How Acquisitions Affect Firm Behavior and Performance: Evidence from the Dialysis Industry*

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Abstract

Many markets have become increasingly concentrated through mergers and acquisitions, which in health care may have important consequences for spending and outcomes. Using a rich panel of Medicare claims data for nearly one million dialysis patients, we advance the literature on the effects of mergers and acquisitions by studying the precise ways in which providers change their behavior following an acquisition. We base our empirical analysis on more than 1,200 acquisitions of independent dialysis facilities by large chains over a twelve-year period, and find that chains transfer several prominent strategies to the facilities they acquire. Most notably, acquired facilities converge to the behavior of their new parent companies by increasing patients' doses of highly reimbursed drugs, replacing high-skill nurses with less-skilled technicians, and waitlisting fewer patients for kidney transplants. We then show that patients fare worse as a result of these changes: outcomes such as hospitalizations and mortality deteriorate, with our long panel allowing us to identify these effects from within-facility or within-patient variation around the acquisitions. Because overall Medicare spending increases at acquired facilities, mostly as a result of higher drug reimbursements, this decline in quality corresponds to an unambiguous decline in value for payers. We conclude our paper by linking these effects to measures of local market concentration, finding that an increase in market power cannot explain the decline in quality. Rather, the adoption of the acquiring firm's strategies and practices drives our main results.

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1 Introduction

Health-care markets have become increasingly concentrated through mergers and acquisitions (Gaynor et al. 2015). Proponents of this industry trend cite several potential benefits of consolidation, including lower costs through economies of scale and better patient outcomes through coordinated care. But greater concentration may also come with important downsides: hospital mergers can lead to higher prices and lower quality (Gaynor & Town 2012); physician groups acquired by hospitals may increase their prices in less-competitive markets (Cuellar & Gertler 2006); and some insurance mergers result in higher premiums but lower reimbursements for providers (Dafny et al. 2012). Previous studies of this topic typically consider fairly broad measures of competition and outcomes — by showing, for instance, that more-concentrated hospital markets have higher mortality rates. Comparatively less work has examined the precise channels through which mergers and acquisitions ultimately lead to changes in outcomes. In this paper, we use detailed claims and facility data from the U.S. dialysis industry to show directly how large chains transfer their corporate strategy to the independent facilities they acquire, which consequently has a large effect on the cost and quality of their treatments.

We focus our study on the U.S. market for outpatient dialysis — a medical procedure that cleans the blood of patients suffering from end-stage renal disease (ESRD) — because it offers several distinct advantages as an empirical setting for this topic. First, dialysis is a fairly standardized treatment that allows for a direct comparison of providers. Second, the dialysis industry has become increasingly concentrated following a series of mergers and acquisitions: today, dialysis is provided primarily by multi-establishment for-profit firms, with the share of independently owned and operated dialysis facilities falling from 86% to 21% over the past three decades and the two largest publicly traded corporations, DaVita and Fresenius, now owning 65% of facilities.[1] Third, detailed Medicare claims and clinical data allow us to identify important changes in providers' behavior and patients' outcomes following acquisition. Lastly, the dialysis industry is an important market to study in and of itself, with total Medicare reimbursements for treating the nation's 430,000 dialysis patients amounting to about $33 billion each year, or

[1] Source: USRDS Annual Data Report, 2016.

6% of total Medicare expenditures.

From our analysis, we find that acquired facilities alter their treatments to increase reimbursements and decrease costs. One important way facilities capture higher payments from Medicare is by increasing the amount of drugs they administer to patients, for which Medicare paid providers a fixed per-unit rate during our study period. The most notable of these is Epogen, a drug used to treat anemia, which represented the single largest prescription drug expenditure for Medicare in 2010, totaling $2 billion.[2] Perhaps reflecting the profits at stake, we find that patients at independent facilities received 128.9% higher doses of Epogen after being acquired by a large chain. Similarly, acquired facilities increased their use of the iron-deficiency drug Venofer relative to Ferrlecit, a perfect substitute that offered lower reimbursements. On the cost side, large chains replace high-skill nurses with lower-skill technicians at the facilities they acquire, reducing labor expenses. Facilities also increase the patient-load of each employee by 11.9% and increase the number of patients treated at each dialysis station by 4.6%, stretching resources and potentially reducing the quality of care received by patients.

Adopting the acquiring firm's strategies directly affects patients' outcomes and Medicare's expenditures. Patients at acquired facilities are 6.1% more likely to be hospitalized in a given month, with the rate increasing from 14.1% to 15.0%, while the survival rate for new patients falls by 1.3-3.0% depending on the time horizon considered. In addition, new ESRD patients who start treatment at an acquired facility are 9.4% less likely to receive a kidney transplant or be added to the transplant waitlist during their first year on dialysis, a reflection of worse care because transplants provide both a better quality of life and a longer life expectancy than dialysis. Other measures of clinical quality are mixed, at best. Although we find that patients are 10.3% less likely to have low hemoglobin values post acquisition, they are also 9.8% more likely to have hemoglobin values that are too high and 5.3% less likely to have hemoglobin values in the recommended range.[3] The only measure where we find unequivocal evidence of increased quality at acquired facilities is the urea reduction ratio (URR), a measure of the waste cleared during dialysis, with patients at acquired facilities becoming 2.5% more likely to have adequate

[2]Source: GAO-13-46R Medicare Part B Drug Spending.

[3]These do not net to 0 because they are relative effects. Percentage point values net to 0.

clearance levels. Despite no compelling evidence that patients receive better care following acquisition, acquired facilities increase their per-treatment Medicare reimbursements by 7.5%, amounting to $274.5 million in additional spending for Medicare throughout our sample.

As in much of the merger-effects literature, our findings may face multiple threats to identification, as acquisitions are not random events and acquired facilities likely differ from those not acquired in important, potentially unobservable ways. For instance, acquired facilities may systematically alter their patient mix after acquisition, in which case the differences in outcomes we attribute to changes in ownership may actually stem from changes in a facility's demographics. Likewise, chains may disproportionately target facilities located in areas with more lucrative patients, potentially biasing our estimates of how reimbursements change following acquisition. We overcome these challenges by leveraging the uniquely detailed nature of our data. Unlike many claims datasets, we have repeated measures of patients' clinical outcomes and precise measures of their conditions' severity, allowing us to mitigate concerns about a changing mix of patients. Additionally, the length of our panel allows us to observe patients with the same characteristics being treated at the same facility before and after acquisition, permitting us to identify the effects of an acquisition solely from within-facility changes in ownership. Finally, in many cases we can estimate specifications with patient fixed effects that control for any time-invariant patient characteristics, meaning that the main effects we estimate come only from the changes induced by the acquisition.

We conclude our paper by considering whether an acquisition's effect on market power can explain the changes we observe for patient outcomes, as would be predicted by standard models of regulated markets with endogenous product quality (e.g., Gaynor (2004) and the models discussed therein). With prices set administratively for Medicare patients, these models predict that a facility facing more competition in its market would offer higher-quality care to attract more patients, given the assumption that demand is elastic with respect to quality. In dialysis, however, this assumption fails to hold: patients do not respond to changes in quality and rarely switch facilities (for many reasons, but mainly due to high travel costs). We therefore find very similar qualitative and quantitative results across all of our outcome measures when comparing

acquisitions that increased market concentration with those that did not. As such, changes in market power cannot explain the decline in dialysis quality that occurs after a takeover, which implies that the strategy of the acquiring chain, rather than the subsequent concentration of the market, largely determines how patients fare following an acquisition.

Our paper contributes to multiple bodies of literature. The first studies the effects of mergers and acquisitions, both in health care and more generally.[4] Much of this literature has focused on how mergers affect prices through changes in market power. In health care, these studies have primarily focused on hospital mergers, broadly finding that they result in higher prices paid by insurers (e.g., Dafny et al. 2016, Dafny 2009, Gowrisankaran et al. 2015).

The literature examining the effects of mergers and acquisitions on quality is more limited.[5] Even in regulated markets, the net effect is theoretically ambiguous. On the one hand, standard models without merger efficiencies (e.g., Gaynor 2004) show that acquisitions leading to increased market power reduce the incentive to provide high-quality care. Bloom et al. (2015) provide empirical evidence of this by showing that U.K. public hospitals improve their quality when patients can more easily switch from low-quality to high-quality providers.[6] On the other hand, mergers that result in efficiency gains, such as through economies of scale, may lead to higher-quality care.

Outside the hospital industry, research on how mergers and acquisitions affect quality is similarly sparse. The few studies covering this topic include Prince & Simon (2017), who use flight-level data to examine how U.S. airline mergers affect on-time performance, and Fan (2013), who uses a structural model to simulate the impact of consolidation on price and quality in the newspaper market. We extend this literature by directly tying the changes in quality to the corresponding changes in firm behavior following acquisitions.

[4]This is an extensive literature that cannot be fully reviewed here. For a thorough review in the context of health care, see Gaynor et al. (2015).

[5]This stands in contrast to a relatively large number of papers that study the effect of market concentration on hospital quality without focusing explicitly on mergers and acquisitions (e.g., Kessler & McClellan 2000, Gaynor et al. 2013).

[6]More directly, Ho & Hamilton (2000) compare quality measures at hospitals before and after being acquired or merging with another hospital, finding that quality deteriorates along some dimensions following acquisition, especially in more-concentrated markets. Hayford (2012) and Capps (2005) also investigate the direct impact of mergers on hospital quality.

Additionally, this paper contributes to the somewhat limited literature on how firms transfer their strategies and processes following changes in corporate control. Braguinsky et al. (2015) study this in the context of early twentieth century Japanese cotton mills, where they find that acquired firms become more profitable due to both better inventory management and greater capacity utilization. Natividad (2014) conducts a related study of a large fishing firm that acquired some of its suppliers, finding that total factor productivity increased among the newly integrated ships. To the best of our knowledge, the only other paper to study this topic in a health-care setting is Capps et al. (2017), who find that the cost of services increase after hospitals acquire physician groups, largely because the hospitals exploit payment rules. This is analogous to what we find regarding injectable drugs at acquired facilities, although Capps et al. focus solely on where physicians bill for services and do not consider changes in firms' input choices, nor the implications for patients' outcomes. In our setting, we show how treatment changes along many dimensions after acquisition, and that these changes result in worse outcomes for patients.[7]

Understanding how managerial practices and corporate strategies are transferred following an acquisition may be particularly important in the health-care sector, as the adoption of new practices may affect welfare by directly changing the processes through which care is delivered.[8] For example, Dranove & Shanley (1995) hypothesize that hospital systems may benefit from the reputation gains that come from within-system standardization, which may motivate mergers. By standardizing processes across locations, along with pricing and quality, firms may reduce information and search costs for consumers. Additionally, some view the standardization of medical practices as a potential path for improving the overall quality of care while simultaneously reducing the costs of providing it (Gawande 2010).

Finally, our paper contributes to a recent literature specifically focused on the economics of the dialysis industry (e.g., Dai 2014, Cutler et al. 2017, Dai & Tang 2015, Grieco & McDevitt 2017, Eliason 2017, Gaynor et al. 2018, Wilson 2016*a*,*b*). Within this literature, our paper is

[7]Eliason et al. (Forthcoming) hint at this by documenting how long-term acute care hospitals acquired by national chains change their discharge practices.

[8]See, for example, the finding in Dafny & Dranove (2009) that "up-coding" increases when independent hospitals become affiliated with for-profit chains.

most closely related to Cutler et al. (2017), who study how market concentration in the dialysis industry impacts quality and the price charged to privately insured patients. Using data from the Health Care Cost Institute and Dialysis Facility Compare (DFC), they exploit mergers of national dialysis chains as shifters in local market concentration and find no effect of concentration on quality and a weakly positive effect on prices. This differs substantially from our paper in a number of ways. First, they perform their analysis at an aggregate level because they do not observe patient-level data and are unable to match data from private insurers to facilities from DFC. By contrast, much of our analysis is performed at the patient level, allowing us to control for a large set of patient covariates and to observe how quality and treatment change within a facility — and even within a patient — over time. Moreover, our paper focuses on the role of chain strategy in treatment choices, which is less likely to be influenced by local market competition. Also similar to our paper, Garg et al. (1999) and Zhang et al. (2014) both study the effect of facility ownership on patients' treatments. These papers provide descriptive evidence that for-profit facilities and chain-owned facilities, respectively, are less likely to refer patients to the transplant waitlist, with Garg et al. also finding lower mortality rates at for-profit facilities. Furthermore, Zhang et al. (2011) find that chain-owned facilities also have higher mortality rates than independent facilities. None of these papers, however, consider how acquisitions change firm strategies or the causal mechanisms through which they affect patient outcomes.

The rest of the paper proceeds as follows. Section 2 summarizes important institutional details of the dialysis industry. Section 3 describes our data. Section 4 presents our main results on the effects of dialysis facility acquisitions. Section 5 shows that these effects do not vary based on market concentration, likely because patients rarely switch facilities. Section 6 concludes. The appendices contain further details on how we constructed our sample as well as additional analyses that illustrate the robustness of our findings.

