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The quicker the better: Fostering timely responses in public hospitals

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Abstract

Pre-surgery waiting times are viewed as a process indicator of the quality of care for hip fracture surgeries. International clinical guidelines recommend that these treatments are performed within two days after hospitalisation. In year 2011, the Italy's Emilia-Romagna region incentivised hospitals to achieve the target of two days for pre-surgery waiting times, by allowing the chief executives of Local Health Authorities and hospital Trusts to receive greater rewards if they managed to achieve a higher proportion of hip fracture patients treated within the threshold. We analyse the effect of this policy by applying a difference-in-differences estimation strategy on patient-level data between 2007 and 2016. We find that the introduction of managerial incentives reduced hip fracture surgery delays with differences between the treated and control groups increasing over time. There is also evidence of a convergence in the pre-operative waiting times across hospitals, with those experiencing longer surgery delays in the pre-policy period achieving the greatest reductions after policy implementation. Finally, our findings lend support to the hypothesis that hospitals reacted to the policy by targeting patients with less severe health conditions as recorded at the time of hospital admission.

Key terms: pre-surgery waiting times, public hospitals, managerial incentives.

JEL codes: I11.

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1. Introduction

Financial incentives are extensively used in the private sector, which has long adopted compensation mechanisms linking payments to performance achievements. In contrast, the risk of crowding out intrinsic motivation and the multiplicity of objectives of public agencies have casted doubts on their effectiveness in the public sector (Propper, 2010; Burgess and Ratto, 2003; Dixit, 2002).

Nevertheless, governments aiming to raise public sector productivity have often sought to reward performance. In health care, pay-for-performance (P4P) schemes have been used to foster provider performance. The underlying idea being that also public organizations can be extrinsically motivated by financial incentives (Lazear, 2000). Various studies have substantiated the belief that financial incentives affect public healthcare providers by relating fixed price payments and competition to improvements in the quality of services (e.g., Cooper et al, 2011; Kessler and Geppert, 2005).

Despite their importance, only a few studies have analyzed the role of managerial incentives in healthcare organizations. The existing evidence supports the hypothesis that managers of both private nonprofit and for-profit hospitals are responsive to financial incentives with beneficial effects in terms of hospital financial performance (Brickley and Van Horn, 2002). The scant research on the effect of competition in a publicly run healthcare system suggests that it can improve management practices and, therefore, the quality of services delivered by public hospitals (Bloom et al, 2015).

Our study adds to the literature that examines the response to managerial incentives in the public sector by examining whether public hospitals improved their performance in reaction to the financial incentives given to top managers. We analyze a policy

implemented in Italy's Emilia-Romagna region, aimed to incentivize timely delivery of surgical interventions for patients with hip fracture. Such patients require urgent surgery, and international clinical guidelines recommend treatment within two days of hospitalization.[1] In year 2010, however, only 49% of hip fracture patients admitted to Emilia-Romagna hospitals underwent surgery within that threshold. The regional initiative introduced in year 2011 aimed to encourage hospitals to perform hip fracture surgeries within the two-day target by allowing the Chief Executives Officers (CEOs) of Local Health Authorities and of Hospital Trusts to receive greater financial compensations if the facilities managed to achieve a higher proportion of hip fracture patients undergoing surgery within two days.

We use patient-level data over years 2007-2016 to examine the effect of the policy by exploiting a difference-in-differences (DiD) identification strategy based on comparisons in waiting times for hip and tibia/fibula fracture surgeries before and after policy implementation. While clinical recommendations suggest that timely surgical interventions also benefit tibia/fibula fracture patients, the latter were not included in the incentive scheme. Given that the pre-policy trends in surgery delays for hip and tibia/fibula fracture patients were very similar, we take the latter as our main control group. In the sensitivity analysis, we also consider an alternative control group to test for the robustness of results. Our identification strategy account for unobserved heterogeneity

[1] Numerous medical studies find a positive association between treatment delays and adverse health outcomes (see Simunovic et al, 2010, for a review), although other researchers in the economics literature cast doubt on the hypothesis of a causal relationship (e.g., Hamilton et al, 1996; Hamilton and Bramley-Harker, 1999; Hamilton et al, 2000). Based on the existing evidence favouring improved outcomes associated with early surgery, international clinical guidelines recommend access to surgery for patients with hip fracture within two days of hospital admission (e.g., National Institute for Health and Clinical Excellence, 2011).

across hospitals and allows to analyze the short-, medium- and long-run effects of the incentive scheme.

Our paper contributes to the empirical literature on the effect of performance-based incentives in health care (Dranove, 2012) by focusing on features that have received relatively little attention so far. We consider performance-based incentives granted to the top management of public hospitals, where the incentivized outcome (reduction in pre-operative waiting times) is deemed to improve health outcomes and generate financial savings at the same time. In contrast, most previous studies examined the impact of efficiency enhancing choices pursuing cost savings that may compete with improvements in clinical outcomes, and that may imply misalignments between financial and clinical considerations (e.g., Papanicolas and McGuire, 2015). Other studies investigating the causal effects of economic incentives on the performance of hospitals in treating hip fracture patients addressed issues different from the one that motivates our analysis. These include, among others, integration and coordination problems between health and social care on delayed hospital discharges (Fernandez et al, 2014), and the role of national- and regional-level factors in explaining cross-country differences in the performance of hospitals providing hip fracture surgeries (Medin et al, 2015).

Our results provide evidence on the effectiveness of performance-based incentives granted to top managers of public hospitals. We find that after policy implementation, relative to the pre-policy period, patients with hip fracture experience a significantly higher probability of being operated on within two days compared to those in the control group. While we also find a significant reduction in the average waiting times, the impact of the policy appears to vanish at the top end of the waiting times distribution. These results suggest that the reform succeeded in increasing the rate of hip fracture patients

treated within two days by moving the waiting times distribution leftwards, while leaving the top end of the distribution almost unaffected. CEO individual effects do not appear to affect the response of hospitals to the policy initiative at stake, and our findings are robust to a wide range of additional sensitivity checks.

We also provide evidence of response heterogeneity across hospitals. We document that the policy led to a convergence in pre-operative waiting times, with hospitals that were more distressed by longer pre-policy delays being the ones that experienced the greatest improvements. This suggests that the policy reduced disparities between hospitals in terms of pre-surgery waiting times.

Finally, our results reveal that, on average, hip fracture patients lying in the right-hand tail of the waiting time distribution appear to suffer from more severe health conditions (as recorded at the time of hospital admission) in the post-policy years relative to the pre-policy period. On the contrary, for patients with shorter delay times, we find that average severity does not vary after policy change. Since sicker patients may need to be delayed for surgery until their conditions are stabilized, our results can be interpreted as consistent with the incentives introduced by the reform to encourage hospitals to reduce pre-surgery waiting times for patients with less severe health conditions.

2. Institutional background and CEO payment scheme

The Italian National Health System (NHS) is tax-financed and provides universal and comprehensive coverage where inpatient services are free of charge at the point of

delivery.[2] Hospital care absorbs nearly half of health expenditure, with inpatient care accounting for 61% of hospital expenditure (OECD, 2018). Patients gain access to the hospital either through a referral by their General Practitioner (GP) for elective care or directly through the Emergency Department (ED) for urgent treatments.

In the 1990s, the Italian NHS underwent extensive reforms consisting of a devolution to regional governments of political, administrative and financial responsibility for the organization and delivery of health services. Since then, most hospitals have been managed by Local Health Authorities (*Aziende Sanitarie Locali*, ASLs), public enterprises funded by the regional government mainly on a capitation basis. The remaining hospitals, including highly specialized centres and University hospitals, enjoy the status of semi-independent Trusts (*Aziende Ospedaliere*, AOs), self-governing public enterprises mainly financed through a prospective payment system (PPS).

With regard to the NHS internal organization, the 1990s' reforms promoted an increasing professionalism of management bodies, with politicians substituted by professional managers as heads of ASLs and AOs. Contract rules for the top management were modified to grant more flexibility through the introduction of new management functions, such as cost accounting, budgeting, strategic planning, need assessments and performance-based payments (France et al, 2005).

Under current legislation, CEOs are appointed by the regional government under a fixed-term contract. They are selected from a list of candidates with a University degree and a solid management experience (Ferré et al, 2014). The compensation of the CEOs is determined by the national Government, which defines the scheme, the content and the

[2] Co-payments may apply for outpatient services and pharmaceuticals.

maximum salary, which, as required by law, cannot be lower than those earned by other senior NHS managers. It is then delegated to regional Governments to identify the remuneration level for the CEOs' compensation, based on the size of the health organization each CEO runs. Their compensation is determined on an annual basis. There is no ancillary compensation, expect for up to 20% of the annual compensation that can be related to performance targets.

In year 2011, the Italian region of Emilia-Romagna implemented a policy aimed to encourage hospitals to improve their performance in accordance with a set of specific objectives to achieve. The initiative allows the 20% of health managers' annual compensation to be linked to the results reached on three different evaluation areas: 30% on the reduction of waiting lists, 20% on the achievement of budget balance, and 50% on a list of selected targets. The targets valid for the CEOs have been defined by Regional decree, and became strategic objectives linked to the annual budgets assigned to the internal departments of the health organizations.

Starting from year 2011, the regional Government of Emilia-Romagna includes the proportion of hip fracture patients operated within two days among the performance indicators for the CEOs' payment scheme. The score system assigns a maximum of 10 points if the percentage of surgeries within two days is above 90%; 9 points if it is above 80%; 8 points if it is above 70%; 5 points if it is above 50% and 0 points if it is below 50%. Clinical audits and analyses of data on pre-surgery waiting times have been used as supporting levers to evaluate hospital performance, with information feedback provided to the CEOs. Notably, the payment scheme did not introduce any targets based on the time taken to initiate tibia or fibula fracture surgery, despite the fact that clinical guidelines recommend providing timely surgical interventions also for these patients.

3. Data and preliminary evidence

Our data source is the administrative hospital discharge dataset (*Schede di Dimissione Ospedaliera*, SDO) provided by the Health Department of Emilia-Romagna. We analyse individual records for emergency patients admitted to public hospitals of the region between 2007 and 2016.[3] Patients are divided in two groups, depending on whether they are exposed to the incentive scheme of the policy or not. The treatment group includes patients diagnosed with a hip fracture as identified by the International Classification of Diseases (ICD-9 CM codes 820.0-820.9), while the control group consists of patients with a tibia or fibula fracture (ICD-9 CM codes 823.0-823.9).[4] Our final sample includes 59,549 observations, with 50,573 admissions for patients who received a hip fracture surgery, and 8,976 records for tibia or fibula fracture. The list of providers is the same for both groups and comprises 25 hospitals.

