Physicians Treating Physicians at the End of Life: The Relational Advantage in Treatment Choice

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December 24, 2019

Abstract

This study examines the agency problems by estimating the informational and relational effects of physician-patients on their invasive treatment. To address potential issues of patient selection, we compare treatment intensity between physician- versus nonphysician-patients attended by the same doctor in the same hospital, and control for patients' previous choices of doctors. To identify the relational effect, we further compare the impacts of physician-patients specializing in the same area as their attending doctors versus those in different areas. We test whether physician-patients receive more care than comparable nonphysician-patients and whether the increased volume results from physician-patients' relational advantages or their information advantages. *JEL: D83, I11, J44. Keywords: physician practice style; communication and information; end-of-life medical care*

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A growing literature in labor economics examines the question of whether complete information or strong social ties can solve agency problems (e.g., Bandiera, Barankay, and Rasul 2009; Jackson and Schneider 2011). Health economists recently join this discussion through randomizing physicians to black men on the basis of race and incentives (Alsan, Garrick, and Graziani 2018) or using rotating call schedules as an exogenous variation in doctor-patient relationships (Johnson et al. 2016). Building upon this literature, we use a large administrative database to study the distinct roles of information and human relations in addressing the question of whether inpatient doctors use the same amount of treatment for physician- and nonphysician-patients and whether such differences in treatment affect patient survival.

Previous research exploring agency problems within the healthcare context has examined whether physician mothers are more/less likely to have a Cesarean section than nonphysician-mothers. These studies find mixed results.[1] On the one hand, Grytten, Skau, and Srensen (2011) find that physician-mothers are more likely to receive a Cesarean section, which they attribute to a closer relationship or better communication with attending doctors. On the other hand, Chou et al. (2006) and Johnson and Rehavi (2016) find that physician-mothers are less likely to receive a Cesarean section, which they attribute to access to better information about potential complications and side effects. However, the conjectured relational and informational advantages afforded physician-mothers are empirically inseparable when restricting the scope of analysis to one medical specialty. Through relaxing this restriction, our study contributes to the empirical literature on agency problems by evaluating the relative importance of relational and informational effects on the choice of inpatient treatments AMI, stroke, or end-stage cancer patients.

In any study of physician-patient effects on treatment choice, there is a potential patient selection bias. Physician-patients are typically more capable than nonphysician-patients of choosing specific doctors who can provide the desired level of medical care, even within the same

[1] Bunker and Brown (1974) and Hay and Leahy (1982) find that physician-patients tend to use more healthcare although both studies omit hospital factors. Bronnenberg et al. (2015) and Carrera and Skipper (2017) find that pharmacists/physicians recommend different drugs/treatments for patients from what they would choose for themselves. Levitt and Syverson (2008) adopt the same approach to test for agency problems when consumers are experts. However, as Ubel, Angot, and Zikmund-Fisher (2011) and Shaban, Guerry, and Quill (2011) note, the treatments that physicians choose for themselves might not be comparable with the treatment that they would apply to patients because the difference in those treatments might also capture the difference in susceptibility to choose self-treatments versus treating others, not necessarily reflecting the physician-patients effect on treatment choice.

hospital. Because doctors differ in procedure skills or practice styles and because patients differ in their preexisting demand for treatment intensity, these differences may confound the observed difference in treatment choice between physician- and nonphysician-patients. To address the patient selection bias issue, we use a combination of a data matching scheme and econometric models. ??? Specifically, we hold patients' prior doctor choices constant and compare the treatment options of physician- and nonphysician-patients attended by the same doctor within the same hospital. Doing so allows us to control for doctors' practice style and patients' demand for intensive care, which are typically unobservable to researchers.

For this study, we use Taiwanese health insurance data between 2000 and 2006, collected by the National Health Insurance (NHI) Administration.[2] In Taiwan, participation in the NHI systems is mandatory, and thus the data includes all insurance participants, including those who have never checked into a hospital. Given the national fee schedule, doctors cannot indulge in price discrimination against patients, regardless of the hospital type, and patients can freely choose attending doctors without going through a gatekeeper. Additionally, the ratio of the palliative care users to the number of deaths is as low as approximately one percent during our data period, and the NHI has not covered hospice care until the end of our data period. These institutional features allow us to overcome potential selection biases in focusing on patient choices, doctor attributes, and invasive procedures performed in hospitals.

Using the NHI data, we construct doctor-hospital fixed effect models, including patient attributes and previous doctor choice, to obtain a selection-bias-adjusted estimate of the physician-patient impact on treatment choices. Our results suggest that physician- and nonphysician-patients have about the same probability of using most of the end-of-life invasive care procedures. However, we find that physician-patients utilize 1.4 percentage points more care volume, relative to identical patients treated by the same doctor in the same hospital (table 4), without staying longer in a hospital or paying more out of pocket. The estimated effect on care volume is non-negligible because it accounts for about six percent of the variability in the treatment decision within the doctor and hospital given the same month, with statistical significance at conventional levels. Notably, including patients' prior choices of physicians in our

[2] Chen and Chuang (2016) systematically evaluate the credibility of the NHI Database by comparing the database with survey data and official statistics.

regressions adjusts the estimated impact *upward* by 44 percent or more (table 3) while excluding doctors who have never attended a physician-patient adjusts the estimates *downward* by more than one half (table 4). These findings suggest that both the differential patient sorting and the unobserved differences in doctor quality can explain a large portion of the gap in treatment intensity between physician- and nonphysician-patients.

A critical concern for our end-of-life analysis is that restricting the data by proximity to death might have biased the estimates. If physicians have a longer life expectancy and if those who die later would use less invasive care, then our end-of-life analysis understates the physician-patient effects on invasive care; the estimated coefficient on physician-patients would have been higher if we could also include survivors in our analysis.

Furthermore, using a simple extension of the doctor-hospital fixed effect model, we find that our observed increased volume of invasive care among physician-patients at the end of life results mostly from the relational advantage of physician-patients (when belonging to the same specialty category as their attending doctors) rather than the informational advantage (when specializing in a surgical area). We find that this relational premium is substantial as it exceeds the total physician-patient impact by three percentage points and accounts for 15 percent of the variability in treatment choice for a given doctor and hospital.

Our finding of distinct relational and informational advantages in physician-patient treatment choices is consistent with the previous findings regarding the utilization of a Cesarean section. Although physician-mothers have a lower rate of Cesarean section than nonphysician-mothers (Johnson and Rehavi 2016), this rate increases with a strong preexisting clinical relationship between general patients and attending doctors since the doctors are more likely to be empathetic and more willing to reduce pain during childbirth by recommending a Cesarean section (Johnson et al. 2016). Following Johnson et al. (2016), we also include all patients' preexisting clinical relationship with their doctors. Our result shows that such clinical relationships decreased invasive care volume for general patients, contrary to the positive impact of having a closer professional relationship on invasive care volume for physician-patients because of better communication. To our knowledge, this study is the first in the literature to explore the differential effects of having a preexisting clinical relationship, a professional relationship, and an informational advantage on treatment choice.

We further extend our analysis and find that the relative significance of the professional relationship effect on invasive care decreases with the introduction of a global expenditure cap in 2002. As context, in 2002, the Taiwanese NHI administration began capping hospital care budgets in each region. These budget caps resulted in a zero-sum game that intensified both quantity competition and demand inducement likely because the markup remained sufficiently high despite the global-budget caps (Mougeot and Naegelen 2005; Earle, Schmedders, and Tature 2007; Cheng 2015). Our results verify that quantity competition has intensified after 2002, particularly at the end of reimbursement season. Our results also show that the global-budget reduces the dominant role of the professional relationship effects on physician-patient treatment options although the estimated reduction is statistically insignificant. Overall, the global-budget caps seem to have closed the gap in invasive care utilization/volume between physician- and nonphysician-patients because of the combination of quantity competition and the decreased impact of physician-patients' professional relationship on treatment options.

The rest of the paper proceeds as follows. Section 1 describes the clinical and institutional settings. Section 2 describes our matching scheme in constructing the study sample and summarizes our data features and descriptive statistics. In Section 3, we introduce our econometric models, report the core estimates, implement robustness checks, and discuss possible interpretations. Section 5 considers alternative explanations for our data and undertakes additional analysis of the data in an attempt between the alternatives. Section 6 extends the econometric models to distinguish relational effects from informational advantages of treatment intensity and discusses the results. Section 7 concludes.

1 Clinical and Institutional Settings

1.1 Patient Cost Sharing and Provider Reimbursement

Similar to the Canadian and German healthcare systems, the Taiwanese NHI is a mandatory single-payer system for all citizens and residents that consists of one uniform comprehensive care benefits package covering drugs, hospital, and primary care (Hsiao et al. 2016). Because participation in the NHI is mandatory, there is no issue of adverse selection into insurance. Within the NHI system, almost all patients choose their physicians directly, given the minimal penalty for visiting

a hospital without a primary care referral (7 USD in 2014) and low co-pays ranging from 2 to 14 USD. Furthermore, the NHI charges no deductible and sets no cap on out-of-pocket expenditure, choosing instead to manage health expenditure inflation through provider reimbursement.