2 Background on the Dialysis Industry

The kidneys perform two primary functions in the human body: filtering wastes and toxins out of the blood and producing erythropoietin, a hormone that stimulates red blood cell production. For those suffering from end-stage renal disease, a chronic condition in which a person's kidneys no longer adequately filter wastes and toxins, the medical procedure dialysis replaces this life-sustaining function. Patients with ESRD can receive one of two types of dialysis, hemodialysis or peritoneal dialysis. Hemodialysis uses a machine to circulate blood through a filter outside the body, which can be performed at the patient's home or at a dialysis center, whereas peritoneal dialysis uses the lining of the abdomen to filter blood inside the body.[9] Because over 90% of dialysis patients choose in-center hemodialysis, we focus on this modality for our analysis.

The only alternative to dialysis for patients suffering from ESRD is a kidney transplant. Although a transplant is considered the best course of treatment, it is often not possible, either due to the scarcity of available kidneys or the patient's poor physical condition. Fewer than 20% of dialysis patients are currently on a kidney waitlist, and for those who are, the median wait time for a transplant is 3.6 years (USRDS 2014). As a result, most patients with kidney failure rely on dialysis, either permanently or for an extended period.

A defining feature of the dialysis industry is that 90 days after being diagnosed with ESRD, all patients become eligible for Medicare coverage, regardless of age, which makes Medicare the primary payer for most ESRD patients. In 2014, 460,000 patients received dialysis treatments in the U.S., with over 80% of them enrolled in Medicare. Medicare spends more than $33 billion each year for costs associated with ESRD, approximately 1% of the entire federal budget (Ramanarayanan & Snyder 2014).

Throughout the time period of our study, Medicare paid dialysis facilities a composite rate of around $128 per treatment, up to three times per week for each patient, with injectable drugs reimbursed separately on a fee-for-service basis. For these drugs, providers were reimbursed at a rate equal to 95% of their Average Wholesale Price (AWP) prior to 2005.[10] After investigations

[9] For more information see `https://www.niddk.nih.gov`.

[10] This was actually 85% in 2004.

by the Centers for Medicare and Medicaid Services (CMS) found that providers were being reimbursed much more than they were spending, Congress altered the payment scheme to be 106% of the Average Sales Price (ASP), a more accurate reflection of the true acquisition costs for providers. In both of these schemes, providers were reimbursed at a fixed rate for each administered unit, a crucial feature of the industry that we study below.

Because many ESRD patients do not naturally produce enough erythropoietin, they often suffer from anemia. To treat this condition, they receive a cocktail of injectable drugs, most commonly an erythropoietin stimulating agent (ESA) known as Epogen (EPO), along with an intravenous iron analog, such as Venofer. Prior to 2011, facilities were paid a fixed amount per dose for administering these drugs to patients, which they exploited as a significant source of revenue. For example, more than 90% of dialysis patients received EPO during the mid 2000s, with expenditures reaching $2 billion in 2010 and constituting the largest prescription drug expense for CMS.[11] This proved lucrative for providers, accounting for as much as 25% of DaVita's revenue and up to 40% of its accounting profits.[12] Many patient advocates questioned this practice, however, as several studies linked excessive EPO doses to an increased risk of mortality and cardiovascular events (Besarab et al. 1998, Singh et al. 2006, Brookhart et al. 2010).

Beginning in 2011, Medicare made a number of changes to the way it reimbursed dialysis providers. In particular, it substantially changed its reimbursement scheme by bundling dialysis and anemia treatment (including injectable drugs) into a single prospective payment, changing the case-mix adjustments to those payments, and introducing the Quality Incentive Program. Because these reforms likely had many confounding effects on the dialysis industry, in this paper we restrict our analysis of facility acquisitions to the years spanning 1998 to 2010 and study the effects of the 2011 reform in a separate paper (Eliason et al. 2018).

Although Medicare covers the vast majority of dialysis patients in the U.S., those who have private insurance and become eligible for Medicare solely due to ESRD retain that coverage for

[11] Source: GAO-13-46R Medicare Part B Drug Spending.
[12] 2004 Annual Report, DaVita.

the first 30 months of treatment before Medicare becomes the primary payer.[13] Reimbursements from private insurers tend to be much higher than those from Medicare, with estimates suggesting that the average private insurance rates are anywhere from 2.1 times (USRDS 2013) to 4.5 times (Boyd 2017) as generous as Medicare.[14] Such high rates make privately insured patients extremely lucrative for providers, with DaVita claiming during earnings calls that privately insured patients make up the entirety of its profits and Medicare patients yield negative margins of up to 10% (Shinkman 2016).

Patients receiving dialysis choose their provider much like they do in other segments of the U.S. health-care system, with those covered under Medicare able to seek treatment at any facility that has an opening for them. Patients primarily receive dialysis at one of the more than 6,000 dedicated dialysis facilities across the country, where they typically go three times per week for treatment that lasts 3-4 hours each visit.[15] These facilities are run a by mix of for-profit and non-profit firms, and over the past three decades the two largest for-profit chains, DaVita and Fresenius, have grown to the point where they now control over 60% of the market (National Institutes of Health 2014). The remainder of the market comprises smaller chains as well as independent facilities that are often run by nephrologists.

Dialysis chains potentially have a number of advantages over independent facilities. Large chains, for example, may have lower average costs due to volume discounts for pharmaceuticals as well as centralized clinical laboratories; they may have a stronger bargaining position with commercial insurance companies (Pozniak et al. 2010); and their brand and network may make them more attractive to potential patients.

Chains also stand apart from independent facilities by having firm-wide standards that they implement across their facilities. Notably, large chains have operation manuals that dictate each of their facilities' procedures during treatment. We see evidence of this standardization in the predictability of a patient's EPO dose: an acquired facility's use of EPO becomes nearly twice

[13]Including the 90-day waiting period for Medicare eligibility, private insurance coverage may last up to 33 months.

[14]DaVita's annual reports suggests that the average patient with private insurance generates 3.8 times more revenue than the average Medicare patient (See page four of DaVita's 2007 Annual Report).

[15]Unless otherwise specified, for the rest of the paper when we use the term "dialysis" we are referring to in-center hemodialysis.

as predictable — and twice as high — compared to its pre-acquisition doses.[16] The use of these manuals represents a clear channel through which an acquisition could alter patients' treatments and outcomes, which we study at length below.

Chains' system-wide standards do not universally lead to higher-quality care, however, as a number of anecdotal reports suggest that the quality of dialysis care varies widely across facilities. For example, ProPublica examined the inspection records of more than 1,000 clinics in which surveyors came across filthy or unsafe conditions in almost half the units they checked.[17] At other times, extreme cases of poor conditions and treatment quality have led to lawsuits against providers.[18] Multiple reports by the Office of the Inspector General have also scrutinized dialysis facilities' drug use.[19] Moreover, chains potentially provide worse care by discouraging their patients from seeking kidney transplants. Although patients can self-refer for a transplant, they often lack adequate information about the procedure and fail to understand its risks and benefits. Facilities thus play an important role in a patient's decision to pursue a transplant, and some have allegedly discouraged patients from seeking one out to avoid losing their reimbursements.[20] In the analysis below, we will move beyond such anecdotes and use our comprehensive claims data to consider the relationship between firm strategy and patient outcomes.

[16]These statements about predictability are based on comparing regressions of EPO dose per patient on patient characteristics interacted with year fixed effects estimated using facilities owned by DaVita or Fresenius, or with facilities that are independently owned; or, when we are describing how within-facility use of EPO becomes more predictable, using observations from facilities that are acquired either pre- or post-acquisition.

[17]At some, blood was found encrusted on patients' treatment chairs or even splattered around the room. At a unit in Durham, N.C., ants were reportedly so common that staffers would simply hand a can of bug spray to patients who complained. See `https://www.propublica.org/article/in-dialysis-life-saving-care-at-great-risk-and-cost`.

[18]As an example, in 2008 Fresenius Medical Care North America agreed to settle a wrongful-death lawsuit brought by a deceased patient's survivors. According to a federal inspection report, during treatment the patient's bloodline became disconnected and, contrary to emergency standing orders, the dialysis technician reconnected the line to the patient's catheter, "infusing him with 'potentially contaminated blood'." He was later taken to a hospital where tests showed that his catheter had become infected with antibiotic-resistant staph. The infection moved swiftly to his heart and brain and he died a few days later. See `https://www.theatlantic.com/magazine/archive/2010/12/-god-help-you-youre-on-dialysis/308308/`.

[19]See OEI-03-06-00200 or OEI-03-06-00590 for two examples.

[20]See `https://optn.transplant.hrsa.gov/resources/guidance/educational-guidance-on-patient-referral-to-kidney-transplantation/` and `https://www.vox.com/policy-and-politics/2017/5/15/15641064/john-oliver-kidney-transplant-dialysis-davita`.

3 Data & Descriptive Statistics

A primary contribution of our paper is to show how acquisitions affect the quality of care provided by dialysis facilities, which we accomplish in part by tracking a patients' treatments and tests before and after their facilities are acquired. The micro-level data we use in our analysis is essential for observing any changes in a facility's strategic choices and how these choices subsequently impact patients' outcomes and overall Medicare spending. In this section, we describe our data and provide descriptive results for the most-prominent changes in firm strategy.

3.1 Data Sets

For our analysis, we use patient- and facility-level data from the United States Renal Data System (USRDS).[21] The USRDS is a data clearing house funded by the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) and the National Institute of Health (NIH) that collects and stores data related to chronic kidney disease (CKD). They combine data from a variety of sources, including Medicare administrative files, Medicare claims, annual facility surveys, and clinical surveillance data, to create the most comprehensive dataset for studying the U.S. dialysis industry.[22]

Patient Data

USRDS uses a number of data sources to create an exhaustive treatment history for almost all dialysis patients in the U.S. since at least 1991. Patient demographics are obtained from the Medical Evidence form submitted to Medicare by providers at the patient's onset of ESRD, which CMS uses to determine eligibility for Medicare coverage.[23] Information collected at this time includes a patient's sex, race, BMI, cause of ESRD, payer, hemoglobin, measures of kidney failure severity, comorbidities (e.g., diabetes and hypertension), type of initial treatment, initial

[21] U.S. Renal Data System. 2016 USRDS annual data report: Epidemiology of kidney disease in the United States. National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2016.

[22] For a more thorough description of USRDS, see the *Researcher's Guide to the USRDS System* at USRDS.org.

[23] The Medical Evidence form is used to establish the 90 day Medicare eligibility cutoff as well as the 30 month private insurance coordinating period. Consequently, it is required for all patients regardless of payer.

residence ZIP Code, and facility. After initiation, a patient's residence is updated over time in the CMS Medicare Enrollment Database.

Using a number of different sources, USRDS constructs the Treatment History Standard Analytical File (SAF), which details the complete ESRD treatment history for all patients included in the USRDS database. These data primarily come from the Consolidated Renal Operations in a Web-Enabled Network data system (CROWNWeb), a system established by CMS to track the treatment of ESRD patients. This system contains information submitted by the provider regarding treatments for each individual patient over the previous month.

We combine these data with institutional claims from Medicare, which provide a more granular view of the dialysis treatments received by Medicare patients. Providers submit line-item claims for services other than dialysis. These include all the injectable drugs administered during treatment, which we identify by their HCPCS codes.[24] Unique to this setting, the claims also include clinical measures related to dialysis care and anemia treatment at a monthly frequency, making them among the more detailed claims data available.

Transplant and waitlisting events are available to us through the Transplant and Transplant Waiting List SAFs. The Transplant File includes a patient and provider ID for each kidney transplant received by a patient in the USRDS database. Similarly, the Transplant Waiting List SAF includes information on a patient's waitlist status, including their listing date and the transplant center where they are waitlisted.[25] Both of these files are populated using information from the Organ Procurement and Transplantation Network (OPTN) operated by the Department of Health and Human Services.

We focus primarily on four patient outcomes: mortality, hospitalization, urea reduction ratios, and hemoglobin levels. Mortality information comes from the USRDS Patient History File, which includes a date of death for patients. USRDS constructs this variable using information from the CMS Death Notification form, CROWNWeb, and the Social Security Death Master File.

[24] We use all HCPCS codes for epoeitin alfa, ferric gluconate, and iron sucrose according to the CMS ASP pricing guide at `https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Part-B-Drugs/McrPartBDrugAvgSalesPrice/`.

[25] A patient is waitlisted at a particular transplantation center. They are able to be listed at multiple centers concurrently.

Hospitalization data come from institutional claims obtained from Medicare. We focus on three categories of hospitalizations, classified by their reported diagnoses: all cause, septicemia, and cardiovascular events. Urea reduction ratios and hemoglobin levels are reported in the claims data. Medicare required facilities to report urea reduction ratios for all dialysis claims and hemoglobin levels for ESA claims during our sample period, and for all dialysis claims since 2008.[26] With the exception of mortality, we only observe these outcomes for patients for whom we have claims data.

