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## New Evidence on Medicare's Prospective Payment System: A Survival Analysis based on the NHANES I Epidemiologic Followup Study

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New Evidence on Medicare's Prospective Payment System:  
A Survival Analysis based on the NHANES I Epidemiologic Followup Study

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## New Evidence on Medicare's Prospective Payment System:

### A Survival Analysis based on the NHANES I Epidemiologic Followup Study

#### Abstract

Medicare's prospective payment system (PPS), introduced in 1983, pays hospitals a fixed price for each stay rather than reimbursing costs. Previous studies evaluated its first few years using endogenous measures to control for heterogeneity in patients' health. We examine PPS over a full decade using competing risks Cox survival models and a national longitudinal survey with independent information on patients' health. New findings include: risk of death in hospital increased; risk of discharge to a nursing home continued to increase as PPS matured; and risk of nursing home admission from the community following hospital discharge rose. HMOs may have contributed to these outcomes.

JEL classification numbers: C41, I18

## Introduction

In October 1983, the Medicare program of health insurance for the elderly and disabled introduced a prospective payment system (PPS) for hospitals. Until 1983 Medicare had reimbursed hospitals on the basis of costs incurred. PPS instead pays a fixed rate that depends on the patient's diagnosis at admission. The new payment system led to shorter stays for Medicare patients as hospitals tried to keep costs below the fixed rates. Turning to substitute forms of care that were not included under the system, hospitals discharged more patients to nursing homes and discharged them earlier. The location of death shifted, with more deaths occurring in nursing homes and fewer in hospitals (Feigenbaum et al., 1992; Russell, 1989b).

Our knowledge of the effects of PPS comes from studies that analyzed data for the first few years after its implementation, comparing them with one or two years before 1983. Its effects may, however, have changed as PPS matured. In the first years, hospitals experimented to see what worked and had financial reserves that gave them flexibility, but, as PPS continued, hospital margins turned negative (Helms, 2000). Moreover, HMOs grew rapidly during the later 1980s and the 1990s. While HMOs primarily enrolled people under 65 during these years, their cost-cutting strategies may have put pressure on hospitals that affected the care of elderly patients as well.

In this paper we report a survival regression analysis of PPS using data for 1977-1992 from the NHANES I Epidemiologic Followup Study (NHEFS). NHEFS tracked a large, nationally representative sample of U.S. adults and collected data on their hospital admissions, nursing home admissions, and mortality. Using data on these adults as they turned 65, we examined

most outcomes considered by previous studies, and some new ones, over a longer time period both before and after introduction of PPS. We analyzed risk of death in the hospital, in a nursing home, or in the community after discharge from the hospital. We examined transitions between these three settings, including discharge from the hospital to a nursing home or the community, readmissions to the hospital from both locations, and admission to a nursing home from the community. Because NHEFS collected extensive baseline information on each individual, we were able to control for heterogeneity in health without relying on information collected at hospital admission, as previous studies had to do.

### Background

Prospective payment created very different incentives from those of the earlier cost-based payment system. To stay within the fixed rate for each patient, a hospital must try to keep its costs for that patient low by cutting services or substituting less expensive for more expensive services. It can substitute care outside the hospital for hospital care, by discharging the patient to another provider earlier than it would have under cost reimbursement -- to a nursing home, to a long-term care hospital, or to the community where family or a home health provider may provide care. Thus PPS can affect costs and health outcomes across the spectrum of hospital and post-hospital care, shifting care and costs to other parts of the formal and informal caregiving system.

PPS caused the expected shifts to alternative settings in its first few years (Russell, 1989). The average stay for Medicare patients in short-stay hospitals declined by about a day (from just under 10 days) between 1983 and 1984. To accommodate Medicare patients who were

discharged earlier, the percentage discharged to formal home health care rose from 3.8% in 1983 to 5.8% in 1984 and 6.8% in 1985. Patients discharged to nursing homes were more likely to die there, an indication that nursing homes were receiving more seriously ill patients. Except for a fall in hospital admissions – probably due to the monitoring system created to prevent extra admissions as hospitals tried to game the system – the changes were logical consequences of the incentives of fixed payment rates.

Studies of these early years include the important series of articles by a team from the Rand Corporation and UCLA (Kahn et al., 1990; Kosecoff et al., 1990; Rogers et al, 1990). They analyzed data for 14,012 Medicare patients in five states -- half hospitalized in 1981 and 1982, before PPS, and half in 1985 and 1986 -- who were admitted for congestive heart failure, myocardial infarction, pneumonia, hip fracture, or stroke. Outcomes were adjusted for sickness at admission, as measured by a scale developed from information in patients' hospital records. The study found that length of stay dropped from 14.4 days to 11.0 days, mortality in the hospital declined from 16.1% to 12.6%, and mortality 30 days after admission declined from 16.5% to 15.4%; the changes were statistically significant at better than the 95% level of confidence. There was no statistically significant change in mortality 180 days after admission. Four percent more patients were discharged to nursing homes. Readmissions to hospital within a year were unchanged. The one adverse effect associated with PPS was that more patients were discharged from the hospital in unstable condition. Kahn et al. concluded that “because our post-PPS data are from 1985 and 1986, we recommend that clinical monitoring be maintained to ensure that changes in prospective payment do not negatively affect patient outcome.”

Cutler (1995) examined the effects of PPS in the six New England states, using longitudinal data on 40,000 Medicare admissions for 1981-88; Massachusetts was exempt from PPS until 1986 because of its state program for regulating hospital payment. Cutler used a binary variable to represent PPS's marginal reimbursement effect -- the fact that, in contrast to cost-based reimbursement, hospitals' marginal costs are not reimbursed under PPS. Patients' health status at admission was represented by age, sex, type of admission, and whether the stay was a readmission. He found that mortality was compressed under PPS, with more deaths occurring soon after discharge from the hospital but no increase in deaths at one year. He also noted an increase in readmissions, which he attributed to coding changes, and a decrease in deaths in the hospital. In his conclusion he observed that PPS "has been in place for less than a decade and reimbursement was relatively generous for much of that period, [so] there has been little experience with prolonged reductions in prices."