Before 2002, the NHI reimbursed providers solely on a fee-for-service basis. In this system, hospitals, in turn, pay doctors with a combination of fees-for-services plus a basic salary that varies across hospitals, meaning that doctors and hospitals have similar financial incentives. Since July 2002, the NHI has followed Canada, France, and Germany in imposing a regional-level global hospital care budget to curb rapidly increasing expenditure. This global budget is determined annually by a committee of providers, academics, and representatives of premium payers. It also takes account of inflation, previous spending, population size, and new technologies. While the NHI system precludes price-discrimination, a sufficiently large markup under the global budget can incentivize providers to "expand their volume of services to maximize their share of the common budget, making it a classic zero-sum game" (Cheng 2015; also see Mougeot and Naegelen 2005).

To reconcile the fee-for-service structure and the global-budget cap, the NHI administrator assigns a reimbursement point value to each possible service, with a conversion rate calculated *ex-post* by the ratio of the global budget cap to the total number of points in the region. As a result, providers face an uncertain reimbursement value for services as well as an uncertain marginal revenue. These uncertainties create incentives for providers to control the volume collectively for a higher conversion rate if the expected markup is small and decreasing with volume (Earle, Schmedders, and Tatur 2007). By contrast, a sufficiently high markup leads to a zero-sum game as there is no benefit from controlling volume. In equilibrium, hospitals adjust the expected markup until when quantity control and quantity competition are equally profitable to all hospitals within the region.

1.2 Invasive Care Utilization

To examine whether physician-patients receive higher volumes of invasive care as part of their end-of-life treatment, we identify four procedures for our study: nasogastric intubation feeding, urinal catheterization, and endotracheal intubation, and tracheostomy intubation. Each of these treatments requires an affidavit signed by a family member. Thus, the choice of an invasive care treatment depends on both supply and demand for invasive care. Clinical situations do not

always precisely indicate to wean or apply an invasive procedure, and the medical guidelines and recommendations often leave room for discrepancies between appropriate and potentially inappropriate uses. In practice, while tubes and catheters may be placed for appropriate reasons, it is possible they are not removed promptly if patients or caregivers express a desire to maintain their use as a substitute for nursing care (e.g., Roland, Mansour, and Schwarz 2012; Meddings et al. 2014).

Medical guidelines recommend using nasogastric intubation feeding when patients can digest but cannot eat or swallow. Urinary catheterization is recommended when a patient has bladder outlet obstruction, or there is a need to measure urinary output. Both procedures could have some potential complications although none is fatal. For example, complications associated with nasogastric intubation, such as dehydration, skin issues, or gastrointestinal disorders, are uncommon and easy to manage. Urinary catheters are likely to cause urinary tract infections, which routinely cleaning catheters can prevent.

Our third and fourth measures of invasive care are forms of mechanical ventilation, which is recommended during episodes of acute respiratory failure or as an ongoing ventilation option. During episodes of acute respiratory failure, most patients are ventilated through an endotracheal tube. Use of endotracheal tube requires suctioning to clear the airway, but routine suctioning may cause fatal complications, such as desaturation, pneumonia, arrhythmias, and bronchospasm. When ongoing ventilation is needed, patients are ventilated through a tracheostomy tube. While a tracheostomy tube may induce complications such as air trapping, experienced surgeons can avoid or address these issues. Caregivers must prevent complications from a tracheostomy tube (e.g., such as infection or accidental removal of the tube), but the long-term care workload is much less than with an endotracheal tube. Long-term use of a tracheostomy tube can result in the development of granulation tissue, narrowing of the airway, or failure of the tracheal stoma to close after removal of the tube, all of which requires an additional surgical procedure for repair.[3]

In 2000, to address the issue of ICU capacity shortages, the NHI initiated a payment program to encourage mechanical ventilation weaning in a non-ICU setting for both acute and chronic patients.

[3]In a large representative sample of hospital patients who have ventilated through a tracheostomy tube for at least 21 days in the hospital during 1998–2003, Lu et al. (2012) find that the average patient continues to use a tracheostomy for an additional 66 days. Approximately one half of those in the study died within three months after being discharged from the hospital and more than 90 percent within six months.

Since then, use of mechanical ventilation has risen rapidly, with tracheostomy intubation showing the steepest increase. Indeed, the aggregate expense for mechanical ventilation accounts for 6 percent of the total 2005 NHI budget, according to the 2008 NHI Administration's annual report. To put this increase in context, we note that between 1997 and 2004, mechanical ventilation usage rose at least 180 percent while the total hospital inpatient days increased by no more than 50 percent (Cheng, Jan, and Liu 2008). Among patients in the last six months of life between 2001 and 2006, the utilization rates range from 22 percent of endotracheal tube insertion to 48 percent of nasogastric intubation feeding. About 61 percent of hospitalized patients use one of the four invasive care procedures (column 1 of table 3).

2 Data and Summary Statistics

2.1 Data Construction

We obtain data for the period 2000 to 2006 from the central database of Taiwan's NHI Administration, which provides unique identifiers and detailed information on all providers, physicians, and patients in the system, except for military personnel and their families. The database covers more than 90 percent of hospitals under contract with the NHI system.

An essential feature of the NHI database is that it provides data on both beneficiaries who have never checked into a hospital and those who have been admitted. To capture the possibility that patients may check into different hospitals or into the same hospital to see various physicians during our sample period, we set our unit of observation as hospital admission and both beneficiaries who have ever checked into a hospital and those who have never checked into a hospital. Hospitals in Taiwan follow a closed-staff structure where the on-staff doctor assumes full responsibility for the patient's medical care. This institutional setting ensures that our patient-physician matched dataset well-defines the interactions between doctors and patients during each hospital admission.

To construct our master data set, we first obtain Cause of Death Data from the NHI Administration database for our sample period. We then match this information to the NHI Registry for all beneficiaries, which contains each beneficiary's socioeconomic attributes such as sex, birthday, work status, registry location, and income (which is reported by the premium payer if the beneficiary is a dependent). Because the last three attributes can vary over time, we use the

information recorded during the penultimate year, as in Chen and Chuang (2016). Specifically, we calculate individual income by averaging over all income levels during the penultimate year. For work status and registry location, we use the latest record during the penultimate year. Although this data step drastically complicates our data work, it ensures that all the covariates have been determined before the year of death.

To obtain the data of deceased physician-patients, we match our master data set to the Registry for Medical Personnel which contains information about each doctor's sex, birthday, and date of certification, including retirees. For our physician- and nonphysician-patients, we then match each deceased person to his or her hospital admissions information (if any) using the Reimbursement Claim Data, which consists of data on inpatient expenditures by admissions. We use this matched data to obtain hospital type and location as well as the respective unique identifiers for the hospital and attending doctor.

To derive our sample of attending doctors, we link the above-matched data to the Registry for Board-Certified Specialists, which indicates each doctor's specialty, work history, and practice location(s) since being certified. Note that an attending doctor may have multiple practice locations because of relocation or because a single practice has multiple locations.

Finally, to obtain our data on the use of invasive care for each hospital admission, we link the matched dataset to the Physician Orders for Inpatients data, which includes both treatment decisions and medical supply usage. This data also allows us to observe each inpatient's treatment history during our sample period. We use physician orders, instead of ICD codes (mostly missing in the database), to identify the volume and utilization of a specific invasive care procedure to avoid potential misreporting issues associated with ICD codes.[4]

2.2 Summary Statistics

In assessing the use of invasive care in end-of-life treatment, we consider three sets of outcomes in the last six months of life: (1) the utilization of hospital care, measured as the total number of days in a hospital; (2) the utilization of any of the four invasive procedures – nasogastric intubation feeding,

[4]Each order code for a procedure consists of five digits followed by one letter, and each code for a medical supply consists of three letters, followed by nine digits or letters. Nasogastric intubation is coded by 47017C, 47018C, 47019C, or CFD0216120W6; urinal catheterization 47013C, 47014C, CKF03FL000EF, or CKF042103NWN; endotracheal intubation 47031C or CRT02C0050WN; and tracheostomy intubation 57001B or 57002B.

urinal catheterization, endotracheal intubation, and tracheostomy intubation; and (3) care volumes and hospital expenditures associated with a patient, both converted to standardized percentiles. Among 989 deceased doctors, the youngest doctor died at age 29. To form a comparison group, we include 765,649 nonphysician beneficiaries who died at age 29 or older during the data period.