Facility Data

Dialysis facilities must be certified by CMS to receive reimbursements for ESRD treatment. The CMS ESRD Annual Facility Survey is administered each year to all certified facilities. It records information including the facility ID, address, chain affiliation, labor inputs, number of dialysis stations, for-profit status, and types of treatment offered (e.g., hemodialysis, peritoneal dialysis, or transplant). Using these data, we construct a yearly panel of chain ownership for each facility in our sample. This allows us to examine, at a yearly level, how changes in ownership affect the treatment received by patients.

To construct a monthly chain ownership panel, we first find all facility-years in our yearly facility panel where the facility listed no chain ownership in one year but did so in the following year. We then get precise acquisition dates for each facility using data from the Provider of Services (PoS) dataset and annual cost reports submitted to CMS, each of which lists certification and change of ownership dates.[27] From this algorithm, we are able to find precise acquisition dates for 1,100 of the 1,248 acquisitions we observe.[28]

We combine these datasets and drop any patient who is missing demographic or comorbidity data. We also drop observations at facilities that are acquired but do not have reliable dates

[26] It is not problematic that hemoglobin is only available for ESA-treated patients prior to 2008, as more than 97% of patients receive ESAs each year.

[27] A more detailed description of this matching process is available in Appendix D.

[28] Identification of ownership changes requires being able to track the same facility before and after acquisition. This is complicated by the fact that the facility ID sometimes changes with acquisition. We identify ownership changes in these cases by looking at facilities in the same location that have different chain affiliations in consecutive years.

of acquisition, as well as the 12-month window surrounding acquisition to reduce measurement error in the timing of acquisition.[29] Appendix D gives further details on how we constructed our sample.

3.2 Descriptive Statistics

Figures 1-3 illustrate the significant change in the dialysis industry's market structure over our sample period. Figure 1 shows that the number of acquisitions has varied between 50 to 150 each year, and by the end of our sample we observe over 1,200 first-time acquisitions of independent facilities, providing us a large sample to conduct our analysis.

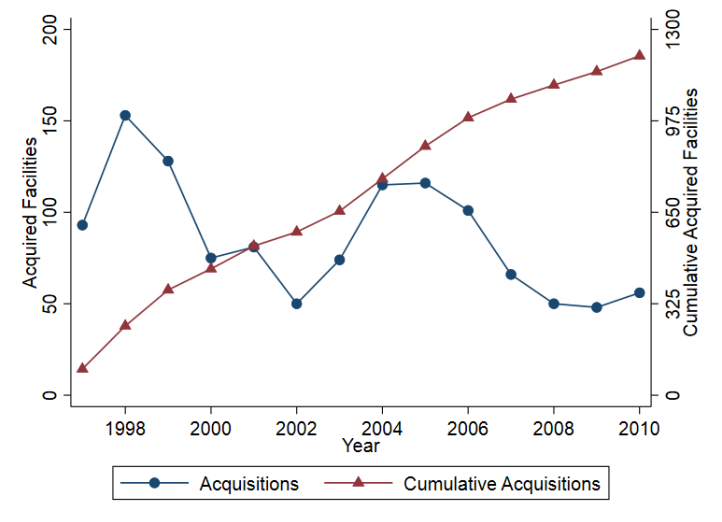

Figure 1: Acquisitions of Independent Dialysis Facilities, 1998-2010

Consolidation increased sharply during our sample period. Figure 2 illustrates the extent of this change, with DaVita and Fresenius owning the majority of facilities by 2010 and the other chains collectively commanding a somewhat smaller market share. A large portion of DaVita and Fresenius' expansion came from their acquisitions of major chains such as Gambro and Renal Care Group, respectively. We do not consider the effects of these large acquisitions because issues stemming from the integration of large chains may confound our analysis. Instead, we focus on the acquisition of independent facilities, as they allow us to cleanly link changes in ownership

[29] Our qualitative results are robust to the inclusion of this time period, though quantitative results are somewhat weaker due to measurement error. See Tables 12 and 13 in Appendix A.

to the resulting changes in behavior and outcomes. Figure 3 illustrates how the acquisitions of independent facilities have contributed to each chain's overall growth during our sample period.[30]

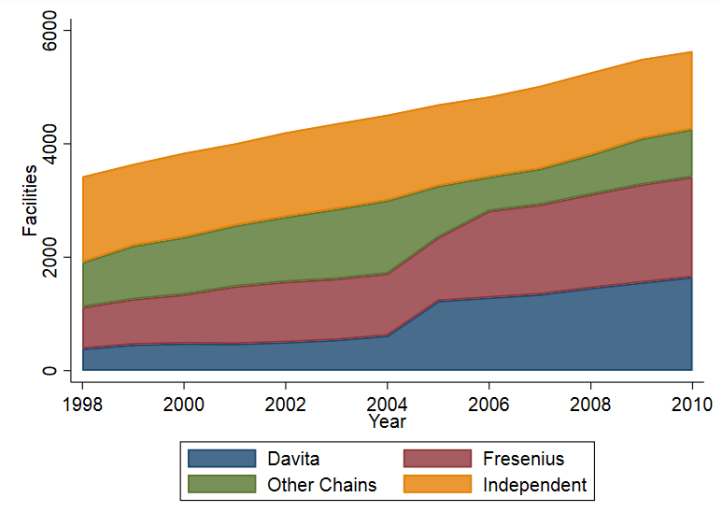

Figure 2: Dialysis Market Evolution, 1998-2010

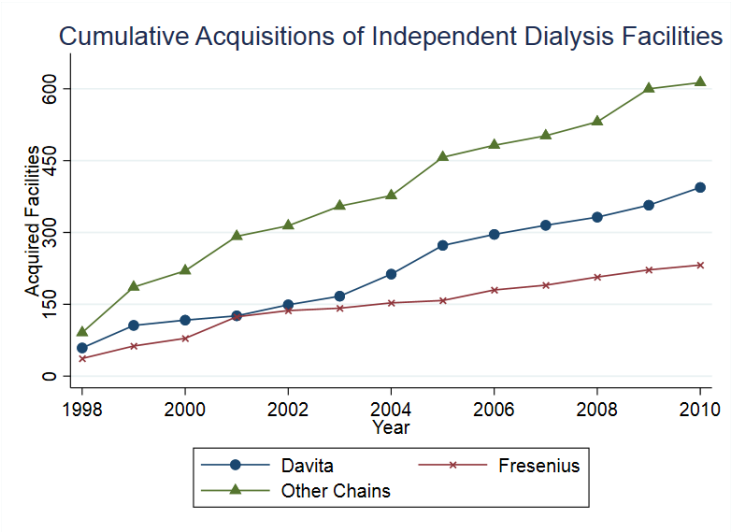

Figure 3: Dialysis Facility Acquisitions by Major Chains Over Time, 1998-2010

[30] As Wollmann (2018) points out, one reason why such consolidation is possible is that most of the acquisitions that led to these firms' growth were exempt from the Hart-Scott-Rodino's pre-merger notification program due to the relatively small size of the target firms.

Table 1 presents descriptive statistics at a patient-month level for all of the covariates included as controls in our analysis. Of particular note, cardiovascular conditions (the last four conditions in the Clinical Characteristics section) are widespread among dialysis patients. In total, approximately 50% of patients have at least one cardiovascular condition, with congestive heart failure the most common. The prevalence of such conditions makes any increase in EPO use especially hazardous because it elevates a patient's risk of cardiovascular events. Dialysis patients are also disproportionately African-American, comprising over 30% of our sample compared to less than 15% of the U.S. population. In our analysis, we also include demographic characteristics that vary both across ZIP Codes and within a ZIP Code over time. Lastly, in our regressions we control for the age of the facility and, in specifications without facility fixed effects, the facility's elevation, as medical evidence suggests that elevation influences a patient's need for EPO.[31]

Table 2 presents descriptive statistics at a patient-month level split by acquisition status, which highlight the potential challenges to identification that we must address with our empirical strategy. Namely, patients at acquired facilities may be inherently different from patients at facilities that are not acquired, and the patient mix at acquired facilities could change after acquisition. The top panel shows how the different types of facilities vary by demographics, while the middle panel shows how they vary by clinical characteristics. For many of these attributes, we observe no systematic differences across facility-types, such as age, BMI, GFR, and congestive heart disease. We also see no meaningful difference in the share of privately insured patients across each type of facility. We do observe differences in racial composition and the rates of ischemic heart disease, however, with these differences largely coming from long-run trends in patient characteristics, as the pre-acquisition column tends to sample from earlier years and the post-acquisition column from later years. For example, the prevalence of ischemic heart disease among dialysis patients has declined from 21.8% in 1998 to 10.6% in 2010. Reflecting this, when we consider only those patients treated within 12 months of the acquisition window,

[31] At higher elevations, the richness of oxygen in the blood decreases and tissue-hypoxia sets in, which causes the body to produce more endogenous erythropoietin (Brookhart et al. 2011). Although ESRD patients still require exogenous erythropoietin in the form of ESAs, the more-efficient use of erythropoietin at higher elevations results in correspondingly lower required dosages of EPO.

Table 1: Patient, Area, and Facility Covariate Descriptive Statistics

	Mean	Std. Dev.
Clinical Characteristics		
Months With ESRD	36.16	(30.46)
Diabetic (%)	54.67	(49.78)
Hypertensive (%)	85.11	(35.60)
BMI	28.32	(7.72)
GFR	7.79	(4.55)
Albumin $\geq$ 3.0g/dL (%)	52.22	(2.98)
Cancer (%)	4.78	(21.33)
Drug Use (%)	1.14	(10.60)
Alcohol Use (%)	1.38	(11.67)
Smoker (%)	5.65	(23.09)
Requires Assistance (%)	4.99	(21.77)
Chronic Obstructive Pulmonary Disease (%)	6.29	(24.29)
Atherosclerotic Heart Disease (%)	5.22	(22.24)
Peripheral Vascular Disease (%)	12.32	(32.86)
Ischemic Heart Disease (%)	15.33	(36.03)
Congestive Heart Failure (%)	29.68	(45.68)
Patient Demographics		
Age	63.78	(14.91)
Male (%)	52.72	(49.93)
Non-Hispanic White (%)	44.00	(49.64)
Black (%)	36.92	(48.26)
Hispanic (%)	13.79	(34.48)
Asian (%)	2.65	(16.05)
Other Race (%)	4.88	(21.55)
Zip Code Demographics		
% High School	32.75	(10.09)
% College	8.00	(8.02)
Median Income ($)	48,233.91	(19,280.30)
Facility Characteristics		
Facility Age	13.19	(8.78)
Facility Elevation	196.45	(282.63)
Patient-Months	14,159,136	

Notes: An observation is a patient-month. BMI stands for Body Mass Index. GFR stands for glomerular filtration rate, a test used to check how well the kidneys are working. Specifically, it estimates how much blood passes through the glomeruli, tiny filters in the kidneys, each minute (a GFR below 15 may indicate kidney failure). Clinical characteristics come from the Medical Evidence form. ZIP Code characteristics come from the American Community Survey. Facility characteristics come from the USRDS Facility file.

we find no meaningful difference between the pre- and post-acquisition groups. This is further evidence that any differences in demographics are driven by time trends, not changes in the mix of patients treated at facilities. Nevertheless, to ensure that time trends do not bias our results, we account for them by controlling for detailed patient characteristics and including month-year fixed effects in our regressions. Furthermore, to address any concerns that our findings may be driven by changes in patient unobservables, we show that our results are robust to including patient fixed effects in Appendix B.

These descriptive statistics also highlight stark differences in the treatments received by patients at each type of facility. As the bottom panel of Table 2 clearly shows, patients at chain-owned facilities receive substantially more EPO per session, are much more likely to get Venofer than Ferrlecit, and are less likely to be placed on a transplant list — or receive a transplant — within a year of starting dialysis. As a result, payments per session jump by about 8% at facilities acquired by a chain.

Treatments are not the only dimension along which we see changes in firm strategy following acquisition. Table 3 shows that chain-owned facilities have a greater number of stations per facility, substitute towards lower-cost technicians and away from higher-cost nurses, and generally stretch resources further as the number of patients per employee is higher at these facilities compared to independent ones. All of these changes are consistent with a firm strategy that prioritizes profits over patient outcomes, which we consider in greater detail in the next section.

