Time-Saving Technology and the Allocation of Specialist Work: Evidence from High-Skilled Physicians*

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Abstract

Many new technologies reduce the time needed to complete a task, and how workers reallocate the time saved determines how work is restructured after adoption. We study this question using the arrival of pulsed-field ablation - a faster technology for treating atrial fibrillation. Since many physicians practice at several hospitals that adopt at different times, we compare the same physician in the same month at hospitals where the technology is and is not available. We find that when the technology arrives at a hospital, a physician performs about 37 percent more ablations there, or about eight additional procedures a year. We also find that relocation of cases from her other hospitals explains little of this increase. The increase comes from physicians who were already performing ablations, and the additional procedures go to commercially insured and Medicare patients in proportion to their existing share. Physicians use the time saved to do more of the same procedure, which leaves the distribution of who provides and who receives ablation unchanged.

Keywords: Technology Adoption, Physician Behavior, Pulsed-field Ablation

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1 Introduction

Many recent innovations reduce the time required to complete an existing task rather than change the set of tasks a worker can perform. Consequently, how work is restructured after adoption depends on how workers choose to reallocate the time saved, whether toward more of the same task, toward other work or toward leisure. For instance, recent work documents how generative AI and AI scribes restructure work (Humlum and Vestergaard, 2025a; Dillon et al., 2025; Rotenstein et al., 2026). Since adoption is typically the worker's own choice and a worker who adopts a new tool tends to use it across all of her work, a key challenge in measuring this reallocation is that the same worker is rarely observed with and without the technology in the same period.

This question is especially relevant in health care. U.S. health spending reached $5.3 trillion in 2024 (Hartman et al., 2026) and medical technology accounts for roughly a third of its long-run growth (Smith and Newhouse, 2026). Since physician time is a binding input and many new technologies shorten existing procedures, how physicians restructure their work around a new technology shapes what adoption delivers. Existing evidence finds large returns to adoption (Cutler and McClellan, 2001; Skinner and Staiger, 2015), but these estimates are measured at the hospital level and largely concern technologies that are not primarily time-saving (Horn et al., 2022). Hospitals choose whether to adopt while physicians choose how to restructure their work once the technology is available. Consequently, an increase in hospital volume after adoption may reflect more procedures by incumbent physicians, cases relocated from other hospitals or the entry of new physicians, and separating these channels requires observing the same physician with and without the technology.

We study a setting that allows us to observe the same physician with and without a new tool - the introduction of pulsed-field ablation (PFA) to treat atrial fibrillation (AF). AF is the most common form of sustained cardiac arrhythmia, for which catheter ablation is the standard invasive treatment (Joglar et al., 2024). Until recently in the United States, ablation relied on thermal energy, either radiofrequency heating or cryoablation. PFA, approved by the FDA in late 2023, instead uses short electrical pulses to ablate the

target tissue. Previous work finds that PFA matches thermal ablation on safety and efficacy and takes substantially less time (Reddy et al., 2023). PFA imparts no expertise, and ablation with any energy source can be performed only by a trained physician. It is also quick to learn, as a physician reaches steady procedure times within about twenty cases, compared with several hundred for point-by-point radiofrequency ablation (Kueffer et al., 2026).

To separate the aggregate effect of PFA from the physician response that produces it, we proceed in two steps. We begin at the hospital level, estimating the effect of PFA availability on the share of a hospital's encounters that are cardiac ablations in an event-study design that compares adopting hospitals to those that never adapted during our sample. Hospitals acquire PFA through capital procurement, and the determinants of such purchases are institutional rather than physician-driven, including hospital size, financial position, and competition with nearby hospitals (Barbash et al., 2014; Wright et al., 2016). This makes PFA adoption plausibly exogenous from the physician's perspective. The hospital-level comparison helps us understand how PFA adoption changes the mix of care delivered at the adopting hospital. However, it cannot say which physicians produced the change.

Next, we focus on the physicians performing cardiac ablations. Ablation is performed by cardiac electrophysiologists (EPs), and EPs in our setting routinely practice at more than one hospital. Therefore, in a given month we observe the same EP operating at a hospital that has PFA and at a hospital that does not. Our empirical strategy compares an EP's ablation activity with their own, in the same month, at their PFA hospital versus their non-PFA hospital. We include physician by month, physician by hospital, and hospital by year fixed effects. The first absorbs a physician's own activity and any shock to their practice that month, the second absorbs the sorting of physicians to different hospitals, and the third absorbs time-varying hospital-level shocks. Identification comes from the remaining variation within a physician-month, equal to the gap in ablation activity between their PFA and non-PFA hospitals. Since we observe procedures rather than time, our estimates describe how a physician allocates work across tasks and sites rather than output per hour.

Our data are hospital discharge records covering all inpatient and outpatient encounters at every hospital in a large U.S. metropolitan area from January, 2022 through December, 2025. Three features of the data make them well suited to this research question. First, the data are all-payer, where we observe commercial, Medicare, Medicaid, and uninsured encounters alike, so we can ask who captures the gains from PFA across the full patient population rather than within a single insurer. Second, every encounter carries a physician identifier as well as a hospital identifier, and the same identifier follows a physician across all the hospitals at which they practice. This is what allows us to follow the same EP as PFA becomes available at some of their hospitals but not others. Third, the panel begins two years before FDA approval, giving us a clean pre-period against which to assess trends. These three features are rarely available in combination. National claims datasets cover a single payer, all-payer state discharge files typically do not report a physician identifier that can be tracked across facilities, and neither observes a full market's inpatient and outpatient activity at monthly frequency.

We identify inpatient ablations from ICD-10-PCS procedure codes and outpatient ablations from CPT codes. We date a hospital's adoption of PFA from the first month in which it reports the PFA-specific inpatient procedure code. Our primary outcome is the ablation share which is the fraction of a physician's encounters at a hospital in a given month that are cardiac ablations. However, a rising share can reflect more ablations or fewer other encounters, so we also examine ablation volume and non-ablation volume in levels. To trace incidence across patients, we disaggregate ablation volume by primary payer, distinguishing commercial, Medicare, Medicaid, and uninsured encounters. To trace incidence across physicians, we group them separately by their ablation volume and by their total clinical volume in the two years before any hospital in the market adopted PFA.

We find that PFA adoption tilts adopting hospitals' case mix toward ablation. The ablation share of encounters at adopting hospitals is flat before adoption and rises by about 3.6 percentage points when PFA becomes available. However, this hospital-level shift need not reflect any change in physician behavior. The hospital may have gained EPs, or its existing EPs may have moved cases in from the other hospitals where they practice. To distinguish across these channels we would need to observe physicians across hospitals.

The within-physician estimates rule out both. When PFA becomes available at a hospital, the same physician becomes 20 percent more likely to perform any ablation there and performs about 37 percent more of them, roughly eight additional procedures a year, relative to their own contemporaneous activity at their other non-adopting hospitals. Their ablation share at the adopting site rises by 4.8 percentage points, more than the 3.6-point increase we measured at the hospital level. These are not old cases moved between hospitals, since ablation volume at the same physician's non-adopting hospitals does not move, which bounds relocation of their own cases at a small fraction of the increase.

When we group physicians by their pre-period ablation volume, those in the bottom quarter show no detectable change, while the middle half and the top quarter raise their ablation share by 5.3 and 6.7 percentage points respectively. Grouping the same physicians by overall clinical volume yields no such gradient as the busiest and least busy differ by only 0.2 percentage points. Overall, we find that the response is predicted by prior ablation practice rather than by how busy a physician is overall. On the patient side, commercially insured and Medicare patients each account for about four additional procedures per physician-year and the increase is statistically indistinguishable from what the existing payer mix would predict.

This paper contributes to three strands of research. The first is the economics of technology adoption and productivity. A large literature studies how new technologies change what workers do and what they produce, from information technology reorganizing work (Autor et al., 2003; Acemoglu and Autor, 2011) to robots and automation displacing some tasks while raising output in others (Acemoglu and Restrepo, 2020). A parallel line of work brings these questions to health care, spanning low-cost innovations such as beta blockers (Skinner and Staiger, 2015), payment-driven technology choices (Acemoglu and Finkelstein, 2008), and the volume effects of high-cost equipment (Horn et al., 2022). Horn et al. (2022) is closest to our setting, showing that robot adoption raises an adopting hospital's volume. Hospital-level data, however, cannot reveal whether any individual physician performs more procedures or whether the workforce simply reorganized around the technology. We move the unit of analysis from the hospital to the physician, comparing the same physician in the same month across hospitals that differ in technology access. To

our knowledge, this is the first within-physician estimate of how a new medical technology changes an individual physician's provision of a procedure. It also lets us ask which physicians and patients account for the increase.