Our end-of-life summary statistics in Table 1, based on both hospital-admitted and non-hospital-admitted beneficiaries, show that physicians are 13 percent (0.10/0.75) more likely than nonphysicians to check into a hospital and that their hospital stays are about 16 days or 25 percent (15.95/64.38) longer. We further find that physicians are 16 percent (0.08/0.51) more likely to receive one of the four invasive care procedures. The summary statistics also show that, upon adoption, physicians utilize 6 percent (3.58/60.1) more care volume while spending 12 percent (6.93/57.3) less out of pocket, compared to nonphysicians. The gap in the use of a tracheostomy tube, in particular, is about 13 percent (0.07/0.55) of nonphysicians' utilization. Although only a handful of physicians check into an emergency room (ER) in the last six months of life in our sample, this subset still has a 7 percent (3.89/56.8) higher probability of receiving an endotracheal tube insertion. Our further analyses show that these differences are driven mostly by patient selection and past utilization, as we explain later.

The statistics in Table 1 also show that our physician-patients live six years longer on average and are at least 78 percent more likely to be admitted into surgery or another highly specialized department (e.g., neurology, otolaryngology, or orthopedic surgery; not reported in the table). Since we expect that the costs for those who live longer and receive more specialized care are higher for both physician- and nonphysician-patients, our analysis includes patient demographics and department-fixed effect in the regressions.

Continuing with Table 1, we see that physician-patients show a 13 percent (0.10/0.75) higher hospitalization rate than nonphysician-patients and that they are 65 percentage points more likely to see a chosen doctor for their end-of-life treatment. Finally, we see that physician- and nonphysician-patients are equally likely to die of a heart attack, while physician-patients significantly more likely died of chronic disease or cancer. In contrast, acute diseases or unnatural causes are less likely to result in death among physician-patients. These differences may be driven by patients' preexisting health conditions, lifestyles, or socioeconomic status, as we will discuss further in Section 5.

Table 2 presents our summary statistics for attending physicians in our study. Our data includes

17,401 doctors who have treated an end-of-life patient, of which 2,390 are considered to be chosen doctors (since they have treated at least one physician-patient in the last month of their life). While these chosen doctors account for less than 14 percent of the physicians in the data, they comprise 28 percent of the invasive care treatments prescribed within their respective medical specialties. Compared to unchosen doctors, we find that chosen doctors are more experienced, more specialized (as indicated by fewer specialty certificates) particularly in internal medicine, more likely to relocate or work in multiple locations, and more likely to work in private hospitals. They also receive about five percentiles greater reimbursement and have patients who pay three percentiles less out of pocket.

Finally, we summarize the descriptive statistics of our outcome variables in the first two columns of table 3. We report the sample mean and standard deviation over all nonphysician-patients' hospital admissions during the last six months of life. The statistics show that the average hospital stay for a nonphysician-patient is 42 days per admission and that about 61 percent of admitted nonphysician-patients receive an invasive procedure. The specific treatment utilization rate ranges from 22 percent for endotracheal intubation to 48 percent for nasogastric intubation. We standardize the care volumes and costs in all tables and cluster standard errors and deviations at patient levels.

3 Empirical Strategies

To determine whether physician-patients experience an informational or relational advantage in their end-of-life treatment, we use a series of fixed-effect regressions. This methodology is appropriate as it is a standard approach to empirically testing agency problems when consumers are experts (Levitt and Syverson 2008, Bronnenberg et al. 2015) or, in our case, when physicians treat physician-patients (Johnson and Rehavi 2016). Following the same econometric setting in the previous literature, we begin with a basic model for the invasive care utilization Y of patient i in hospital h during year-month t:

$$Y_{iht} = \alpha_{ht} + \beta D_i + \gamma X_{iht} + u_{iht}, \tag{1}$$

where D is a physician-patient dummy with the parameter of interest β, and the coefficient α captures hospital- and time-fixed effects. The covariates X include a patient's risk factors (measured by past utilization during the penultimate six months of life), socioeconomic characteristics, and district fixed effects, as well as time-varying characteristics of both the hospital and the district at the time the patient is admitted. Finally, the error term u reflects random factors in the decision to prescribe an invasive procedure. Because of the richness of our data, we also control for hospital-department fixed effects. It is noteworthy that this conventional model assumes the absence of patient selection; that is, doctors in the same hospitals have the same practice style, and physician- and nonphysician-patients who choose the same hospital have the same demand for invasive care.

Next, we extend this model to address the issue of potential patient selection bias by adding more controls and matching physician- and nonphysician-patients by the same attending doctor:

$$Y_{ijht} = \alpha_{ht} + \beta D_i + \gamma X_{iht} + \delta W_{jt} + \theta_j + \lambda_h + \phi Z_{jh} + u_{ijht}, \tag{2}$$

where θ_j and λ_h represent doctor and hospital fixed effects, respectively, that capture each doctor's and hospital's time-invariant attributes and practice style. Since 58 percent of the doctors in our study practice across multiple locations, we account for differences in practice styles across locations for each doctor by presenting specifications in which Z_{jh} contains either doctor-hospital fixed effects or the doctor and hospital controls.

Moreover, in the above regression, we include W_jt an attending doctor's years of experience at the time a patient is admitted to a hospital, thus allowing us to capture time-varying factors that might influence doctor practice styles over time. Also, we control for a patient's previous choice of doctor (or *patient choosiness*) in the covariate set X, defined as the fraction of the patient's hospital admissions attended by a chosen doctor during the final year of life. By construction, all physician-patients have their choosiness measure equal to one. For nonphysician-patients, patient choosiness ranges from zero to one, reflecting their level of choosiness compared to physician-patients. Patients who have never seen a chosen doctor have their choosiness measure equal to zero. If choosiness reflects a patient's private information about their preexisting demand for invasive care and doctor practice styles, the inclusion of this measure in our estimation can mitigate potential selection bias.

Finally, we

4 Estimation Results

We present the results of our estimation in table 3. Columns 3 and 5 first compare the variability in outcomes within hospital cells versus doctor-hospital cells, conditional on the year-month when a patient is admitted to a hospital. The results in column 3 reflect the variability in care utilization and volumes within a hospital; that is, the standard deviation of the residual when we regress our variables on hospital fixed effects and year-month dummies. The results in column 5 present our findings regarding variability within a doctor-hospital unit.

Comparing the standard deviations in column 3 to those in column 2, we see that within-hospital variation and year-month fixed effects account for only a small fraction of unconditional variability; less than 2 percent in utilization rates (1-0.48/0.49), no more than 3 percent in care volume (1-28.12/28.87), and about 5 percent in reimbursement (1-25.86/28.86). Re-running our regression including doctor-hospital fixed effects, the statistics in column 5 show that variation in doctor-specific factors removes a substantially larger portion of unconditional variability than hospital-specific effects: more than 7 percent in utilization rates (1-0.45/0.49) and more than 11 percent in care volumes (1-25.65/28.87). We further note that the unconditional variability in reimbursement decreases by an additional 5 percent ((27.31-25.86)/28.86). Finally, the statistics show that doctor-hospital fixed effects account for an additional 9 percent of unconditional variability in car2e volume ((28.12-25.65)/28.87), which triples that removed by the hospital and year-month dummies combined. Together, these results imply the importance of including doctor-hospital fixed effects in the regression analysis. They also reinforce the need for caution in inferring a causal relation. That is, given the variability in medical spending and care volumes accounted for by doctor-hospital fixed effects, it is likely that the observed gap in treatment choice between physician- and nonphysician-patients might have reflected the unobserved differences in doctor quality due to patient selection.

Regarding the observed differences in attending doctors who are chosen versus unchosen by end-of-life physician-patients, the statistics in Table 2 indicate that chosen doctors are highly selective, accounting for only less than 14 percent of all physicians who have ever attended patients in the final year of life (2,390/17,401). Even within hospitals chosen by end-of-life physician-patients, only 15 percent of a given hospital's doctors are chosen to treat an end-of-life physician-patient

(2,390/(2,390+13,248)). Overall, the statistics show that chosen doctors are among the most experienced and specialized, particularly in internal medicine, and they have a significantly larger market share and are more likely practice in multiple locations than unchosen ones. These results lead us to conclude that the assumptions underlying the conventional model (1) are unlikely.

Given the above discussion, we re-run our regressions using the set of covariates in our extended model (2) and present the results in columns 4, 6, and 7 of table 3. We report the utilization coefficients on physician-patients in the top panel and the corresponding coefficients for care volume and spending in percentiles in the bottom panel. Since a given patient can check into a hospital multiple times during the last six months of life, we report the cluster standard errors at the patient level in parentheses.

We begin with the conventional model (1) to which we then include fixed effects for each hospital and year-month, in addition to a wide range of controls such as patient attributes, past utilization rates, and local market conditions. The results in column 4 indicate that the effect of invasive care on the utilization rate accounts for only two percent of within-hospital variability (0.011/0.48) and is not significant.