The most recent studies of hospital stays and nursing home admissions, also published in the late 1980s and early 1990s, generally corroborate earlier findings that hospital stays decreased, discharges to nursing homes increased, and more deaths occurred in nursing homes (Gerety et al., 1989; Kane et al., 1996; Kenny and Holahan, 1991; Leibson et al., 1990; Newhouse and Byrne, 1988; Sager et al., 1987; Sager et al., 1988; Sager et al., 1989). Except for Kane's study of 1988-89 data for three cities, which had no pre-PPS baseline, none of these studies analyzed data more recent than 1987.

As a consequence, our knowledge of the effects of PPS comes from studies that analyzed the first few years under PPS, 1988 being the most recent year included (Cutler, 1995). Baseline

periods used for comparison were limited to all or part of the years 1981-1983 (Leibson's single baseline year was 1980). The longer-term effects of PPS on the medical care of the elderly are unknown. While longer-term effects should be in the same general direction – a tendency to reduce the use of resources during the hospital stay and to use substitutes for hospital care more often and earlier in a patient's course of illness – the magnitude of the effects may have changed, and new effects may have appeared for the first time.

Several factors suggest that this could be the case. First, with experience hospital administrators and physicians learned what worked best under PPS for patients and for hospitals' financial health. Second, after the transition period, PPS payment rates were set at less generous levels and hospitals' margins turned negative, giving them less flexibility (Helms 2000).

Third, the rapid growth of HMO enrollment among the younger population, which occurred during the later 1980s and early 1990s, put additional pressure on hospitals' revenues, reducing their ability to shift Medicare costs to other payers. HMOs have traditionally controlled costs by controlling hospital use; hospital occupancy rates dropped sharply after implementation of PPS and HMOs reinforced that trend. Findings on the relationship between HMO enrollment and the quality of care given elderly patients have been mixed. Kessler and McClellan (2000) found that, after 1990, increasing HMO enrollment contributed to lower costs and better outcomes for Medicare patients with acute myocardial infarction. Picone et al. (2003) reported that higher HMO enrollment was associated with shorter stays for elderly patients admitted for hip fracture, stroke, coronary heart disease, or congestive heart failure who stayed 30 days or less; it did not affect mortality in the hospital, but was associated with a lower probability of living in the

community (rather than a nursing home). For a national sample of hospital admissions, Sari (2002) found that higher HMO enrollment reduced wound infections and adverse/iatrogenic complications. Shen (2003) analyzed Medicare patients with acute myocardial infarction and found that financial pressure, represented by PPS and by HMO enrollment, had “an adverse effect on hospital quality . . . . The adverse effect [was] strongest on short- or medium-term health outcomes; its magnitude decrease[d] over time and [became] statistically insignificant for patient survival beyond 1 year.”

Finally, four states were initially exempt from PPS because they had their own rate-setting systems. Three of these “waiver” states were not granted further waivers and were brought under PPS after 1983 -- Massachusetts and New York in 1986, New Jersey in 1988. Maryland is still exempt.

### Study Strategy and Data

The study sample was drawn from the first National Health and Nutrition Examination Survey (NHANES I), which enrolled a nationally representative sample of adults aged 25-74 during the years 1971-1975 and collected extensive information on their health through medical examinations and personal interviews. The NHANES I Epidemiologic Followup Study (NHEFS) then tracked these adults through 1992, recording deaths, hospital admissions, and nursing home admissions. The National Center for Health Statistics (NCHS) conducted the first followup in 1982-84, locating about 95% of the original cohort (Cohen et al., 1987; Cox et al., 1992). NCHS conducted additional follow-ups in 1987 and 1992. Hospital and nursing home admissions were identified through personal interviews and matched with institutional records, which provided

diagnosis codes and exact dates of admission and discharge. Deaths were traced through interviews with proxies (confirmed by death certificates) and the National Mortality Index.

We selected NHANES I adults for this study on the basis of age and completeness of baseline health information. We selected all adults who were 65 or older on January 1, 1977 and added persons who turned 65 later as of the date of their 65<sup>th</sup> birthday. For each individual we created a timeline, noting dates of hospital and nursing home admission and discharge, and calculating time spent in each setting (Figure 1).

For the competing risks survival analysis, three types of spells (periods at risk) were defined from the timeline: spells in the hospital; spells in a nursing home following hospital discharge; and spells in the community following hospital discharge. Spells that ended before January 1, 1977 were excluded from the sample to start the analysis after all participants were enrolled and to avoid the undercount of hospital admissions that marked the earliest years of followup (Russell et al., 1997). The final sample consisted of 3,551 persons 65 and older in 46 states and 24,308 spells for those persons (Table 1).

In each setting, three transitions (outcomes) were possible: death or discharge/admission to one of the other two settings. Thus we examined the following transitions (Figure 1):

- for hospital spells, death in hospital; transfer to a nursing home, or discharge to the community;
- for nursing home spells that followed a hospital stay, death in the nursing home,

readmission to hospital, or discharge to the community;

- for community spells that followed a hospital stay, death in the community, readmission to a hospital, or admission to a nursing home.

A spell could also be censored, ending before any of the outcomes occurred, because of loss to followup or the end of the survey period.

### Definitions of Variables

The following independent variables were used in the analysis. Table 2a shows their means over spells, by type of spell.

*Age* is the individual's age in years at the beginning of the spell.

*Female* is a binary variable equal to 1 for a woman.

*Diagnostic category.* The information for each hospital stay included ICD-9 diagnosis codes.