Second, we contribute to the evidence on who benefits when a new technology reaches skilled work. Existing estimates come largely from artificial intelligence. In customer support, generative AI compresses the productivity distribution, with the largest proportional gains accruing to the least experienced agents (Brynjolfsson et al., 2025), and in medicine, AI predictions improve radiologists' diagnoses only for some physicians (Agarwal et al., 2023). Unequal gains can also arise from adoption itself, as higher-performing workers are more likely to take up the technology even in occupations where it would most help lower performers (Humlum and Vestergaard, 2025b). These technologies share a feature that plausibly explains the pattern, in that each supplies expertise that less-experienced workers lack. PFA supplies none. It saves time on a task only trained specialists can perform, and it is quick to learn, so it lowered the barrier to performing ablations without transferring any of the underlying skill. It nonetheless did not widen the set of physicians performing them. The response comes from physicians already doing ablations, and is unrelated to how busy they were otherwise.

Third, we build on the literature on physician practice variation and the allocation of care across providers and patients. Physicians differ substantially in how they treat similar patients, and these differences largely reflect skill, training, and practice environment (Chandra and Staiger, 2007; Molitor, 2018; Chan et al., 2022). Allocation also responds to shocks, as when entry restrictions on cardiac surgery were lifted in Pennsylvania and volume shifted away from incumbents toward higher-quality surgeons (Cutler et al., 2010). This literature holds technology fixed and studies the variation across physicians. We do the opposite, holding the physicians fixed and varying the technology, and ask where in the existing distribution of care a technology shock lands. We find that the additional procedures arrive among physicians already performing them, and they go to patients in almost exactly the proportions in which ablation was already provided, with the commercial and Medicare shares of the increase matching their shares of the baseline. A shock large enough to raise a physician's ablation volume by more than a third left both

distributions unaffected.

2 Background

2.1 Atrial Fibrillation and Pulsed-Field Ablation

Atrial fibrillation (AF) is a disorder in which disorganized electrical activity in the atria produces a rapid, irregular heartbeat. It is a key contributor to morbidity and mortality with the condition raising the risk of stroke, heart failure, and death (Joglar et al., 2024). At least 10.5 million U.S. adults have diagnosed AF which is about 4.5 percent of the adult population (Noubiap et al., 2024). The prevalence of AF rises sharply with age, from 0.3 percent among adults under 50 to nearly 25 percent among those 90 and older (Oltman et al., 2024). The condition becomes especially important with population aging and rising rates of hypertension, obesity, and diabetes (Joglar et al., 2024). A growing patient population makes AF treatment an increasingly important use of physician time.

Until recently, ablation in the United States relied on thermal energy and took two principal forms. Radiofrequency ablation heats the target tissue point by point, and cryoballoon ablation freezes it. While both methods are effective and time-intensive, because heat and cold spread beyond the targeted tissue, both methods carry a small risk of injury to nearby structures such as the esophagus and the phrenic nerve (Joglar et al., 2024). Meanwhile, PFA delivers a series of ultra-rapid electrical pulses that kill the target cells through irreversible electroporation. The pulses act preferentially on myocardial tissue, largely avoiding these thermally mediated complications (Ekanem et al., 2024). In a separate randomized trial, PFA achieved safety and efficacy comparable to thermal ablation while taking substantially less time, with a mean total procedure time of 106 versus 123 minutes and a mean ablation time of 29 versus 50 minutes (Reddy et al., 2023).

The FDA approved the first PFA system, Medtronic's PulseSelect, in December 2023, and a second, Boston Scientific's Farapulse, in January 2024. Three more systems followed within the year, including Medtronic's Affera in October 2024 and Johnson & Johnson's Varipulse in November 2024, and Abbott entered in January 2026. Boston Scientific accounted for essentially all PFA spending in 2023 and roughly 83 percent in 2024,

but its share fell to about 41 percent by early 2026 as competitors entered (Guidepoint Qsight, 2026). PFA's gains came at the expense of existing thermal and cryoablation procedures. Radiofrequency ablation fell from 63 percent of ablation catheter spending in 2023 to 22 percent by the end of 2025, and cryoablation fell from 21 percent to under 2 percent, even as total catheter volume continued to grow (Guidepoint Qsight, 2026).

Adopting PFA is a capital decision made by the hospital. A PFA system pairs a generator, which is purchased once, with single-use catheters bought per procedure. Generators are tied to particular mapping platforms, so a hospital that commits to one manufacturer faces meaningful costs to switch to another (Mordor Intelligence, 2026). Staff must be trained on the new workflow, though the technology is straightforward to learn, with procedure times stabilizing after roughly 15 to 20 cases per operator compared with the several hundred typically required for point-by-point radiofrequency (Kueffer et al., 2026). Therefore, the binding constraint on use is the hospital's purchase rather than the physician's skill. An individual physician can use PFA only if the hospital where they are operating has bought and installed a system, and the timing of that purchase is set by the hospital rather than by the physician.

2.2 Electrophysiologists and the Production of Ablation

Ablation is performed by cardiac electrophysiologists (EPs), specialists in a subspecialty of cardiology focused on heart rhythm disorders. Training requires an internal medicine residency, a cardiology fellowship, and a further fellowship in electrophysiology, so the supply of EPs is fixed in the short run. Ablations take place in dedicated electrophysiology laboratories, specialized rooms equipped for cardiac mapping and catheter navigation. Lab time is a scarce hospital resource, and EPs work in scheduled blocks. Within a block, the number of ablations an EP can complete depends on how long each procedure takes and how quickly the room is turned over. Evidence from German hospitals quantifies this constraint, with the slower modality generating five times the cumulative overtime and leaving usable lab time on far fewer days (Metzner et al., 2023). A faster procedure therefore creates room for more cases within a block. In our setting, EPs commonly hold privileges at more than one hospital and divide their lab time across them.

Recently, ablation has also shifted from inpatient to outpatient delivery. Among Medicare patients undergoing AF ablation between 2016 and 2019, 82 percent were treated as outpatients (Obeid et al., 2023). Same-day discharge also followed the same path, rising from 1 percent of AF ablations in early 2016 to 62 percent by mid-2023 and overtaking overnight hospitalization in 2021 (Sandhu et al., 2025). Accordingly, most ablation volume in our data appears in outpatient claims.

3 Data

Our data come from a regional hospital data consortium covering all hospitals in a large U.S. metropolitan area. The data are at the patient encounter-level and span both inpatient and outpatient settings. For each encounter we observe the hospital, the year and month of service, the attending and operating physician National Provider Identifier number, the primary payer, and the full set of billed procedure codes.

We draw two extracts, one for each level of analysis. The first is procedure-based and returns every encounter in the market that carries a cardiac ablation code. This extract supports the hospital-level analysis, since it gives us each hospital's monthly ablation volume and the date on which a hospital first performs a pulsed-field ablation. The second extract is for the physician level analysis. Using the set of electrophysiologists identified in the first extract, we request every encounter for those physicians, whether or not it involves an ablation, in both attending and operating roles. It supplies the denominator of our share outcomes, which is a physician's total caseload at a hospital in a month, along with each encounter's payer group.

Inpatient procedures are coded in ICD-10-PCS, in which the seventh character is a qualifier that records the ablation modality. We classify a percutaneous catheter destruction of the cardiac conduction mechanism, denoted by codes beginning 02583, as pulsed-field when it carries the qualifier F for irreversible electroporation (02583ZF), and as thermal when it carries the null qualifier Z (02583ZZ), which covers radiofrequency and cryoablation. In both codes the sixth character, which records the device, is Z for no device (Prescott, 2024). CMS established the irreversible electroporation qualifier effective

April 1, 2024. It concurrently approved a New Technology Add-on Payment conditional on reporting 02583ZF, which gives hospitals a direct financial incentive to code pulsed-field cases correctly and lends confidence to our adoption measure.