When we include doctor-hospital fixed effects, the effect of a physician-patient on utilization rates reflects a comparison of treatment choices of identical patients attended by the same doctor in the same hospital, rather than those of patients treated by different doctors. If chosen doctors are more likely to use invasive care only for patients who need it, then the inclusion of doctor-hospital fixed effects and doctor experience in our model should yield an increase in the estimated impact of physician-patients on the use of invasive care treatments. The results in column 6 support this conjecture. Specifically, these results show that the estimated effect of a physician-patient on the probability of using any invasive care increases by 70 percent (0.019/0.011-1) while the impact on care volume increases by almost 30 percent (1.599/1.242-1). However, despite these increases, we find that the estimated effect of a physician-patient on using any of our four identified invasive care procedures continues to be small.

Notably, if we replace the doctor-hospital fixed effect θ_{jh} with a comprehensive set of controls for time-invariant characteristics of attending doctor j and hospital h, the results remain almost unchanged. This finding suggests that patients generally have little private information about doctors and hospital characteristics that our data cannot capture. Doctor quality or practice styles

seem to be public information for both the physician- and nonphysician-patients. From this result, we can predict that the selection biases in our analysis are driven primarily by factors unrelated to doctor-hospital fixed effects, such as patients' demand for treatment intensity.

To further adjust for patient selection biases, we additionally control for patients' previous choices of physicians (patient choosiness) in column 7. The results show that including patient choosiness more than doubles the physician-patient effect on invasive care utilization (0.041/0.019-1) and increases the effect on care volumes by more than 80 percent (2.917/1.599-1), while the effect on out-of-pocket payment decreases by about a quarter (3.094/4.197-1). Given identical health conditions and socioeconomic characteristics, if choosier patients prefer using less invasive care but are more willing to pay out of pocket for items not covered by NHI coverage, then omitting patient choosiness would understate the causal effect of physician-patients on invasive care utilization and overstate the impact on out-of-pocket payment, as our estimation results indicate.

Regarding the magnitude of the causal effects, the estimates in column 7 suggest that the effect on the utilization rate is approximately 9 percent of the conditional variability within doctor and hospital (0.041/0.45) and it is significant. Similarly, we see the effect of physician-patients on care volume accounts for more than 11 percent of our within-doctor-hospital variation (2.917/25.65). By contrast, we find that our physician-patients have three percentiles less out-of-pocket payments for invasive care procedures, which accounts for about 12 percent (3.094/26.17) of the within doctor-hospital variation and is significant. Moreover, the results remain almost unchanged if we drop income controls, district-specific time trends, or both. Overall, our findings strongly suggest that regression models should include patient choosiness as one of the key covariates.

We next rerun our regressions using only patients attended by chosen doctors (matched patients) and present our results in table 4. It is possible that our previous results may be affected by the inclusion of all doctors in our sample, including those who have never treated a physician-patient. That is, it is possible that our observed gap in utilization between physician- and nonphysician-patients might also capture the difference in practice styles between chosen and unchosen doctors. From the results in columns 2 and 4, we see that re-running our analyses using only chosen doctors yields estimated coefficients for both intensive care utilization rate and care volume that are 51 percent to 57 percent smaller (1-1.436/2.917 and 1-0.018/0.041), while the coefficient for out-of-pocket payment increases in magnitude by about a quarter (1-3.912/3.094). These results suggest

that including unchosen doctors in our sample can substantially overstate the impact of physician-patients on utilization or other outcomes.

5 Competing Explanations for Higher Treatment Intensity for Physician-Patients

Several theories could explain our observed increase in physician-patient care volume. In this section, we examine the possibility that relational or informational advantages do not drive our results. To do so, we explore three potential explanations for our observed increase in care volume for physician-patients: physician-patients exhibit a poorer health status compared to nonphysician-patients, physician-patients are less likely to sue for malpractice, and, finally, physician-patients differ from nonphysician patients in unobserved ways. We examine each explanation below.

5.1 Physician-Patients Exhibit Poorer Health

To ensure our physician- and nonphysician-patient groups are similar in health status, we include a comprehensive list of controls for care utilization in the penultimate six months of life. Nonetheless, it remains possible that physician-patients are sicker than nonphysician-patients in a way not captured in our model. We test this hypothesis by regressing the primary cause of death for a given patient in our sample on a physician-patient dummy. If physician-patients have poorer health than nonphysician-patients at the end of life, then we should observe a significantly positive coefficient for our physician-patient dummy. However, the results in table 5 show that physician-patients are 15 percent significantly less likely to die from cancer (0.0473/0.315). Also, physician-patients have a less than 5 percent lower probability of dying from chronic disease or heart attack than nonphysician-patients, although both coefficients are statistically insignificant (0.0008/0.016 and 0.0187/0.865). Incidentally, we also find that the physician-patients in our study are insignificantly 0.61 percentage points more likely to die from an accident, such as natural disaster, car accident or food poisoning. Although this estimated coefficient on accidents accounts for more than a quarter of the sample mean among nonphysician-patients (0.0061/0.022), dying from an accident is unlikely related to differences in lifestyles or other unobserved health conditions between physician- and nonphysician-patients. Based on the above findings, we conclude that our finding of increased care

volume is not attributable to the poorer health status of physician-patients.

5.2 Physician-Patients are Less Likely to Sue for Malpractice

Another possible explanation for our finding of increased invasive care for physician-patients is that physician-patients are less likely than nonphysician-patients to sue for malpractice. During our data period (2000-2006), medical doctors in Taiwan were subject to both no-fault liability and joint and severe liability (Chen et al., 2012). As Currie and MacLeod (2008) suggest, concerns about potential liability if complications arise may make doctors cautious about prescribing invasive care, especially for nonphysician-patients in our context. To test this explanation, we examine the frequency of possible malpractice lawsuits for the physicians in our data. In Taiwan, physicians in the ER are those most likely to be sued and to make the highest median payment (Chen et al. 2012). However, the majority of our physician-patients checked into the department of internal medicine, rather than the ER; only four hospital admissions in the data are by physician-patients. Statistics in Table A4 suggest that only one or fewer malpractice lawsuits per 1,000 internal medical doctors likely appear in our data. These statistics suggest that defensive medicine is an unlikely explanation for the magnitude of the increased utilization rates among physician-patients.

5.3 Physician-Patients Differ from Nonphysician-Patients in Unobserved Ways

Despite our best attempts to control for socioeconomic backgrounds (including each beneficiary's sex, age, employment status, income percentile, and district of residence during the penultimate six months of life), it is possible that our physician- and nonphysician-patients differ on dimensions not included in our study, such as wealth, education, or level of risk aversion. We directly test whether invasive care intensity changes with either informational or relational advantages among physician-patients. While all physician-patients have closer professional relationships with their attending doctors and greater access to medical information, these advantages can vary across the compositions of physician-patients and their attending doctors. For example, if both the patient and attending doctor specialize in a non-surgical area, then they are more likely to have a closer professional relationship but less likely to have relevant knowledge or clinical experience related to invasive care complications. By looking into the variation in treatment intensity among physician-patients who have either a closer professional relationship or more relevant clinical experience, we

can address the potential issue of omitted variable bias. In the next section, we expand on this idea and document our findings.

6 Informational and Relational Advantages of Physician-Patients

This section further investigates the relative importance of the relational versus the informational advantage effect of physician-patients on care volumes. To study the relative importance of each advantage, we expand model (2) to allow the total effect β to vary with the relevance of medical knowledge and the professional relationship between the patient and the attending doctor. By comparing the care volumes across various specialty compositions among physician-patients and attending doctors, we can extract those parts of the physician-patient effect related to having a professional connection, which the previous studies often interpret as an informational effect. In doing so, we find that the effect of a closer professional relationship is substantially more likely to explain why physician-patients utilize more invasive care, compared to the informational advantage mechanism.

6.1 The Expanded Model

To consider both informational and relational channels, we first define an *informational indicator*, I_i, for patient i who has the medical expertise in the area of the patient's diagnosed disease. Among physician-patients whose specialty is not in the area of the diagnosed disease ($I_i = 0$), those who share a medical specialty with their attending doctor have a closer professional relationship. The observed effect of the patient's medical expertise on treatment intensity, at least in part, captures the impact of a closer professional relationship between the doctor and the patient.

This discussion leads us to define a *relational indicator*, R_{ij}, for whether patient i and attending doctor j share the same specialty area. Physician-patients and attending doctors who belong to the same specialty area may have met in training programs or professional workshops and may belong to the same specialist association. On the other hand, patients and doctors may have met in non-specialty contexts, such as medical school, even if they do not share the same specialty. In several specifications, we add controls for whether both the physician-patient and attending doctor are in the same cohort (with seven or fewer years apart at the time they are certified, reflecting

the seven-year medical education path) as well as whether the physician-patient is less experienced than the attending doctor. It is noteworthy that $I_i \times D_i = I_i$ and $R_{ij} \times D_i = R_{ij}$ by construction.