The dataset contains administrative and clinical information, including patient age, sex, foreign citizenship, comorbidities, dates of admission, surgery and of final discharge. We construct various performance indicators for surgery delay. The first is pre-operative waiting times, expressed as the number of days elapsing between the date of admission and of surgery. The second is a dummy variable that identifies those episodes successfully meeting the target, taking value 1 for surgeries performed within 2 days, and 0 otherwise. Additionally, we examine the effect of interest at different points in the waiting times

[3] Private hospitals treat elective patients only and cannot be included in our sample that only comprises emergency admissions.
[4] We exclude patients aged less than 18 and those aged more than 100. We also exclude patients with a primary or secondary diagnosis of cancer, as well as those with multiple trauma or who were transferred from another hospital.

distribution, by constructing dummies indicating whether patients have been waiting at least 5 days, 6 days, or 7 days for surgery. Such values correspond, respectively, to the 85th, 90th and 95th percentiles of the waiting times distribution for patients undergoing hip fracture surgery in the pre-policy years.

3.1 Descriptive statistics

Table 1-A displays the descriptive statistics of our estimating sample.[5] Panel 1 shows figures for hip fracture patients, while panel 2 shows those for tibia or fibula fracture surgeries (our control group for the main analysis). For each group, we provide statistics for the years prior to the introduction of the new incentive scheme (i.e., 2007-2010), and after policy implementation (i.e., 2011-2016). These data illustrate changes in means after the introduction of managerial incentives by treatment group, including a formal test for differences in means reported in the last columns of Panels 1-2.[6]

The summary statistics for the dependent variables are reported in the upper section of Table 1. The average pre-surgery delays for hip fracture patients show a reduction between the pre- and post-policy years (Panel 1). On average, patients treated within two days increased from about 47% to 70%, waiting times for surgery declined from 3.3 to 2.3 days, and the proportion of patients waiting at least twice the target fell from 34% to 16%. Such changes are substantial as the normalized differences exceed the threshold value of 0.25. The proportion of hip fracture patients waiting at least 6 or 7 days for surgery also decreased, but to a lower, not sizable, extent, as indicated by the normalized

[5] We refer to Table A1 in the Appendix for a detailed description of these variables.
[6] As the t-statistic partly reflects sample size, we use the scale-invariant Normalized Difference proposed by Imbens and Wooldridge (2009) to test whether, within the groups of treated and control patients, there were significant changes in means before and after policy implementation. The rule of thumb considers a normalized difference greater than 0.25 substantial.

differences falling below the cut-off of one quarter. Prior to the introduction of the policy scheme, pre-surgery waiting times for tibia/fibula fracture patients mirror those of hip fracture patients, with only minor changes recorded for the former in the post-policy years, and the normalized differences are well below the 0.25 critical value (upper section of Panel 2). This preliminary evidence points to a successful increase in the proportion of surgeries performed within two days for the targeted patients. Moreover, there are some indications of a left shift in the distribution of waiting times, as suggested by the substantive decrease in average surgery delays. However, the effect appears to vanish at the top end of the waiting times distribution, where the proportion of patients waiting far beyond the target remains fairly stable.

The bottom panel of Table 1 displays the summary statistics for the control variables. Patients' characteristics differ between the treated and control groups in terms of case-mix and complexity. Treated patients are older, include a larger proportion of females and a smaller proportion of foreigners. In addition, hip fracture patients are more likely than tibia/fibula fracture ones to have a CCI greater than 0, and to suffer from at least one chronic disease. These differences across groups are not surprising, given that the risk of hip and tibia injuries characterises different types of patients. However, for the validity of our identification strategy what is relevant is that the composition of each group remains stable over time. This is confirmed by the normalized differences being well below the critical threshold of 0.25 in all cases.

3.2 Preliminary evidence

To gain further insights into the changes in waiting times for hip fracture patients after policy implementation, we examine time trends in pre-surgery waiting times by year and

treatment group. Figure 1 plots the time trends for the average share of patients waiting within two days after hospital admission (on the left-hand side), and for the average pre-surgical waiting times (on the right-hand side) over years 2007-2016 for hip and tibia/fibula fracture patients separately. The vertical lines indicate the year preceding the introduction of the new managerial incentive scheme (i.e., year 2010). For both measures of pre-surgery waiting times, the treated and control groups display very similar trends prior to the introduction of the policy (2007-2010), thus supporting the common trends assumption required for identification in DiD estimation (Blundell and Costa Dias, 2009; Lechner, 2011). The gap between hip and tibia/fibula fracture patients widens in the first year after policy implementation, and sharply increases in later years. Such pattern is consistent with the hypothesis that hospitals reacted to the incentive scheme by shortening time to surgery for the targeted patients.

In Figure 2, we plot the distribution of pre-operative waiting times for patients with hip fracture for each year between 2010 and 2016. The vertical line marks the policy target of two days. The evidence suggests that the introduction of the policy induced a left shift in the distribution of waiting times, with decreasing effects at the right-hand tail. Figure 3 plots the time trends for the proportion of patients waiting at least 5 days, 6 days or 7 days, separately for hip fracture and tibia/fibula fracture surgeries. Before policy implementation, we observe similar trends for the two groups. Whilst we can still detect divergent trends after policy implementation for the proportion of patients waiting more than twice the target, the gap tends to disappear for those at the top end of the distribution. Such evidence is suggestive that the new incentive scheme contributed to shift leftwards the distribution of pre-surgery waiting times, while leaving mainly unaffected those cases that were largely above the target.

In the next section, we develop an identification strategy aimed at assessing the causal impact of the policy change.

4. Estimation methods

To identify the causal effect of managerial incentives on surgery delays, we rely on the following DiD equation:

$$y_{iht} = \beta_0 + \beta_1 Year_t + \beta_2 Hip_i + \beta_3 Hip_i \times Year_t + \beta_4 X_{it} + \alpha_h + \alpha_h \times T_t + \varepsilon_{iht} \quad (1)$$

where *i* denotes the patient, *h* the hospital, and *t* the year, ranging between 2007 and 2016. Eqn (1) is first estimated for two dependent variables: a dummy equal to 1 for patients treated within two days after hospital admission, and 0 otherwise; or the log of the time taken to surgical intervention, expressed in number of days.[7]

$Year_t$ is a vector of year dummies, with 2010 set as the baseline year. Hip_i is a dummy equal to 1 for patients undergoing hip fracture surgeries, and 0 otherwise (i.e., for the control group of patients undergoing tibia/fibula fracture interventions). X_{it} is a vector of controls for patient characteristics, comprising demographics and co-morbidities. We also control for hospital fixed effects, α_h, absorbing any hospital-specific factors that are constant over time and that may influence treatment delays. Additionally, we include a set of interactions between hospital fixed effects and a linear time trend, $\alpha_h \times T_t$, ensuring

[7] By log transforming pre-surgery waiting times, we account for the skewed distribution of the variable. There are 3,605 observations (6% of the total sample) for which surgery is performed in the same day of admission (i.e., with waiting time equal to zero). Since the log of zero is undefined, we add 1 day to every observation before taking logs. The results are robust when we add one-half day to every observation, and when the observations with a waiting time of zero are excluded from the analysis (available upon request).

that the estimated effects do not reflect unobserved hospital characteristics affecting the dependent variables in the form of linear time trends.[8]

We estimate Eqn (1) by Ordinary Least Squares (OLS) with robust standard errors clustered at the hospital level.[9] The key coefficients of interest are β_3 on the interactions between Hip_i and $Year_t$. The estimated coefficients (multiplied by 100) can be interpreted as giving the % differences in the dependent variable between the treated and control patients in each given year relative to 2010 (i.e., one year before the introduction of the new incentive scheme).[10]

We further investigate whether the policy induced a left shift at higher points in the distribution of surgery delays. For this purpose, we estimate Eqn (1) by Linear Probability Model (LPM) where the dependent variable equals 1 for patients waiting at least 5 days, 6 days or 7 days for hospital surgery, and 0 otherwise.

5. Results

Tables 2-6 present the DiD results for each outcome variable. Column (1) reports the estimates from the most parsimonious specification, where we control only for patient demographics. The remaining columns (2)-(4) sequentially add covariates for patient

[8] As robustness check, we also control for seasonal effects by adding month fixed effects or a dummy for admissions during winter, and for weekend effects by including a dummy for patients admitted during the weekend. Our results shown in Appendix Tables C1-C5 are largely insensitive to these additional controls.
[9] The estimated effects when fitting probit models for the binary dependent variables were very similar and are available from the authors upon request. However, as observed by previous studies, one issue that arises when estimating a DiD model with non-linear specifications such as probit specifications is that the common trend assumption is fulfilled only under a set of additional restrictions that may not hold in typical applications (Lechner, 2011).
[10] The interpretation of the estimated coefficients as percent changes makes use of a Taylor-series approximation. The exact percent changes are given by $100 \times [\exp(\beta_3) - 1]$, which in our context are very close to the percent changes implied by the Taylor-series approximation (Wooldridge, 2019).

complexity and hospital-specific linear time trends. The estimated coefficients are robust in terms of sign and statistical significance.

Table 2 presents the results from the LPM, using as dependent variable the dummy taking value 1 for patients who have been waiting up to the target of two days. We find that for hip fracture patients, compared with patients undergoing tibia or fibula fracture surgeries, the probability of waiting within two days from hospital admission significantly increases in the post-policy years 2012-2016, relative to the pre-treatment year 2010. Interestingly, the estimated difference also increases over time. Consistently with the common trend hypothesis, the interaction terms for the anticipatory effects are never significant. Compared with year 2010, we find that in years 2012-2016 the probability of treatment within 2 days increases by an amount ranging between 9% and 25% for hip fracture patients relative to the control group.

In Table 3, we show the OLS estimates for the log of pre-surgery waiting times. These results yield a significant impact of the policy from year 2012 onwards. Relative to the pre-treatment year 2010, the difference in pre-surgery waiting times between hip and tibia/fibula fracture patients decreases by about 10% in 2012, 11% in 2013, 17% in 2014, 18% in 2015 and 23% in 2016. By contrast, there are no significant differences in any of the years before the introduction of the new managerial incentive scheme.

Finally, the results in Tables 4-6 indicate that the impact of the policy tends to disappear at the top end of the distribution, as changes in the probability of waiting far above the target are both smaller in magnitude and gradually become not significant.