Because the qualifier did not exist beforehand, no hospital can be dated as adopting before April 2024. A facility that began performing pulsed-field ablation after FDA approval in late 2023 but before the code existed would have billed those cases as 02583ZZ. This censoring works against us. It dates the earliest adopters late and places some genuine pulsed-field activity in the pre-period, both of which attenuate the estimated effect. Our outcome and treatment are defined on percutaneous catheter ablation. We exclude open surgical ablation (02580) and percutaneous endoscopic ablation (02584), which are distinct procedures.

Outpatient procedures are coded in CPT, where the relevant ablation codes, 93653 through 93657, identify the arrhythmia treated and the anatomic target but not the energy source. Radiofrequency, cryoballoon, and pulsed-field ablations are billed identically (American Medical Association, 2023). No Category III CPT code appears anywhere in our outpatient data, and Category III is the category to which any pulsed-field-specific outpatient code would belong. An audit of the outpatient supply lines returns only generic electrophysiology hardware. We therefore anchor treatment on the inpatient channel, where energy is observable, and treat outpatient ablations as energy-agnostic in the outcome. This is also conservative. If pulsed-field ablation were simply substituting one for one for thermal ablation, total outpatient ablation counts would not move, so any measured increase reflects additional activity rather than a relabeling of energy source.

Treatment is assigned at the hospital-month level. A hospital's adoption month is the first calendar month in which it records an inpatient PFA encounter (02583ZF). We treat PFA as available in that month and every month thereafter. A hospital that records no PFA cases in a later month is still coded as having the technology, since the generator is a one-time purchase and a gap in cases reflects scheduling rather than the loss of capability.

We impose three restrictions each driven by the research design rather than by the outcome. First, from all physicians performing any ablation in either setting, we retain

those observed at two or more hospitals. The within-physician design compares a physician across facilities, so a physician observed at a single hospital contributes no identifying variation. Second, we retain pairs with at least three encounters in the estimation window. This drops incidental affiliations, such as a single consult at a facility where the physician does not otherwise practice, which would enter the panel as near-empty cells. Third, our panel runs from January 2022 through December 2025, or 48 months. It begins more than two years before the first adoption in April 2024 and ends at the close of reliable claims coverage.

The hospital-level and physician-level analyses use different units of observation and therefore different panels. Both are built from the same encounter records and cover the same 48 months, January 2022 through December 2025. The hospital-level panel is a balanced panel of hospital-months. It covers the 83 hospitals in the market that perform cardiac ablation, of which 31 adopt PFA during the window and 52 never adopt. The estimation sample is 2,989 hospital-months across the 78 hospitals contributing an estimable comparison, 30 adopting and 48 never-adopting, and identification comes from the staggered timing of adoption among the adopters. We estimate a Callaway and Sant'Anna (2021) difference-in-differences estimator with never-treated hospitals as the comparison group.

The physician-level panel is a balanced panel of physician-hospital-months. We begin from the 212 physicians in our ablation cohort, defined as physicians who perform at least one ablation in the market. The 212 physicians in our cohort account for roughly one-tenth of the estimated 2,000 cardiac electrophysiologists in the US (Kabra et al., 2025), so a single metropolitan market captures a substantial share of the physicians nationally who perform ablation. Out of this cohort, we keep 181 EPs who practice at more than one hospital during the estimation window. We drop physician-hospital pairs with fewer than three encounters, which removes incidental affiliations such as a single consult at a facility where the physician does not otherwise practice. The saturated fixed effects then absorb 3,232 singleton observations, meaning physician-months, physician-hospital pairs, or hospital-years observed only once, leaving an estimation sample of 15,886 physician-hospital-months covering 177 physicians and 82 hospitals. Because the ablation share is

undefined when a physician has no encounters at a hospital in a given month, we restrict to physician-hospital-months with positive volume and estimate count outcomes on the same sample. We confirm that PFA availability does not affect whether a physician-hospital-month is non-empty, which we show in the Web Appendix.

The estimation sample contains 15,886 physician-hospital-month cells covering 238,682 encounters, of which 29,036 are ablations, 3,915 inpatient and 25,121 outpatient, performed by 177 physicians across 82 hospitals. The identifying variation comes from physicians who practice in the same month at one hospital where pulsed-field ablation is already available and at least one where it is not, either because that hospital never adopts or because it has not yet done so. This condition is met by 145 of the 177 physicians, supplying 1,232 physician-months of identifying variation across 74 of the 82 hospitals.

4 Empirical Strategy

We first ask whether adopting PFA raises a hospital's ablation activity, and we trace the response over time with an event study. The unit is the hospital-month, and the outcome Y_{ht} is the ablation share, the fraction of our cohort physicians' encounters at hospital h in year-month t that are cardiac ablations. These dynamic effects are our main coefficients of interest, and we represent them in the following event study equation

$$Y_{ht} = \sum_{\substack{k=-\underline{K} \\ k\neq -1}}^{\overline{K}} \beta_k \, \mathbf{1}\{\, t - G_h = k \,\} + \alpha_h + \tau_t + \varepsilon_{ht}, \tag{1}$$

Here, β_k denotes the effect of adoption on this share k months out and G_h is hospital h's PFA adoption month. We include α_h hospital fixed effects and τ_t year-month fixed effects. To estimate β_k we use the Callaway and Sant'Anna (2021) estimator which compares each adoption cohort to the 48 never-adopting hospitals and aggregates the resulting effects by event time. Identification is based on two assumptions. First, hospitals do not alter their ablation activity in advance of adoption in response to knowing it is coming. Second, it is required that absent adoption, adopting hospitals' ablation share would have evolved in line with never-adopters'. The pre-adoption coefficients test

both assumptions, and the post-adoption coefficients trace the effect over event time. We summarize the post-adoption path as an average over the first twelve months after adoption rather than over all post-adoption periods. Coverage falls sharply with event time, since hospitals adopting late in the panel are observed for only a few months afterward, so the longest horizons are identified by a small number of hospitals while receiving the same weight as the earliest ones in an unweighted average. Standard errors are clustered at the hospital level.

The hospital-level effect does not shed light on whether any individual physician became more productive and on which patients are treated. To recover the incidence of the gain, we move to the physician-hospital-month level and exploit the fact that a physician who practices at several hospitals gains PFA at some before others. We estimate,

$$Y_{iht} = \beta \times PFA_{ht} + \alpha_{it} + \gamma_{ih} + \delta_{h,y} + \epsilon_{iht} \tag{2}$$

where α_{it} is physician by year-month fixed effects, γ_{ih} is physician by hospital fixed effects, and $\delta_{h,y}$ is hospital by year fixed effects. PFA_{ht} indicates the same hospital-month availability indicator of PFA as above.

The fixed effects define the identifying variation, and with it the identifying assumption. The physician-by-month effect absorbs each physician's time-varying total output and any shock common to her practice in year-month t, including the national diffusion of PFA itself. As a result, β is identified only from differences, within a physician and a month, between the hospitals at which she does and does not have PFA available. The physician-by-hospital effect absorbs the persistent sorting of physicians to facilities, so the comparison is not contaminated by a physician being busier at some sites than others. The hospital-by-year effect absorbs hospital-level capacity and demand shocks, such as a lab expansion. Identification therefore requires only that, conditional on these fixed effects, which of a physician's hospitals offers PFA in a given month is unrelated to her residual, hospital-specific propensity to perform ablations. The institutional setting makes this plausible, since adoption is a hospital procurement decision rather than the physician's own.

Three further specifications use the same design. To separate the extensive from the intensive margin, we replace the outcome with an indicator for whether the physician performed any ablation at that hospital in that month, which asks whether PFA changes the probability of operating at a site rather than only the number of cases conditional on operating. To ask which physicians account for the response, we interact PFA availability with indicators for a physician's position in the distribution of pre-period activity, cutting at the twenty-fifth and seventy-fifth percentiles of the estimation-sample physicians. We construct these groups twice, once on ablations performed and once on total encounters, both measured over January 2022 through December 2023, which ends before any hospital in the market adopts. The two groupings are close to uncorrelated in our data, so the second is not a rescaling of the first, and comparing them separates prior ablation practice from overall clinical activity.