We assume that both informational I_i and relational channel R_{ij} may affect the doctor j's treatment choice for physician-patient i. Holding constant the relational indicator allows us to use the variation in the informational indicator to capture the change in physician-patient medical knowledge relevant to the diagnosed disease. Similarly, holding constant the physician-patient i's specialty, we can interpret the variation in the relational indicator as a reflection of differing relationship between the physician-patient and the attending doctor. Thus, we can expand model (2) by interacting both information and relational indicators with our physician-patient dummy in the model. That is, we allow the physician-patient effect β to vary with the informational and relational indicators, I_i and R_{ij}:

$$\beta_{ij} = \pi + \rho R_{ij} + \eta I_i. \tag{3}$$

Consider the four possibilities in the physician-patient effect β_{ij} on treatment choice:

		More informed physician-patient?	
		$I_i = 0$	$I_i = 1$
Doctor and physician-patient in the same specialty?	$R_{ij} = 0$	π	$\pi + \eta$
	$R_{ij} = 1$	$\pi + \rho$	$\pi + \eta + \rho$

In the above specification, if the diagnosed disease is not in the area of the medical specialty for both the physician-patient and the attending doctor ($I_i = 0 = R_{ij}$), then the physician-patient effect is π. By contrast, if both the patient and the doctor specialize in the area of the diagnosed disease ($I_i = 1 = R_{ij}$), then the effect equals $(\pi + \eta + \rho)$. If either the patient or the doctor specializes in the area of the diagnosed disease, $(I_i, R_{ij}) = (1, 0)$ or $(0, 1)$, then the effect equals $(\pi + \eta)$ or $(\pi + \rho)$. By exploiting the variation in the specialty composition of the doctor and the patient in the data, we can identify the relative importance of information and relational effects on treatment intensity; that is, η and ρ. In the previous studies, all physician-patients and attending doctors are in the same specialty ($I_i = 1 = R_{ij}$). With no variation in specialties in the data, it is unlikely to separate the relational and informational effects.

Moreover, it is possible that nonphysician-patients in our study also have a relationship with their attending doctor, albeit not a professional one, which might affect treatment intensity. To address this potential relationship, we follow Johnson et al. (2016) to define a *strong preexisting*

clinical relationship indicator (r_{ij}) for doctor j who has attended over 50 percent (around the median) of patient i's hospital admissions during the penultimate six months of life. Because the patient-doctor preexisting clinical relationship also carries information about the past hospital care utilization of a given patient, we continue to include past hospital care utilization during the penultimate six months of life in X.

Finally, the coefficients η and ρ on the informational and relational indicators respectively represent the relative importance of informational and relational effects of physician-patients on the extent of invasive care, all others equal.

6.2 Estimation Results

Table 6 summarizes our estimation results using our expanded fixed-effect model (3) including patient choosiness, doctor experience, and doctor-hospital fixed effects, as before. To make our results comparable with the previous finding, we document the estimates in this table using all patients (including unmatched patients) as in column 2 of table 4. If we use the matched data, the estimated coefficients on relational and informational effects (η and ρ) are almost unchanged although the standard errors increase slightly. The top panel of table 6 shows the estimated effects on the utilization rates while the bottom panel reports the effects on care volumes.

Looking at the first three columns of table 6, we see that our estimated coefficients for physician-patients who are better informed are all small, insignificant, or even negative, with or with the inclusion of relational controls. These coefficients contrast with the large, significant, positive ones for our total effects (reported in table 4 and at the bottom of this table). This result suggests that more relevant medical knowledge cannot explain the higher use of invasive care for physician-patients. Column 1 of the top panel shows that the coefficient on the informational advantage is negative, opposite to the sign of the total effect. Although the result in column 1 of the bottom panel suggests that the informational advantage can explain about 24 percent of the total effect on care volumes (0.71/2.92), this finding is statistically insignificant. By contrast, the result in column 2 of the bottom panel suggests that physician-patients who share a specialty with their attending doctor have a five percentage points higher utilization rate and receive four percentage points more volume. These estimates suggest that the relational channel is more important than the informational channel in explaining the difference in invasive care between physician- and

nonphysician-patients.

Continuing with Table 6, the results in column 3 shows that the results in column 2 are robust, after including additional dummies for the professional but non-surgical related relationships. Column 3 shows that a closer professional relationship with the attending doctor is significantly associated with a 5.5 percentage point higher invasive care utilization rate and a 4.0 percentage point higher volume of care, representing 12 and 16 percent of the standard deviation within a doctor-hospital unit (0.055/0.45 and 4.03/25.65), respectively. Both exceed the total effect by at least 20 percent (0.055/0.041-1 and 4.03/2.92). The results by individual invasive procedure, in columns 4 to 7, show similar patterns although the estimated coefficient on the professional relationship is mostly imprecise.

It is noteworthy that invasive care volume significantly increases with a closer professional relationship but strongly decreases with a stronger pre-existing clinical relationship. When doctors share a specialty with their physician-patients, they can communicate more effectively and professionally about the need for invasive care. By contrast, doctors who have an existing clinical relationship with a physician- or nonphysician-patient may be more empathetic to patient discomfort and thus more reluctant to prescribe invasive care. Finally, our results in table A1 using days-in-hospital and medical cost show similar patterns, albeit insignificantly so.

6.3 Financial Incentives

To better understand our findings, in this subsection, we test whether our observed professional relationship effect varies with a change in the financial incentive environment, specifically the introduction of a global expenditure cap in July 2002. As discussed, the NHI began imposing a quarterly expenditure cap in each region in 2002 to combat increasing expenditures. This cap was placed on top of the fee-for-service system, setting the conversion rate ex-post by taking the ratio of the expenditure cap to the regional aggregate volume. Given this expenditure cap, providers may choose to control volume in order to raise conversion values. Given the incentive to control volume, one possibility is that doctors would prioritize the appropriate use of invasive care to physician-patients, who have professional connections or better information. By contrast, if the markup is low, most likely at the end of the quarter, physician-patients could be less affected by incentives to raise invasive care volume, again because of professional connections or more information. We

examine these two possibilities.

We estimate a difference-in-difference model to compare invasive care volumes before and after the policy change between physician- and nonphysician-patients. The results in table 7, columns 1 and 2, show no increase in the physician-patient effect with the change in the financial environment. From the results in column 2, we see that the coefficient on the interaction between post-2002 July and the end of the quarter is significantly positive, showing no evidence of volume controls. Given that the expenditure cap causes doctors to compete for quantity rather than ration care, this result suggests that doctors may not prioritize invasive care for physician-patients.

Continuing with table 7, we find in columns 3 to 7 that physician-patients with either informational or relational advantages are less affected by the change in the financial environment, although the estimated changes in the effects are not precise enough to be conclusive. The coefficients on the interaction between post-2002 July and the indicators for being more informed or having the same specialty (a stronger professional relationship) account for more than 20 percent of the standard deviation in care volume among patients treated by the same doctor in the same hospital (6.08/25.65 and 5.47/25.65), but the standard errors of both estimates are large. In contrast, columns 3 to 7 suggest that the impact of a stronger preexisting clinical relationship remains substantial (between 3 to 6 percentage points, or 22 percent of the variability within doctor and hospital) and almost unchanged throughout our data period. The coefficient on the clinical relationship and the coefficient on its interaction with post-2002 July are both precisely estimated with small standard errors.

6.4 End of Life

Researchers and policymakers are interested in the cost of end-of-life care, given the wide regional variation in its contribution to overall medical spending, a variation that markedly increases as the time to death nears (French et al. 2017).[5] This considerable variation in end-of-life medical spending raises the question of how and when invasive care treatments are used, especially in the case of chronic diseases. We examine this issue by exploring whether the variation in end-of-life spending can be explained by differences in treatment patterns between physician- versus

[5]For hospital spending in the last twelve months of life in 2011, Japan has 8 percent of its aggregate hospital expenditures, Quebec 23 percent, and the United States 10 percent. For the spending in the last three calendar years of life, Japan is up to 14 percent and the United States about 16 percent, while Taiwan reaches 35 percent.

nonphysician-patients, who differ considerably for their medical knowledge and social ties with their attending doctors. Although past studies have examined several possible reasons for high expenditures, few have focused on end-of-life health care. One notable exception is Einav et al. (2018), who show death timing is highly unpredictable, suggesting end-of-life medical spending is not necessarily a waste, and the proximity to death is an arguably plausible control for morbidity.

7 Conclusion

This study compares the invasive care treatment and volume of end-of-life care for physician- versus non-physician patients in order to investigate the agency problems in healthcare. Previous studies have found that, given the same observed health and socioeconomic conditions, physician-patients may select doctors by quality or practice styles for their end-of-life care. However, a significant concern with past estimates of the physician-patient effects on treatment choice is that the doctors chosen by physician-patients may differ from other doctors in unobservable ways. Our study addresses this issue and adjusts for patient self-selection by comparing treatment choices between physician- and nonphysician-patients treated by the same doctor in the same hospital and by controlling for patients' past choices of doctors and doctors' experience.