Even admissions that occurred before 1980, when ICD-9 was introduced, were coded using ICD-9 since information about these admissions was not collected until 1982-84, when ICD-9 was the standard. Based on codes for the primary diagnosis, three groups were defined to distinguish the most serious and common diagnoses from the rest: *cardiovascular disease*, *cancer*, and *all other*.

Cardiovascular disease is the reference group. Nursing home and community spells that followed a hospital stay were assigned the diagnostic group of the hospital stay.

*Health status.* Because of the monitoring system designed to prevent unnecessary hospital admissions, and the incentives to discharge patients early, elderly patients admitted to hospitals

and nursing homes under PPS were sicker than before. A major challenge for evaluations of PPS has been to control for heterogeneity in health in a way that captures this change. If health is not fully accounted for, effects attributed to PPS may instead be due to differences in health. This problem is difficult to address because PPS changed hospitals' incentives for collecting and reporting diagnostic information, making information collected at admission endogenous to the payment system. Before PPS, the diagnoses recorded for each patient did not affect reimbursement. Under PPS hospitals benefit from reporting the most serious diagnoses possible, because more serious diagnoses qualify for higher payment rates. Thus the health status variable in our analysis is of particular importance.

Our measure of health status is the probability of survival at the date of hospital admission, expressed as a percentage. The probability of survival was derived from Weibull regressions, fitted to NHEFS data, which relate survival, in days, to risk factors measured at baseline in NHANES I (1971-1975): age, sex, race, smoking, systolic blood pressure, overweight and underweight, laboratory test results (serum albumin, serum cholesterol), exercise, alcohol consumption, diet (fiber, fish/shellfish, fruits/vegetables), and nine groups of chronic conditions; the regressions are part of a simulation model (Russell et al., 1998; Russell et al., 2004, Russell et al., 2005). The risk factors, identified through a review of the medical literature by two physicians, include all that were statistically significant in multiple studies, except for more recent measures of lipids, which were not measured in NHANES I. All the major risk factors (e.g., smoking, blood pressure) were statistically significant in the Weibull regressions. Regressions based on followup through 1987 accurately projected mortality during the final followup, 1988-1992 (Russell and Valiyeva, 2003).

For this analysis, we used the Weibull regressions to project each individual's survival probability as of the date of hospital admission. Separate regressions were fitted for four baseline age-sex groups (men 45-64, women 45-64, men 65-74, and women 65-74) and the appropriate regression was used for each individual. A higher probability of survival denotes better health status. Since the estimate is based on information collected before the hospital stay, and independent of it, it is uncorrelated with the payment system and corrects for heterogeneity in underlying health in a way that other studies, which used information recorded at admission, were not able to do.

Regressions of the projected survival probabilities at hospital admission on age at admission, sex, and the PPS binaries confirmed that the health of elderly patients admitted to hospitals under PPS was poorer than that of patients admitted before PPS (Table 2b). The regression includes a squared term in age because that produced a more reasonable intercept (and modestly lower coefficients for the PPS binaries). Average survival probability was 7.8 percentage points lower under PPS and declined another 1.4 percentage points after 1986, for a total decline of 9.2 percentage points. Both PPS effects were estimated precisely, with t-statistics of 25 and 4 respectively. Since age and sex were included in the regressions, the decline cannot be accounted for by shifts in the age-sex composition of the sample over time.

*PPS indicators.* NHEFS allowed us to distinguish three time periods: (1) a pre-PPS baseline, 1977 - September 1983, during which hospitals were still reimbursed on the basis of costs; (2) a transition period, October 1983 - September 1986, during which hospitals were phased into PPS,

with New York and Massachusetts included in 1986; and (3) full PPS, October 1986-1992, during which the system was fully phased in and all states were covered (New Jersey was included in 1988, Maryland remains exempt even today). We experimented with finer divisions but they did not show distinct effects.

Two binary variables define the PPS period. The first, called PPS, is 1 for spells that began between October 1983 and the end of 1992, and 0 for spells that occurred earlier or in waiver states during the period of their waivers; it measures the average effect of PPS over the entire PPS period. The second binary, PPS8692, is 1 for spells that began October 1986 or later; it tests for any *incremental* effect of “mature” PPS, once the transitional period was over.

Because their rate-setting programs qualified for waivers, New York and Massachusetts were not brought under PPS until 1986, and New Jersey not until 1988. The PPS binaries are zero for spells in these states until the date they were included in the national system. Since Maryland is still exempt, the PPS binaries are always zero for spells in Maryland.

*PSU fixed effects.* Selection of individuals in the NHEFS was based on a stratified sample design that identified primary sampling units (PSUs, a county or group of contiguous counties) representative of the U.S. Because of confidentiality requirements, the exact identity of each PSU could not be determined from the public-use tapes. As a result, although PSUs are similar in geographic scope to markets, we could not merge market measures at this level with the data on individuals. To control for differences in unmeasured characteristics among the 102 PSUs, particularly market characteristics, we included PSU fixed effects.

Each individual's state of residence, at each followup, was identified on the public-use tapes.

We used this information to adjust the PSU designations used to estimate fixed effects to account for migration. The adjustment was approximate because we could only identify a move if the person moved out of the state (or states – some PSUs crossed state boundaries) in which the original PSU was located; in the few cases where individuals ultimately moved back to the state we assumed that they returned to the original PSU. Spells that took place when individuals were not in their original PSUs, about 7% of each type of spell, were assigned a separate fixed effect.

We made an additional adjustment in the regressions for nursing home spells. Since there were only 1176 nursing home spells that followed a hospital stay, some PSUs had few such spells.

We combined the 67 PSUs with 10 or fewer nursing home spells (375 spells in all) into a single fixed effect used only in the nursing home regressions.