The estimand is a local effect, identified by the physicians who, within a single month, have PFA available at one hospital where they practice and not at another, whether that second hospital never adopts or adopts only later. Standard errors are clustered at the hospital level. Standard errors are clustered at the hospital level. The outcome is the same object at two units of aggregation, which makes the two analyses directly comparable. At the hospital level it is the share of a hospital's encounters in a month that are cardiac ablations, where encounters are those of the physicians in our cohort, and at the physician level it is the share of a physician's own encounters at a given hospital in a given month that are cardiac ablations, defined whenever they have at least one encounter there. In both situations, the numerator is ablation encounters and the denominator is total encounters, so the outcome measures how intensively a caseload is devoted to ablation.

5 Results

Figure 1 plots the estimated effect of PFA availability on a hospital's ablation share by event time, using the Callaway and Sant'Anna (2021) estimator with never-adopting hospitals as the comparison group. The pre-adoption path shows no discernible trend toward adoption. The six coefficients preceding adoption average 0.72 percentage points (SE =

1.50), and the average across all forty-four pre-adoption event times is -1.24 percentage points, neither of which suggests that adopting hospitals were on a differential trajectory before the technology arrived. The share increases in the month of adoption and remains elevated for the remainder of the window, with all twelve post-adoption coefficients positive and averaging 3.59 percentage points (SE = 1.67). Against a pre-adoption mean of 12 percent at adopting hospitals, this represents a relative increase of roughly 30 percent. The monthly coefficients are individually imprecise, with standard errors ranging from 1.2 to 4.5 percentage points, so the figure is informative about the level and persistence of the shift, and we treat the twelve-month average as the estimate of interest. Truncating the aggregation window earlier yields similar estimates with 3.41 percentage points six periods after and 3.85 percentage points nine periods after, so the 12 period average is not sensitive to the horizon over which the post-adoption coefficients are aggregated.

There are two things this analysis cannot establish. The first is whether more ablations were performed anywhere, since the outcome is a share and a hospital devoting a larger fraction of its electrophysiology caseload to ablation is consistent both with the technology drawing existing activity to the adopting facility and with additional procedures being performed. The second is the source of the shift. An adopting hospital may have gained electrophysiologists, or the physicians already practicing there may have brought cases in from the other hospitals at which they operate, and neither possibility can be distinguished from a change in physician behavior when the unit of observation is the hospital-month. Separating them requires following the physicians themselves, which is what we describe below.

Table 1 reports the within-physician estimates. We find that when PFA becomes available at a hospital, the same physician's ablation share at that hospital rises by 4.83 percentage points against a pre-treatment mean of 12.7, and their ablation count rises by 0.672 procedures per month against a pre-treatment mean of 1.83. This roughly translates to eight additional procedures over a year of exposure. We report each count outcome twice, in levels by ordinary least squares and in proportional terms by Poisson pseudo-maximum likelihood. We find that the physician's other work at the adopting hospital does not move in a way we can sign. Non-ablation encounters fall in both specifications, by 0.202 in levels

and by 10.5 percent under Poisson, but the levels estimate is imprecise enough to include zero while the Poisson estimate is not. In levels the two count outcomes are additive, and the coefficient on total encounters is 0.470, so the physician's total caseload at the site rises by less than their ablation count does.

Table 2 asks how the additional ablations arise and where they come from. The first three columns replace the outcome with an indicator for whether the physician performs any ablation at that hospital in that month. Availability raises that probability by 6.9 percentage points against a base of 34 percent, an increase of about a fifth, so part of the response is a change in whether the physician operates at the site rather than only in how many cases they perform once there. Restricting to physicians with prior ablation activity gives 9 percentage points. The corresponding estimate for physicians with no ablations before April 2024 is small and negative, but it rests on 37 physicians and a pre-treatment mean of 0.04, and its confidence interval spans roughly twice that mean in either direction, so it is uninformative rather than evidence that PFA drew in no previously inactive operators.

The remaining possibility is that the physician performs more ablations at the adopting hospital by performing fewer somewhere else. Column (4) tests this directly on the same physicians' cells at hospitals that never adopt during the panel, asking whether their ablation volume at those hospitals falls when PFA becomes available at one of their other hospitals. The estimate is 0.025 against a pre-treatment mean of 0.194, with a confidence interval running from -0.049 to 0.099. Taking the lower bound at face value, relocation of the physician's own existing cases could account for at most 7.4 percent of the 0.672 increase in Table 1. The additional ablations at the adopting site are therefore new to that physician's practice rather than moved into it.

Table 3 asks which physicians perform the additional ablations. We grade physicians on pre-treatment information alone, cutting at the twenty-fifth and seventy-fifth percentiles of the estimation sample, and interact PFA availability with the resulting groups. Panel A grades them by the number of ablations they performed before any hospital in the market adopted. Panel B grades them by their total encounters of any kind over the same window, which measures how busy a physician is overall rather than how

much ablating they do.

The two panels give different answers. Grading by prior ablation activity, physicians in the bottom group show no detectable response, while the middle group and the top group raise their ablation share by 5.29 and 6.73 percentage points. The differences from the bottom group are 3.52 and 4.96 percentage points, and both survive a wild cluster bootstrap on hospital clusters. Grading the same physicians by overall clinical volume produces nothing. The top-versus-bottom difference is 0.18 percentage points with a bootstrap p-value of 0.94, and the middle-versus-bottom difference is likewise indistinguishable from zero.

The two gradings are close to orthogonal, so Panel B is not a rescaling of Panel A. The correlation between a physician's pre-period ablation count and their pre-period total encounters is 0.08. What predicts the response is prior ablation practice rather than practice size. A technology that lowered the barrier to performing a procedure did not broaden the set of physicians performing it.

Table 4 decomposes the increase by the payer of the patient treated. The four payer-specific coefficients sum to 0.672, the effect on total ablations in Table 1, so the decomposition is exact rather than approximate. Commercially insured and Medicare patients account for 97 percent of the additional procedures, at 3.8 and 4.1 more per physician-year. The Medicaid and uninsured coefficients are small and imprecise, and their pre-treatment bases are small enough that we do not read them as demonstrated nulls. Medicaid patients receive on the order of one additional ablation per physician every twenty-four years.

The more important comparison here is between each payer's share of the increase and its share of ablations before adoption. Commercial patients receive 46.7 percent of the additional procedures against a baseline share of 41.3, and Medicare 50.6 against 54.1. For no payer can we reject that the increase is proportional to the baseline distribution. The same conclusion follows from estimating the effect on each payer's share of a cell's ablations directly, where every coefficient is indistinguishable from zero. The technology reproduces the existing distribution of ablation care rather than altering it, leaving payer

composition unchanged while widening the absolute differences between payer groups.

The within-physician estimate survives a range of checks which we report in the Web Appendix. It is stable across five alternative estimation samples, where the effect on the ablation share ranges from 4.49 to 5.96 percentage points and is significant in every one. Dating adoption one to three months earlier, which mimics the censoring imposed by the coding rule, attenuates the estimate monotonically to 2.23 percentage points, and the corresponding pre-adoption averages are negative throughout, so mis-dating cannot manufacture the positive effect. Reclassifying the never-adopting hospitals most likely to have acquired PFA without recording an inpatient case leaves the estimate at 4.89 and 4.94 percentage points while raising the hospital-level estimate, so our baseline treatment of those hospitals as controls is conservative. Take-up at adopting hospitals is zero in every month before adoption and reaches about half of inpatient ablations within a year, and is zero throughout at hospitals we classify as never-adopting.

6 Discussion

When a technology arrives that saves time on work only trained specialists can perform, the response of those specialists determines what the technology delivers and to whom. We ask how an individual physician's provision of a procedure changes when it becomes available at one of the hospitals where they work. The answer is that provision at that hospital rises substantially, by about 37 percent, along with a rise of a fifth in the probability of performing any ablation there at all. The additional cases are not drawn from the physician's other hospitals, where volume is unchanged, and the case mix at the adopting hospital tilts toward ablation. The response comes from physicians who were already performing ablations rather than from busy physicians in general, and the additional procedures accrue to commercially insured and Medicare patients in proportion to their existing share of ablation care. Two things follow from this pattern, the first being that a technology which lowers the barrier to a procedure need not widen the set of people who perform it, and the second that a shock large enough to raise a physician's ablation volume by more than a third can nonetheless leave the distribution of who provides and who receives that

care where it was previously.