Table 2: Patient and Treatment Descriptive Statistics by Facility Type

	Always Independent	Pre-Acquisition	Post-Acquisition	Always Chain
Demographics				
Age	64.31	64.53	64.02	63.38
	(15.24)	(14.90)	(14.72)	(14.82)
Months With ESRD	35.83	31.75	37.06	36.88
	(30.60)	(26.97)	(30.99)	(30.82)
Non-Hispanic White (%)	48.56	53.42	44.42	40.44
	(49.98)	(49.88)	(49.69)	(49.08)
Black (%)	32.30	30.65	36.20	39.98
	(46.76)	(46.10)	(48.06)	(48.99)
Hispanic (%)	13.06	10.03	13.81	14.77
	(33.70)	(30.04)	(34.50)	(35.48)
Clinical Characteristics				
BMI	28.16	27.92	28.63	28.38
	(7.61)	(7.57)	(7.83)	(7.75)
GFR	7.92	7.74	7.99	7.71
	(4.59)	(4.40)	(4.61)	(4.54)
Ischemic Heart Disease (%)	17.25	20.58	14.85	13.75
	(37.78)	(40.43)	(35.56)	(34.44)
Congestive Heart Disease (%)	31.07	32.04	30.27	28.56
	(46.28)	(46.66)	(45.94)	(45.17)
Treatment				
EPO Per Session ('000 IU's)	4,495.76	4,728.96	6,222.30	6,259.81
	(5,261.87)	(4,973.10)	(6,129.32)	(6,131.78)
Venofer Per Session (mg)	7.95	7.60	15.92	14.85
	(16.87)	(16.18)	(21.40)	(21.10)
Ferrlecit Per Session (mg)	6.49	7.22	4.65	4.86
	(15.36)	(16.29)	(13.54)	(13.81)
Waitlist or Transplant[a] (%)	13.61	12.73	11.92	11.47
	(34.29)	(33.33)	(32.41)	(31.86)
Payments Per Session	179.22	171.79	184.57	183.15
	(56.83)	(53.25)	(55.93)	(56.12)
Patient-Months	2,880,459	1,483,910	1,958,193	7,836,574
Incident Patients	233,930	142,669	118,390	400,379

Notes: An observation is a patient-month. Standard deviations are in parentheses. BMI stands for Body Mass Index. GFR stands for glomerular filtration rate, a test used to check how well the kidneys are working. Specifically, it estimates how much blood passes through the glomeruli, tiny filters in the kidneys, each minute (a GFR below 15 may indicate kidney failure).

[a] Dummy for being waitlisted or transplanted within 1 year for incident patients only.

Table 3: Facility Summary Statistics

	Always Independent	Pre-Acquisition	Post-Acquisition	Always Chain
Stations	14.28	16.63	18.37	17.92
	(8.65)	(7.83)	(8.13)	(7.39)
Hemodialysis (%)	89.83	91.68	92.33	94.22
	(19.32)	(15.94)	(14.79)	(13.06)
Privately Insured (%)	6.52	7.43	6.66	6.79
	(6.17)	(5.85)	(4.11)	(5.38)
Nurses	5.65	5.17	4.23	3.70
	(4.09)	(3.79)	(2.63)	(2.26)
Technicians	4.94	6.20	6.64	6.22
	(5.08)	(4.78)	(4.53)	(4.13)
Nurses/Techs	1.63	1.09	0.77	0.72
	(2.22)	(1.23)	(0.70)	(0.59)
Patients/Employee	4.11	4.75	5.85	5.52
	(2.75)	(2.15)	(2.09)	(2.34)
Has Night Shift (%)	24.83	23.83	23.81	18.44
	(43.20)	(42.60)	(42.59)	(38.78)
Facility-Years	7,826	4,053	4,129	16,418

Notes: An observation is a facility-year. Standard deviations are in parentheses.

4 The Impact of Acquisitions on Firm Strategy, Patient Outcomes, and the Cost of Care

In this section, we show how independent facilities change their behavior after being acquired by a chain, and how these changes then impact the quality and cost of care. To do so, we use a difference-in-differences research design that compares independent facilities acquired by chains to those that are never acquired:

$$Y_{ijt} = \beta^{Pre} D_{jt}^{Pre} + \beta^{Post} D_{jt}^{Post} + \beta^{Chain} D_{jt}^{Chain} + \alpha X_{ijt} + \epsilon_{ijt}, \tag{1}$$

where Y_{ijt} is the outcome of interest for patient i at facility j in month t; D_{jt}^{Pre} and D_{jt}^{Post} are indicators for whether facility j in month t will be acquired in the future or has already been acquired; and D_{jt}^{Chain} is an indicator for whether facility j is always owned by a chain. The excluded category comprises independent facilities that are not acquired during our sample period. Although X_{ijt} varies by specification, in our preferred specification it includes a host of facility and patient controls, including age, comorbidities, race, sex, time on dialysis, and facility age; X also includes year, state, and facility fixed effects. Without facility fixed effects, β^{Post} would capture the mean difference in Y for a facility that has been acquired relative to a facility that is never acquired in our sample, conditional on other covariates. To avoid measurement error in our determination of the exact date of acquisition, and to allow enough time for a firm's strategy to be fully implemented, we exclude all observations within a six-month window on either side of the acquisition date. As demonstrated in Appendix A, however, our main results are robust if we include this period, although slightly attenuated due to measurement error. In all specifications, we cluster standard errors at the facility level.[32]

The primary threat to identification in this setting is that chains may acquire independent facilities whose patients have certain characteristics that affect Y through channels other than a change in ownership. As shown in the top panel of Table 2, however, patients treated at indepen-

[32]Clustering at the patient level yields standard errors which are 25-75% smaller than those clustered at the facility level. We choose facility clustering as the more conservative of the two.

dent facilities acquired by chains are not systematically different along observable characteristics than those treated at other independent facilities. Additionally, the richness of our data allows us to control for all clinically relevant covariates, making this an even smaller concern. Lastly, to make a causal claim about acquisitions from a specification that includes facility fixed effects requires only that chains do not systematically *change* the mix of patients along unobservable dimensions when they acquire a facility, a relatively weak assumption. Moreover, our results are robust to the inclusion of patient fixed effects, which further limits this concern. In short, the rich data of our empirical setting allow us to cleanly identify the effects of acquisitions on facilities' practices and patients' outcomes, affording us a unique opportunity to disentangle the otherwise opaque nature of firms' corporate strategies.

4.1 Drug Doses

We first consider the use of EPO at dialysis facilities due to its importance for firms' profits, outsize effect on Medicare's total spending on drugs, and potential for abuse by providers. Table 4 presents estimates of equation (1) where the dependent variable is the log of EPO doses per treatment.[33] Columns (1) and (2) of the table show that although acquired facilities were already using slightly more EPO per treatment than independent facilities that are never acquired, they experience such a substantial increase following acquisition that their levels converge to those of facilities always owned by a chain. Column (3) adds facility fixed effects, with the estimates suggesting that acquisitions cause EPO doses to more than double for patients at the same facility with the same observable characteristics.

To interpret this estimate as the causal effect of acquisition on EPO use, we are relying on the assumption that an acquisition creates a discontinuous change in facility behavior and that any trends in dosing during the period surrounding acquisition are common to all of the facilities in the control group. To support this assumption, in Figure 4 we plot EPO doses during the time period around acquisition, where the horizontal axis is months relative to acquisition, month 0 is the month of acquisition denoted by a vertical dashed line, and the omitted category is the month

[33]Dependent variable is log(1+Dose) in case there are doses of 0.

Table 4: Effect of Acquisition on Per-Treatment EPO Dose

	(1) EPO	(2) EPO	(3) EPO
Pre-Acquisition	0.265*	0.270*	
	(0.134)	(0.124)	
Post-Acquisition	1.485***	1.350***	0.828***
	(0.0868)	(0.0822)	(0.0725)
Always Chain	1.509***	1.343***	
	(0.0841)	(0.0775)	
Observations	14,159,136	14,159,136	14,159,136
Dep. Var. Mean	7.538	7.538	7.538
Dep. Var. Units	log(IU)	log(IU)	log(IU)
Year x Month FE	X	X	X
Pat. & Fac. Controls		X	X
Facility FE			X

Notes: Facility-clustered standard errors in parentheses. An observation is a patient-month. Sample includes hemodialysis patients treated at facilities involved in an independent-to-chain acquisition or a facility which is independent or owned by the same chain for the entirety of our sample and who have complete covariates. We drop observations within 6 months of the month of acquisition. Drug doses are winsorized at the 99th percentile. *, ** and *** indicate significance at the 5%, 1% and 0.1% level, respectively.

prior to acquisition. The graph plots coefficients on the pre- and post-acquisition month dummies estimated with the same set of controls as in equation (1). We find no evidence of a pre-trend. We do see a short adjustment period of approximately 6 months following acquisition where facilities slowly adjust EPO doses upwards before leveling off. In order for this phenomenon to arise due to selection bias (in the sense that chains acquire facilities that were going to increase EPO doses irrespective of being acquired), acquiring firms would need to observe some indication of a looming increase in doses when negotiating the sale of the facility. This strikes us as implausible given that negotiations occur many months prior to the date of acquisition.

We extend our baseline analysis to study the effect of acquisitions on the use of other commonly used intravenous drugs. Specifically, we examine the use of iron-supplement drugs given to patients with anemia. Table 5 repeats the research design used in Table 4 to focus on these drugs, with the number of observations differing across the columns because Ferrlecit and Venofer did

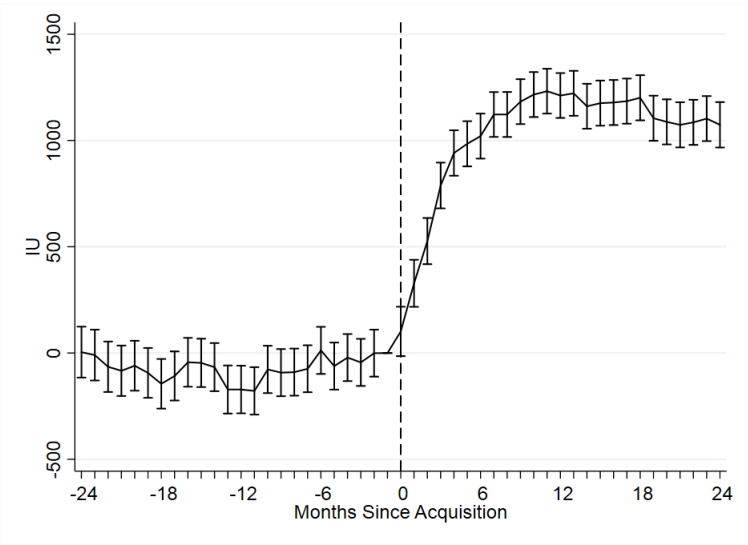

Figure 4: EPO Dosing Dynamics at Acquired Firms

Notes: Months outside the 24 month window are included in the regression, but not shown here. Error bars are 95 percent confidence intervals. Observations within 6 months of acquisition are included in this plot.

not receive FDA approval until 1999 and 2000, respectively, whereas EPO was in use at the start of our sample in 1998. Due to delays in the creation of HCPCS codes, we have Ferrlecit doses since 2001 and Venofer doses since 2002. The results in Table 5 show that acquired facilities substantially increase their use of Venofer and decrease their use of Ferrlecit.

The switch from Ferrlecit to Venofer reflects the profits at stake. With both sold by their manufacturers in single-use vials, so any amount of the drug left over in a vial must be discarded to reduce the risk of infection, CMS reimburses facilities for the amount in the vial, rather than the amount actually administered to the patient. And although Ferrlecit and Venofer had nearly identical per-milligram reimbursement rates during our study period, Venofer was produced exclusively in 100mg vials, whereas Ferrlecit was produced in 62.5mg vials. As a result, facilities effectively received higher reimbursements per vial for Venofer because they could, for example, use 25mg from four vials rather than one 100mg vial but still bill CMS for four 100mg vials, discarding 75mg from each of the four. A company accused of engaging in this practice paid $450 million to settle a whistleblower lawsuit.[34] Again, to illustrate the onset of these strategies at newly acquired firms, we replicate Figure 4 for both Venofer and Ferrlecit in Figures 5 and 6.

[34]See `https://www.nytimes.com/2011/07/26/health/26dialysis.html` and `https://www.reuters.com/article/davita-healthcr-lawsuit-idUSL1N0XV2Y520150504`.

Table 5: Acquisition Effects on Drug Dosing

	(1) Venofer	(2) Ferrlecit
Post-Acquisition	0.608***	-0.299***
	(0.0744)	(0.0621)
Observations	11,593,289	12,471,067
Dep. Var. Mean	1.340	0.586
Dep. Var. Units	log(mg)	log(mg)
Year x Month FE	X	X
Pat. & Fac. Controls	X	X
Facility FE	X	X

Notes: Facility-clustered standard errors in parentheses. An observation is a patient-month. Venofer and Ferrlecit specifications have different observations due to availability of the two drugs. Ferrlecit was introduced in 1999 and Venofer in late 2000. Sample includes hemodialysis patients treated at facilities involved in an independent-to-chain acquisition or a facility which is independent or owned by the same chain for the entirety of our sample and who have complete covariates. We drop observations within 6 months of the month of acquisition. Drug doses are winsorized at the 99th percentile. *, ** and *** indicate significance at the 5%, 1% and 0.1% level, respectively.