*State-level variables.* As a supplement to the PSU fixed effects, the patient data were merged with a panel of state-level data for the years 1977-1992, to try to represent market conditions more explicitly. The match was based on the individual's state of residence in the year a spell began. For individuals who moved between follow-up rounds, we assumed the move took place halfway between the two follow-up periods – a standard assumption for longitudinal data analysis (Trussell and Hammerslough, 1983). For persons who died, we did not have the state of death and assumed that they died in the state shown for the last follow-up.

Following the hospital competition literature (Baker, 2001; Kessler and McClellan, 2000; Picone et al., 2003; Sari, 2002; Shen, 2003), we collected the following state-level market variables:

percentage of state population enrolled in HMOs; number of short-term general hospitals in the state; average occupancy rate in short-term general hospitals; number of short-term hospitals per 1000 square miles of area, a proxy for travel distance; nursing home beds per 1000 short-term hospital beds (available for only 3 years); and percentage of the state's population aged 65 or older. Values were entered for each state in each year 1977-1992. Where data were missing, values were interpolated. Population 65 and older came from the Census Bureau. All other state data were drawn from the Bureau of Health Professions Area Resource File (ARF), a database containing over 6,000 data elements for each county in the U.S. State level data were obtained by summing county level values.

### Econometric Approach

Since PPS was expected to affect the length of a spell, we examined transitions among hospital, nursing home, community, and death using Cox proportional hazard survival models. Survival models show the risk of an outcome over the period (or spell) at risk (Allison, 1995). An individual was at risk until an outcome occurred or until the individual was last observed. For example, during a hospital spell, an individual was at risk of death, discharge to a nursing home, or discharge to the community until one of those outcomes (transitions) occurred.

To model these competing risks, we estimated a series of survival regressions, one for each outcome; all other outcomes were included in the censored category for that model. For instance, when we estimated the regression for death in the hospital, inpatient spells that ended in discharge to nursing homes or the community were treated as censored. For each outcome, we estimated regressions using different censoring dates to explore the timing of PPS's effects.

For death in the hospital, for example, we estimated separate regressions for death within 15 days and for the entire spell.

For outcome  $j$  of spell type  $s$ ,  $j=1, 2, 3$  and  $s=1, 2, 3$ , Cox's model specifies individual  $i$ 's instantaneous probability of risk, conditional on survival to  $t$  as

$$\lambda_{ijs}(t) = \lambda_{0,js}(t) \exp(X_i \beta),$$

where  $\lambda_{0,js}(t)$  is the baseline hazard, which does not require a parametric form, and  $X_i$  represents the covariates. Coefficients from a Cox model are estimates of the log-relative hazard of the outcome. To obtain relative hazards (or hazard ratios, a form of relative risk), the coefficients are exponentiated. Hazard ratios and spell length are inversely related: for example, higher hazards of hospital discharge correspond to shorter stays.

Given the hazard function  $\lambda_{ijs}(t)$ , the survival function at time  $t$  is

$$S_{ijs}(t) = \exp\left(-\int_0^t \lambda_{ijs}(u) du\right)$$

and the probability density function is

$$f_{ijs}(t) = \lambda_{ijs}(t) S_{ijs}(t)$$

Defining  $\delta$  as an indicator for censored observations, we obtain the likelihood function as:

$$L = \prod_{i=1}^n f_{ijs}(t)^{\delta_i} S_{ijs}(t)^{1-\delta_i}$$

We estimated  $\beta$  by Cox's Partial Maximum Likelihood estimator.

Because sample persons were chosen with unequal probabilities, we assigned the NCHS sample

weight to each individual to obtain unbiased estimates. We experimented with trimming the weights at the 5<sup>th</sup> and 95<sup>th</sup> percentiles; the results were essentially unchanged, so we present results for untrimmed weights. To estimate the regressions we used SAS-callable SUDAAN, release 9, which applies a robust variance estimator to adjust for the multistage, clustered data: multiple spells for (within) individuals, individuals within PSUs, and PSUs within states (Research Triangle Institute, 2005). The original PSUs, unadjusted for migration, were used for this adjustment procedure.

In exploratory analyses, we estimated three models for each outcome. In model 1 (not shown), the hazard function was specified to depend on patient characteristics (age at the beginning of the spell, female gender, health status, diagnostic category) and the two PPS binaries. Model 1 served as a benchmark for comparison with models 2 and 3; it showed that the results for the basic variables were robust to alternative ways of representing market characteristics. Model 2 added PSU fixed effects (Tables 3-5). In addition to PSU fixed effects, Model 3 explored ways of incorporating state-level variables, particularly HMO enrollment (Tables 6a and 6b).

To examine whether the effects of PPS varied with spell duration, each spell type was analyzed with alternative censoring rules. For hospital spells, we estimated regressions for spells censored at 15 and 31 days, and for full spells. Since the effects of PPS on post-hospital care were expected to appear soon after discharge from the hospital, regressions were estimated for nursing home and community spells censored at 31 and 61 days. We also estimated death within 180 and 365 days of hospital admission, and readmission within 180 days of hospital discharge, outcomes analyzed by the Rand authors and by Cutler.

## Results

Tables 3-5 show the estimated hazards ratios (HR) from Cox regressions for hospital spells, nursing home spells that followed a hospital stay, and community spells that followed a hospital spell. An HR greater than 1 indicates increased risk of the outcome, while an HR less than 1 indicates decreased risk. The regressions include all the patient-level variables, the PPS binaries, and PSU fixed effects. We discuss these results first and then our experiments with state-level variables.

### *Health status.*

Health status – the individual’s predicted probability of survival at the time of hospital admission based on health characteristics measured at baseline in NHANES I -- performs as expected in Tables 3-5. The hazard ratios are above or below 1 when they should be and are statistically significant at the 95% level or better in most regressions, evidence that the measure successfully controls for health, without relying on information collected at admission.