What our design cannot recover is the mechanism behind the response, since a faster procedure frees lab time, referrals may route toward the hospital that has the equipment, and hospitals allocate electrophysiology block time in ways we do not observe. These are observationally equivalent in our data, and the donor-site test rules out only the narrower possibility that the physician moved their own existing cases. We therefore describe the response as a reallocation of work toward the newly faster task rather than as a gain in productivity, since we observe procedures and not the time they take.

Two features of the setting bear on how the magnitudes should be read. The first is that ablation demand in this market was growing rapidly over our sample, roughly doubling between 2022 and 2025, with non-adopting hospitals growing nearly as fast. A physician who gains a faster technology in a market with a queue of eligible patients can convert freed capacity into cases in a way that would not be possible where demand binds, so our estimates are best understood as an upper region of the plausible response rather than a general one. The second is that the technology is observable only in the inpatient setting, since outpatient codes do not record the energy source, while most ablation volume is outpatient. Hospitals that adopted PFA only in their outpatient laboratories are therefore treated as controls, and the Appendix A.3 shows that correcting this raises rather than lowers the estimated effect. Our sample is also a single metropolitan area, which is what buys the within-physician comparison, and whether the same pattern holds where market structure or payer mix differs is an open question.

The findings speak to how the benefits of medical technology are distributed rather than to whether hospitals should acquire it. Policies that subsidize adoption, including the add-on payment that accompanied this technology, operate on the hospital's purchase decision, and our results suggest that the distributional consequences are settled after that decision rather than by it. If the concern is who performs a procedure, easing the technical barrier appears not to be the binding margin, since the physicians who did not already ablate did not begin doing so when the barrier fell. If the concern is which patients receive new technology, a proportional increase preserves existing composition while widening absolute gaps, and whether that is the desired outcome is a question our

estimates frame rather than answer. More broadly, the contrast with recent evidence on artificial intelligence suggests that the incidence of a new tool depends on whether it supplies expertise that some workers lack or saves time for workers who already have it, and that the two cases can point in opposite directions.

References

Acemoglu, D. and D. Autor (2011). Skills, tasks and technologies: Implications for employment and earnings. In *Handbook of labor economics*, Volume 4, pp. 1043–1171. Elsevier.

Acemoglu, D. and A. Finkelstein (2008). Input and technology choices in regulated industries: Evidence from the health care sector. *Journal of Political Economy 116*(5), 837–880.

Acemoglu, D. and P. Restrepo (2020). Robots and jobs: Evidence from us labor markets. *Journal of political economy 128*(6), 2188–2244.

Agarwal, N., A. Moehring, P. Rajpurkar, and T. Salz (2023). Combining human expertise with artificial intelligence: Experimental evidence from radiology. Technical report, National Bureau of Economic Research.

American Medical Association (2023). *Current Procedural Terminology (CPT) 2024, Professional Edition*. Chicago, IL: American Medical Association.

Autor, D. H., F. Levy, and R. J. Murnane (2003). The skill content of recent technological change: An empirical exploration. *The Quarterly journal of economics 118*(4), 1279–1333.

Barbash, G. I., B. Friedman, S. A. Glied, and C. A. Steiner (2014). Factors associated with adoption of robotic surgical technology in us hospitals and relationship to radical prostatectomy procedure volume. *Annals of surgery 259*(1), 1–6.

Brynjolfsson, E., D. Li, and L. Raymond (2025). Generative ai at work. *The Quarterly Journal of Economics 140*(2), 889–942.

Callaway, B. and P. H. Sant'Anna (2021). Difference-in-differences with multiple time periods. *Journal of econometrics 225*(2), 200–230.

Chan, D. C., M. Gentzkow, and C. Yu (2022). Selection with variation in diagnostic skill: Evidence from radiologists. *The Quarterly Journal of Economics 137*(2), 729–783.

Chandra, A. and D. O. Staiger (2007). Productivity spillovers in health care: evidence from the treatment of heart attacks. *Journal of political Economy 115*(1), 103–140.

Cutler, D. M., R. S. Huckman, and J. T. Kolstad (2010). Input constraints and the efficiency of entry: Lessons from cardiac surgery. *American Economic Journal: Economic Policy 2*(1), 51–76.

Cutler, D. M. and M. McClellan (2001). Is technological change in medicine worth it? *Health affairs 20*(5), 11–29.

Dillon, E. W., S. Jaffe, N. Immorlica, and C. T. Stanton (2025). Shifting work patterns with generative ai. Technical report, National Bureau of Economic Research.

Ekanem, E., P. Neuzil, T. Reichlin, J. Kautzner, P. van der Voort, P. Jais, G.-B. Chierchia, A. Bulava, Y. Blaauw, T. Skala, et al. (2024). Safety of pulsed field ablation in more than 17,000 patients with atrial fibrillation in the manifest-17k study. *Nature medicine 30*(7), 2020–2029.

Guidepoint Qsight (2026, June). The pulsed field ablation market and the remaking of AFib treatment. Qsight Market Models, Guidepoint. Purchasing data from more than 4,500 U.S. healthcare facilities.

Hartman, M., A. B. Martin, D. Lassman, A. Catlin, and National Health Expenditure Accounts Team (2026). National health care spending increased 7.2 percent in 2024 as utilization remained elevated. *Health Affairs 45*(2), 110–120.

Horn, D., A. Sacarny, and A. Zhou (2022). Technology adoption and market allocation: The case of robotic surgery. *Journal of Health Economics 86*, 102672.

Humlum, A. and E. Vestergaard (2025a). *Large language models, small labor market effects*, Volume 33777. National Bureau of Economic Research Cambridge, MA.

Humlum, A. and E. Vestergaard (2025b). The unequal adoption of chatgpt exacerbates existing inequalities among workers. *Proceedings of the National Academy of Sciences 122*(1), e2414972121.

Joglar, J. A., M. K. Chung, A. L. Armbruster, E. J. Benjamin, J. Y. Chyou, E. M. Cronin, A. Deswal, L. L. Eckhardt, Z. D. Goldberger, R. Gopinathannair, et al. (2024). 2023 acc/aha/accp/hrs guideline for the diagnosis and management of atrial fibrillation: a report of the american college of cardiology/american heart association joint committee on clinical practice guidelines. *Circulation 149*(1), e1–e156.

Kabra, R., P. K. Mason, R. Navara, D. Lakkireddy, and J. W. Cheung (2025). The state of the cardiac electrophysiology workforce in the united states: projections, challenges, and keeping pace with clinical demands.

Kueffer, T., R. King, J. Maurhofer, G. Thalmann, N. A. Kozhuharov, O. Galuszka, H. Servatius, A. Haeberlin, F. Noti, H. Tanner, et al. (2026). Beyond the learning curve: How operator experience affects pulsed-field ablation outcomes. *Heart Rhythm 23*(7), 1569–1576.

Metzner, A., F. Straube, R. R. Tilz, M. Kuniss, G. Noelker, J. Tebbenjohanns, D. Andresen, H. Wieneke, C. Stellbrink, J. Franke, et al. (2023). Electrophysiology lab efficiency comparison between cryoballoon and point-by-point radiofrequency ablation: a german sub-analysis of the freeze cohort study. *BMC cardiovascular disorders 23*(1), 8.

Molitor, D. (2018). The evolution of physician practice styles: evidence from cardiologist migration. *American Economic Journal: Economic Policy 10*(1), 326–356.

Mordor Intelligence (2026). Pulsed field ablation market size and share analysis: Growth trends and forecast (2026–2031). Technical report, Mordor Intelligence. Page last updated February 1, 2026.

Noubiap, J. J., J. J. Tang, J. T. Teraoka, T. A. Dewland, and G. M. Marcus (2024). Minimum national prevalence of diagnosed atrial fibrillation inferred from california acute care facilities. *Journal of the American College of Cardiology 84*(16), 1501–1508.

Obeid, M.-J., J. Zhou, A. J. Sale, C. Longacre, E. P. Zeitler, J. Andrade, S. Mittal, and J. P.