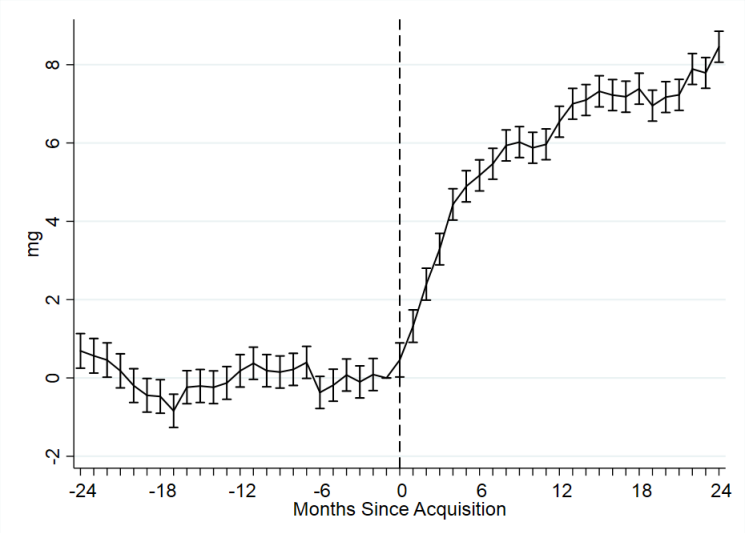

Figure 5: Venofer Dosing Dynamics at Acquired Firms

Notes: Months outside the 24 month window are included in the regression, but not shown here. Error bars are 95 percent confidence intervals. Observations within 6 months of acquisition are included in this plot.

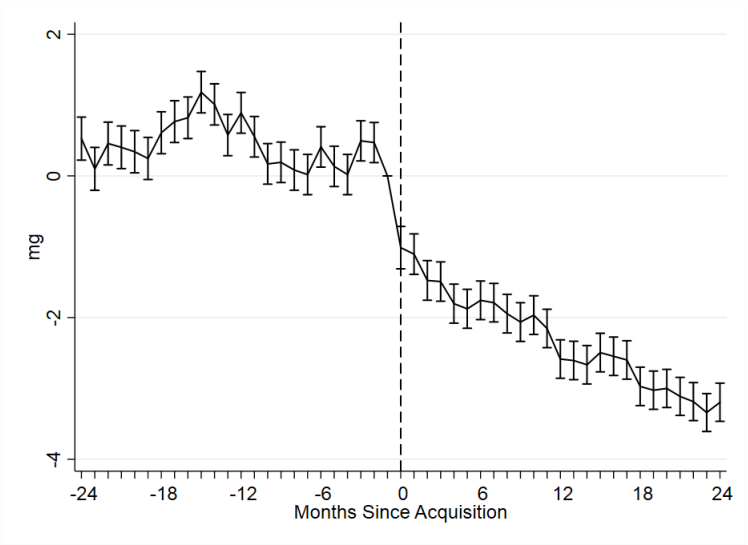

Figure 6: Ferrlecit Dosing Dynamics at Acquired Firms

Notes: Months outside the 24 month window are included in the regression, but not shown here. Error bars are 95 percent confidence intervals. Observations within 6 months of acquisition are included in this plot.

4.2 Facility Inputs

The evidence in Section 4.1 clearly shows that chains strategically alter the drug doses at newly acquired facilities. In this subsection, we investigate how they alter the input choices of their targets following takeovers in ways that reduce costs. To do so, we modify our baseline specification (1) to analyze data at the facility-year level, as data for many of the inputs (e.g., staff and the number of dialysis stations) are only available at the annual level. Specifically, we include facility fixed effects and estimate specifications of the form:

$$Y_{ijt} = \gamma^{Post} D_{jt}^{Post} + \delta X_{jt} + \nu_{jt}. \tag{2}$$

Aside from the change in the unit of observation, this analysis is very similar to our patient-level analysis and relies on similar identifying assumptions. Namely, for a causal interpretation of γ^{Post}, we require that the acquisition results in a discrete change in the environment determining facilities' input choices. With annual data, measurement error for the timing of acquisition is an even greater concern; to remedy this, we drop the entire year of acquisition for each facility that changes ownership, keeping only observations where a facility has the same ownership for

the entire year.

Table 6 displays the effect of acquisitions on facility-level labor and capital decisions. These estimates show a consistent shift in the utilization of inputs by chains, with acquired facilities decreasing their use of nurses while increasing their use of dialysis technicians. Such a switch reduces facilities' costs because technicians have less training and are paid much less than nurses.[35] Upon acquisition, the target firm decreases its nurse-technician ratio by roughly 15.1%. Newly acquired facilities also stretch their resources by increasing their patient-to-employee ratio by 11.9% and their patient-to-station ratio by 4.6%. Taken together, we find that acquiring firms adjust the inputs of their targets by substituting away from more-experienced, higher-cost labor, and by increasing both the number of patients per employee and station.

Although these changes reduce the acquired facilities' operating costs, patients may fare worse if being treated by busier employees with less training diminishes their quality of care. Additionally, if the number of patients per station increases because the time each patient spends on a machine decreases, or because machines are not adequately cleaned between patients, this too may result in worse outcomes for patients, as shown in Grieco & McDevitt (2017). In the next section, we will show that these changes in firm strategy following an acquisition directly impact the quality and cost of patient care.

4.3 Patient Outcomes

The richness of our data, along with the clinical and operational links between drugs and facility inputs, allows us to connect the changes in strategy at an acquired facility to its effects on patient outcomes. In this way, we can demonstrate how acquisitions directly impact the quality of care received by patients and the cost of this care to Medicare.

We begin by considering a number of clinical outcomes. The first five columns of Table 7 show the effect of acquisitions on patients' urea reduction ratio (URR) and hemoglobin (HGB) levels, two important diagnostic statistics for dialysis patients. Urea is a primary waste that dialysis

[35]Dialysis technicians typically require only 12 months of training, much of which is done on the job. By contrast, nurses are typically required to pass an RN licensure exam.

Table 6: Acquisition Effects on Facility Input Choices

	(1) Nurses	(2) Technicians	(3) Nurses per Technician	(4) Patients per Employee	(5) Patients per Station
Post-Acquisition	-0.0197	0.0464*	-0.147***	0.609***	0.186*
	(0.0195)	(0.0231)	(0.0411)	(0.107)	(0.0832)
Observations	24,897	24,897	23,220	24,897	43,033
Dep. Var. Mean	1.550	1.701	0.974	5.120	3.991
Units	log(FTE)	log(FTE)	-	-	
Year FE	X	X	X	X	X
Facility FE	X	X	X	X	X

Notes: Facility-clustered standard errors in parentheses. An observation is a facility-year. Observations differ in column 3 due to observations with 0 reported dialysis technicians. Sample includes facilities involved in an independent-to-chain acquisition and facilities which are independent or owned by the same chain for the entirety of our sample. We drop observations in the year of acquisition. FTE are Full-Time Equivalents. *, ** and *** indicate significance at the 5%, 1% and 0.1% level, respectively.

filters, and URR measures the percent of urea filtered out of a patient's blood during dialysis (urea levels are measured before and after a dialysis session), which increases as patients spend more time on a machine. Patients vary in how long it takes them to achieve a given URR, with the standard of care being that a dialysis session should continue until a patient achieves a URR of at least 0.65.[36] In column (1) of Table 7, we measure whether a patient's URR reaches this level and find a 2.16 percentage point increase in the probability that a patient has an adequate URR following acquisition, one of the few cases where quality improves at independent facilities after they are acquired by a chain.

Another important measure of clinical quality is a patient's HGB level. As explained above, anemia is common among dialysis patients, and a blood test for HGB measures the onset or severity of anemia. During the period of our study, the FDA recommended Epogen dosing to target HGB levels between 10 and 12 grams per deciliter (g/dL) (Manns & Tonelli 2012). On the lower end, patients with HGB below 10g/dL are anemic. On the other side of this range, high levels of HGB can result in serious complications, such as cardiovascular events (Besarab et al.

[36]See `https://www.niddk.nih.gov/health-information/kidney-disease/kidney-failure/hemodialysis/dose-adequacy`.

1998, Singh et al. 2006). Columns (2)-(5) of Table 7 show a variety of HGB measures. We find that hemoglobin levels at acquired facilities increase by 0.096 g/dL, which may be beneficial for patients if it pushes them into the recommended range. Looking more closely at the thresholds for low, ideal, and high HGB, we find decreases in the likelihood that patients have good (4.0%) or low hemoglobin (11.6%), and a 9.7% increase in the likelihood of having hemoglobin above the recommended upper limit of 12 g/dL.

The overall increase in HGB is consistent with our finding above that acquired facilities substantially increase their use of EPO, which treats anemia by increasing HGB. Nephrologists have informed us that there is no clear consensus on whether having low or high hemoglobin is worse for patients, as their respective negative effects are largely incomparable. Having low hemoglobin diminishes a patient's quality of life (by causing chronic fatigue, for example). High hemoglobin levels, on the other hand, increase a patient's risk of cardiac events and death. Despite this ambiguity, CMS weighted high hemoglobin twice as heavily as low hemoglobin when computing scores for a quality incentive program in 2012 (after our sample period). Additionally, low hemoglobin has since been dropped as a relevant quality measure by CMS, while high hemoglobin is still monitored closely. In our view, this suggests that the increase in patients' hemoglobin values at acquired facilities may, on net, represent a decline in the quality of care received by patients.

Hospitalizations represent another indicator of a facility's overall quality. Columns (6)-(8) of Table 7 show the results from estimating our primary specification where the dependent variable is equal to 1 if a patient was hospitalized for a given cause during the month.[37] Our estimates indicate that patients are more likely to be hospitalized, both for any cause and for several individual causes. We find that all-cause hospitalization rates increase by 4.5%. For septicemia, an infection of the blood for which dialysis patients are especially susceptible due to their weakened immune systems and the frequent connection between the dialysis machine and their bloodstream, we find that patients are 10.0% more likely to be hospitalized following acquisition. Providers can reduce infections by properly cleaning machines between patients (Patel et al. 2013), but this is costly since it takes up to an hour to adequately sanitize a dialysis

[37]Episodes of hospitalization are assigned to the month in which they begin.

station (Grieco & McDevitt 2017). Therefore, we think that the two most likely explanations for the higher rate of infections following a takeover are (i) the decrease in per-patient staffing levels at acquired facilities, which leave employees with less time to properly clean machines between patients (column (4) of Table 6), and (ii) the relative increase in the use of low-skilled employees who may be less likely to follow proper cleaning and treatment protocols (column (3) of Table 6). For our final type of hospitalization, we estimate that patients are 2.9% more likely to be hospitalized for an adverse cardiac event following acquisition, though this effect is not statistically significant at the 5% level (p-value of 0.139).[38] Such an increase would be expected given the much larger EPO doses received by patients post acquisition, as the principal risk of elevated hemoglobin values is a higher incidence of adverse cardiovascular events.

We next consider kidney transplants and waitlists. As discussed above, the most-preferred treatment for ESRD is a kidney transplant. A shortage of available kidneys, however, means that patients must first join a waitlist before receiving a transplant.[39] The process for receiving a kidney transplant is complicated and involves a number of different parties, including a patient's dialysis facility and a kidney transplant team. Regulations require dialysis facilities to educate patients with ESRD about all treatment options, including a kidney transplant. Additionally, to start the transplant process, patients receiving dialysis typically require a referral from their dialysis facility for the evaluation of whether a kidney transplant is appropriate for them. As such, the proportion of patients referred for a transplant is viewed as an important measure of a facility's quality.[40]

Table (8) presents results from estimating equation (1) with an indicator for whether an incident patient was waitlisted or transplanted within the relevant time frame as the dependent variable. After acquisition, new patients are less likely to be placed on a transplant waitlist or to receive a transplant during any of the time frames we study. One year after starting dialysis, a new patient at an acquired facility is 9.4% less likely to receive a transplant or be on the waitlist for a transplant than he or she was at the same facility before it was acquired. We also find

[38] It is worth noting that the estimate is statistically significant when we include patient fixed effects. See Table 14 in Appendix B.

[39] A patient can receive a transplant without ever being on a waitlist if they receive a living donor transplant.

[40] See Patzer et al. (2015) for much more on the relationship between kidney transplants and dialysis facilities.

consistent effects after both 180 and 730 days, with patients respectively 8.8% and 9.6% less likely to be placed on the waitlist or receive a transplant by the end of those periods.

Although we interpret these results as another example of acquisitions resulting in worse care for patients, an important limitation of this analysis is that we cannot discern what drives the decline in transplants. It could be that acquired facilities are less likely to refer their patients for transplants; or, patients could be referred at the same rate but rejected more often by a transplant center. To partially address this, we include a large number of patient characteristics that are likely to affect his or her suitability for a transplant, but there remain unobserved factors, such as the ability to make appointments or comply with doctors' directives.[41] In our view, both explanations have the same implication for patients: an acquisition of their independent facility by a chain makes them less likely to receive a transplant.[42]

As a final measure of quality, we consider patient survival rates. Table 9 presents estimates of the acquisition effect on patient survival after 180, 365, and 730 days since starting dialysis. We restrict our attention to patients starting dialysis at facilities that do not change ownership or for whom the entire observation window is before or after acquisition (for example, to be included in the 180-day specification, a patient must start dialysis more than 180 days prior to the acquisition date). We also restrict attention to those patients who remain at the same facility until their date of death or the end of the observation window.[43] We find that patients' 365-day survival rate decreases by 1.26 percentage points, or 1.7%. In addition, we see significant decreases after both 180 and 730 days, with patient survival rates falling by 1.3% and 3.0%, respectively.

