from the second-stage regression (i.e., number of observed preventable hospitalizations minus predicted values) on the set of IVs. Both IVs and overall model were not significant, supporting our postulation that the IVs do not directly affect preventable hospitalizations.

We conducted two additional analyses to assess the sensitivity of our results. Due to data limitations we identified preventable hospitalizations in a county based on hospital location rather than patient residence. Because hospitals may draw patients from neighboring counties, some preventable hospitalizations could be incorrectly allocated. Our first sensitivity analysis analyzed the data using Health Service Area (HSA) as unit of analysis. An HSA is defined as one or more counties that are relatively self-contained with respect to the provision of routine hospital care (Makuc et al. 1991). Analysis of the 371 HSAs produced similar results. Our second sensitivity analysis included 133 rural counties and 932 urban counties. The 133 rural counties

Table 3: Regression of Counts of Preventable Hospitalizations (Coefficients [SE])#

Variable	*Non-IV Estimate*	*IV Estimate*
HMO penetration, %	−.0038 (.0009)**	−.0043 (.0018)*
Age 14 or younger, %	−.0137 (.0052)*	−.0134 (.0052)*
Age 15–34, %	.0093 (.0035)**	.0091 (.0035)**
Age 65 or older, %	−.0196 (.0083)*	−.0206 (.0088)*
Female, %	.0455 (.0129)**	.0458 (.0132)**
Blacks, %	.0023 (.0018)	.0023 (.0018)
Asians, %	.0089 (.0016)	.0011 (.0018)
Native, %	−.0083 (.0029)**	−.0084 (.0028)**
Below poverty line, %	.0108 (.0055)*	.0104 (.0057)
With 4+ year college, %	−.0131 (.0077)	−.0131 (.0078)
Unemployed, %	.0231 (.0140)	.0226 (.0139)
Five-year average infant deaths, per 1,000	.0125 (.0802)	.0059 (.0861)
Three-year average malignant neoplasm deaths, per 1,000	.1376 (.0694)*	.1414 (.0710)*
Three-year average COPD deaths, per 1,000	.3522 (.1380)*	.3493 (.1365)**
Three-year average IHD deaths, per 1,000	.0912 (.0285)**	.0913 (.0289)**
Three-year average other cardiovascular deaths, per 1,000	.0507 (.0391)	.0496 (.0401)
Three-year average cerebrovascular deaths, per 1,000	−.0200 (.0624)	−.0193 (.0649)
Three-year average AIDS deaths, per 1,000	−.2325 (.1640)	−.2297 (.1662)
Three-year average diabetes deaths, per 1,000	.1394 (.1662)	.1548 (.1664)
Three-year average chronic liver/cirrhosis deaths, per 1,000	.5509 (.3430)	.5735 (.3489)
Three-year average influenza/pneumonia deaths, per 1,000	.2413 (.1085)*	.2420 (.1084)*
Hospital beds, per 1,000 population	.0725 (.0061)**	.0722 (.0062)**
Physicians, per 1,000 population	.0619 (.0388)	.0647 (.0403)
Primary care physicians$, %	−.0039 (.0013)**	−.0039 (.0013)**

*$p<.05$;

**$p<.01$.

#Estimates from negative binomial regressions; logged county population included as a regressor but not reported in the table because its coefficient was set to 1.

$Includes office-based MDs for general practice, general family practice, general internal medicine, and general pediatrics.

Note: COPD = chronic obstructive pulmonary disease; IHD = ischemic heart disease.

were excluded from our primary analysis because the relationship between hospital use and supply factors in urban areas differ from rural areas (Bindman, Grumbach, and Osmond 1996; Schreiber and Zielinski 1997). The populations in these excluded counties were less than 2,500 and the average HMO penetration rate was only 5.6 percent. Inclusion of these counties did not change our overall results.

Table 4: Estimated Effects of HMO Penetration on Preventable Hospitalizations[$]

	Coefficient (SE)	
Ambulatory Care Sensitive Condition	*Non-IV Estimate*	*IV Estimate*
Diabetes, short-term complications	– .16 (.11)	– .26 (.22)
Diabetes, long-term complications	– .23 (.11)*	– .13 (.26)
Pediatric asthma	– .48 (.17)**	– .41 (.39)
COPD	– .24 (.11)*	– .50 (.25)*
Pediatric gastroenteritis	– 1.36 (.21)**	– 1.96 (.42)**
Hypertension	– .69 (.16)**	– .52 (.31)
Congestive heart failure	– 15 (.09)	– .28 (.19)
Dehydration	– .61 (.12)**	– .68 (.24)**
Bacterial pneumonia	– .68 (.10)**	– .93 (.22)**
Urinary infection	– .43 (.10)**	– .66 (.20)**
Angina	– .25 (.21)	– .08 (.37)
Diabetes, uncontrolled	– .86 (.15)**	– 1.09 (.32)**
Adult asthma	– .07 (.12)	– .60 (.25)*
Lower extremity amputation	– .21 (.15)	– .28 (.34)
Total	– .38 (.09)**	– .43 (.18)*

*$p<.05$;
**$p<.01$.
[$]Expressed as %; changes in preventable hospitalizations due to 1% increase in HMO penetration.
Note: COPD = chronic obstructive pulmonary disease.