Piccini (2023). Early mortality after inpatient versus outpatient catheter ablation in patients with atrial fibrillation. *Heart rhythm 20*(6), 833–841.

Oltman, C. G., T. P. Kim, J. W. Lee, J. D. Lupu, R. Zhu, and I. D. Moussa (2024). Prevalence, management, and comorbidities of adults with atrial fibrillation in the united states, 2019 to 2023. *JACC: Advances 3*(11), 101330.

Prescott, L. (2024, March). Note from the ACDIS interim director: First quarter 2024 Coding Clinic update. CDI Strategies, Volume 18, Issue 11, Association of Clinical Documentation Integrity Specialists.

Reddy, V. Y., E. P. Gerstenfeld, A. Natale, W. Whang, F. A. Cuoco, C. Patel, S. E. Mountantonakis, D. N. Gibson, J. D. Harding, C. R. Ellis, et al. (2023). Pulsed field or conventional thermal ablation for paroxysmal atrial fibrillation. *New England Journal of Medicine 389*(18), 1660–1671.

Rotenstein, L. S., A. J. Holmgren, R. Thombley, A. Sriram, R. H. Dbouk, M. Jost, D. Aizenberg, S. MacDonald, N. Kanaparthy, B. Williams, et al. (2026). Changes in clinician time expenditure and visit quantity with adoption of artificial intelligence–powered scribes: a multisite study. *JAMA 335*(16), 1408–1417.

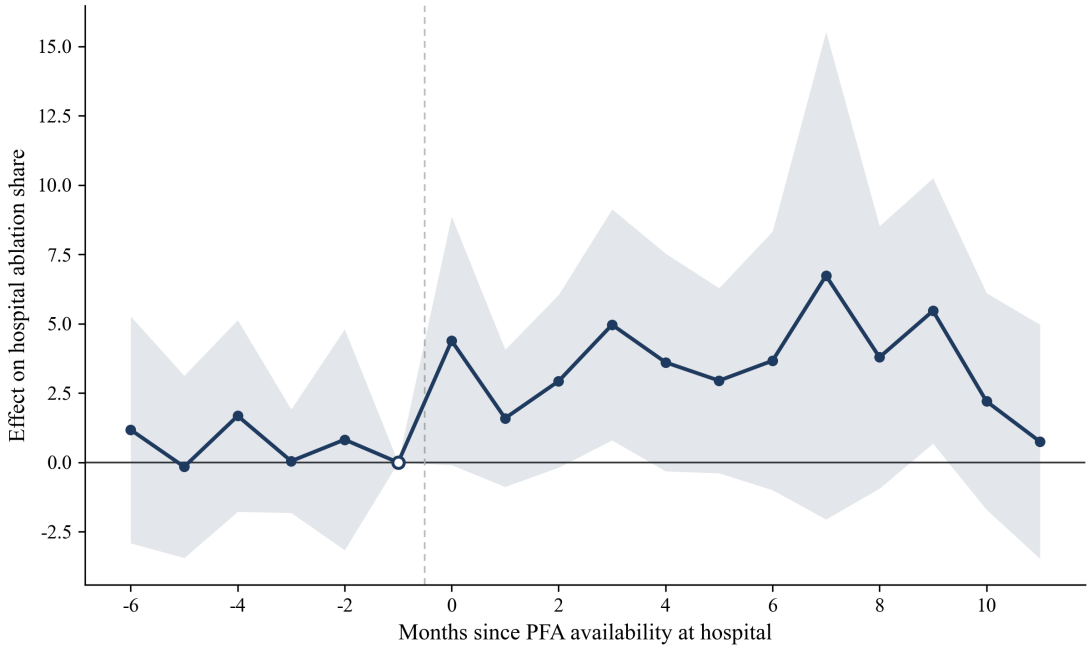
Sandhu, A., L. Qin, K. Minges, S. Zimmerman, R. T. Borne, V. B. Polsinelli, P. M. Ho, J. C. Hsu, S. M. Al-Khatib, J. V. Freeman, et al. (2025). Same-day discharge after catheter ablation of atrial fibrillation in the united states. *Journal of the American Heart Association 14*(9), e039190.

Skinner, J. and D. Staiger (2015). Technology diffusion and productivity growth in health care. *Review of Economics and Statistics 97*(5), 951–964.

Smith, S. D. and J. P. Newhouse (2026). Health-care spending growth has slowed: Will the bend in the curve continue? *American Journal of Health Economics 12*(1), 1–34.

Wright, J. D., A. I. Tergas, J. Y. Hou, W. M. Burke, L. Chen, J. C. Hu, A. I. Neugut, C. V. Ananth, and D. L. Hershman (2016). Effect of regional hospital competition and hospital financial status on the use of robotic-assisted surgery. *JAMA surgery 151*(7), 612–620.

Figure 1: Effect of PFA Availability on Hospital Ablation Share



Notes: The figure plots event-study estimates of the effect of PFA availability on a hospital's ablation share, defined as the share of sample electrophysiologists' (EPs) encounters at a hospital in a month that are cardiac ablations. The shaded region gives 95 percent confidence intervals from standard errors clustered at the hospital level.

Table 1: Effect of PFA Availability on Physician Ablation Provision

	Ablation share (pp)	Ablation count		Non-ablation count	
	(1)	(2)	(3)	(4)	(5)
PFA available	4.831***	0.672***	0.313***	-0.202	-0.111**
	(1.085)	(0.157)	(0.078)	(0.444)	(0.051)
95% confidence interval	[2.703, 6.958]	[0.364, 0.980]	[17.4%, 59.2%]	[-1.072, 0.669]	[-19.0%, -1.0%]
Estimator	OLS	OLS	PPML	OLS	PPML
Physician × month FE	Yes	Yes	Yes	Yes	Yes
Physician × hospital FE	Yes	Yes	Yes	Yes	Yes
Hospital × year FE	Yes	Yes	Yes	Yes	Yes
Mean dep. var., pre-treatment	12.685	1.829	3.746	13.823	13.823

Notes: An observation is a physician × hospital × month cell, restricted to cells with positive encounter volume. *PFA available* equals one from the month a hospital records its first pulsed-field ablation. Columns (1), (2) and (4) use 15,886 observations and 82 hospital clusters, column (5) uses 15,883 and 82, and column (3) uses 6,259 and 43. Columns (3) and (5) report Poisson pseudo-maximum-likelihood estimates, whose coefficients are semi-elasticities, so the implied effects are +36.7% and −10.5% and their intervals are reported on the same scale. Poisson drops fixed-effect groups whose outcome is identically zero, which is why those samples are smaller. The mean of the dependent variable is reported on each column's own estimation sample.
Standard errors in parentheses are clustered by hospital.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2: Margins of Adjustment and the Source of the Additional Ablations

	Performs any ablation at the site			Ablation count
	(1)	(2)	(3)	(4)
PFA available	0.069***	-0.012	0.090***	0.025
	(0.022)	(0.033)	(0.026)	(0.038)
95% confidence interval	[0.025, 0.114]	[-0.076, 0.052]	[0.040, 0.141]	[-0.049, 0.099]
Sample	All	No prior abl.	Prior ablators	Donor sites
Saturated FE	Yes	Yes	Yes	–
Physician × hospital, month FE	–	–	–	Yes
Mean dep. var. (pre-treatment)	0.340	0.036	0.394	0.194

Notes: Columns (1)–(3) are linear probability models for whether a physician performs any ablation at a hospital in a month, using the saturated specification of Table 1 with standard errors clustered by hospital, and resting on 15,886 observations and 82 clusters, 2,468 and 62, and 13,390 and 78 respectively. Column (2) restricts to physicians with no ablations before April 2024 and column (3) to those with prior ablations. Column (4) is estimated only on multi-hospital physicians' cells at hospitals that never adopt PFA, using physician × hospital pair and calendar-month effects.
Standard errors in parentheses are clustered by physician.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: Who Performs the Additional Ablations?