6. CEO fixed effects

In this section, we explore the role of top management on hospital performance. Previous works have shown that the performance of private organizations systematically depends on the specific top executives in charge (e.g., Bertand & Schoar, 2003; Bennedsen et al, 2020). For public sector organizations, however, most existing studies on the effect of top managers focus on relatively small organizations or those characterized by a low level of task complexity (e.g., Lavy & Boiko, 2017; Fenizia, forthcoming). One notable exception is Janke et al (2019), who examined the effect of top managers on large and complex public sector organizations as represented by English NHS hospitals. Their results provide little evidence of CEOs being systematically able to generate persistent performance differentials across the organizations they lead.

To account for the potential impact of CEOs on hospital performance in our study sample, we construct a variable enabling us to track the identity of top managers and their movements across different organizations over time. The total number of CEOs actively engaged over the period of study amounts to 36, 12 of which took office in different regional organizations during the span covered by our data. The tenure length is on average 5 years for the entire sample of CEOs, while for the subset of mover CEOs we observe an average tenure of 7 years.[11]

Table 7 adds to the model in column (4) of Tables 2-6 the CEOs' identifiers as executive fixed effects. As they show, our main coefficients of interest are very stable, both in qualitative and quantitative terms. While the top-down approach of assessing CEOs' performance through process indicators such as pre-surgery waiting times is effective in steering the behaviour of the organization, the intensity of the effect does not seem to

[11] These figures are computed over the sample period and, therefore, are not based on complete spells for all CEOs.

depend on persistent differences across executives. We interpret these findings as being in line with those provided by Janke et al (2019), suggesting a lack of persistent CEO effect.

7. Sensitivity analyses

7.1 Statistical inference

We perform various sensitivity analyses to guard against spurious inference. As previous studies point out (Bertrand et al, 2004; Donald and Lang, 2007), the presence of a small number of clusters may challenge statistical inference in DiD studies. In the context of our paper, standard errors are clustered at the hospital level to account for correlation in the outcome across patients treated in the same hospital. To address concerns relating to the structure of the error distribution, we follow earlier work (Carrieri et al, 2019, 2020; Wing et al, 2014) by implementing a randomization test. We first randomly select a set of treated × year cells to define a kind of "placebo" treatment variable. We then estimate the placebo effect in the DiD models by using the placebo treatment variable in the place of the vector of interactions between the real treated groups and years. We repeat these steps 2,000 times by using permutation tests based on Monte Carlo simulations to plot a distribution of the placebo effects. Figure 4 displays the kernel density estimates of the placebo effects for our main outcome variables of interest. Graphical inspection shows that the means are approximately zero, suggesting that the estimator is unbiased. In addition, the treatment effects in Tables 2-3 fall in the very extreme tails of the placebo effects' distribution. On the whole, these findings suggest that it is unlikely that the policy effects observed in our main analysis occur only by chance.

7.2 Alternative control group

So far, we have taken patients undergoing tibia/fibula fracture surgeries as control group, as this procedure was not included in the incentive scheme for the hospital top management compensation. Moreover, a further advantage of tibia/fibula fracture surgeries is that it is performed within the same hospital departments where hip fracture patients are treated: asymmetric shocks in technological or human capital endowment across groups are therefore unlikely. Additionally, our identification strategy benefitted from very similar pre-policy trends with respect to pre-operative waiting times. Yet, the common features characterising hip and other orthopaedic surgeries, including those for tibia/fibula fractures, may raise some concerns due to the possible spillovers between treated and control groups. Such an occurrence would make the waiting times for tibia/fibula fracture surgery endogenous, thereby challenging our estimation strategy.[12]

The evidence of section 3 can mitigate such concerns. As shown in Figures 1 and 3, surgical delays for tibia/fibula fracture patients appear to follow a fairly linear time trend over the decade 2007 to 2016. Consistent with this, the normalized differences reported in the first rows of Panel 2 in Table 1 indicate that there were only minor changes in delays for this type of surgery between the pre- and post-policy periods. Consequently, the introduction of the two-day target for hip fracture surgeries does not appear to have affected pre-operative waiting times for tibia/fibula fracture surgeries.

[12] Positive spillovers would arise, and our estimates would be downward biased, if hospitals responded to the policy by introducing organisational improvements in their orthopaedic departments, with the consequence of reducing pre-surgery waiting times also for patients with tibia/fibula fracture. In contrast, we would get upward biased estimates if the policy induced negative spillover effects, with hospitals achieving reductions in surgical delays for hip fracture patients at the expense of the waiting times for tibia/fibula fracture surgeries.

To complement the descriptive evidence, we test for the robustness of our findings to the use of alternative control units. We extend the control group by considering patients undergoing urgent surgery for cholecystectomy (ICD-9 CM codes 51.21-51.24).[13] As for the main control group, these interventions were not included in the incentive scheme. However, unlike previous control units, they are not performed in orthopaedic departments. Hence, the likelihood of the occurrence of spillovers in surgery delays is minimized. The assumption of no spillover effects on the alternative control units is also reinforced by the results on the normalized differences presented in the first rows of Panel 2 of Appendix Table A2, which provide no evidence of substantial changes in pre-operative waiting times for cholecystectomy surgeries before and after policy reform. As reported in Figures A1-A2 in the Appendix, we find similar pre-treatment trends between hip fracture and cholecystectomy patients, thus supporting the common trend assumption and the validity of the DiD strategy.

In Tables B1-B5 in the Appendix, we replicate our regression analysis by using the alternative control group just described. The results support the main findings on the impact of the incentive scheme, as they do not appear to be substantially affected by the choice of a specific control group. In the post-policy years, compared with the baseline 2010, we find that, on average, hip fracture patients, relative to the control units, have a significantly higher probability of waiting within two days after hospital admission, and experienced a significant reduction in surgical delays. Consistently with the main

[13] Also in this case, we exclude patients with a primary or secondary diagnosis of cancer, those with multiple trauma and patients transferred from other hospitals. The list of hospitals included is the same as the one used for our main analysis, with the exception of a hospital that is now excluded from the regressions since it is specialized in orthopaedic procedures only, and so does not treat patients with cholecystectomy.

analysis, the effect of the policy gradually disappears at the top end of the waiting times distribution.

8. Responses by type of hospitals

In this section, we investigate heterogeneity in policy responses across hospitals. First, we test whether hospitals reacted differently according to the pressure exerted by their pre-policy waiting times. For this purpose, we split the sample of hospitals into three tertiles, based on the proportion of patients waiting within two days for a hip fracture surgery as recorded in 2010 (i.e., one year before the introduction of the policy). We find that the proportion of patients waiting up to the target fall within one of the following ranges: below 37% for hospitals in the 1st tertile (most distressed), between 37% and 53% in the 2nd tertile and over 53% in the 3rd tertile (least distressed). We then estimate Eqn (1) separately for the three subsets of hospitals. The results are shown in Tables 8-9. Hospitals with longer pre-policy waiting times for hip fracture surgeries are more responsive than the least distressed according to all outcome measures. These findings provide evidence of convergence in hospital performance, with those poorly performing in the pre-policy period experiencing the greatest improvements after policy change. The policy can thus be associated to a reduction in disparities in pre-surgery waiting times among hospitals.

Next, we examine whether providers' responsiveness to managerial incentives varies by legal status. Our sample includes 19 hospitals directly managed by ASLs and 6 AOs, with the latter enjoying greater financial and decision-making independence. To test whether such differences affect the response of hospitals to the policy, we estimate Eqn (1)

separately for the two types of organizations. Tables 10-11 show no evidence of significant variations in hospital response by legal status for any performance measure considered, suggesting that the reaction of public hospitals to managerial incentives is not influenced by their legal status.

9. Did the policy reduce unnecessary waiting times?

To gain additional insights on the underlying dynamics induced by the policy, it is worth investigating whether the reduction of pre-operative waiting times involved specific sub-populations of patients, thus gaining additional insights on the underlying dynamics induced by the policy. The rationale behind the new incentive scheme is that, in the absence of it, a fraction of patients would not be treated within two days because of poor patient management. Yet, even after overcoming the organizational inefficiencies, some patients may still be delayed treatment, due to their frail conditions that require to be stabilized before surgery. As a consequence, clinicians, weighting CEOs' pressure with patients' expected benefits, should selectively target for early surgery patients with medical conditions similar to those who would have been timely treated even with no change in incentives. If the introduction of the policy selectively shifts towards the two-day target patients who suffer from fewer comorbidities at the time of hospital admission, then we should expect negligible variations before and after policy implementation in the average severity of patients treated within the two-day threshold. Conversely, in the post-policy years relative to the pre-policy period, the group of patients waiting more than the target should display on average more severe health conditions as recorded at the time of hospital admission.

To explore this issue empirically, we run regression-based analyses using patient-level data. We consider pre- and post-policy differences for hip fracture patients treated within two days, and those for hip fracture patients waiting more than the target. Table 12 presents the results. We perform the analysis separately for four groups of patients, defined according to their observed pre-operative waiting times: 0-2 days, 3 days, 4 days, 5 or more days. Formally, we estimate the following equation:

$$y_{iht} = \beta_0 + \beta_1 Post_t + \alpha_h + \varepsilon_{iht} \quad (2)$$

As dependent variables, we use the three measures of patient complexity: the Charlson Comorbidity Index (CCI), a dummy for patients suffering from at least one chronic disease, and the number of chronic disease conditions. Continuous variables are all in log forms. The dummy $Post_t$ assumes the value 1 for the years after policy implementation, and 0 otherwise. All models include hospital fixed-effects. Estimation is by OLS for the continuous variables, and by probit for the binary variable, with robust standard errors clustered at the hospital level.

The results show no significant differences in patient complexity between the pre- and the post-policy phase in any group sharing the same waiting times. The only exceptions are patients waiting 5 or more days for whom we find, on average, more severe health conditions in the post-policy years relative to the pre-policy period. This holds true irrespectively of the severity measure adopted. These findings are consistent with the hypothesis that providers reacted to the policy by selectively targeting for early surgery those patients who are in relatively better health, while leaving the most critical patients,

whose delays are due to clinical reasons rather than to poor management, in the right-hand tail of the waiting time distribution.

10. Conclusions

We studied the response of public hospitals to a change in managerial incentives following a contractual innovation in the compensation of the Chief Executives of public hospitals in the Italy's Emilia-Romagna region. Starting from 2011, the policy introduced the proportion of hip fracture patients operated on within two days after hospital admission among the strategic objectives against which the performance of hospitals was assessed, allowing the CEOs of LHAs and Hospital Trusts to be evaluated and to receive greater compensations if they managed to achieve pre-set targets. By including this process indicator into the incentive scheme, the policy aimed to encourage hospitals to achieve shorter surgery delays for patients with hip fracture.