Healthier people, i.e., people with higher predicted survival probabilities, were:

- < less likely to die in the hospital
- < less likely to be discharged to a nursing home
- < more likely to be discharged to the community
- < less likely to be readmitted to a hospital from a nursing home
- < more likely to be discharged to the community from a nursing home
- < less likely to die in the community following a hospital stay

- < less likely to be readmitted to a hospital from the community and
- < less likely to be admitted to a nursing home from the community after a hospital stay.

The only outcome not affected by predicted health status/survival probability was death in a nursing home.

Since survival probability is continuous, each hazard ratio shows the percentage change in the risk of the outcome for a one percentage point increase in survival probability. For example, the hazard ratio of 0.984 for death within the first 15 days of a hospital stay (Table 3, column 1) implies that the risk of death declined 1.6% for each one percentage point increase in health status at admission.

*PPS: Hospital Spells (Table 3)*

Risk of death during a hospital stay increased 28% under PPS; the effect did not reach statistical significance within the first 15 days of a stay. This result appears to reflect a change in the timing of death because regressions that examined mortality 30, 180, and 365 days after hospital admission did not show a PPS effect. The result differs from the Rand Study, which found a decline in mortality in the hospital for five diagnoses in five states. It is in general agreement with their findings of a small decline in mortality 30 days after admission, but no change 180 days after admission, and with Cutler, who found that mortality was compressed under PPS with no change in mortality one year after admission.

The daily hazard of discharge to a nursing home doubled under PPS and increased further after

the transition period. This pattern reflects both the shift in location found by other studies, with more patients discharged to nursing homes than before PPS, and earlier discharges. The finding of a further increase in risk once PPS was fully implemented is new; other studies could not test for this possibility because of their shorter followup periods. When the two PPS coefficients are summed and exponentiated, the results shows that the risk of discharge to a nursing home within 15 days of admission more than tripled under mature PPS, compared with the pre-PPS period, and was almost triple for the full stay.

Again reflecting hospitals' efforts to discharge patients quickly, shortening lengths of stay, the daily risk of discharge to the community increased about 20% overall. The risk was highest during the first 15 days of a hospital stay -- 27% higher than before PPS.

*PPS: Nursing Home Spells (Table 4)*

The regressions in Table 4 do not show statistically significant PPS effects for any of the three outcomes – death, readmission to hospital, or discharge to the community -- within the first two months of transfer to a nursing home. Other studies found an increase in the risk of death in nursing homes. The hazard ratios for our regressions are positive for both the average and the incremental PPS effect, but neither achieves statistical significance at even the 10% level.

*PPS: Community Spells (Table 5)*

Risk of admission to a nursing home from the community rose sharply under PPS. It was 3.4 times its pre-PPS level in the first month after a hospital stay and almost 3 times the pre-PPS level when the first two months are considered. The risk was higher from the beginning of PPS

and did not increase further after the transition period. Previous studies did not have data on this outcome.

The risk of readmission to a hospital from the community did not rise. Instead, risk within the first 2 months of discharge fell after the transition period. Regressions for readmission to a hospital within 180 or 365 days after hospital discharge, whether from a nursing home or from the community, confirmed that, on net, risk of readmission declined under PPS. The Rand Study found no change in readmission rates in the year after admission, while Cutler found an increase in readmissions in the New England states, which he attributed to coding changes.

PPS had no statistically significant effect on the risk of death in the community following a hospital stay.

#### *PPS and State-level Variables*

PSU fixed effects control for stable cross-sectional differences among PSUs, and, since PSUs are similar in scope to markets, for stable cross-sectional differences among markets. They do not control for changes over time in individual markets nor can they identify the reasons for differences among markets. We noted earlier that HMO enrollment among persons under 65 rose rapidly in the late 1980s and early 1990s and may have put additional pressure on hospitals that affected elderly patients as well as younger ones. If such spillover effects occurred in this period, the mature PPS binary would attribute them to PPS. We attempted to control for the effects of HMO enrollment and other changes in hospital markets over time by including state-level measures.

Multicollinearity was a severe problem with the state-level variables. Condition numbers, calculated for all 6 variables and for subsets, were well above 20, indicating serious multicollinearity (Greene, 2000). Because HMO enrollment was of primary interest, we thus focused our analysis on the percentage of the state population enrolled in HMOs. The condition number for HMO enrollment and the PPS binaries was 42, so, to sidestep this collinearity, we stratified the sample by 1990 state HMO enrollment and ran separate regressions for each stratum. Baker (2001) notes that HMO enrollment is a good proxy for managed care “in the early 1990s and before”. We found that state enrollment levels were fairly stable in the years around 1990, making it reasonable to stratify on the basis of a single year. We split the states in the sample at the median 1990 enrollment, 10%. Our expectation was that, if part of the effect attributed to PPS in the full sample was due to HMOs, the hazard ratios for the PPS binaries would be larger, and more often statistically significant, in the stratum with higher HMO enrollment.

Tables 6a and 6b show the results for hospital and community spells. Each table shows the hazard ratios for average and mature PPS for the full sample in the first column, for spells in states with an HMO enrollment below 10% in the second column, and for spells in states with higher HMO enrollment, in the third column. Since the nursing home regressions did not yield significant findings for PPS, they were not stratified.

For hospital spells, the regressions for the full sample showed that the risk of discharge to a nursing home increased under PPS and increased further after the transition phase (Table 3).

The stratified regressions show statistically significant average increases in both strata, but the additional increase under mature PPS is significant only for high-enrollment states (Table 6a), suggesting that it might have been due at least partly to HMOs rather than PPS. However, the risk associated with the PPS binary in the low-enrollment states is about the size of the combined risk associated with both binaries in the high-enrollment states, which casts some doubt on the notion that HMOs were responsible.