Perhaps surprisingly, adjusting for doctors' attributes and experience does not significantly change the estimation result. In contrast, adjusting for patients' previous choice of doctors makes substantial differences; the estimated effect of physician-patients on utilization more than doubles and the estimated effect on care volume increases by more than 80 percent. As our result indicates, patient selection cannot be ignored and including patients' past choice is an effective way to address the selection bias.

We find that physician-patients in the last six months of life are approximately equally likely to use invasive care as nonphysician-patients but that these physician-patients receive more care volume. We examine alternative explanations for this result including the possibility that physician-patients have poorer health status or are less likely to sue for malpractice. We cannot easily reconcile our estimation results with these competing explanations.

Further, we address unobserved differences in patients' characteristics by directly testing if the physician-patient effects on invasive care utilization and volume vary with more relevant medical

information or a closer professional relationship with the attending doctor. In this analysis, we find that the closer professional relationship with the attending doctor is the main driver for the positive effect of physician-patients on care volume. In contrast, we find that the effect of more relevant information on care volume is small and statistically insignificant.

Our positive effect of physician-patients on care volume is consistent with the findings that greater intensive care treatment can prolong life. For example, Balsa and McGuire (2003) and Currie, MacLeod, and Van Parys (2015) show that patients benefit from the aggressive treatment of lung cancer or heart attacks through the use of invasive procedures. Finally, we examine whether our results are sensitive to financial incentives. Specifically, we study whether the increased use of invasive care at the ends of accounting quarters has an impact on our observed physician-patient effect. Our results show that the effect of professional relationships between physician-patients with their attending doctors somewhat decreases with the introduction of a global expenditure cap, although the estimation results are imprecise.

Overall, our study employs a sophisticated approach and unique database to identify the relational channel that can explain most of the variation in the physician-patient treatment choices at the end-of-life. This new piece of empirical evidence suggests that other things equal, doctor-patient relationships can play a more critical role in determining physician treatment choices, compared to patients' medical knowledge.

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Table 1: Hospital and Invasive Care Use of Beneficiaries in the Last Six Months of Life

	Nonphysicians' mean	Physicians minus Nonphysicians	Standard Error
Number of beneficiaries	765,649	766,638	-
Number of admissions	1,366,507	1,364,840	-
Hospital utilization			
Ever checked into a hospital	0.75	0.10	0.011**
Number of admissions	1.53	0.21	0.041**
Total number of days in hospital	64.38	15.95	2.143**
Average number of days per admission	32.5	8.59	1.016**
Ever use an invasive procedure			
Any invasive procedure	0.51	0.08	0.013**
Nasogastric intubation	0.40	0.09	0.014**
Urinary catheterization	0.36	0.06	0.013**
Endotracheal intubation	0.21	0.04	0.012**
Tracheostomy intubation	0.30	0.07	0.013**
Used volume in percentile if > 0			
Total expenditure in NHI items	61.8	5.74	0.779**
Total reimbursement for hospital care	61.8	6.01	0.775**
Out-of-pocket payment on NHI items	57.3	-6.93	0.957**
Hemodialysis	58.0	2.03	0.944**
Any invasive procedure	60.1	3.58	0.885**
Nasogastric intubation	58.4	4.16	0.930**
Urinary catheterization	57.7	0.81	0.948
Endotracheal intubation	55.4	1.11	1.009
Tracheostomy intubation	56.8	3.86	0.987**
Demographics 1 year before death			
Male	0.62	0.36	0.005**
Age at death	69.10	6.11	0.444**
Full time work	0.68	0.12	0.013**
Certified low income	0.02	-0.02	0.001**
Income percentile	50	-2.143	1.286
Sorting			
Beneficiary checked into a chosen hospital	0.64	0.21	0.011**
Beneficiary saw a chosen doctor	0.21	0.65	0.011**
Cause of death			
Heart attack	0.03	0.00	0.006
Acute disease	0.15	-0.03	0.010**
Accident	0.06	-0.02	0.006**
Suicide	0.03	-0.02	0.003**
Chronic disease	0.76	0.07	0.012**
Cancer	0.22	0.05	0.014**

Note: This table covers the 766,638 deceased beneficiaries (including 989 medical doctors) during the last six months of life, recorded in Taiwan's NHI system over the period of 2001–06. We also include persons who have never checked into a hospital (with spending and utilization indicated as zero). We use hospital admission data and cluster the standard errors at the person level. Statistics regarding payment, expenditure, reimbursement, and care volumes are indicated in percentiles for the 578,436 deceased beneficiaries (including 846 medical doctors) who had checked into a hospital in the last six months of life. 742,961 beneficiaries have non-missing information about income. ** indicates the 95 percent significance level.

Table 2: Sample Mean of Attending Doctors, by whether Chosen by Physician-Patients in the Last Year of Life

	Chosen doctors mean (1)	Unchosen doctors working in chosen hospital (2)	Unchosen doctors working in Unchosen hospital (3)	Mean difference (1)-(2)	Mean difference (2)-(3)
Number of attending doctors	2,390	13,248	1,763	15,638	15,011
Years of experience at attending	9.030	7.104	8.564	1.926**	-1.460**
Number of licenses	1.196	1.237	1.218	-0.041**	0.018
Female	0.064	0.101	0.070	-0.037**	0.031**
External medicine	0.262	0.486	0.408	-0.224**	0.078**
Practice in multiple districts	0.581	0.481	0.449	0.100**	0.031**
Practice in multiple counties	0.397	0.345	0.317	0.052**	0.029**
Hospital characteristics:					
Teaching hospital	0.149	0.113	0.003	0.037	0.109**
Veteran hospital	0.140	0.083	0.000	0.058	0.083**
Private hospital	0.419	0.337	0.178	0.082**	0.160**
Number of providers in district	168	159	113	9	45**
Number of beds in district	104	106	69	-3	37**
Patient composition and share					
Physician-patients	0.011	0.000	0.000	0.011**	0.000
Choosy patients	0.588	0.070	0.046	0.518**	0.024**
Specialty-specific market share	0.283	0.167	0.207	0.116**	-0.040
Usage rates of invasive care:	0.623	0.558	0.441	0.066**	0.117**
Nasogastric intubation	0.491	0.387	0.287	0.104**	0.100**
Urinary catheterization	0.431	0.393	0.308	0.039**	0.084**
Endotracheal intubation	0.210	0.167	0.090	0.044**	0.077**
Tracheostomy intubation	0.351	0.258	0.151	0.093**	0.107**
Volume per patient in percentile:					
Any invasive care	51	45	39	6**	7**
Nasogastric intubation	51	45	41	6**	4**
Urinary catheterization	50	48	43	3**	5**
Endotracheal intubation	49	47	44	2**	4**
Tracheostomy intubation	52	46	41	6**	5**
Reimbursement	51	46	30	5**	16**
Out of pocket	49	52	48	-3**	5**

Note: This table includes all 17,401 certified doctors who have ever attended patients in the last year life during our sample period 2000–06. "Choosy patients" have more than one half of their admissions attended by chosen doctors. ** indicates the 95 percent significance level.

Table 3: Physician-Patients Effects on Hospital Care and Invasive Care Utilization in the Last Six Months of Life

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Nonphysician patients' admissions		Within hospital		Within doctor-hospital			
						Coefficient on physician-patient		
Dependent variables	Mean	SD	SD	Coefficient on physician-patient	SD	Adding doctor experience	Adding patient choosiness	Adjusted R-squared
Days in hospital	41.97	25.37	24.54	0.836 (0.768)	23.78	0.783 (0.761)	0.999 (0.762)	0.124
Any invasive procedure	0.61	0.49	0.48	0.011 (0.013)	0.45	0.019 (0.013)	0.041 (0.013)**	0.148
Nasogastric intubation	0.48	0.50	0.49	0.025 (0.013)*	0.46	0.032 (0.013)**	0.052 (0.013)**	0.152
Urinary catheterization	0.42	0.49	0.48	0.022 (0.013)*	0.47	0.024 (0.013)*	0.039 (0.013)**	0.119
Endotracheal intubation	0.22	0.41	0.41	0.019 (0.010)*	0.39	0.020 (0.010)**	0.034 (0.010)**	0.113
Tracheostomy intubation	0.32	0.46	0.46	0.018 (0.011)	0.41	0.022 (0.010)**	0.040 (0.010)**	0.237
Volume in percentile								
Any invasive procedure	49.49	28.87	28.12	1.242 (0.768)	25.65	1.599 (0.739)**	2.917 (0.740)**	0.221
Nasogastric intubation	49.49	28.87	28.14	1.780 (0.778)**	26.50	2.192 (0.762)**	3.200 (0.764)**	0.167
Urinary catheterization	49.50	28.87	28.39	1.648 (0.751)**	27.34	1.708 (0.750)**	2.550 (0.751)**	0.109
Endotracheal intubation	49.50	28.87	28.59	0.164 (0.698)	27.67	0.133 (0.683)	1.007 (0.684)	0.073
Tracheostomy intubation	49.49	28.86	28.40	1.849 (0.711)**	26.16	2.079 (0.667)**	2.986 (0.668)**	0.177
Reimbursement	49.49	28.86	27.31	0.535 (0.777)	25.86	0.507 (0.769)	1.267 (0.771)	0.197
Out of pocket	49.49	28.87	28.04	-4.324 (0.762)**	26.17	-4.197 (0.746)**	-3.094 (0.747)**	0.215