	Effect by group			Difference	
	Bottom 25%	Middle 50%	Top 25%	Mid − Bot	Top − Bot
	(1)	(2)	(3)	(4)	(5)
Panel A. Physicians graded by pre-period ablation volume					
PFA available	1.771	5.287***	6.731***	3.516*	4.960*
	(1.364)	(1.594)	(2.148)	(1.818)	(2.581)
95% confidence interval	[-0.90, 4.45]	[2.12, 8.46]	[2.46, 11.00]	[-0.05, 7.08]	[-0.10, 10.02]
Wild cluster bootstrap p	—	—	—	0.024	0.027
Mean dep. var. (pre-treatment)	1.15	6.47	26.74		
Mean pre-period ablations	0.4	21.7	247.3		
Physicians	70	63	44		
Panel B. Physicians graded by pre-period total encounters					
PFA available	3.295	5.742***	3.479*	2.446	0.183
	(2.941)	(1.440)	(1.755)	(3.382)	(2.918)
95% confidence interval	[-2.47, 9.06]	[2.88, 8.61]	[-0.01, 6.97]	[-4.18, 9.07]	[-5.54, 5.90]
Wild cluster bootstrap p	—	—	—	0.420	0.939
Mean dep. var. (pre-treatment)	11.24	15.79	4.53		
Mean pre-period encounters	160.2	707.8	1849.1		
Physicians	45	88	44		
Physician × month FE	Yes	Yes	Yes	Yes	Yes
Physician × hospital FE	Yes	Yes	Yes	Yes	Yes
Hospital × year FE	Yes	Yes	Yes	Yes	Yes
Clustering			Hospital		

Notes: The dependent variable is the ablation share of a physician's encounters at a hospital in a month, in percentage points. An observation is a physician × hospital × month cell with positive encounter volume. Each panel is a single regression in which *PFA available* is interacted with the physician's group: columns (1)–(3) report the implied effect for each group and columns (4)–(5) the differences from the bottom group. Both panels use 15,886 observations and 82 hospital clusters, and rest on the 177 physicians in the estimation sample of Table 1, of whom 145 supply identifying variation. Standard errors, clustered by hospital, are in parentheses; 95% confidence intervals in brackets. Bootstrap p-values come from a wild cluster bootstrap with 9,999 Rademacher draws and hospital clusters, computed after partialling out the fixed effects, and are reported for the contrasts.

Groups are formed at the 25th and 75th percentiles of the estimation-sample physicians, using pre-treatment information only. Panel A grades physicians by the number of ablations they performed in 2022m1–2023m12 (cut points 1 and 85). Panel B grades them by their *total* encounters of any kind over the same window (cut points 358 and 1160). Because 39 physicians performed no ablations in the pre-period and a further 31 performed exactly one, Panel A's bottom group holds 70 of the 177 physicians rather than a clean quarter; those physicians are retained. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Who Receives the Additional Ablations?

	Commercial (1)	Medicare (2)	Medicaid (3)	Uninsured (4)
PFA available	0.314***	0.340**	0.004	0.015
	(0.079)	(0.130)	(0.010)	(0.012)
95% CI	[0.159, 0.468]	[0.085, 0.595]	[-0.015, 0.022]	[-0.009, 0.038]
Additional ablations per physician-year	3.76	4.08	0.04	0.18
Share of the total increase (%)	46.7	50.6	0.5	2.2
Baseline share of ablations (%)	41.3	54.1	1.5	3.1
p-value, increase = proportional	0.645	0.856	0.514	0.592
Mean dep. var. (pre-treatment)	0.755	0.990	0.027	0.057

Notes: The dependent variable is the physician's ablation count for patients of the indicated payer, in a hospital-month. The specification and sample are those of Table 1 (physician × month, physician × hospital and hospital × year fixed effects, 15,886 observations and 82 hospital clusters), with standard errors clustered by hospital. The final rows compare each payer's share of the increase with its share of ablations before adoption, and test the null that the increase is proportional to the baseline distribution.
Standard errors in parentheses are clustered by hospital.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Appendix

Time-Saving Technology and the Allocation of Specialist Work: Evidence from High-Skilled Physicians

A Robustness of the Within-Physician Estimate

A.1 Alternative Estimation Samples

Table A1: Robustness to the Estimation Sample

	(1) Baseline	(2) Adopters only	(3) Drop adoption month	(4) Drop first 3 months	(5) Inpatient-abl. hospitals
PFA available	4.83***	4.49***	4.68***	5.96***	4.68***
	(1.09)	(1.25)	(1.26)	(1.67)	(1.16)
Saturated FE	Yes	Yes	Yes	Yes	Yes
Mean dep. var., pre-treatment	12.68	12.74	12.71	12.74	12.60
Observations	15,886	10,703	15,495	14,818	13,511
Hospital clusters	82	31	82	82	44

Notes: Every column repeats the specification of Table 1 (physician × month, physician × hospital and hospital × year fixed effects) on a different sample. Column (1) is the baseline. Column (2) keeps only hospitals that ever adopt PFA. Column (3) drops the adoption month itself and column (4) the first three months of exposure. Column (5) keeps only hospitals with any inpatient ablation volume. The mean of the dependent variable is reported on each column's own estimation sample.
Standard errors in parentheses are clustered by hospital.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A1 re-estimates the within-physician effect of PFA availability on the ablation share across five alternative samples, each chosen to address a specific concern about how the estimation sample is built. Column (1) reproduces the baseline of Table 1, 4.83 percentage points. Column (2) restricts the sample to hospitals that ever adopt PFA, so that the comparison is made within the set of adopters rather than against never-adopting hospitals, and the estimate is 4.49. Columns (3) and (4) drop the adoption month and the first three months of exposure, periods in which the timing of availability is most likely to be mismeasured, and return 4.68 and 5.96. Column (5) keeps only hospitals with any inpatient ablation volume, where PFA use would have been observable in the coding, and gives 4.68. The estimate stays between 4.49 and 5.96 and is significant at the one percent

level in every column, with a pre-treatment mean of roughly 12.7 percent throughout, so the result is not an artifact of a particular sampling choice. If anything, dropping the first three months raises the estimate, consistent with a gradual ramp-up that attenuates the effect when the earliest post-adoption months are included.

A.2 Earlier Dating of Adoption

Table A2: Dating Adoption Earlier than the First Coded PFA Case

	Baseline	1 month earlier	2 months earlier	3 months earlier
	(1)	(2)	(3)	(4)
Ablation share (pp)	4.831***	3.963***	3.055***	2.225*
	(1.085)	(1.008)	(1.057)	(1.334)
Ablation count	0.672***	0.664***	0.576***	0.523***
	(0.157)	(0.176)	(0.175)	(0.191)

Notes: Each column repeats the specification and sample of Table 1 after moving each hospital's adoption date earlier by the stated number of months, so that months genuinely preceding adoption are treated as post-adoption.
Standard errors in parentheses are clustered by hospital.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A2 probes whether the coding rule, which can date adoption no earlier than the first inpatient PFA case, biases the estimate by placing genuine post-adoption months in the pre-adoption window. Each column moves every hospital's adoption date earlier by one to three months and re-estimates the baseline specification, so that months that truly precede adoption are deliberately treated as post-adoption. If the recorded date is approximately correct, this misclassification dilutes a correctly dated post period and mechanically attenuates the effect, whereas a genuine anticipatory response would instead raise it. The pattern is the former. The ablation-share estimate falls monotonically from 4.83 percentage points under the recorded dating to 3.96, 3.06, and 2.23 as the date is moved one, two, and three months earlier, and the ablation-count estimate declines in parallel. The hospital-level pre-adoption averages from the primary event-study specification are negative at every dating (-1.24, -2.58, -0.73, and -2.59 percentage points) and statistically insignificant except for a marginal case at the three-month re-dating (p = 0.06), where the sign is a pre-adoption decline, the opposite of anticipation and incapable of generating

the positive post-adoption estimate. Mis-dating therefore works against the result, so the baseline estimate is conservative.