The increased risk of death under PPS, found in the full sample, is statistically significant for high-enrollment states, but not those with lower enrollment. The increased hazard of discharge to the community within 15 days is confirmed in both strata, but the hazard ratio is higher in the high-enrollment states. The higher hazard over the full spell is only statistically significant for those states. Both results suggest that these effects might be due in part to HMOs.

For community spells the increased hazard of admission to a nursing home from the community within 31 days of hospital discharge is higher in high-enrollment states and statistically significant only for these states. The hazard of nursing home admission within 61 days is about the same in both strata, but again only statistically significant in high-enrollment states.

Moreover, the low-enrollment states show a strongly significant decline in this risk, at both 31 and 61 days, after the transition period. The decreased risk of readmission to a hospital from the community within 61 days of discharge, found in the full sample, appears in both strata and the hazard ratios are virtually the same size.

## Conclusion

Using longitudinal data on a nationally representative sample of people who were 65, or turned 65, between 1977 and 1992, we analyzed the impact of Medicare's prospective payment system on outcomes in the hospital and in nursing homes or the community after discharge from the hospital. We tested separately for the average effect of PPS over the period 1983-1992 and for an incremental effect once PPS was fully implemented (1986-1992). Earlier studies, based on only the first few years of experience under PPS, could not explore this possibility. We ran regressions stratified by the level of HMO enrollment in the state to assess whether the effects we found might be partly due to HMOs, which grew rapidly during the late 1980s and early 1990s.

Unlike previous studies, which used endogenous measures to control for heterogeneity in patients' health, we were able to control for health status at admission using information that was independent of the hospital admission. Regressions of our health status measure on age, sex, and the PPS binaries confirmed that the health status of elderly patients admitted under PPS was poorer than that of patients admitted in the pre-PPS period.

Like previous studies, we found a much higher daily hazard of discharge to a nursing home under PPS. The risk increased further once PPS was fully implemented, for a total risk that was triple the pre-PPS level. The stratified regressions showed that the later increase may have been limited to states with higher HMO enrollment and thus may have been due in part to the additional financial pressures created by HMOs, although this interpretation is undermined by the fact that overall risk in the later years (average plus mature PPS) was nearly as high in low-enrollment as in high-enrollment states.

Unlike previous studies, our results showed a 28% increase in mortality in the hospital under PPS. We may have been able to detect this effect because of the longer period covered by our data, but the stratified regressions suggest, alternatively, that HMOs may have been a contributing cause: the hazard ratio was larger in high-enrollment states and was statistically significant only for those states. We found no effect of PPS on death in nursing homes or in the community after a hospital stay.

For a new outcome not examined in previous studies -- admission to a nursing home from the community in the first month or two after a hospital stay -- we found that the risk tripled under PPS. This result is consistent with the Rand Study's finding that more patients were discharged from the hospital in unstable condition. The stratified regressions showed that this risk was higher, and statistically significant, in states with higher HMO enrollment. Moreover, it remained high in those states in the later years of the period at the same time that it declined in low-enrollment states.

The risk of readmission to a hospital from a nursing home or the community did not increase under PPS. Indeed, once PPS was fully implemented, risk of readmission, whether from a nursing home or the community, declined below pre-PPS levels in the full sample and in the stratified regressions. Regressions that examined readmission over 180 and 365 days following admission confirmed that the net effect of PPS was a reduction in readmissions from either setting. The finding that persons discharged to the community were more likely to be admitted to a nursing home within two months suggests that nursing homes accepted some of those who

would otherwise have been readmitted to the hospital.

These results, particularly the finding that admissions to nursing homes from the community increased, provide additional evidence of shifts in the location of care as hospitals responded to fixed payment rates by discharging patients more quickly to nursing homes, home health programs, hospices (then newly covered under Medicare), and family. Our findings confirm that these other caregivers were dealing with sicker patients: patients were sicker at hospital admission under PPS and were discharged earlier in the course of their illness. At the outset, it was recognized that PPS had the potential to affect care at the same time that it controlled costs. Our analysis of its longer-term effects suggests that it affected the continuity and outcomes of care for the elderly, but they also suggest that the growth of HMOs during the same period contributed to these effects.

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Table 1: Number of spells and disposition, by type of spell and censoring date, persons aged 65 and older, 1977-1992 NHEFS

Type of spell	Disposition	Disposition of spell by time since admission (days)			
		≤15 days	≤31 days	≤61 days	Full spell
Inpatient hospital spells	Died	648	794	859	884
	Discharged to nursing home	866	1,082	1,143	1,176
	Discharged to community	9,114	10,220	10,468	10,530
	Censored	1,974	506	132	12
	<b>Total</b>	<b>12,602</b>	<b>12,602</b>	<b>12,602</b>	<b>12,602</b>
Nursing home spells that followed a hospital stay	Died	--	104	146	316
	Readmitted to hospital	--	137	219	227
	Discharged to community	--	111	163	549
	Censored	--	824	648	84
	<b>Total</b>	<b>--</b>	<b>1,176</b>	<b>1,176</b>	<b>1,176</b>
Community spells that followed a hospital stay	Died	--	156	209	702
	Readmitted to hospital	--	1,540	2,288	8,656
	Admitted to nursing home	--	76	103	350
	Censored	--	8,758	7,930	822
	<b>Total</b>	<b>--</b>	<b>10,530</b>	<b>10,530</b>	<b>10,530</b>

Table 2a. Means of explanatory variables, by type of spell, persons aged 65 and older, 1977-1992 NHEFS

Variable name/definition	Hospital spells	Nursing home spells	Community spells
Age at start of spell, in years	74.1	78.7	73.6
Female, %	53.9	65.6	53.0
Health status (predicted survival, %) <sup>a</sup>	69.5	55.7	70.7
Primary diagnosis			
Cardiovascular disease, %	28.9	25.6	29.1
Cancer, %	11.0	7.8	11.0
Other, %	60.1	66.7	59.9

Means are over spells.

a. Predicted survival probability, estimated from health characteristics measured at survey baseline (see text), is reported as a percentage. Higher percentages denote better health.