We exploited longitudinal data to estimate the causal relationship between the policy and hospital behaviour by means of a DiD estimator. We compared pre-operative waiting times for patients undergoing a hip fracture surgery (i.e., those exposed to the new managerial incentives) with surgery delays for procedures not included in the incentive scheme. Our results provide evidence that the policy successfully incentivised hospitals to reduce treatment delays for hip fracture surgeries, and a variety of robustness checks are performed to confirm the main findings. Our estimates reveal that in the post-policy period the probability of waiting within two days of hospitalisation significantly increased for hip fracture patients compared with the control group. Such effect cumulated over time, with the difference in the estimated probability rising from 9% in 2012 to 25% in

2016. We also show that the policy affected the average waiting time for hip fracture surgery. On average, relative to 2010, the estimated difference in surgery delays between treated and control patients decreased by an amount ranging between 10% in 2012 and 23% in 2016. There is some degree of heterogeneity in the response to the policy across hospitals. We find evidence of convergence in pre-operative waiting times towards the target of two days, with hospitals that were having the poorest performance before policy implementation being those that achieved the greatest reductions after the introduction of the new incentive scheme. This point to a reduction of disparities between hospitals with respect to quality provision as measured in terms of pre-operative waiting times.

Our results also show that the treated group of patients, relative to the control units, experienced a significant reduction in the probability of waiting at least more than twice the target of two days, with the effect of the policy vanishing for patients at higher points in the waiting times distribution. These findings indicate that, whilst the top end of the waiting times distribution remained substantially unaffected after policy change, the new incentive scheme induced a leftward shift in the remaining part of the distribution.

Notably, all the main findings are robust to the inclusion of CEOs' fixed effects, which account for the identity of the top managers in charge of managing the different hospitals, some of whom rotate across centres during the period of study. Such findings suggest that the estimated hospital response to the policy initiative do not reflect fixed differences among executives that may affect quality provision in terms of pre-surgery waiting times.

Finally, we provide evidence that the severity of conditions, as recorded at the time of hospital admission, increased for hip fracture patients waiting more than twice the two-day target, while did not change significantly for the other groups. These results lend support to the hypothesis that the policy reduced "avoidable" delays, by encouraging

hospitals to shift the least severe patients within the groups of those waiting less for surgery. In contrast, the fact that in the post-policy period the severity of patients at the top hand of the distribution increases is consistent with the hypothesis that the incentive scheme left unaffected the waiting times of patients whose conditions need to be stabilized before surgical treatment.

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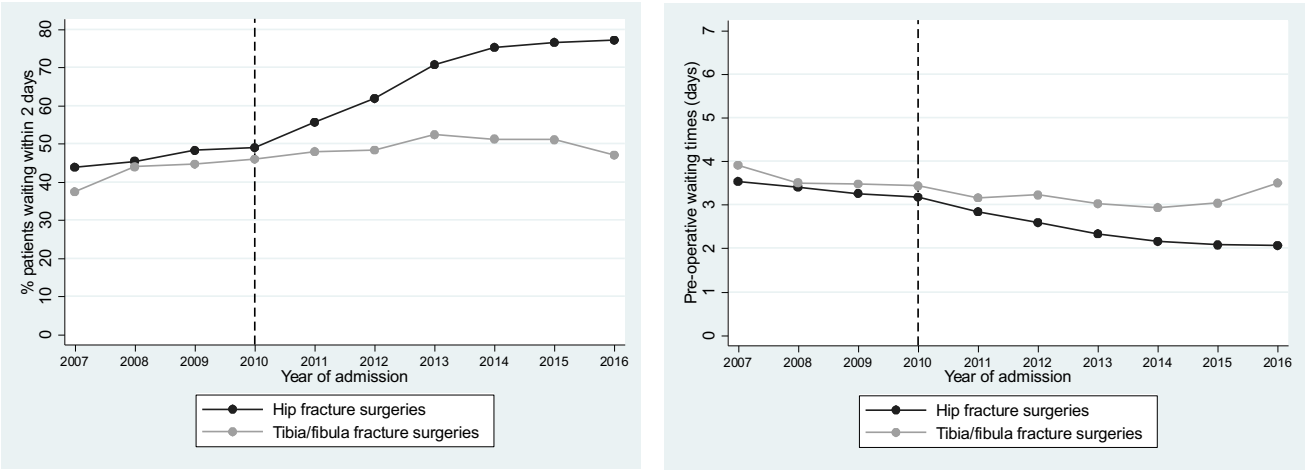
Table 1. Summary statistics of the dependent and control variables by policy periods for the treated and main control groups.

	(1) Treated group: hip fracture patients					(2) Main control group: tibia/fibula fracture patients				
	Pre-policy (n = 19,242)		Post-policy (n = 31,331)		Normalised difference	Pre-policy (n = 3,801)		Post-policy (n = 5,175)		Normalised difference
Variable name	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Dependent variables										
Pre-surgery wait time ≤ 2 days	0.466	0.499	0.699	0.459	**0.343**	0.430	0.495	0.496	0.500	0.094
Pre-surgery wait time	3.337	3.124	2.327	2.337	**-0.259**	3.573	3.484	3.142	3.307	-0.090
Pre-surgery wait time ≥ 5 days	0.202	0.402	0.078	0.269	**-0.256**	0.268	0.443	0.200	0.400	-0.113
Pre-surgery wait time ≥ 6 days	0.125	0.331	0.048	0.213	-0.196	0.168	0.374	0.123	0.328	-0.091
Pre-surgery wait time ≥ 7 days	0.082	0.274	0.031	0.173	-0.158	0.114	0.317	0.078	0.268	-0.086
Control variables										
Age	81.092	10.814	81.698	10.661	0.040	50.431	17.500	52.596	17.060	0.089
Female	0.757	0.429	0.749	0.434	-0.014	0.390	0.488	0.426	0.495	0.051
Foreigner	0.005	0.067	0.008	0.087	0.028	0.093	0.290	0.101	0.302	0.020
CCI 0	0.605	0.489	0.628	0.483	0.034	0.931	0.254	0.931	0.254	0.000
CCI 1	0.235	0.424	0.213	0.409	-0.038	0.050	0.217	0.049	0.216	-0.001
CCI 2	0.096	0.294	0.093	0.290	-0.007	0.011	0.106	0.013	0.113	0.011
CCI 3	0.040	0.196	0.040	0.196	0.001	0.002	0.049	0.003	0.054	0.007
CCI 4+	0.025	0.156	0.026	0.160	0.005	0.006	0.078	0.004	0.065	-0.018
Heart disease	0.043	0.202	0.039	0.194	-0.014	0.006	0.078	0.005	0.071	-0.010
Dementia	0.148	0.355	0.146	0.353	-0.004	0.005	0.071	0.007	0.085	0.021
Cerebrovascular disease	0.102	0.303	0.096	0.295	-0.015	0.009	0.097	0.012	0.107	0.015
Arthritis	0.009	0.095	0.007	0.083	-0.017	0.002	0.043	0.002	0.044	0.001
Nutritional disease	0.008	0.091	0.008	0.089	-0.003	0.001	0.028	0.001	0.024	-0.006
Hemiplegia	0.010	0.098	0.007	0.081	-0.024	0.002	0.049	0.004	0.065	0.023
Blood disease	0.067	0.250	0.083	0.276	0.043	0.011	0.103	0.014	0.118	0.021
Vascular disease	0.041	0.198	0.035	0.183	0.023	0.011	0.102	0.011	0.103	0.002
Kidney disease	0.050	0.218	0.058	0.234	0.025	0.005	0.072	0.006	0.080	0.010
Other chronic disease	0.005	0.073	0.004	0.066	-0.009	0.002	0.040	0.002	0.048	0.012
Obesity	0.005	0.072	0.007	0.081	0.014	0.005	0.069	0.005	0.071	0.003

Notes. Pre- and post-policy years include 2007-2010 and 2011-2016, respectively. The normalised difference is defined as the difference in the variables' means between the post- and pre-policy periods, scaled by the square root of the sum of variances. Normalised differences exceeding the cut-off 0.25 are marked in bold.

Figure 1. Time trends in (a) the average proportion of patients waiting within 2 days of hospitalisation, and (b) pre-surgical waiting times among hip fracture and tibia/fibula fracture patients over years 2007-2016. The dashed vertical line is placed at 2010, i.e. one year before policy implementation.



(a) (b)

Figure 2. Distribution of pre-operative waiting times for hip fracture patients between years 2010 and 2016. The dashed vertical line marks the target of two days introduced in 2011.

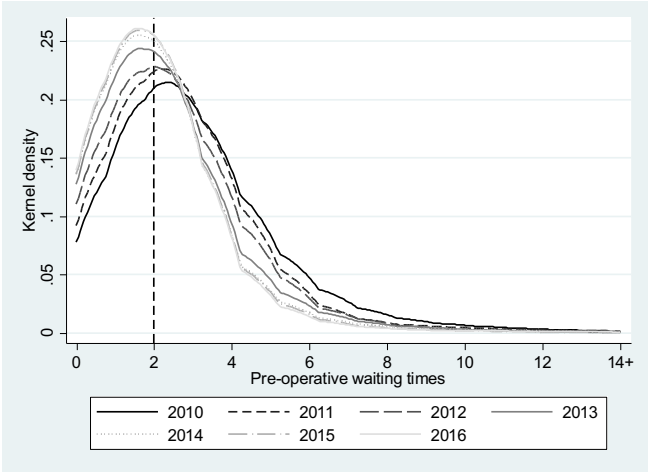
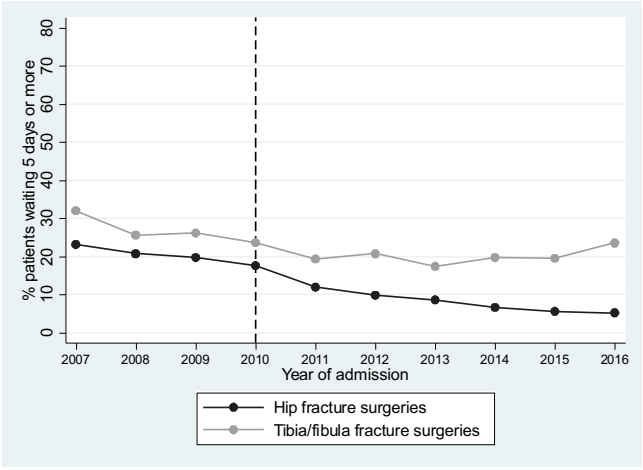
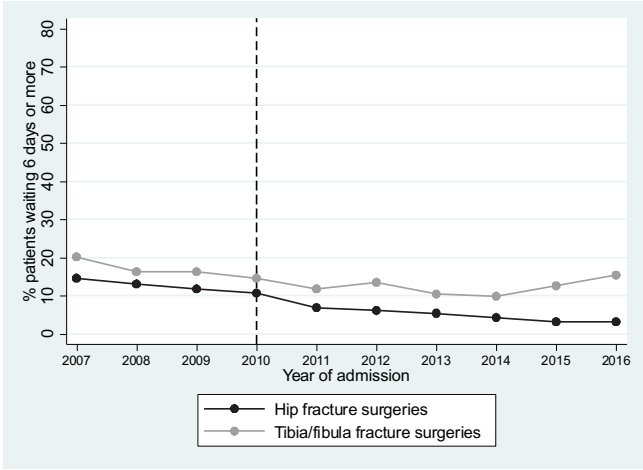