COMMENT

Our analysis indicates that HMO penetration has a significant effect in reducing preventable hospitalizations. Consistent with findings from earlier single-state studies by Friedman and Basu (2001) and Backus et al. (2002), our study suggests that HMOs may be more successful than other care models in prevention and managing ambulatory care sensitive conditions in outpatient settings, leading to reduced preventable hospitalizations. Our study also confirms findings from earlier research that show higher rates of preventable hospitalizations are associated with lower socioeconomic status, advanced age, poor health (Billings, Anderson, and Newman 1996; Blustein, Hanson, and Shea 1998; Cable 2002; Carr-Hill et al. 2002; Gaskin and Hoffman 2000), a lower supply of primary care physicians (Parchman and Culler 1994), and a higher supply of hospital beds (Schreiber and Zielinski 1997).

Some limitations should be noted. First, although in general lower ACSC admissions are indicators of high-quality preventive and outpatient care, it is possible that lower ACSC admissions are attributable to underutilization of health care (Restuccia et al. 1996). Second, our reliance on administrative data introduces measurement errors to some extent and limits our ability to control confounding factors (Iezzoni 1997; Romano and Mark 1994). For example, we have no data on the percentages of the county populations that are uninsured or with Medicaid, factors found to be associated with increased preventable hospitalizations (Porell 2001; Weissman, Gatsonis, and Epstein 1992). Moreover, variation in physician practice styles across communities may impact hospitalization rates (Wennberg 1999). This variation may be correlated with HMO penetration. Because we do not have any way to control for physician practice style, some bias may be introduced into our parameter estimates for HMO penetration. However, the extent of bias due to these variables may be mediated by the inclusion of other socioeconomic variables and supply factors that correlate with them. Third, we are not able to separate the effect of HMO penetration on HMO enrollees (i.e., direct effect) from the effect on non-HMO enrollees (i.e., spillover effect) because we are not able to identify individuals enrolled in HMOs and link them to individuals who had ACSC hospitalizations.

Health maintenance organizations, as defined by an InterStudy HMO survey, include four mutually exclusive types of models: staff and group model HMOs, independent practice associations (IPAs), network HMOs, and mixed model HMOs (Health Resources and Services Administration 2000). Each model may behave differently (Wholey et al. 1997) and therefore have different effects on preventable hospitalizations. Our study does not provide a distinction between these HMO models. Our study does not provide comparison between HMOs and different types of non-HMO plans either. Nevertheless, our study shows that market penetration by HMOs, in contrast to other models including traditional fee-for-service plans, less restrictive managed care such as preferred providers organizations, point-of-service plans and defined contribution plans, and the uninsured, leads to reduction in preventable hospitalizations.

The landscape of U.S. health care has been changing constantly in pursuit of a system that contains costs and delivers high-quality care. In the 1980s, HMOs quickly expanded (Gold 1991; Wholey et al. 1997), with promises of containing costs and reorienting toward better health instead of better and more services. Broad market changes ensued within and outside of HMOs. Traditional plans like Blue Cross and Blue Shield developed PPO plans that were capitated but with fewer restrictions in gatekeeping and specialty care as compared to HMOs. In the 1990s, many HMOs were converted to for-profit status and developed less-restrictive products to compete with these entities. More recently, in response to consumers' and purchasers' demand for more choices and flexibility as well as legislative pressure over restrictive care, HMOs started offering broad provider network and relaxing gatekeeping requirements, while raising premiums, increasing cost-sharing, and cutting unprofitable lines of business (Draper et al. 2002). As traditional HMO penetration gives way to less restrictive managed care plans that may not offer as comprehensive benefits for preventive care and wellness programs, the effect of HMO penetration on reducing preventable hospitalizations may erode. More than ever, individual health care professionals and public programs need to take initiatives in using evidence-based preventive services and outpatient care while we as a nation search for a system with better infrastructure and incentives for quality and efficiency (Agency for Healthcare Research and Quality 2002b).

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NOTES

1. We also used occupancy rate instead of beds per 1,000 population in the regression. The coefficient for the occupancy rate was $-0.0498(0.0150)$, $p<.01$, while the

coefficient for HMO penetration remained the same at $-0.0039(0.0010)$, $p<.01$. The result suggests that lower occupancy rates may put more pressure on hospitals to fill their beds, resulting in more preventable hospitalizations.

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