When considering the totality of our results for clinical outcomes, hospitalizations, transplants, and mortality, the overarching finding is that acquisitions result in worse care for patients. But providing high-quality care is costly, so potentially these acquisitions could reduce overall spending on dialysis, making the overall impact on welfare inconclusive. We do not find evi-

[41] Discussions with nephrologists have informed us that patients can be denied if they miss appointments, as transplant centers may view them as unlikely to follow through with follow-up care necessary for post-transplant recovery.

[42] There is a small but growing literature on the distinction between waitlisting and referral, such as Patzer et al. (2015). To our knowledge, none of these papers have examined chain ownership or acquisitions.

[43] We have done robustness checks, estimating these effects including all patients as well as those who return to the facility within 30 or 60 days, finding similar effects.

Table 7: Acquisition Effects on Outcomes

	Clinical Outcomes					Hospitalized			
	URR Good	HGB	HGB Good	HGB Low	HGB High	Any Cause	Sept.	Cardiac Event	Payments
Post-Acquisition	0.0216***	0.0961**	-0.0260***	-0.0110***	0.0369***	0.00630***	0.000702**	0.000865	0.0666***
	(0.00490)	(0.0298)	(0.00811)	(0.00304)	(0.00883)	(0.00168)	(0.000258)	(0.000585)	(0.00608)
Observations	14,159,136	13,269,069	13,269,069	13,269,069	13,269,069	14,159,136	14,159,136	14,159,136	14,159,136
Dep. Var. Mean	0.881	11.670	0.523	0.095	0.382	0.141	0.007	0.030	5.150
Dep. Var. Units	%	g/dL	%	%	%	%	%	%	log($)
Year x Month FE	X	X	X	X	X	X	X	X	X
Pat. & Fac. Controls	X	X	X	X	X	X	X	X	X
Facility FE	X	X	X	X	X	X	X	X	X

Notes: Facility-clustered standard errors in parentheses. An observation is a patient-month. Hemoglobin specifications have different observations because it is not submitted with non-ESA claims for most of our sample. Sample includes hemodialysis patients treated at facilities involved in an independent-to-chain acquisition or a facility which is independent or owned by the same chain for the entirety of our sample and who have complete covariates. We drop observations within 6 months of the month of acquisition. Payments are winsorized at the 99th percentile. *, ** and *** indicate significance at the 5%, 1% and 0.1% level, respectively.

Table 8: Acquisition Effects on Waitlisting and Receiving Transplant

	Waitlisted for or Received Transplant within:		
	180 Days	365 Days	730 Days
Post-Acquisition	-0.00595*	-0.0120**	-0.0197**
	(0.00284)	(0.00445)	(0.00649)
Observations	687,179	609,511	499,479
Dep. Var. Mean	0.068	0.127	0.208
Dep. Var. Units	%	%	%
Year x Month FE	X	X	X
Pat. & Fac. Controls	X	X	X
Facility FE	X	X	X

Notes: Estimates from OLS regression. Facility-clustered standard errors in parentheses. An observation is a new dialysis patient. Sample includes patients starting dialysis at facilities involved in an independent-to-chain acquisition or facilities which are independent or owned by the same chain for the entirety of our sample. We drop any patients which start dialysis at facilities acquired within six months of acquisition. *, ** and *** indicate significance at the 5%, 1% and 0.1% level, respectively.

dence that acquisitions reduce Medicare expenditures in the dialysis industry, however; rather, we find that they substantially increase the cost of care. The final column of Table 7 shows that acquired facilities increase their per-session Medicare reimbursements by 7.5% following acquisition, amounting to $274.5 million in additional spending for Medicare throughout our sample. In short, we find that acquisitions lead to clear changes in firm strategy that substantially worsen the quality of care received by patients and increase the cost of care borne by Medicare.

5 The Effect of Competition on Firm Behavior

In this section, we investigate whether competition from other dialysis firms can discipline the behavior of newly acquired facilities. With the price for dialysis fixed by Medicare, facilities may compete for patients by offering higher-quality treatments or other services. Such competition may prevent the acquirer from implementing its strategies to increase profits if patients respond to the corresponding decline in quality by defecting to a rival facility. In what follows, we find no evidence that competition disciplines the transference of firm strategy in the dialysis industry.

Table 9: Acquisition Effects on Patient Mortality

	Patient Survives for:		
	180 Days	365 Days	730 Days
Post-Acquisition	-0.0106**	-0.0126**	-0.0177**
	(0.00347)	(0.00475)	(0.00652)
Observations	603,425	533,640	452,178
Dep. Var. Mean	0.844	0.746	0.597
Dep. Var. Units	%	%	%
Year FE	X	X	X
Pat. & Fac. Controls	X	X	X
Facility FE	X	X	X

Notes: Facility-clustered standard errors in parentheses. An observation is a new dialysis patient. Sample includes patients starting dialysis at facilities involved in an independent-to-chain acquisition or facilities which are independent or owned by the same chain for the entirety of our sample. We drop any patients which start dialysis at facilities acquired within six months of acquisition. We only include those patients who remain at their original facility until death or the end of the observation window. *, ** and *** indicate significance at the 5%, 1% and 0.1% level, respectively.

In this way, our findings echo those of Cutler et al. (2017), who, using a different identification strategy and more-aggregate data, also find no evidence that competition affects the quality of care received by dialysis patients. We then explore why competition does not discipline provider behavior, with a primary explanation being that patients do not often switch dialysis facilities for a host of institutional reasons.

To investigate the effect of competition on firm behavior, we must first establish a relevant geographic market and then select an appropriate measure of competition. The existing literature lacks a clear consensus on how to define markets for the dialysis industry — Cutler et al. (2017) and Grieco & McDevitt (2017) define markets as Hospital Service Areas (HSAs); Wilson (2016*a*) and Dai (2014) use counties; and Wilson (2016*b*) and Eliason (2017) develop facility-specific markets using distances around each facility. In light of this, we focus below on a specification that defines markets as HSAs and uses HHI to measure competition, but show in Appendix C that our results are robust to a variety of market definitions and measures of competition.

5.1 Most Acquisitions Do Not Change Market Concentration

We begin by examining whether the acquisitions of independent facilities by chains actually affect market concentration. We first locate market-months where an acquisition will occur in the following month, finding 891 such instances.[44] We then calculate the HHI for that market and what the HHI would have been if the acquisition had already occurred.[45]

Figure 7 shows a scatterplot of pre- and post-acquisition HHI for each HSA-month where an acquisition is about to occur. We have reduced the transparency of each dot to 30%, so that darker regions imply more overlapping markets or more mass in that area. HHI increases in only 34.4% of HSA-months following acquisition.[46]

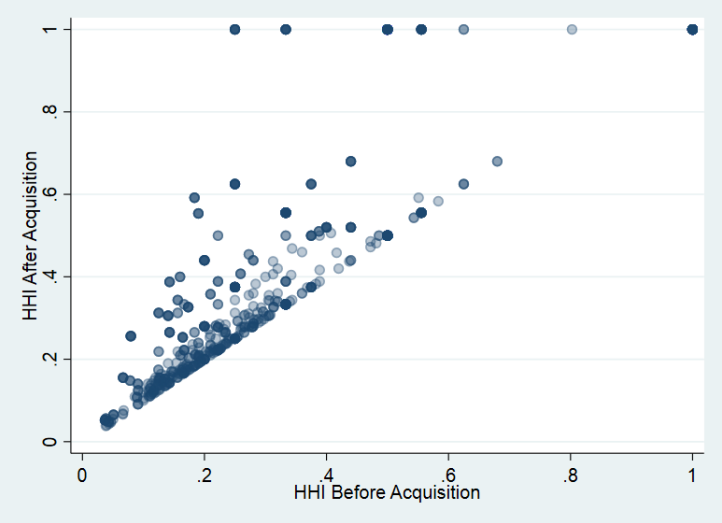

Figure 7: Changes in Concentration Across Markets

Note: An observation is an acquisition. The horizontal axis the Hospital Service Area HHI before acquisition. The vertical axis is what the HSA HHI would have been in the month before acquisition had the facility already been acquired. Opacity is reduced to 30%, so darker regions represent regions of more mass.

That HHI increases in only a few markets following a takeover strongly suggests that changes

[44] This is less than the total acquisitions due to HSA-months where multiple facilities are acquired.

[45] We use this as our definition of post-acquisition HHI to avoid confounding the effect of acquisition with the entry of new dialysis facilities. In addition, we treat the market share of each facility as $\frac{1}{N}$ for simplicity. Since we are only examining the extensive margin of whether concentration increases, this will not yield different results than calculating market shares at a patient level. To illustrate: Suppose an HSA has 3 facilities, DaVita, Fresenius, and an independent that will be acquired by DaVita in the next period. Then HHI today is $\frac{1}{3}$ and predicted HHI is calculated assuming the independent is DaVita, which is $(\frac{2}{3})^2 + (\frac{1}{3})^2 = \frac{5}{9}$.

[46] Note that 34.23% of markets where acquisitions occur have only one facility, denoted by the mass at (1,1) in the figure.

in facility behavior and patient outcomes are not driven by changes in market concentration. To this point, we find that our results are quantitatively very similar to those in Section 4 when we restrict our sample to markets with only one facility, meaning that the results for these markets could not possibly be explained by changes in concentration.[47] Rather, firm strategy appears to be the main determining factor.

5.2 Acquisitions That Increase HHI Have Similar Effects

Next, we show in Table 10 that the outcomes in markets where an acquisition increased concentration do not differ from those where an acquisition did not affect market concentration. To do so, we modify our baseline specification by interacting our post-acquisition dummy with a dummy for whether the acquisition of that facility increased HHI in the market.[48] The effects in Panels 1 and 2 of Table 10 are not substantially different from our baseline results, either qualitatively or quantitatively. On cardiac and septicemia hospitalizations, we lose some statistical significance, but the point estimates are similar. In addition, we see no effect on the dummy for acquisitions that increase HHI, implying that the changes in outcomes we see after acquisition are not driven by changes in market concentration, leaving changes in management practices as the most likely explanation.

A noteworthy implication of these results is that consolidation can have detrimental effects that are independent of competition, irrespective of the measure of competition we use. As acquisitions lead to fewer active firms nationwide, the strategies and management practices of the expanding firms may increasingly affect aggregate outcomes. In this case, acquisitions drive both concentration and a decrease in the quality of care, but the channel through which the latter occurs is the transference of firm strategy, not an increase in market power.

[47] Analysis not reported but available from the authors upon request.

[48] In Appendix Table 15, we show that our results are robust to other measures of competition beyond HHI.

Table 10: Acquisition Effects By Concentration Increase

	Epo	Venofer	Ferrlecit	HGB	Low HGB	High HGB	Good HGB	Good URR	Hosp.	Hosp., Card.	Hosp., Sep.
Market = Hospital Service Area											
Post-Acquisition	0.806***	0.500***	-0.251**	0.0494	-0.00941*	0.0320**	-0.0226*	0.0236***	0.00581**	-0.000239	0.000541
	(0.0809)	(0.114)	(0.0926)	(0.0434)	(0.00426)	(0.0103)	(0.00978)	(0.00666)	(0.00223)	(0.000765)	(0.000404)
Increases HSA HHI	0.0479	0.188	-0.0927	0.0855	-0.00301	0.00925	-0.00624	-0.00341	0.000933	0.00116	0.000281
	(0.0892)	(0.146)	(0.120)	(0.0550)	(0.00564)	(0.0163)	(0.0153)	(0.00881)	(0.00315)	(0.00109)	(0.000492)
Market = Core Based Statistical Area											
Post-Acquisition	0.940***	0.490**	-0.202	0.0938	-0.0134	0.0359**	-0.0225	0.0124	0.00533	0.000585	0.000481
	(0.124)	(0.159)	(0.124)	(0.0627)	(0.00759)	0.0134)	(0.0137)	(0.00780)	(0.00308)	(0.00102)	(0.000595)
Increases CBSA HHI	-0.137	0.150	-0.131	0.00366	0.00301	0.00153	-0.00453	0.0119	0.00126	0.000381	0.000274
	(0.122)	(0.179)	(0.141)	(0.0688)	(0.00804)	(0.0166)	(0.0164)	(0.00919)	(0.00354)	(0.00119)	(0.000643)
Patient-Months	14,011,137	11,471,833	12,340,156	13,130,676	13,130,676	13,130,676	13,130,676	14,011,137	14,011,137	14,011,137	14,011,137
Units	log(UI)	log(mg)	log(mg)	g/dL	%	%	%	%	%	%	%
Pat. & Fac Controls	X	X	X	X	X	X	X	X	X	X	X
Year x Month FE	X	X	X	X	X	X	X	X	X	X	X
Facility FE	X	X	X	X	X	X	X	X	X	X	X

Notes: Facility-clustered standard errors in parentheses. An observation is a patient-month. Sample includes hemodialysis patients treated at facilities involved in an independent-to-chain acquisition or a facility which is independent or owned by the same chain for the entirety of our sample and who have complete covariates. We drop observations within 6 months of the month of acquisition. Drug doses are winsorized at the 99th percentile. Each panel represents a separate specification. The top panel includes a dummy for whether Hospital Service Area HHI increases due to the acquisition. The bottom panel includes a dummy for whether the CBSA HHI increases due to the acquisition. Observations differ from baseline due to missing ZIP Code to market crosswalk data. *, ** and *** indicate significance at the 5%, 1% and 0.1% level, respectively.