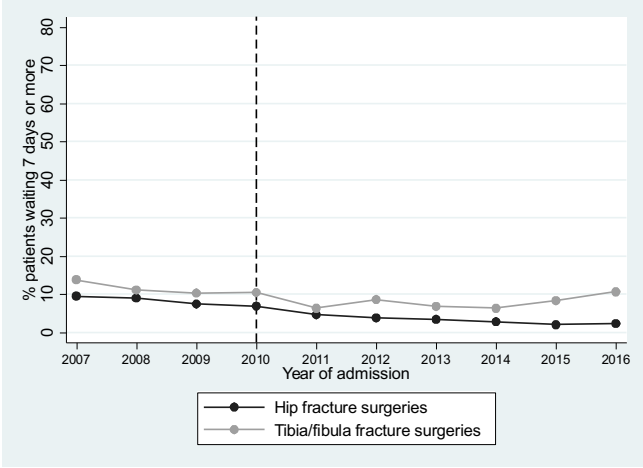
Figure 3. Time trends in the proportion of patients waiting at least: (a) 5 days, (b) 6 days, or (c) 7 days for hip fracture and tibia/fibula fracture surgeries over years 2007-2016. The dashed vertical line is placed at year 2010, i.e. one year before policy implementation.



(a)



(b)



(c)

Figure 4. Kernel density distribution of 2,000 placebo estimates.

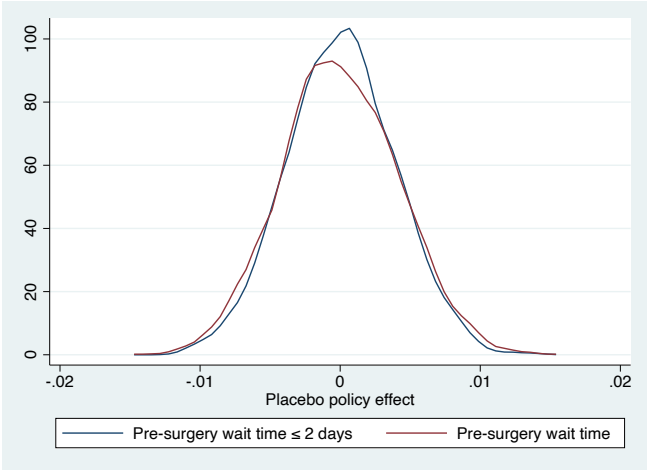


Table 2. DiD results (LPM). Dependent variable: dummy = 1 if pre-surgery waiting time ≤ 2 days.

Variable	LPM (1)		LPM (2)		LPM (3)		LPM (4)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Treated	0.038	(0.029)	0.047	(0.029)	0.048	(0.029)	0.048	(0.029)
Treated × year 2007	0.045	(0.034)	0.045	(0.034)	0.045	(0.034)	0.052	(0.032)
Treated × year 2008	-0.011	(0.027)	-0.011	(0.027)	-0.011	(0.026)	-0.007	(0.027)
Treated × year 2009	0.009	(0.020)	0.010	(0.020)	0.010	(0.020)	0.011	(0.021)
Treated × year 2011	0.039	(0.035)	0.038	(0.035)	0.040	(0.035)	0.040	(0.035)
Treated × year 2012	0.089*	(0.032)	0.089*	(0.032)	0.089*	(0.032)	0.090**	(0.032)
Treated × year 2013	0.141***	(0.032)	0.139***	(0.032)	0.139***	(0.033)	0.139***	(0.032)
Treated × year 2014	0.199***	(0.039)	0.199***	(0.039)	0.198***	(0.039)	0.197***	(0.041)
Treated × year 2015	0.198***	(0.037)	0.198***	(0.037)	0.198***	(0.037)	0.201***	(0.038)
Treated × year 2016	0.244***	(0.039)	0.244***	(0.039)	0.244***	(0.039)	0.248***	(0.036)
Age	-0.010***	(0.001)	-0.010***	(0.001)	-0.009***	(0.001)	-0.009***	(0.001)
Age squared	0.000***	(0.000)	0.000***	(0.000)	0.000***	(0.000)	0.000***	(0.000)
Female	0.034***	(0.003)	0.026***	(0.003)	0.024***	(0.003)	0.025***	(0.003)
Foreigner	-0.036*	(0.016)	-0.036*	(0.015)	-0.036*	(0.0152)	-0.034*	(0.015)
CCI 1			-0.026**	(0.007)	-0.027***	(0.007)	-0.027***	(0.007)
CCI 2			-0.058***	(0.010)	-0.051***	(0.010)	-0.050***	(0.009)
CCI 3			-0.097***	(0.012)	-0.078***	(0.013)	-0.078***	(0.013)
CCI 4+			-0.124***	(0.020)	-0.088***	(0.022)	-0.086***	(0.021)
Heart disease					-0.113***	(0.016)	-0.115***	(0.016)
Dementia					0.036***	(0.007)	0.036***	(0.006)
Cerebrovascular disease					-0.017*	(0.007)	-0.015*	(0.007)
Arthritis					-0.028	(0.024)	-0.022	(0.023)
Nutritional disease					0.008	(0.027)	0.010	(0.027)
Hemiplegia					0.004	(0.021)	0.005	(0.019)
Blood disease					-0.004	(0.008)	0.005	(0.009)
Vascular disease					-0.033*	(0.012)	-0.036**	(0.012)
Kidney disease					-0.016	(0.011)	-0.018	(0.010)
Other chronic disease					0.034	(0.030)	0.029	(0.029)
Obesity					-0.044*	(0.021)	-0.041	(0.020)
Constant	0.857***	(0.046)	0.858***	(0.046)	0.849***	(0.045)	0.926***	(0.047)
N	59,549		59,549		59,549		59,549	
Year FE	Y		Y		Y		Y	
Hospital FE	Y		Y		Y		Y	
Hospital time trends	N		N		N		Y	

Notes. See Tables 1-A1 for more information on the dependent and control variables. We define the treated group as patients undergoing a hip fracture surgery (ICD-9 CM codes 820.0-820.9), and the control units as patients operated on for a tibia or fibula fracture (ICD-9 CM codes 823.0-823.9). Hospital cluster robust standard errors in parentheses. * P < 0.05. ** P < 0.01. *** P < 0.001.

Table 3. DiD results (OLS). Dependent variable: (log of) pre-surgery waiting time (days).

Variable	OLS (1)		OLS (2)		OLS (3)		OLS (4)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Treated	-0.027	(0.040)	-0.038	(0.041)	-0.040	(0.041)	-0.037	(0.041)
Treated × year 2007	-0.063	(0.049)	-0.063	(0.050)	-0.063	(0.049)	-0.069	(0.049)
Treated × year 2008	0.011	(0.032)	0.012	(0.032)	0.011	(0.032)	0.008	(0.033)
Treated × year 2009	-0.018	(0.017)	-0.018	(0.017)	-0.019	(0.017)	-0.021	(0.017)
Treated × year 2011	-0.030	(0.037)	-0.030	(0.037)	-0.030	(0.037)	-0.032	(0.037)
Treated × year 2012	-0.098*	(0.036)	-0.098*	(0.036)	-0.098*	(0.036)	-0.101*	(0.036)
Treated × year 2013	-0.113**	(0.033)	-0.111**	(0.033)	-0.111**	(0.033)	-0.114**	(0.033)
Treated × year 2014	-0.169***	(0.036)	-0.168***	(0.036)	-0.167***	(0.036)	-0.171***	(0.037)
Treated × year 2015	-0.169***	(0.040)	-0.169***	(0.041)	-0.168***	(0.041)	-0.180***	(0.043)
Treated × year 2016	-0.220***	(0.042)	-0.219***	(0.042)	-0.220***	(0.042)	-0.234***	(0.037)
Age	0.014***	(0.001)	0.014***	(0.001)	0.013***	(0.001)	0.013***	(0.001)
Age squared	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)
Female	-0.041***	(0.007)	-0.031***	(0.006)	-0.028***	(0.006)	-0.029***	(0.006)
Foreigner	0.052**	(0.014)	0.051**	(0.014)	0.052**	(0.014)	0.048**	(0.015)
CCI 1			0.041***	(0.009)	0.041***	(0.010)	0.042***	(0.010)
CCI 2			0.074***	(0.009)	0.063***	(0.010)	0.062***	(0.010)
CCI 3			0.118***	(0.016)	0.089***	(0.017)	0.090***	(0.017)
CCI 4+			0.155***	(0.020)	0.100***	(0.023)	0.097***	(0.022)
Heart disease					0.124***	(0.014)	0.125***	(0.014)
Dementia					-0.042***	(0.006)	-0.042***	(0.006)
Cerebrovascular disease					0.016	(0.009)	0.013	(0.009)
Arthritis					0.011	(0.025)	0.005	(0.026)
Nutritional disease					0.004	(0.031)	0.002	(0.030)
Hemiplegia					0.0108	(0.027)	0.009	(0.025)
Blood disease					0.008	(0.010)	0.000	(0.010)
Vascular disease					0.054**	(0.016)	0.056**	(0.016)
Kidney disease					0.031*	(0.011)	0.033**	(0.011)
Other chronic disease					0.003	(0.039)	0.008	(0.039)
Obesity					0.052*	(0.024)	0.051*	(0.024)
Constant	0.661***	(0.0833)	0.661***	(0.0840)	0.671***	(0.083)	0.594***	(0.083)
N	59,549		59,549		59,549		59,549	
Year FE	Y		Y		Y		Y	
Hospital FE	Y		Y		Y		Y	
Hospital time trends	N		N		N		Y	

Notes. See Tables 1-A1 for more information on the dependent and control variables. We define the treated group as patients undergoing a hip fracture surgery (ICD-9 CM codes 820.0-820.9), and the control units as patients operated on for a tibia or fibula fracture (ICD-9 CM codes 823.0-823.9). Hospital cluster robust standard errors in parentheses. * P < 0.05. ** P < 0.01. *** P < 0.001.