Table 2b. OLS regression of health status (predicted survival probability)<sup>a</sup>

Variable	Coefficient (t-statistic)
Intercept	-0.330** (-2.04)
Age	0.048*** (11.31)
Age squared	-0.0005*** (16.59)
Female	0.130*** (54.49)
Time period	
PPS, 1983-92	-0.078*** (-24.84)
Mature PPS, 1986-92	-0.014*** (-4.19)
N (hospital spells)	12,602

Statistical significance levels: \* 10%; \*\* 5%; \*\*\* 1%.

a. Dependent variable is predicted survival probability, estimated from health characteristics measured at survey baseline (see text), expressed as a percentage. Higher percentages denote better health.

Table 3. Inpatient Hospital Spells: Estimated hazard ratios from Cox regressions, persons aged 65 and older, 1977-1992 NHEFS

	Death in hospital		Discharge to nursing home		Discharge to community	
	15 days	Full spell	15 days	Full spell	15 days	Full spell
Age at start of spell	1.013 (0.97)	1.032** (2.59)	1.059*** (3.63)	1.060*** (4.28)	0.990** (-2.30)	0.992** (-2.09)
Female	0.944 (-0.61)	0.829* (-1.90)	1.931*** (4.84)	1.914*** (4.55)	0.937 (-1.33)	0.930 (-1.58)
Health status <sup>a</sup>	0.984*** (-4.49)	0.991** (-2.51)	0.982*** (-3.06)	0.984*** (-2.94)	1.009*** (6.53)	1.009*** (6.22)
Primary diagnosis <sup>b</sup>						
Cancer	0.949 (-0.29)	1.331** (2.05)	0.465*** (-2.96)	0.495*** (-3.33)	0.816*** (-3.12)	0.821*** (-3.19)
Other diagnosis	0.545*** (-4.58)	0.599*** (-4.05)	1.192 (1.50)	1.163 (1.53)	1.037 (0.82)	1.033 (0.77)
Time period <sup>c</sup>						
PPS, 1983-92	1.160 (0.95)	1.279** (2.02)	2.435*** (4.14)	1.943*** (4.09)	1.274*** (5.28)	1.211*** (4.19)
Mature PPS, 1986-92	1.117 (0.77)	1.082 (0.73)	1.322* (1.83)	1.489*** (2.74)	1.012 (0.21)	0.992 (-0.14)
PSU fixed effects	yes	yes	yes	yes	yes	yes
N spells (# outcomes)	12,602 (648)	12,602 (884)	12,602 (866)	12,602 (1,176)	12,602 (9,114)	12,602 (10,530)
Likelihood ratio test	354***	371***	1148***	1338***	884***	885***

t-statistics in parentheses: \* p < 0.10, \*\* p < 0.05, \*\*\* p < 0.01

- a. Predicted survival probability, in percent.
- b. Reference category: cardiovascular disease
- c. Reference category: Pre-PPS, 1977-1982.

Table 4. Nursing Home Spells that follow a hospital stay: Estimated hazards ratios from Cox regressions, persons aged 65 and older, 1977-1992 NHEFS

	Death in nursing home within		Readmission to hospital within		Discharge to community within	
	31 days	61 days	31 days	61 days	31 days	61 days
Age at start of spell (yrs)	0.975 (-0.76)	0.983 (-0.59)	0.968 (-1.15)	0.954** (-2.16)	1.062** (2.59)	1.062** (3.04)
Female	0.661 (-1.07)	0.705 (-1.23)	1.470 (1.06)	1.202 (0.81)	0.804 (-0.73)	0.610 (-1.79)
Health status <sup>a</sup>	0.993 (-0.67)	0.993 (-0.80)	0.986* (-1.69)	0.978*** (-3.25)	1.041*** (4.73)	1.037*** (4.54)
Primary diagnosis <sup>b</sup>						
Cancer	3.951*** (3.78)	4.600*** (5.40)	1.305 (0.67)	1.962** (2.58)	0.561 (-0.56)	0.720 (-0.41)
Other diagnosis	0.491** (-2.10)	0.553** (-2.15)	0.694 (-1.45)	0.745 (-1.56)	1.904 (1.63)	2.073** (1.99)
Time period <sup>c</sup>						
PPS, 1983-92	1.680 (1.17)	1.522 (0.99)	1.649 (1.17)	1.204 (0.61)	1.674 (1.08)	1.765 (1.47)
Mature PPS, 1986-92	1.487 (1.20)	1.411 (1.19)	0.723 (-1.16)	0.940 (-0.29)	1.667 (1.42)	1.610 (1.62)
PSU fixed effects <sup>d</sup>	yes	yes	yes	yes	yes	yes
N spells (# outcomes)	1,176 (104)	1,176 (146)	1,176 (137)	1,176 (219)	1,176 (111)	1,176 (163)
Likelihood ratio test	119***	142***	72***	96***	110***	152***

t-statistics in parentheses: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

a. Predicted survival probability, in percent.

b. Reference category: cardiovascular disease

c. Reference category: Pre-PPS, 1977-1982.

d. PSUs with 10 or fewer spells are grouped as one fixed effect.