5.3 Why Competition Does Not Discipline Provider Behavior

In regulated markets, standard models of competition (e.g., Gaynor (2004) and the models discussed therein) with endogenous provider quality predict that quality increases with the extent of competition in the market. This theoretical result relies on the assumption that demand increases in product quality, which in our setting would mean that patients are more likely to choose a high-quality facility, all else equal, and thus facilities would compete for patients by offering higher-quality care. In practice, patient demand in the U.S. dialysis market does not respond to the decreased product quality following acquisition. As suggested in column (5) of Table 6, acquired facilities are actually able to increase the number of patients they treat per machine despite a decline in quality.

We look more directly at this result by considering whether patients are more likely to switch away from a facility after it is acquired, finding that they are not. In general, it is very rare for dialysis patients to switch providers, where 98.4% of patient-months in our sample have the patient visiting the same facility the following month. Additionally, those who do switch tend to be newer dialysis patients — 36.3% of switches are patients in their first 12 months of dialysis, while those patients make up only 24.6% of observations overall — and 19.9% of switchers eventually return to the facility from which they switched.[49] Patients in their first 12 months of dialysis likely make up a disproportionate share of switches due to the capacity constraints described in Eliason (2017): new patients choose the best facility that has available capacity and then switch to their most-desired facility when a free space opens up there. For patients who have completed 12 months of dialysis, only 1.1% of patient-months reflect a permanent switch away from a facility.

In addition to the low absolute levels of switching among patients, we show in Table 11 that patients do not become more likely to switch after their facility is acquired. For the full sample of patients, our point estimate of the effect of acquisition on switching is -0.06 percentage points, which is small economically and not statistically significant at conventional levels. In addition,

[49]Patients who return to their initial facility are typically people who travel to another location, such as for vacation, and are unable to visit their original facility. Since they return, it is unlikely their behavior is reflective of concern about facility quality.

Table 11: Effect of Acquisition on Facility Switching

	All		First Year	
	Any Switch	Never Return	Any Switch	Never Return
Post-Acquisition	-0.000604	-0.000355	-0.000638	-0.000459
	(0.000498)	(0.000444)	(0.000383)	(0.000765)
Observations	13,896,231	13,896,231	3,416,391	3,416,391
Dep. Var. Mean	0.016	0.013	0.024	0.020

Notes: Facility-clustered standard errors in parentheses. An observation is a patient-month. Sample includes hemodialysis patients treated at facilities involved in an independent-to-chain acquisition or a facility which is independent or owned by the same chain for the entirety of our sample and who have complete covariates. We drop observations within 6 months of the month of acquisition. Columns 3 and 4 include only patients in their first 12 months on dialysis. The dependent variable in columns 1 and 2 is defined as 1 if the patient is on dialysis the next month at a different facility and 0 if they remain on dialysis at their current facility. Columns 2 and 4 is 1 only for those patients who do not return to the initial facility at any point in our sample. *, ** and *** indicate significance at the 5%, 1% and 0.1% level, respectively.

we find no meaningful effects of acquisition on switching behavior for patients in their first year or if we only include facility switches where the patient does not return to their initial facility.

A host of institutional and behavioral factors explain why patients do not leave low-quality providers. In many markets, patients may not have a valid outside option — one-third of markets in our sample have only 1 facility. Our findings are unchanged, however, if we repeat the analysis in Table 11 but restrict our sample to include only markets with at least two facilities.[50] Moreover, even patients who live in markets with multiple facilities face significant travel costs due to the frequency of visits required for dialysis, as documented in Eliason (2017). These travel costs are exacerbated by comorbidities that make travel difficult as well as the low income of most dialysis patients. As such, travel costs may outweigh concerns about quality for most patients. Behavioral inertia likely also plays a significant role in this market, as it does in other health-care settings (e.g., Handel 2013). Tilipman (2018) in particular finds patients exhibit significant loyalty to their physicians, and the physicians to whom they are the most loyal are their primary care doctors. As dialysis facilities are the primary source of health care for many patients, the

[50]Results available upon request.

significant inertia in their choice of a provider is in line with such findings.

6 Conclusion

Changes in ownership affect the treatment and outcomes of patients at independent dialysis facilities acquired by chains. We show that acquired facilities change their strategies to increase profitability in three main ways. First, acquired facilities capture higher per-session reimbursements from Medicare by increasing drug doses and shifting to more-lucrative drugs. Second, acquired facilities stretch their resources by treating more patients relative to the number of staff and stations at the facility. Third, acquired facilities reduce their costs of providing dialysis treatment by replacing high-skill nurses with low-skill technicians.

Adopting the acquiring firm's strategies reduces the acquired facilities' quality of care. Along almost every dimension we measure, patients fare worse at the target facility after acquisition, most prominently in terms of fewer kidney transplants, more hospitalizations, and lower survival rates. Because Medicare spends more after acquired facilities implement these strategic changes, the diminished quality represents an unambiguous decline in the overall value of dialysis treatments.

As the largest for-profit dialysis chains have gradually acquired one independent facility after another, the industry has become increasingly dominated by just a handful of firms. The heightened market concentration resulting from these acquisitions has not directly harmed patients, however. Instead, we show that a diffusion of firm strategy rather than an increase in market power has caused quality to decline at acquired dialysis facilities.

In this way, our results illustrate the importance of well-designed payment systems in controlling health-care costs and improving patient outcomes. As we show with the case of Epogen, poorly structured reimbursement schemes can induce provider behavior that not only wastes resources, but also harms patients. By improving the design of Medicare's payment systems, policymakers can simultaneously reduce costs and improve patient outcomes.

References

Besarab, A., Bolton, W., J. Browne, J. E., Nissenson, A., Okamoto, D., Schwab, S. & Goodkin, D. (1998), 'The effects of normal as compared with low hematocrit values in patients with cardiac disease who are receiving hemodialysis and epoetin', *The New England Journal of Medicine* **339**, 584–590.

Bloom, N., Propper, C., Seiler, S. & Reenen, J. V. (2015), 'The Impact of Competition on Management Quality: Evidence from Public Hospitals', *Review of Economic Studies* **82**(2), 457–489.

Boyd, R. (2017), 'DaVita Inc.: Warren and Charlie's Excellent Insurance Gambit'.

Braguinsky, S., Ohyama, A., Okazaki, T. & Syverson, C. (2015), 'Acquisitions, productivity, and profitability: Evidence from the japanese cotton spinning industry', *American Economic Review* **105**(7), 2086–2119.

Brookhart, A., Bradbury, B. D., Avorn, J., Schneeweiss, S. & Winkelmayer, W. C. (2011), 'The effect of altitude change on anemia treatment response in hemodialysis patients', *American Journal of Epidemiology* **173**(3), 768–777.

Brookhart, M., Schneeweiss, S., Avorn, J., Bradbury, B., Liu, J. & Winkelmayer, W. (2010), 'Comparative Mortality Risk of Anemia Management Practices in Incident Hemodialysis Patients', *Journal of the American Medical Association* **303**(9), 857–864.

Capps, C. (2005), 'The Quality Effects of Hospital Mergers', *Department of Justics, Economic Analysis Group Discussion Paper* **05**(6).

Capps, C., Dranove, D. & Ody, C. (2017), 'The Effect of Hospital Acquisitions of Physician Practices on Prices and Spending'.

Cuellar, A. & Gertler, P. (2006), 'Strategic Integration of Hospitals and Physicians', *Journal of Health Economics* **25**(1), 1–28.

Cutler, D., Dafny, L. & Ody, C. (2017), 'How Does Competition Impact the Quality of Price of Outpatient Service Facilities? A Case Study of the U.S. Dialysis Industry'.

Dafny, L. (2009), 'Estimation and Identification of Merger Effects: An Application to Hospital Mergers', *The Journal of Law and Economics* **52**(3), 523–550.

Dafny, L. & Dranove, D. (2009), 'Regulatory Exploitation and Management Changes: Upcoding in the Hospital Industry', *Journal of Law and Economics* **52**, 223–250.

Dafny, L., Duggan, M. & Ramanarayanan, S. (2012), 'Paying a Premium on Your Premium? Consolidation in the US Health Insurance Industry', *American Economic Review* **102**(2), 1161–1185.

Dafny, L., Ho, K. & Lee, R. (2016), 'The Price Effects of Cross-Market Hospital Mergers'.

Dai, M. (2014), 'Product Choice Under Price Regulation: Evidence from Out-Patient Dialysis Markets', *International Journal of Industrial Organization* **32**, 24–32.

Dai, M. & Tang, X. (2015), 'Regulation and Capacity Competition in Health Care: Evidence from US Dialysis Margets', *The Review of Economics and Statistics* **97**(5), 965–982.

Dranove, D. & Shanley, M. (1995), 'Cost Reductions or Reputation Enhancement as Motives for Mergers: The Logic of Multihospital Systems', *Strategic Management Journal* **16**(1), 55–74.

Eliason, P. (2017), 'Market Power and Quality: Congestion and Spatial Competition in the Dialysis Industry'.

Eliason, P., Heebsh, B., McDevitt, R. C. & Roberts, J. W. (2018), 'The Effect of Medicare Reimbursement Incentives on Patient Outcomes: The Case of Dialysis'.

Eliason, P. J., Grieco, P. L. E., McDevitt, R. C. & Roberts, J. W. (Forthcoming), 'Strategic Patient Discharge: The Case of Long-Term Care Hospitals', *American Economic Review* .

Fan, Y. (2013), 'Ownership Consolidation and Product Characteristics: A Study of the US Daily Newspaper Market', *American Economic Review* **103**(5), 1598–1628.

Garg, P. P., Frick, K. D., Diener-West, M. & Powe, N. R. (1999), 'Effect of the Ownership of Dialysis Facilities on Patients' Survival and Referral for Transplantation', *New England Journal of Medicine* **341**(22), 1653–1660.

Gawande, A. (2010), 'The Checklist Manifesto: How to Get Things Right'.

Gaynor, M. (2004), 'Quality and Competition in Health Care Markets: What do we Know? What don't we Know?', *Economie Publique* **15**(2), 87–124.

Gaynor, M., Ho, K. & Town, R. J. (2015), 'The Industrial Organization of Health-Care Markets', *Journal of Economic Literature* **53**(2), 235–84.

Gaynor, M., Mehta, N. & Richards-Shubik, S. (2018), 'Optimal Contracting with Altruistic Agents: A Structural Model of Medicare Reimbursements for Dialysis Drugs'.

Gaynor, M., Moreno-Serra, R. & Propper, C. (2013), 'Death by Market Power: Reform, Competition and Patient Outcomes in the National Health Service', *American Economic Journal: Economic Policy* **5**(4), 134–166.

Gaynor, M. & Town, R. J. (2012), *Handbook of Health Economics*, Elsevier North-Holland, chapter Competition in Health Care Markets.

Gowrisankaran, G., Nevo, A. & Town, R. (2015), 'Mergers When Prices Are Negotiated: Evidence from the Hospital Industry', *American Economic Review* **105**(1), 172–203.

Grieco, P. & McDevitt, R. C. (2017), 'Productivity and Quality in Health Care: Evidence from the Dialysis Industry', *The Review of Economic Studies* **84**(3), 1071–1105.

Handel, B. R. (2013), 'Adverse selection and inertia in health insurance markets: When nudging hurts', *American Economic Review* **103**(7), 2643–2682.

Hayford, T. (2012), 'The Impact of Hospital Mergers on Treatment Intensity and Health Outcomes', *Health Services Research* **47**(3), 1008–1029.

Ho, V. & Hamilton, B. H. (2000), 'Hospital Mergers and Acquisitions: Does Market Consolidation Harm Patients?', *Journal of Health Economics* **19**(5), 767–791.

Kessler, D. & McClellan, M. (2000), 'Is Hospital Competitioni Socially Wasteful', *The Quarterly Journal of Economics* **115**(2), 577–615.

Manns, B. & Tonelli, M. (2012), 'The New FDA Labeling for ESA—Implications for Patients and Providers', *Clinical Journal of the American Society of Nephrology* **2**(7), 348–353.

National Institutes of Health (2014), '2014 USRDS Annual Data Report: An Overview of the Epidemiology of Kidney Disease in the United States'.

Natividad, G. (2014), 'Integration and productivity: Satellite-tracked evidence', *Management Science* **60**(7), 1698–1718.