Table 4. DiD results (LPM). Dependent variable: dummy = 1 if pre-surgery waiting time ≥ 5 days.

Variable	LPM (1)		LPM (2)		LPM (3)		LPM (4)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Treated	-0.068**	(0.020)	-0.075***	(0.019)	-0.076***	(0.019)	-0.074***	(0.019)
Treated × year 2007	-0.040	(0.031)	-0.040	(0.032)	-0.040	(0.031)	-0.045	(0.031)
Treated × year 2008	0.004	(0.020)	0.005	(0.020)	0.004	(0.020)	-0.000	(0.020)
Treated × year 2009	-0.010	(0.015)	-0.011	(0.016)	-0.011	(0.016)	-0.013	(0.016)
Treated × year 2011	-0.012	(0.018)	-0.012	(0.018)	-0.013	(0.018)	-0.014	(0.018)
Treated × year 2012	-0.042	(0.024)	-0.041	(0.024)	-0.042	(0.024)	-0.043	(0.025)
Treated × year 2013	-0.023	(0.020)	-0.022	(0.020)	-0.021	(0.020)	-0.023	(0.021)
Treated × year 2014	-0.066*	(0.024)	-0.066*	(0.024)	-0.065*	(0.024)	-0.066*	(0.025)
Treated × year 2015	-0.063*	(0.023)	-0.063*	(0.023)	-0.063*	(0.023)	-0.070**	(0.025)
Treated × year 2016	-0.106**	(0.0334)	-0.106**	(0.034)	-0.106**	(0.034)	-0.115**	(0.032)
Age	0.006***	(0.001)	0.006***	(0.001)	0.006***	(0.001)	0.006***	(0.001)
Age squared	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)
Female	-0.028***	(0.004)	-0.021***	(0.004)	-0.019***	(0.004)	-0.020***	(0.004)
Foreigner	0.027	(0.019)	0.027	(0.018)	0.027	(0.018)	0.025	(0.018)
CCI 1			0.0245***	(0.0045)	0.025***	(0.005)	0.025***	(0.005)
CCI 2			0.047***	(0.007)	0.040***	(0.007)	0.040***	(0.006)
CCI 3			0.073***	(0.010)	0.055***	(0.010)	0.055***	(0.010)
CCI 4+			0.104***	(0.013)	0.067***	(0.015)	0.066***	(0.014)
Heart disease					0.084***	(0.013)	0.085***	(0.013)
Dementia					-0.021***	(0.004)	-0.020***	(0.004)
Cerebrovascular disease					0.002	(0.004)	0.000	(0.005)
Arthritis					-0.012	(0.015)	-0.014	(0.015)
Nutritional disease					0.007	(0.019)	0.005	(0.018)
Hemiplegia					-0.003	(0.016)	-0.001	(0.017)
Blood disease					-0.000	(0.008)	-0.006	(0.008)
Vascular disease					0.037**	(0.010)	0.038***	(0.009)
Kidney disease					0.022*	(0.008)	0.023*	(0.009)
Other chronic disease					0.032	(0.028)	0.032	(0.028)
Obesity					0.031	(0.017)	0.030	(0.017)
Constant	-0.0211	(0.0328)	-0.0213	(0.0330)	-0.015	(0.033)	-0.037	(0.035)
N	59,549		59,549		59,549		59,549	
Year FE	Y		Y		Y		Y	
Hospital FE	Y		Y		Y		Y	
Hospital time trends	N		N		N		Y	

Notes. See Tables 1-A1 for more information on the dependent and control variables. We define the treated group as patients undergoing a hip fracture surgery (ICD-9 CM codes 820.0-820.9), and the control units as patients operated on for a tibia or fibula fracture (ICD-9 CM codes 823.0-823.9). Hospital cluster robust standard errors in parentheses. * P < 0.05. ** P < 0.01. *** P < 0.001.

Table 5. DiD results (LPM). Dependent variable: dummy = 1 if pre-surgery waiting time ≥ 6 days.

Variable	LPM (1)		LPM (2)		LPM (3)		LPM (4)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Treated	-0.043**	(0.012)	-0.048***	(0.012)	-0.049***	(0.012)	-0.047***	(0.012)
Treated × year 2007	-0.026	(0.032)	-0.026	(0.032)	-0.026	(0.032)	-0.030	(0.031)
Treated × year 2008	0.002	(0.014)	0.002	(0.015)	0.002	(0.014)	-0.001	(0.014)
Treated × year 2009	-0.013	(0.014)	-0.013	(0.014)	-0.013	(0.014)	-0.015	(0.015)
Treated × year 2011	-0.009	(0.016)	-0.009	(0.017)	-0.009	(0.016)	-0.010	(0.017)
Treated × year 2012	-0.030	(0.021)	-0.030	(0.021)	-0.030	(0.021)	-0.031	(0.021)
Treated × year 2013	-0.009	(0.015)	-0.008	(0.015)	-0.008	(0.015)	-0.009	(0.016)
Treated × year 2014	-0.014	(0.017)	-0.013	(0.017)	-0.013	(0.017)	-0.014	(0.017)
Treated × year 2015	-0.043	(0.029)	-0.043	(0.029)	-0.043	(0.029)	-0.050	(0.030)
Treated × year 2016	-0.071*	(0.031)	-0.070*	(0.031)	-0.071*	(0.031)	-0.079*	(0.030)
Age	0.004***	(0.001)	0.004***	(0.001)	0.004***	(0.001)	0.004***	(0.001)
Age squared	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)
Female	-0.020***	(0.004)	-0.016***	(0.003)	-0.015***	(0.003)	-0.015***	(0.003)
Foreigner	0.015	(0.012)	0.014	(0.012)	0.015	(0.012)	0.013	(0.011)
CCI 1			0.021***	(0.004)	0.021***	(0.005)	0.021***	(0.005)
CCI 2			0.032***	(0.005)	0.028***	(0.006)	0.028***	(0.006)
CCI 3			0.054***	(0.010)	0.041**	(0.012)	0.042**	(0.013)
CCI 4+			0.064***	(0.012)	0.038*	(0.015)	0.038*	(0.015)
Heart disease					0.046***	(0.010)	0.046***	(0.010)
Dementia					-0.016***	(0.004)	-0.015**	(0.004)
Cerebrovascular disease					0.003	(0.005)	0.002	(0.005)
Arthritis					0.008	(0.013)	0.007	(0.014)
Nutritional disease					-0.006	(0.021)	-0.008	(0.020)
Hemiplegia					-0.000	(0.017)	0.001	(0.017)
Blood disease					0.003	(0.006)	-0.000	(0.007)
Vascular disease					0.033**	(0.010)	0.033**	(0.009)
Kidney disease					0.017*	(0.008)	0.017*	(0.008)
Other chronic disease					0.015	(0.023)	0.015	(0.024)
Obesity					0.023	(0.012)	0.022	(0.012)
Constant	-0.034	(0.027)	-0.034	(0.027)	-0.030	(0.027)	-0.087*	(0.041)
N	59,549		59,549		59,549		59,549	
Year FE	Y		Y		Y		Y	
Hospital FE	Y		Y		Y		Y	
Hospital time trends	N		N		N		Y	

Notes. See Tables 1-A1 for more information on the dependent and control variables. We define the treated group as patients undergoing a hip fracture surgery (ICD-9 CM codes 820.0-820.9), and the control units as patients operated on for a tibia or fibula fracture (ICD-9 CM codes 823.0-823.9). Hospital cluster robust standard errors in parentheses. * P < 0.05. ** P < 0.01. *** P < 0.001.

Table 6. DiD results (LPM). Dependent variable: dummy = 1 if pre-surgery waiting time ≥ 7 days.

Variable	LPM (1)		LPM (2)		LPM (3)		LPM (4)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Treated	-0.037**	(0.011)	-0.041***	(0.011)	-0.042***	(0.011)	-0.041***	(0.011)
Treated × year 2007	-0.015	(0.023)	-0.015	(0.023)	-0.014	(0.023)	-0.018	(0.023)
Treated × year 2008	0.010	(0.015)	0.010	(0.015)	0.010	(0.015)	0.008	(0.015)
Treated × year 2009	0.002	(0.013)	0.002	(0.013)	0.002	(0.013)	-0.000	(0.013)
Treated × year 2011	0.017	(0.012)	0.017	(0.012)	0.017	(0.012)	0.016	(0.012)
Treated × year 2012	-0.010	(0.019)	-0.010	(0.019)	-0.010	(0.019)	-0.011	(0.019)
Treated × year 2013	0.001	(0.011)	0.002	(0.011)	0.002	(0.011)	0.001	(0.012)
Treated × year 2014	0.002	(0.015)	0.002	(0.015)	0.002	(0.015)	0.001	(0.015)
Treated × year 2015	-0.020	(0.022)	-0.020	(0.022)	-0.020	(0.022)	-0.026	(0.023)
Treated × year 2016	-0.040	(0.029)	-0.040	(0.029)	-0.040	(0.029)	-0.047	(0.028)
Age	0.002***	(0.001)	0.002***	(0.001)	0.002***	(0.001)	0.002***	(0.001)
Age squared	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)
Female	-0.013***	(0.004)	-0.010**	(0.003)	-0.009*	(0.003)	-0.010**	(0.003)
Foreigner	0.006	(0.006)	0.006	(0.006)	0.006	(0.006)	0.005	(0.006)
CCI 1			0.015***	(0.003)	0.016***	(0.004)	0.016***	(0.004)
CCI 2			0.023***	(0.004)	0.022***	(0.005)	0.022***	(0.005)
CCI 3			0.041***	(0.009)	0.037**	(0.011)	0.037**	(0.011)
CCI 4+			0.048***	(0.010)	0.036**	(0.012)	0.036**	(0.012)
Heart disease					0.030***	(0.007)	0.030***	(0.007)
Dementia					-0.015***	(0.004)	-0.014**	(0.004)
Cerebrovascular disease					0.002	(0.004)	0.002	(0.004)
Arthritis					0.001	(0.013)	0.001	(0.014)
Nutritional disease					0.007	(0.018)	0.006	(0.018)
Hemiplegia					-0.001	(0.015)	-0.000	(0.015)
Blood disease					0.003	(0.005)	0.002	(0.005)
Vascular disease					0.022*	(0.009)	0.023*	(0.009)
Kidney disease					0.003	(0.008)	0.004	(0.008)
Other chronic disease					0.026	(0.022)	0.026	(0.022)
Obesity					0.026	(0.013)	0.026*	(0.013)
Constant	-0.007	(0.021)	-0.007	(0.021)	-0.003	(0.020)	-0.036	(0.036)
N	59,549		59,549		59,549		59,549	
Year FE	Y		Y		Y		Y	
Hospital FE	Y		Y		Y		Y	
Hospital time trends	N		N		N		Y	

Notes. See Tables 1-A1 for more information on the dependent and control variables. We define the treated group as patients undergoing a hip fracture surgery (ICD-9 CM codes 820.0-820.9), and the control units as patients operated on for a tibia or fibula fracture (ICD-9 CM codes 823.0-823.9). Hospital cluster robust standard errors in parentheses. * P < 0.05. ** P < 0.01. *** P < 0.001.