Note: We include the 578,436 nonphysician-patients and 989 physician-patients who ever checked into a hospital at the last six months of life, at the age 29 or older, including retirees. Combining their admission data with non-missing self-reported income yields 1,152,248 and 1,667, respectively. Column 3 presents information after removing hospital fixed effects and year-month fixed effects, while Column 5 additionally removes doctor-hospital fixed effects. The regressions in Columns 4 and 7 also include patient attributes (sex, age, and the full set of dummies for full-time work, certified low income, income percentile), risk factors in the penultimate six months of life (whether checked into a hospital, the average number of days in hospital per admission, the total medical spending, and medical spending in invasive care), and the local market conditions (measured by provider counts and bed counts in the district). We cluster standard errors at the patient level in (.). * and ** indicate the 90 and 95 percent significance levels, respectively.

Table 4: Benchmark Results Using the Full versus Matched Data

	Within hospital & doctor in the full model			
	All patients		Matched patients	
Dependent variables:	SD (1)	Coefficient on physician-patient (2)	SD (3)	Coefficient on physician-patient (4)
Days in hospital	23.78	0.999 (0.762)	25.94	0.826 (0.762)
Any invasive procedure	0.45	0.041 (0.013)**	0.45	0.018 (0.013)
Nasogastric intubation	0.46	0.052 (0.013)**	0.46	0.032 (0.013)**
Urinary catheterization	0.47	0.039 (0.013)**	0.47	0.022 (0.013)*
Endotracheal intubation	0.39	0.034 (0.010)**	0.38	-0.002 (0.010)
Tracheostomy intubation	0.41	0.040 (0.010)**	0.40	0.007 (0.010)
Volume in percentile				
Any invasive procedure	25.65	2.917 (0.740)**	25.82	1.436 (0.740)*
Nasogastric intubation	26.50	3.200 (0.764)**	26.84	2.520 (0.762)**
Urinary catheterization	27.34	2.550 (0.751)**	27.42	1.700 (0.751)**
Endotracheal intubation	27.67	1.007 (0.684)	27.60	-0.839 (0.684)
Tracheostomy intubation	26.16	2.986 (0.668)**	26.14	1.564 (0.670)**
Reimbursement	25.86	1.267 (0.771)	26.28	0.472 (0.770)
Out of pocket	26.17	-3.094 (0.747)**	25.81	-3.912 (0.744)**
Number of admissions		1,153,915		321,655

All regressions in this table include year-month fixed effects, doctor-hospital fixed effects, doctor experience, patient attributes (sex, age, the full set of dummies for full-time work, certified low income, and income percentile), risk factors in the penultimate six months of life (whether checked into a hospital, the average number of days in hospital per admission, the total medical spending, and medical spending in invasive care), the local market conditions (measured by provider counts and bed counts in the district), and patient choosiness. "Accident" indicates the cause of death related to a car accident or food poisoning. We cluster standard errors at the patient level in (.). * and ** indicate the 90 and 95 percent significance levels.

Table 5: Are Physician-Patients Sicker than Nonphysician-Patients?

	Main cause of death				
	Heart attack	Accident	Suicide	Chronic disease	Cancer
Physician-patient	-0.0008	0.0061	-0.0008	-0.0187	-0.0473**
	(0.0043)	(0.0035)	(0.0011)	(0.0125)	(0.0161)
Adjusted R-squared	0.043	0.146	0.072	0.078	0.299
Nonphysician mean	0.016	0.022	0.008	0.865	0.315

Note: Using data based on 1,153,915 hospital admissions, all regressions in this table include year-month fixed effects, doctor-hospital fixed effects, doctor experience, patient attributes (sex, age, the full set of dummies for full-time work, certified low income, and income percentile), risk factors in the penultimate six months of life (whether checked into a hospital , the average number of days in hospital per admission, the total medical spending, and medical spending in invasive care), the local market conditions (measured by provider counts and bed counts in the district), and patient choosiness. "Accident" indicates cause of death related to a car accident or food poisoning. We cluster standard errors at the patient level in (.). ** indicates the 95 percent significance level.

Table 6: Informational and Relational Effects of Physician-Patients on Utilization/Volume

	Any invasive procedure (1)	(2)	(3)	Nasogastric intubation (4)	Urinary catheter (5)	Endotracheal intubation (6)	Tracheostomy intubation (7)
	Utilization						
Physician-patient	0.057	0.041	0.045	0.049	0.027	0.101**	0.073*
	(0.038)	(0.038)	(0.046)	(0.047)	(0.039)	(0.044)	(0.037)
More informed	-0.018	-0.043	-0.035	0.005	-0.006	-0.044	-0.030
Physician-patient (S)	(0.040)	(0.046)	(0.051)	(0.050)	(0.036)	(0.049)	(0.032)
Professional relationship							
Same specialty (R)		0.051*	0.055*	0.034	0.042	0.031	0.002
		(0.029)	(0.029)	(0.030)	(0.026)	(0.030)	(0.024)
Same cohort			-0.002	-0.012	0.008	-0.024	-0.007
			(0.024)	(0.025)	(0.021)	(0.025)	(0.020)
Less experienced			-0.017	-0.025	-0.022	-0.044	-0.014
			(0.032)	(0.033)	(0.029)	(0.034)	(0.029)
Strong preexisting			-0.083**	-0.073**	-0.063**	-0.055**	-0.033**
clinical relationship (r)			(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Within doctor-hospital standard deviation		0.45		0.46	0.41	0.47	0.39
Total effect		0.041**		0.052**	0.039**	0.034**	0.040**
	Volume in percentile						
Physician-patient	2.35	1.20	1.67	2.96	1.12	4.80*	1.88
	(2.12)	(2.12)	(2.73)	(2.73)	(2.73)	(2.50)	(2.45)
More informed	0.71	-1.13	-0.13	2.72	-1.29	-2.09	-1.41
Physician-patient (S)	(2.26)	(2.61)	(2.88)	(2.68)	(2.39)	(2.80)	(2.19)
Professional relationship							
Same specialty (R)		3.76**	4.03**	2.38	3.52**	3.71**	0.04
		(1.82)	(1.81)	(1.73)	(1.68)	(1.71)	(1.61)
Same cohort			0.35	-0.73	1.20	-0.75	-0.60
			(1.47)	(1.49)	(1.40)	(1.45)	(1.49)
Less experienced			-2.15	-4.19**	-0.25	-3.43*	0.65
			(1.93)	(1.90)	(1.73)	(1.94)	(1.95)
Strong preexisting			-4.62**	-3.55**	-3.50**	-3.05**	-1.97**
clinical relationship (r)			(0.08)	(0.09)	(0.08)	(0.09)	(0.09)
Within doctor-hospital standard deviation		25.65		26.50	26.16	27.34	27.67
Total effect		2.92**		3.20**	2.55**	1.01	2.99**

Note: See table 6 for the included control variables. We cluster standard errors at the patient level in (.). ** and * indicate the 95 and 90 percent significance levels, respectively.

Table 7: Informational and Relational Impacts on Standardized Care Volume, Before and After Global Budgeting