Patel, P., Yi, S., Booth, S., Bren, V., Downham, G., Hoss, S., Kelly, K., Lincoln, J., Morrissette, K., Lindberg, C., Jernigan, J. & Kallen, A. (2013), 'Bloodstream Infection Rates in Outpatient Hemodialysis Facilities Participaring in a Collaborative Prevention Effort: A Quality improvement Report', *American Journal of Kidney Disease* **62**(2), 322–330.

Patzer, R. E., Plantinga, L. C., Paul, S., Gander, J., Krisher, J., Sauls, L., Gibney, E. M., Mulloy, L. & Pastan, S. O. (2015), 'Variation in Dialysis Facility Referral for Kidney Transplantation Among Patients With End-Stage Renal Disease in Georgia', *JAMA* **314**(6), 582–94. 1538-3598.

Pozniak, A. S., Hirth, R. A., Banaszak-Holl, J. & Wheeler, J. R. C. (2010), 'Predictors of Chain Acquisition among Independent Dialysis Facilities', *Health Serv Res* **45**(2), 476–96. 1475-6773 Pozniak, Alyssa S Hirth, Richard A Banaszak-Holl, Jane Wheeler, John R C Health Serv Res. 2010 Apr;45(2):476-96. doi:10.1111/j.1475-6773.2010.01081.x.

Prince, J. & Simon, D. (2017), 'The Impact of Mergers on Quality Provision: Evidence from the Airline Industry', *The Journal of Industrial Economics* **65**(2), 336–362.

Ramanarayanan, S. & Snyder, J. (2014), 'Information Disclousure and Firm Performance: Evidence from the Dialysis Industry'.

Shinkman, R. (2016), 'The big business of dialysis care'.

Singh, A., Szczech, L., Tang, K., Barnhart, H., Sapp, S., Wolfson, M. & Reddan, D. (2006), 'Correction of Anemia with Epoeitin Alfa in Chronic Kidney Disease', *The New England Journal of Medicine* **355**, 2085–2098.

Tilipman, N. (2018), 'Cadillac Tax, Narrow Networks, and Consumer Welfare'.

USRDS (2013), 'US Renal Data System, USRDS 2013 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States'.

USRDS (2014), 'US Renal Data System, USRDS 2014 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States'.

Wilson, N. (2016*a*), 'For-Profit Status & Industrial Evolution in Health Care Markets: Evidence from the Dialysis Industry', *International Journal of Health Economics and Management* **16**(4), 297–319.

Wilson, N. (2016*b*), 'Market Structure as a Determinant of Patient Care Quality', *American Journal of Health Economics* **2**(2), 241–271.

Wollmann, T. (2018), 'Stealth consolidation: Evidence from an amendment to the Hart-Scott-Rodino Act'.

Zhang, Y., Cotter, D. J. & Thamer, M. (2011), 'The Effect of Dialysis Chains on Mortality among Patients Receiving Hemodialysis', *Health Services Research* **46**(3), 747–767.

Zhang, Y., Thamer, M., Kshirsagar, O., Cotter, D. J. & Schlesinger, M. J. (2014), 'Dialysis Chains and Placement on the Waiting List for a Cadaveric Kidney Transplant', *Transplantation* **98**(5), 543–551.

APPENDICES

The following appendices demonstrate that our analyses are robust to the inclusion of data from the year of acquisition, patient fixed effects, and alternative measures of competition. We also give further details on how we constructed our data sample.

A Including the 12 Months Surrounding Acquisition

In this appendix, we present our main results from a sample that includes observations from the year of acquisition. The reason we excluded information surrounding the year of acquisition in the main body of the paper is that the precise data when a facility is acquired may be measured with error, as discussed in Section 3. The results here show that our results are robust to including the year of acquisition. As expected, however, the measurement error we introduce somewhat attenuates the estimated magnitudes.

Table 12: Effect of Acquisition on Per-Treatment EPO Dose

	(1) Epogen	(2) Epogen	(3) Epogen
Pre-Acquisition	0.300*	0.302*	
	(0.131)	(0.121)	
Post-Acquisition	1.465***	1.351***	0.769***
	(0.0863)	(0.0816)	(0.0663)
Always Chain	1.508***	1.362***	
	(0.0841)	(0.0775)	
Observations	14,435,492	14,435,492	14,435,492
Dep. Var. Mean	7.538	7.538	7.538
Units	log(IU)	log(IU)	log(IU)
Year x Month FE	X	X	X
Pat. & Fac. Controls		X	X
Facility FE			X

Notes: Facility-clustered standard errors in parentheses. An observation is a patient-month. Sample includes hemodialysis patients treated at facilities involved in an independent-to-chain acquisition or a facility which is independent or owned by the same chain for the entirety of our sample and who have complete covariates. We do **not** drop observations within 6 months of the month of acquisition. Drug doses are winsorized at the 99th percentile. *, ** and *** indicate significance at the 5%, 1% and 0.1% level, respectively.

Table 13: Acquisition Effects on Outcomes

	Drugs & Payments			Clinical Outcomes					Hospitalized		
	Venofer	Ferrlecit	Payments	URR Good	HGB	HGB Good	HGB Low	HGB High	Any Cause	Sept.	Cardiac Event
Post-Acquisition	0.537***	-0.277***	0.0587***	0.0181***	0.0876**	-0.0289***	-0.00772**	0.0366***	0.00689***	0.000702**	0.000683
	(0.0648)	(0.0528)	(0.00546)	(0.00426)	(0.0276)	(0.00723)	(0.00274)	(0.00785)	(0.00146)	(0.000224)	(0.000501)
Observations	11,801,680	12,694,257	14,435,491	14,435,492	13,518,078	13,518,078	13,518,078	13,518,078	14,435,492	14,435,492	14,435,492
Dep. Var. Mean	1.330	0.592	5.149	0.880	11.669	0.523	0.095	0.382	0.141	0.007	0.030
Units	log(mg)	log(mg)	log($)	%	g/dL	%	%	%	%	%	%
Year x Month FE	X	X	X	X	X	X	X	X	X	X	X
Pat. & Fac. Controls	X	X	X	X	X	X	X	X	X	X	X
Facility FE	X	X	X	X	X	X	X	X	X	X	X

Notes: Facility-clustered standard errors in parentheses. An observation is a patient-month. Hemoglobin specifications have different observations because it is not submitted with non-ESA claims for most of our sample. Sample includes hemodialysis patients treated at facilities involved in an independent-to-chain acquisition or a facility which is independent or owned by the same chain for the entirety of our sample and who have complete covariates. We do **not** drop observations within 6 months of the month of acquisition. Payments are winsorized at the 99th percentile. *, ** and *** indicate significance at the 5%, 1% and 0.1% level, respectively.

B Adding Patient Fixed Effects

In this appendix, we repeat our analysis of the patient-month variables in specifications that include patient fixed effects. Table 14 shows results for patients who stay at a single facility and are treated there both before and after acquisition. These specifications do not include facility fixed effects because they are not separately identified given that each patient receives treatment from only one facility in this sample. We find results consistent with our main specification, with identification of the acquisition effect coming solely from within-patient changes following acquisition.

Table 14: Robustness: Including Patient Fixed Effects

	Drugs			Clinical Outcomes					Hospitalized		
	Epo	Venofer	Ferrlecit	URR Good	HGB	HGB Good	HGB Low	HGB High	Any Cause	Sept.	Cardiac Event
Post-Acquisition	0.857***	0.42***	-0.315***	-0.00150	0.0962*	-0.0408***	-0.00371	0.445***	0.0310***	0.00247***	0.00535***
	(0.181)	(0.0958)	(0.0777)	(0.00662)	(0.0444)	(0.0112)	(0.00473)	(0.0124)	(0.00389)	(0.000528)	(0.00123)
Observations	397,013	321,886	347,865	397,013	357,657	357,657	357,657	357,657	397,013	397,013	397,013
Dep. Var. Mean	7.544	1.354	0.599	0.882	11.660	0.527	0.096	0.377	0.140	0.007	0.030
Dep. Var. Units	log(IU)	log(mg)	log(mg)	%	g/dL	%	%	%	%	%	%
Year x Month FE	X	X	X	X	X	X	X	X	X	X	X
Pat. & Fac. Controls	X	X	X	X	X	X	X	X	X	X	X
Patient FE	X	X	X	X	X	X	X	X	X	X	X

Notes: Facility-clustered standard errors in parentheses. An observation is a patient-month. Hemoglobin specifications have different observations because it is not submitted with non-ESA claims for most of our sample. Sample includes hemodialysis patients who only ever visit a single facility treated at facilities involved in an independent-to-chain acquisition and bridge the date of acquisition. We drop observations within 6 months of the month of acquisition. Specifications include patient, but not facility, fixed effects. *, ** and *** indicate significance at the 5%, 1% and 0.1% level, respectively.

C Alternative Measures of Competition

We have shown that acquisitions that increase HHI at the HSA and CBSA level do not differ in their effects. However, in line with Eliason (2017) and Wilson (2016*b*), many patients seek treatment outside of their HSA, suggesting that these may not be relevant market definitions. With that in mind, in this appendix we perform robustness checks to verify that our acquisition effects do not differ by other measures of competition. Here, we show that the presence of a competitor within 10 miles and the number of competitors within 10 miles do not affect our qualitative findings.

Table 15: Acquisition Effects Across Competitive Environments

	Epo	Venofer	Ferrlecit	Low HGB	High HGB	Good HGB	Good URR	Hosp.	Hosp., Card.	Hosp., Sep.
Post-Acquisition	0.864***	0.609***	-0.242**	-0.00904*	0.0231**	-0.0140	0.0211***	0.00377	0.000962	0.0000378
	(0.0905)	(0.0915)	(0.0800)	(0.00354)	(0.00797)	(0.00739)	(0.00545)	(0.00221)	(0.00849)	(0.00509)
Has Competitor Within 10 Miles	-0.0495	-0.00232	-0.0778	-0.00268	-0.0192	-0.0165	0.00716	0.00349	-0.00134	0.000916*
	(0.0733)	(0.0999)	(0.0853)	(0.00352)	(0.0105)	(0.00976)	(0.00614)	(0.00241)	(0.000932)	(0.000422)
Post-Acquisition	0.884***	0.661***	-0.272***	-0.00902*	0.0247*	-0.0157	0.0203***	0.00378	0.000944	0.0000750
	(0.0901)	(0.0935)	(0.0823)	(0.00375)	(0.00878)	(0.00818)	(0.00556)	(0.00227)	(0.000857)	(0.000417)
1 Competitor Within 10 Miles	0.0427	0.210	-0.204*	-0.00250	0.0273	-0.0248	-0.00340	0.00375	-0.000218	0.0011*
	(0.0895)	(0.114)	(0.0996)	(0.00420)	(0.0173)	(0.0158)	(0.00706)	(0.00279)	(0.00106)	(0.000500)
2 Competitors Within 10 Miles	0.0173	-0.268	0.0600	-0.00439	0.0142	-0.00983	0.00281	0.00126	-0.000194	0.000831
	(0.0933)	(0.0153)	(0.129)	(0.00546)	(0.0158)	(0.0158)	(0.0106)	(0.00371)	(0.00132)	(0.000594)
3+ Competitors Within 10 Miles	-0.137	-0.157	0.0151	-0.00251	0.0133	-0.0108	0.00371	0.00369	-0.0000536	0.000781
	(0.0848)	(0.123)	(0.103)	(0.00491)	(0.0126)	(0.0116)	(0.00771)	(0.00306)	(0.00114)	(0.000486)
Patient-Months	14,159,136	11,593,289	12,471,067	13,269,069	13,269,069	13,269,069	14,159,136	14,159,136	14,159,136	14,159,136
Units	log(UI)	log(mg)	log(mg)	%	%	%	%	%	%	%
Pat. & Fac Controls	X	X	X	X	X	X	X	X	X	X
Year x Month FE	X	X	X	X	X	X	X	X	X	X
Facility FE	X	X	X	X	X	X	X	X	X	X

Notes: Facility-clustered standard errors in parentheses. An observation is a patient-month. Sample includes hemodialysis patients treated at facilities involved in an independent-to-chain acquisition or a facility which is independent or owned by the same chain for the entirety of our sample and who have complete covariates. We drop observations within 6 months of the month of acquisition. Drug doses are winsorized at the 99th percentile. Each panel represents a separate specification. The top panel includes a dummy for having a competing facility within 10 miles. The bottom panel includes dummies for the number of competing facilities within 10 miles. Observations may vary due to availability of zipcode geocoding data. *, ** and *** indicate significance at the 5%, 1% and 0.1% level, respectively.

D Finding Acquisition Dates

We assign each facility the date that is highest in the following hierarchy:

1. Change of Ownership date in PoS
2. Certification date in PoS
3. Change of Ownership date in cost reports
4. Certification date in cost reports
5. Report filing date in cost report if multiple reports are filed for one year

We start with 1,248 acquisitions, 841 of which are matched solely on Provider of Services data and another 259 of which are matched to cost report data, fewer than 10 of which are due to report filing dates.