Table 7. DiD results: controlling for CEO fixed-effects.

Variable	Pre-surgery wait time ≤ 2 days		Pre-surgery wait time		Pre-surgery wait time ≥ 5 days		Pre-surgery wait time ≥ 6 days		Pre-surgery wait time ≥ 7 days	
	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Treated	0.0444	(0.0288)	-0.0326	(0.0407)	-0.0731***	(0.0188)	-0.0462**	(0.0124)	-0.0403**	(0.0109)
Treated × year 2007	0.0542	(0.0344)	-0.0713	(0.0517)	-0.0482	(0.0322)	-0.0330	(0.0327)	-0.0198	(0.0242)
Treated × year 2008	-0.00508	(0.0276)	0.00584	(0.0328)	-0.00105	(0.0193)	-0.00219	(0.0141)	0.00714	(0.0150)
Treated × year 2009	0.0143	(0.0212)	-0.0243	(0.0177)	-0.0144	(0.0165)	-0.0165	(0.0148)	-0.000912	(0.0130)
Treated × year 2011	0.0428	(0.0347)	-0.0347	(0.0366)	-0.0132	(0.0185)	-0.0106	(0.0173)	0.0151	(0.0120)
Treated × year 2012	0.0895*	(0.0324)	-0.100*	(0.0368)	-0.0417	(0.0248)	-0.0306	(0.0214)	-0.0110	(0.0193)
Treated × year 2013	0.141***	(0.0331)	-0.116**	(0.0334)	-0.0222	(0.0210)	-0.00901	(0.0161)	0.000584	(0.0116)
Treated × year 2014	0.197***	(0.0412)	-0.171***	(0.0376)	-0.0651*	(0.0245)	-0.0139	(0.0169)	0.000628	(0.0149)
Treated × year 2015	0.213***	(0.0406)	-0.197***	(0.0469)	-0.0781**	(0.0255)	-0.0547	(0.0306)	-0.0287	(0.0224)
Treated × year 2016	0.261***	(0.0385)	-0.250***	(0.0392)	-0.123**	(0.0330)	-0.0840*	(0.0317)	-0.0500	(0.0285)
Constant	-0.165	(0.0889)	1.401***	(0.118)	0.207**	(0.0599)	0.0238	(0.0439)	-0.00431	(0.0328)
N	59,549		59,549		59,549		59,549		59,549	
CEO FE	Y		Y		Y		Y		Y	
Patients' controls	Y		Y		Y		Y		Y	
Year FE	Y		Y		Y		Y		Y	
Hospital FE	Y		Y		Y		Y		Y	
Hospital time trends	Y		Y		Y		Y		Y	

Notes. See Tables 1-A1 for more information on the dependent and control variables. Patients' controls include the full list of demographics and co-morbidities used in specification (4) of Tables 2-6. Treated patients are those undergoing a hip fracture surgery (ICD-9 CM codes 820.0-820.9). Control patients are the ones operated on for a tibia or fibula fracture (ICD-9 CM codes 823.0-823.9). Hospital cluster robust standard errors in parentheses. * P < 0.05. ** P < 0.01. *** P < 0.001.

Table 8. DiD results (LPM) by hospital group. Dependent variable: dummy = 1 if pre-surgery waiting time ≤ 2 days.

Variable	1st tertile (most distressed)		2nd tertile		3rd tertile (least distressed)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE
Treated	-0.068*	(0.029)	0.083	(0.038)	0.117*	(0.036)
Treated × year 2007	0.109	(0.050)	0.004	(0.090)	0.021	(0.032)
Treated × year 2008	-0.016	(0.029)	-0.038	(0.046)	-0.004	(0.055)
Treated × year 2009	0.008	(0.025)	0.000	(0.038)	0.001	(0.037)
Treated × year 2011	0.095*	(0.041)	-0.001	(0.089)	0.023	(0.061)
Treated × year 2012	0.185**	(0.038)	0.108	(0.051)	-0.001	(0.051)
Treated × year 2013	0.197**	(0.052)	0.152*	(0.058)	0.082	(0.056)
Treated × year 2014	0.314**	(0.068)	0.239**	(0.058)	0.091	(0.053)
Treated × year 2015	0.331***	(0.040)	0.227**	(0.064)	0.097	(0.050)
Treated × year 2016	0.307***	(0.042)	0.267***	(0.046)	0.190*	(0.068)
Age	-0.009***	(0.001)	-0.011***	(0.001)	-0.009***	(0.001)
Age squared	0.000***	(0.000)	0.000***	(0.000)	0.000***	(0.000)
Female	0.031***	(0.005)	0.024**	(0.005)	0.022**	(0.006)
Foreigner	-0.069	(0.032)	-0.009	(0.019)	-0.023	(0.017)
CCI 1	-0.016	(0.011)	-0.010	(0.010)	-0.042**	(0.011)
CCI 2	-0.049***	(0.007)	-0.040	(0.023)	-0.059***	(0.008)
CCI 3	-0.121***	(0.024)	-0.043	(0.035)	-0.078**	(0.016)
CCI 4+	-0.116*	(0.040)	-0.009	(0.030)	-0.121***	(0.019)
Heart disease	-0.105***	(0.016)	-0.084	(0.039)	-0.135**	(0.026)
Dementia	0.031	(0.018)	0.027*	(0.008)	0.044**	(0.010)
Cerebrovascular disease	-0.016	(0.014)	-0.012	(0.011)	-0.017	(0.013)
Arthritis	-0.047	(0.058)	-0.095	(0.042)	0.037	(0.023)
Nutritional disease	0.069	(0.057)	-0.058	(0.055)	0.031	(0.018)
Hemiplegia	0.056	(0.045)	-0.021	(0.029)	0.001	(0.024)
Blood disease	-0.017	(0.014)	-0.007	(0.021)	0.020	(0.012)
Vascular disease	-0.035	(0.028)	-0.052*	(0.021)	-0.022	(0.013)
Kidney disease	-0.006	(0.026)	-0.032*	(0.013)	-0.015	(0.016)
Other chronic disease	0.048	(0.055)	0.074	(0.061)	-0.002	(0.038)
Obesity	-0.056	(0.038)	-0.014	(0.042)	-0.060**	(0.017)
Constant	0.603***	(0.049)	0.870***	(0.088)	0.906***	(0.087)
N	16,136		16,696		26,717	
Year FE	Y		Y		Y	
Hospital FE	Y		Y		Y	
Hospital time trends	Y		Y		Y	

Notes. See Tables 1-A1 for more information on the dependent and control variables. We define the treated group as patients undergoing a hip fracture surgery (ICD-9 CM codes 820.0-820.9), and the control units as patients operated on for a tibia or fibula fracture (ICD-9 CM codes 823.0-823.9). Hospital cluster robust standard errors in parentheses. Most (least) distressed indicate hospitals where the proportion of patients waiting within 2 days for a hip fracture surgery in the pre-policy year 2010 fall in the 1st (3rd) tertile of the distribution. * P < 0.05. ** P < 0.01. *** P < 0.001.

Table 9. DiD results (LPM) by hospital group. Dependent variable: (log of) pre-surgery waiting time (days).

Variable	1st tertile (most distressed)		2nd tertile		3rd tertile (least distressed)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE
Treated	0.120*	(0.048)	-0.092	(0.040)	-0.123	(0.056)
Treated × year 2007	-0.184	(0.100)	0.041	(0.093)	-0.035	(0.049)
Treated × year 2008	0.0433	(0.042)	0.024	(0.051)	-0.001	(0.066)
Treated × year 2009	-0.0434	(0.036)	-0.010	(0.037)	0.006	(0.019)
Treated × year 2011	-0.0990	(0.046)	0.054	(0.102)	-0.030	(0.053)
Treated × year 2012	-0.244***	(0.030)	-0.065	(0.053)	-0.005	(0.055)
Treated × year 2013	-0.160*	(0.057)	-0.128**	(0.035)	-0.061	(0.064)
Treated × year 2014	-0.307**	(0.064)	-0.172*	(0.065)	-0.071	(0.042)
Treated × year 2015	-0.295**	(0.060)	-0.186*	(0.062)	-0.102	(0.074)
Treated × year 2016	-0.227**	(0.056)	-0.207**	(0.042)	-0.249**	(0.069)
Age	0.013**	(0.003)	0.014***	(0.001)	0.012***	(0.002)
Age squared	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)
Female	-0.024	(0.013)	-0.027*	(0.011)	-0.033*	(0.010)
Foreigner	0.091**	(0.023)	0.055	(0.026)	0.010	(0.013)
CCI 1	0.037*	(0.012)	0.035*	(0.012)	0.049*	(0.018)
CCI 2	0.062***	(0.011)	0.047	(0.025)	0.075***	(0.010)
CCI 3	0.134**	(0.027)	0.038	(0.048)	0.103***	(0.014)
CCI 4+	0.120*	(0.036)	0.010	(0.034)	0.146***	(0.021)
Heart disease	0.127***	(0.013)	0.080*	(0.029)	0.146***	(0.022)
Dementia	-0.038*	(0.016)	-0.039*	(0.011)	-0.047**	(0.009)
Cerebrovascular disease	0.006	(0.013)	0.015	(0.016)	0.015	(0.017)
Arthritis	-0.024	(0.044)	0.117*	(0.038)	-0.053	(0.033)
Nutritional disease	-0.024	(0.050)	0.094	(0.063)	-0.058*	(0.017)
Hemiplegia	0.025	(0.054)	0.036	(0.031)	-0.022	(0.038)
Blood disease	0.033	(0.016)	0.005	(0.028)	-0.014	(0.011)
Vascular disease	0.084*	(0.026)	0.071	(0.031)	0.028	(0.019)
Kidney disease	0.027	(0.019)	0.058*	(0.022)	0.017	(0.015)
Other chronic disease	-0.047	(0.083)	0.047	(0.080)	0.014	(0.058)
Obesity	0.071	(0.056)	0.011	(0.035)	0.074*	(0.030)
Constant	0.864***	(0.094)	0.695***	(0.095)	0.641**	(0.160)
N	16,136		16,696		26,717	
Year FE	Y		Y		Y	
Hospital FE	Y		Y		Y	
Hospital time trends	Y		Y		Y	