A.3 Restricting the Control Group

Table A3: Restricting Controls to Hospitals Where PFA Use Would Have Been Observable

	All controls	≥10 inpatient ablations	≥25 inpatient ablations
	(1)	(2)	(3)
Panel A. Within-physician (Table 1 specification)			
Ablation share (pp)	4.831***	4.887***	4.942***
	(1.085)	(1.163)	(1.230)
Observations	15,886	12,893	12,425
Hospital clusters	82	39	37
Panel B. Hospital level (Figure 1 specification, months 0–11)			
Ablation share (pp)	3.589**	5.549***	5.974**
	(1.667)	(2.116)	(2.646)
Pre-period average (pp)	-1.240	-0.079	0.210
Hospitals	83	40	37
Never-adopters	52	9	6

Notes: Columns (2) and (3) retain as controls only hospitals with enough inpatient ablation volume for PFA to have been observed. Of the 52 never-adopting hospitals, 38 record no inpatient ablations at all; adopting hospitals record a median of 92.
Standard errors in parentheses are clustered by hospital.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A3 addresses a measurement concern specific to the never-adopter controls. Because pulsed-field ablation is visible only in inpatient procedure codes, a hospital that performs PFA solely in the outpatient setting would be misclassified as a never-adopter and contaminate the control group. Columns (2) and (3) guard against this by retaining as controls only hospitals with enough inpatient ablation volume, at least 10 and at least 25 cases, for PFA to have been observable. The within-physician estimate is essentially unchanged across the three samples, 4.83, 4.89, and 4.94 percentage points, as expected when identification comes from comparing a physician across their own hospitals rather than from the control group. The hospital-level estimate instead rises from 3.59 to 5.55 and 5.97 percentage points as the least credible controls are dropped, which indicates that control-group contamination attenuates the baseline hospital-level specification and makes it conservative. The pre-period averages stay near zero throughout, so the restriction does not introduce a differential pre-trend, and the credible-control samples retain few never-adopters, which widens the confidence intervals.

B PFA Take-Up

The identification strategy dates a hospital's adoption to the first month in which it records an inpatient pulsed-field ablation, and treats PFA availability from that month onward as the event of interest. Table B1 checks that this coding captures a genuine, growing shift toward PFA rather than an isolated case or a coding artifact. It reports PFA as a share of adopting hospitals' inpatient ablations by months since adoption.

Table B1: PFA Take-Up among Inpatient Ablations

Months since adoption	PFA ablations	Total inpatient ablations	PFA share (%)	Hospitals contributing
-3	0	86	0.0	23
-2	0	100	0.0	24
-1	0	105	0.0	25
0	46	109	42.2	31
1	17	104	16.3	25
2	27	116	23.3	27
3	36	97	37.1	25
4	37	103	35.9	25
5	41	110	37.3	23
6	55	120	45.8	22
7	50	94	53.2	20
8	65	136	47.8	20
9	48	111	43.2	19
10	75	116	64.7	17
11	64	116	55.2	16
12	46	99	46.5	15
13	52	97	53.6	12
14	32	62	51.6	8

Notes: Share of adopting hospitals' inpatient ablations coded as PFA, by months since adoption. Adoption is dated by a hospital's first inpatient PFA case. PFA is measured in inpatient data only because it is not identifiable in outpatient (CPT) codes.

Three features are consistent with the design. Take-up is zero in every pre-adoption month, as it must be under a rule that dates adoption by the first inpatient PFA case, so this pattern confirms that the rule was applied consistently rather than that no PFA was performed earlier. PFA performed before April 2024 would have been billed under the thermal code, and Appendix A.2 examines how earlier dating would affect the estimates. From adoption onward the PFA share rises to roughly half of inpatient ablations within a year, so the treatment reflects real diffusion of the technology into practice rather than a one-time event. Month-zero take-up is positive by construction, since adoption is defined by the first inpatient PFA case, but it is only about 42 percent,

so the subsequent rise reflects genuine diffusion rather than a mechanical jump to full use. Never-adopting hospitals record no inpatient PFA by definition, so take-up cannot establish that the controls are untreated. Because PFA is identifiable only in inpatient procedure codes, take-up is measured on inpatient ablations alone, and Table A3 addresses the possibility that some never-adopters used PFA only in the outpatient setting.

C Selection into the Estimation Sample

The within-physician analysis conditions on physician-hospital-months with positive volume, because the ablation share is undefined otherwise. If PFA availability changed whether a cell is non-empty, that conditioning could induce selection. Table C1 regresses an indicator for a non-empty cell on PFA availability over the full balanced panel, using the Table 1 fixed effects. The results show that PFA does not move cells into or out of the estimation sample.

Table C1: PFA Availability and Whether a Physician-Hospital-Month Is Non-Empty

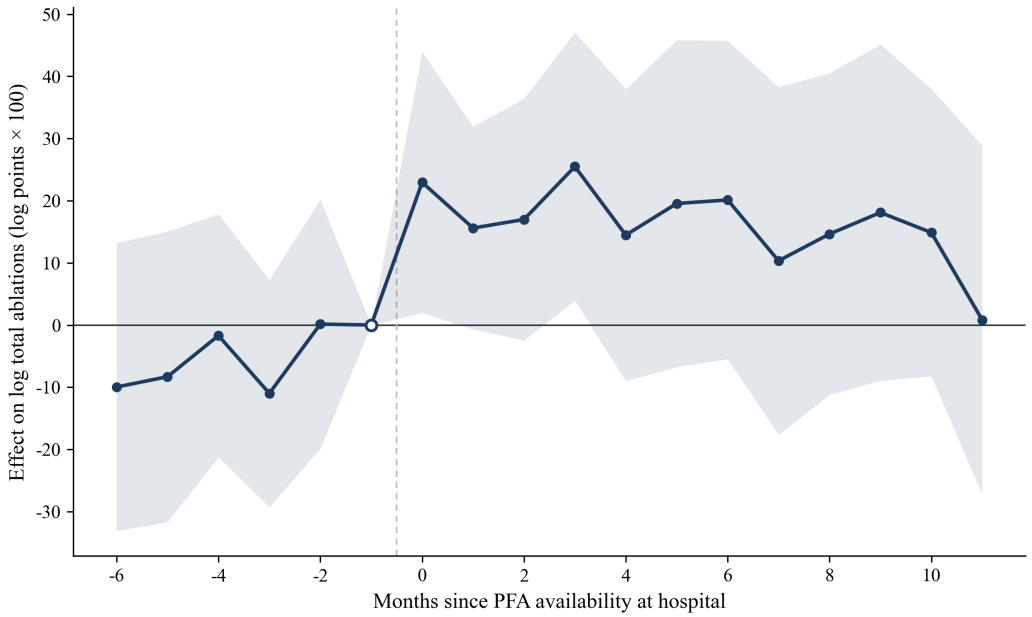
	(1) All physician-hospital-months	(2) Adopting hospitals only
PFA available	0.0164	0.0165
	(0.0124)	(0.0133)
95% confidence interval	[-0.008, 0.041]	[-0.010, 0.043]
Mean dep. var. (pre)	0.458	0.447
Observations	42,288	27,552
Hospital clusters	83	31

Notes: The dependent variable is an indicator for whether a physician records any encounter at a hospital in a month, defined on the full balanced panel of physician-hospital-months, empty cells included. Column (1) uses all physician-hospital-months; column (2) restricts to adopting hospitals. Both columns include physician × month, physician × hospital and hospital × year fixed effects.
Standard errors in parentheses are clustered by hospital.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

D Market-Level Ablation Volume

The main analysis follows the physician cohort, so it speaks to how that cohort reallocates its ablations across sites, not to whether PFA expands the overall market. Figure D1 steps back to the whole market, using the all-operator case extracts, which count every ablation at every hospital regardless of who performed it, and estimates the same hospital-level event study as Figure 1 for a hospital's total ablation volume. Total volume rises after adoption by about 17.5 percent (0.162 log points, p = 0.10) with no differential pre-trend (pre-period p = 0.44), which indicates that PFA expands the market rather than merely shifting activity toward the cohort. The effect is estimated in logs because the raw-count version carries a significant pre-trend and is therefore not reliable.

Figure D1: Market-Level Ablation Volume (All Operators): Effect on Log Total Ablations



Notes: The figure plots event-study estimates of the effect of PFA availability on log total ablations at a hospital, counting every ablation by every operator rather than only the sample electrophysiologists (34,973 cases at 47 hospitals, of which 31 adopt PFA and 16 never adopt). Estimates use the Callaway and Sant'Anna estimator, the outcome is ln(ablations + 1), and the plotted points are log points ×100. The shaded region gives 95 percent confidence intervals from standard errors clustered at the hospital level.