	Volume in percentile						
	Any invasive procedure			Nasogastric intubation	Urinary catheter	Endotracheal intubation	Tracheostomy intubation
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Physician-patient	2.07**	2.17**	-2.83	0.27	-1.72	-1.12	-2.26
	(0.88)	(0.99)	(2.04)	(1.89)	(1.97)	(1.78)	(1.93)
Physician-patient							
× Post	-2.02	-1.89	2.70	0.86	0.85	-0.95	2.35
	(1.63)	(1.76)	(3.57)	(3.20)	(3.69)	(3.21)	(3.41)
× End of quarter		-0.55	-0.52	1.02	-0.12	-0.43	-1.43
		(2.14)	(2.15)	(2.04)	(2.08)	(2.30)	(2.04)
× End of quarter × Post		-1.16	-1.05	-1.33	-3.20	-0.83	3.53
		(4.01)	(4.03)	(4.27)	(4.26)	(4.37)	(3.89)
End of quarter		-0.17	-0.17	-0.12	-0.01	-0.04	-0.21
		(0.18)	(0.18)	(0.19)	(0.20)	(0.20)	(0.19)
End of quarter × Post		0.71**	0.71**	0.32	0.42	0.34	0.61*
		(0.35)	(0.35)	(0.36)	(0.37)	(0.37)	(0.35)
More informed (S)			2.67	0.45	4.15	0.47	3.83
			(3.39)	(3.10)	(3.11)	(2.28)	(2.99)
Same specialty (R)			5.49**	3.17	3.71*	0.27	4.82**
			(2.29)	(2.14)	(2.15)	(1.95)	(2.08)
A stronger preexisting clinical relationship (r)			-5.76**	-4.09**	-3.71**	-3.22**	-4.53**
			(0.18)	(0.19)	(0.19)	(0.18)	(0.18)
Post							
× More informed (S)			-6.08	-6.99	-6.26	2.02	-7.70*
			(5.13)	(4.76)	(5.17)	(4.52)	(4.54)
× Same specialty (R)			-5.47	-3.25	-0.91	-0.21	-4.35
			(3.82)	(3.57)	(3.79)	(3.43)	(3.70)
× Stronger preexisting clinical relationship (r)			-0.14	-0.34	-0.05	0.39	-0.04
			(0.31)	(0.32)	(0.31)	(0.31)	(0.30)
Adjusted R-squared	0.24	0.24	0.25	0.18	0.12	0.10	0.21
Within doctor-hospital standard deviation	25.65	25.65	25.65	26.50	27.34	27.67	26.17
Total effect	2.92**	2.92**	2.92**	3.20**	2.55**	1.01	2.99**

Note: All regressions in this table include year-month fixed effects, doctor-hospital fixed effects, doctor experience, patient attributes (sex, age, the full set of dummies for full-time work, certified low income, and income percentile), risk factors in the penultimate six months of life (whether checked into a hospital , the average number of days in hospital per admission, the total medical spending, and medical spending in invasive care), the local market conditions (measured by provider counts and bed counts in the district), and patient choosiness. We cluster standard errors at the patient level in (.). ** and * indicate the 95 and 90 percent significance levels, respectively.

Table A1: Informational and Relational Components of Physician-Patient Impacts on Hospital Stay and Standardized Cost

				Volume in percentile					
	Days in hospital			Reimbursement			Out of pocket		
Physician-patient	-2.31	-2.94	-2.93	-1.35	-1.60	-1.85	-1.31	-1.13	-0.75
	(2.34)	(2.26)	(2.75)	(2.49)	(2.41)	(2.94)	(1.84)	(1.90)	(2.62)
More informed	-3.91	-2.89	-2.87	-3.13	-2.72	-2.98	2.01	1.71	0.75
physician-patient (S)	(2.47)	(2.85)	(3.12)	(2.61)	(2.96)	(3.19)	(2.01)	(2.18)	(2.32)
Professional relationship									
Same specialty (R)		2.09	2.04		0.85	0.91		-0.61	-0.43
		(1.85)	(1.85)		(1.85)	(1.85)		(1.61)	(1.62)
Same cohort			0.07			0.36			0.58
			(1.59)			(1.56)			(1.46)
Less experienced			0.04			-0.28			-2.00
			(2.08)			(2.08)			(2.06)
Strong preexisting			1.23**			-1.26**			-2.30**
clinical relationship (r)			(0.09)			(0.09)			(0.09)
Adjusted R-squared	0.12	0.12	0.12	0.20	0.20	0.20	0.22	0.22	0.22
Within doctor-hospital									
standard deviation			23.78			25.86			26.17
Total effect			1.00			1.27			-3.09**

Note: All regressions in this table include year-month fixed effects, doctor-hospital fixed effects, doctor experience, patient attributes (sex, age, the full set of dummies for full-time work, certified low income, and income percentile), risk factors in the penultimate six months of life (whether checked into a hospital , the average number of days in hospital per admission, the total medical spending, and medical spending in invasive care), the local market conditions (measured by provider counts and bed counts in the district), and patient choosiness. We cluster standard errors at the patient level in (.). ** and * indicate the 95 and 90 percent significance levels, respectively.

Table A2: Physician-Patient Effects on Hospital and Invasive Care Utilization, Before and After Hospital Global Budgeting

	Days in hospital		Any invasive procedure		Nasogastric intubation	Urinary catheter	Endotracheal intubation	Tracheostomy intubation
Physician-patient	0.891	0.868	0.027	0.026	0.044**	0.026	0.004	0.017
	(0.905)	(1.003)	(0.015)	(0.017)	(0.017)	(0.017)	(0.013)	(0.014)
Physician-patient								
× Post	-0.504	-1.304	-0.030	-0.034	-0.049	-0.013	0.001	-0.013
	(1.591)	(1.682)	(0.028)	(0.030)	(0.030)	(0.030)	(0.022)	(0.024)
× End of quarter		0.261		0.003	0.017	0.012	-0.020	-0.014
		(2.289)		(0.035)	(0.035)	(0.037)	(0.032)	(0.032)
× End of quarter × Post		5.705		0.027	-0.005	-0.010	-0.051	-0.057
		(4.946)		(0.074)	(0.071)	(0.078)	(0.056)	(0.058)
End of quarter		-1.754**		-0.004	-0.004	-0.002	-0.003	-0.002
		(0.187)		(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
End of quarter × Post		-0.007		0.017**	0.011*	0.013**	0.012**	0.012**
		(0.350)		(0.006)	(0.006)	(0.006)	(0.005)	(0.005)
Adjusted R-squared	0.117	0.118	0.154	0.154	0.163	0.122	0.150	0.277
Within doctor-hospital standard deviation		23.78		0.45	0.46	0.47	0.39	0.41
Total effect		0.999		0.041**	0.052**	0.039**	0.034**	0.040**

Note: We cluster standard errors at the patient level in (.). ** and * indicate the 95 and 90 percent significance levels, respectively. See the note of Table 3 for details.

Table A3: Physician-Patient Effects on Standardized Care Volume and Cost, Before and After Hospital Global Budgeting

	Standardized volume and cost							
	Invasive care		Nasogastric intubation	Urinary catheter	Endotracheal intubation	Tracheostomy intubation	Reimbursement	Out of pocket
Physician-patient	2.068**	2.173**	3.077**	2.009**	-0.511	2.308**	0.441	-4.423**
	(0.879)	(0.986)	(1.033)	(1.011)	(0.945)	(0.915)	(1.014)	(0.944)
Physician-patient × Post	-2.023	-1.892	-2.239	-0.576	-0.743	-1.725	0.170	1.621
	(1.626)	(1.765)	(1.744)	(1.850)	(1.599)	(1.539)	(1.780)	(1.792)
× End of quarter		-0.553	0.976	-0.105	-0.441	-1.429	-0.345	1.092
		(2.137)	(2.032)	(2.053)	(2.312)	(2.035)	(2.032)	(1.948)
× End of quarter × Post		-1.157	-1.316	-3.194	-0.964	3.462	0.597	-3.143
		(4.012)	(4.250)	(4.225)	(4.364)	(3.882)	(4.295)	(3.969)
End of quarter		-0.167	-0.118	-0.001	-0.037	-0.205	-0.676**	0.312*
		(0.183)	(0.192)	(0.197)	(0.202)	(0.188)	(0.188)	(0.182)
End of quarter × Post		0.705**	0.315	0.413	0.340	0.610*	0.258	0.130
		(0.348)	(0.360)	(0.370)	(0.370)	(0.354)	(0.354)	(0.339)
Adjusted R-squared	0.245	0.245	0.179	0.115	0.097	0.207	0.152	0.232
Nonphysician-patients' standard deviation within doctor-hospital		25.65	26.50	27.34	27.67	26.16	25.86	26.17
Total effect		2.917**	3.200**	2.550**	1.007	2.986**	1.267	-3.094**

Note: We cluster standard errors at the patient level in (.). ** and * indicate the 95 and 90 percent significance levels, respectively. See the note of Table 3 for details.

Table A4: Numbers of Lost Lawsuits and End-of-Life Hospital Admissions

The attending doctor's specialty	Lost lawsuits per 100 physicians/year during 2000–08	Admissions of physician-patients in the last year of life during 2000–06
Emergency medicine	10.7	4
Neurosurgery	6.5	0
Obstetrics, gynecology, or anesthesiology	0.9	4
Plastic surgery	0.6	0
Orthopedics	0.4	6
General surgery	0.2	277
Ophthalmology	0.2	3
Internal medicine	0.1	1,131
Neurology	<0.1	73
Family medicine	<0.1	69
Therapeutic radiology and oncology	<0.1	14
Pediatrics	<0.1	10
Otolaryngology	<0.1	8
Physical medicine and rehabilitation	<0.1	4
Urology	<0.1	5
Psychiatry	<0.1	5
Occupational medicine	<0.1	3

Note: Column (1) is derived from Table 1 of Chen et al. (2012), in which 35 percent of the 404 lost lawsuits led to patient death. We calculate column (2) using the hospital admissions of the 989 deceased physicians in Table 1. We group the statistics for anesthesiology with those of obstetrics and gynecology because of privacy issues related to the small cell size.