Table 5. Community spells that follow a hospital stay: Estimated hazards ratios from Cox regressions, persons aged 65 and older, 1977-1992 NHEFS

	Death in community within		Readmission to hospital within		Admission to nursing home within	
	31 days	61 days	31 days	61 days	31 days	61 days
Age at start of spell (yrs)	0.978 (-0.88)	0.986 (-0.70)	0.978*** (-2.65)	0.979*** (-3.07)	1.044 (1.55)	1.075** (2.48)
Female	1.629*** (2.60)	1.474** (2.08)	1.211* (1.70)	1.261** (2.52)	2.034* (1.73)	2.083** (2.14)
Health status <sup>a</sup>	0.966*** (-4.59)	0.970*** (-4.79)	0.986*** (-5.41)	0.983*** (-7.07)	0.979** (-2.00)	0.983* (-1.71)
Primary diagnosis <sup>b</sup>						
Cancer	2.319*** (2.87)	2.732*** (4.06)	1.565*** (4.13)	1.395*** (3.50)	1.261 (0.36)	1.817 (1.12)
Other diagnosis	0.852 (-0.52)	0.869 (-0.59)	0.748*** (-2.68)	0.748*** (-3.25)	1.442 (0.91)	1.474 (1.10)
Time period <sup>c</sup>						
PPS. 1983-92	0.951 (-0.16)	0.824 (-0.62)	1.038 (0.32)	1.135 (1.19)	3.414** (2.42)	2.829*** (2.70)
Mature PPS. 1986-92	1.411 (1.20)	1.471 (1.40)	0.853 (-1.41)	0.760*** (-3.03)	0.672 (-0.97)	0.787 (-0.70)
PSU fixed effects	yes	yes	yes	yes	yes	yes
N spells (# outcomes)	10,530 (156)	10,530 (209)	10,530 (1,540)	10,530 (2,288)	10,530 (76)	10,530 (103)
Likelihood ratio test	245***	262***	433***	575***	142***	169***

t-statistics in parentheses: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

- a. Predicted survival probability, in percent.
- b. Reference category: cardiovascular disease
- c. Reference category: Pre-PPS, 1977-1982.

Table 6a. Inpatient Hospital Spells: Hazard ratios for spells stratified by state HMO enrollment, from Cox regressions, persons aged 65 and older, 1977-1992 NHEFS

Outcome <sup>a</sup>	All (Table 3)	HMO < 10%	HMO ≥ 10%
<b>Death within 15 days</b>			
PPS. 1983-92	1.160 (0.95)	1.156 (0.48)	1.153 (0.83)
Mature PPS. 1986-92	1.117 (0.77)	1.049 (0.19)	1.138 (0.72)
<b>Death, full spell</b>			
PPS. 1983-92	1.279** (2.02)	1.177 (0.74)	1.351** (2.00)
Mature PPS. 1986-92	1.082 (0.73)	1.209 (1.13)	1.023 (0.15)
<b>Discharge to nursing home within 15 days</b>			
PPS. 1983-92	2.435*** (4.14)	3.717*** (3.81)	2.054*** (3.04)
Mature PPS. 1986-92	1.322* (1.83)	0.862 (-0.73)	1.610** (2.51)
<b>Discharge to nursing home, full spell</b>			
PPS. 1983-92	1.943*** (4.09)	2.635*** (3.82)	1.795*** (3.24)
Mature PPS. 1986-92	1.489*** (2.74)	1.142 (0.67)	1.659*** (2.88)
<b>Discharge to community within 15 days</b>			
PPS. 1983-92	1.274*** (5.28)	1.140** (2.07)	1.340*** (4.69)
Mature PPS. 1986-92	1.012 (0.21)	0.993 (-0.10)	1.024 (0.33)
<b>Discharge to community, full spell</b>			
PPS. 1983-92	1.211*** (4.19)	1.075 (1.19)	1.273*** (4.03)
Mature PPS. 1986-92	0.992 (-0.14)	0.994 (-0.09)	0.994 (-0.08)
N (states; spells)	(46; 12,602)	(23; 4,610)	(23; 7,992)

t-statistics in parentheses: \* p < 0.10, \*\* p < 0.05, \*\*\* p < 0.01

a. Reference category: Pre-PPS, 1977-1982.

Table 6b. Community spells that follow a hospital stay: Hazard ratios for spells stratified by state HMO enrollment, from Cox regressions, persons aged 65 and older, 1977-1992 NHEFS

Outcome <sup>a</sup>	All (Table 5)	HMO < 10%	HMO ≥ 10%
<b>Death within 31 days</b>			
PPS. 1983-92	0.951 (-0.16)	0.371** (-2.20)	1.246 (0.54)
Mature PPS. 1986-92	1.411 (1.20)	1.813 (0.93)	1.230 (0.63)
<b>Death within 61 days</b>			
PPS. 1983-92	0.824 (-0.62)	0.544 (-1.24)	0.943 (-0.14)
Mature PPS. 1986-92	1.471 (1.40)	1.874 (0.90)	1.302 (0.80)
<b>Readmission to hospital within 31 days</b>			
PPS. 1983-92	1.038 (0.32)	0.794 (-1.11)	1.177 (1.06)
Mature PPS. 1986-92	0.853 (-1.41)	1.014 (0.09)	0.780* (-1.70)
<b>Readmission to hospital within 61 days</b>			
PPS. 1983-92	1.135 (1.19)	1.029 (0.19)	1.181 (1.09)
Mature PPS. 1986-92	0.760*** (-3.03)	0.789* (-1.80)	0.752** (-2.36)
<b>Admission to nursing home within 31 days</b>			
PPS. 1983-92	3.414** (2.42)	2.735 (1.21)	3.364** (2.08)
Mature PPS. 1986-92	0.672 (-0.97)	0.252*** (-2.95)	1.201 (0.38)
<b>Admission to nursing home within 61 days</b>			
PPS. 1983-92	2.829*** (2.70)	2.869 (1.61)	2.578** (2.07)
Mature PPS. 1986-92	0.787 (-0.69)	0.303*** (-3.34)	1.365 (0.75)
N (states, spells)	(46; 10,530)	(23; 3,885)	(23; 6,645)

t-statistics in parentheses: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

a. Reference category: Pre-PPS, 1977-1982.

Figure 1. Transitions among health care settings

## Transitions among Health Care Settings