Notes. See Tables 1-A1 for more information on the dependent and control variables. We define the treated group as patients undergoing a hip fracture surgery (ICD-9 CM codes 820.0-820.9), and the control units as patients operated on for a tibia or fibula fracture (ICD-9 CM codes 823.0-823.9). Hospital cluster robust standard errors in parentheses. Most (least) distressed indicate hospitals where the proportion of patients waiting within 2 days for a hip fracture surgery in the pre-policy year 2010 fall in the 1st (3rd) tertile of the distribution. * $P < 0.05$. ** $P < 0.01$. *** $P < 0.001$.

Table 10. DiD results (LPM) by hospital legal status. Dependent variable: dummy = 1 if pre-surgery waiting time ≤ 2 days.

Variable	ASL hospitals		AO hospitals	
	Coeff.	SE	Coeff.	SE
Treated	0.039	(0.036)	0.067	(0.046)
Treated × year 2007	0.072	(0.036)	0.011	(0.066)
Treated × year 2008	-0.007	(0.025)	-0.009	(0.067)
Treated × year 2009	-0.010	(0.030)	0.039	(0.017)
Treated × year 2011	0.037	(0.043)	0.039	(0.060)
Treated × year 2012	0.090*	(0.042)	0.088	(0.052)
Treated × year 2013	0.106*	(0.043)	0.193**	(0.039)
Treated × year 2014	0.212**	(0.060)	0.171**	(0.040)
Treated × year 2015	0.188**	(0.052)	0.222**	(0.048)
Treated × year 2016	0.218***	(0.054)	0.278***	(0.027)
Age	-0.010***	(0.001)	-0.008**	(0.001)
Age squared	0.000***	(0.000)	0.000**	(0.000)
Female	0.025***	(0.005)	0.024***	(0.002)
Foreigner	-0.022	(0.021)	-0.054*	(0.015)
CCI 1	-0.038***	(0.009)	-0.014	(0.011)
CCI 2	-0.061***	(0.012)	-0.040*	(0.014)
CCI 3	-0.077***	(0.016)	-0.083**	(0.019)
CCI 4+	-0.088**	(0.024)	-0.088	(0.037)
Heart disease	-0.145***	(0.018)	-0.084**	(0.020)
Dementia	0.043***	(0.010)	0.027**	(0.007)
Cerebrovascular disease	-0.014	(0.010)	-0.016	(0.010)
Arthritis	-0.036	(0.035)	-0.014	(0.033)
Nutritional disease	0.006	(0.037)	0.015	(0.039)
Hemiplegia	-0.012	(0.027)	0.028	(0.021)
Blood disease	0.003	(0.014)	0.005	(0.013)
Vascular disease	-0.037*	(0.015)	-0.037	(0.020)
Kidney disease	-0.010	(0.016)	-0.023	(0.012)
Other chronic disease	0.035	(0.039)	0.025	(0.048)
Obesity	-0.083**	(0.026)	-0.004	(0.032)
Constant	0.987***	(0.047)	0.034	(0.071)
N	36,153		23,396	
Year FE	Y		Y	
Hospital FE	Y		Y	
Hospital time trends	Y		Y	

Notes. See Tables 1-A1 for more information on the dependent and control variables. We define the treated group as patients undergoing a hip fracture surgery (ICD-9 CM codes 820.0-820.9), and the control units as patients operated on for a tibia or fibula fracture (ICD-9 CM codes 823.0-823.9). ASL hospitals are hospitals manged by Local Health Authorities. AOs are hospitals enjoying the status of semi-independent Trusts. Hospital cluster robust standard errors in parentheses. * P < 0.05. ** P < 0.01. *** P < 0.001.

Table 11. DiD results (LPM) by hospital legal status. Dependent variable: (log of) pre-surgery waiting time (days).

Variable	AUSL hospitals		AO hospitals	
	Coeff.	SE	Coeff.	SE
Treated	-0.016	(0.047)	-0.079	(0.072)
Treated × year 2007	-0.125*	(0.057)	0.039	(0.073)
Treated × year 2008	-0.001	(0.035)	0.029	(0.074)
Treated × year 2009	-0.010	(0.024)	-0.026	(0.027)
Treated × year 2011	-0.033	(0.047)	-0.016	(0.062)
Treated × year 2012	-0.116*	(0.048)	-0.071	(0.055)
Treated × year 2013	-0.074	(0.046)	-0.176**	(0.032)
Treated × year 2014	-0.186**	(0.054)	-0.141*	(0.039)
Treated × year 2015	-0.161*	(0.061)	-0.205**	(0.050)
Treated × year 2016	-0.213**	(0.056)	-0.236**	(0.035)
Age	0.015***	(0.002)	0.010**	(0.002)
Age squared	-0.000***	(0.000)	-0.000**	(0.000)
Female	-0.029**	(0.009)	-0.028*	(0.007)
Foreigner	0.040*	(0.018)	0.059	(0.024)
CCI 1	0.061***	(0.011)	0.020	(0.013)
CCI 2	0.081***	(0.011)	0.043*	(0.016)
CCI 3	0.109***	(0.018)	0.074*	(0.029)
CCI 4+	0.112***	(0.027)	0.084	(0.039)
Heart disease	0.150***	(0.018)	0.103**	(0.017)
Dementia	-0.047***	(0.010)	-0.032**	(0.006)
Cerebrovascular disease	0.005	(0.011)	0.020	(0.012)
Arthritis	-0.006	(0.039)	0.021	(0.035)
Nutritional disease	0.005	(0.043)	-0.001	(0.040)
Hemiplegia	-0.000	(0.033)	0.019	(0.043)
Blood disease	0.001	(0.015)	0.002	(0.015)
Vascular disease	0.063***	(0.016)	0.052	(0.030)
Kidney disease	0.023	(0.015)	0.042*	(0.016)
Other chronic disease	-0.034	(0.055)	0.052	(0.048)
Obesity	0.080	(0.045)	0.023	(0.028)
Constant	0.479***	(0.082)	1.751***	(0.119)
N	36,153		23,396	
Year FE	Y		Y	
Hospital FE	Y		Y	
Hospital time trends	Y		Y	

Notes. See Tables 1-A1 for more information on the dependent and control variables. We define the treated group as patients undergoing a hip fracture surgery (ICD-9 CM codes 820.0-820.9), and the control units as patients operated on for a tibia or fibula fracture (ICD-9 CM codes 823.0-823.9). ASL hospitals are hospitals manged by Local Health Authorities. AOs are hospitals enjoying the status of semi-independent Trusts. Hospital cluster robust standard errors in parentheses. * P < 0.05. ** P < 0.01. *** P < 0.001.

Table 12. Compositional effects on hip fracture patients.

	Log (CCI)		Dummy chronic condition		Log (no. chronic conditions)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE
Pre-surgery delay ≤ 2 days						
Post-policy	-0.008	(0.013)	0.012	(0.042)	0.006	(0.012)
Constant	0.462***	(0.008)	-0.208***	(0.027)	0.353***	(0.008)
N			30,860			
Pre-surgery delay = 3 days						
Post-policy	-0.002	(0.012)	0.013	(0.033)	0.013	(0.010)
Constant	0.465***	(0.008)	-0.220***	(0.022)	0.336***	(0.007)
N			8,357			
Pre-surgery delay = 4 days						
Post-policy	0.009	(0.018)	0.009	(0.046)	0.004	(0.016)
Constant	0.484***	(0.012)	-0.0684*	(0.030)	0.427***	(0.010)
N			5,011			
Pre-surgery delay > 4 days						
Post-policy	0.049**	(0.015)	0.116***	(0.027)	0.051***	(0.010)
Constant	-0.0568***	(0.013)	0.426***	(0.005)	0.598***	(0.008)
N			6,345			

Notes. All specification models include hospital FEs. Post-policy is a dummy = 1 in the post-policy years (i.e., 2011-2016), and 0 otherwise. Log (CCI) is the log of the Charlson comorbidity index. Dummy chronic condition is a dummy = 1 for patients with at least 1 chronic disease conditions, and 0 otherwise. Log (no. chronic conditions) is the log of the number of chronic disease conditions reported by sample patients. Hospital cluster robust standard errors in parentheses. * P < 0.05. ** P < 0.01. *** P < 0.001.

Appendix A

Table A1. Definitions of the variables used in the estimation analysis.

Variable name	Variable definition
Dependent variables	
Pre-surgery wait time ≤ 2 days	Dummy = 1 if pre-surgery wait time within 2 days of admission
Pre-surgery wait time	Pre-surgery wait times (days)
Pre-surgery wait time ≥ 5 days	Dummy = 1 if pre-surgery wait time equal to 5 days or more
Pre-surgery wait time ≥ 6 days	Dummy = 1 if pre-surgery wait time equal to 6 days or more
Pre-surgery wait time ≥ 7 days	Dummy = 1 if pre-surgery wait time equal to 7 days or more
Control variables	
Age	Patient age in years
Female	Dummy = 1 for females
Foreigner	Dummy = 1 for foreigners
CCI 0	Dummy = 1 if Charlson comorbidity index = 0
CCI 1	Dummy = 1 if Charlson comorbidity index = 1
CCI 2	Dummy = 1 if Charlson comorbidity index = 2
CCI 3	Dummy = 1 if Charlson comorbidity index = 3
CCI 4+	Dummy = 1 if Charlson comorbidity index > 3
Heart disease	Dummy = 1 for patients with chronic heart disease
Dementia	Dummy = 1 for patients with dementia disease
Cerebrovascular disease	Dummy = 1 for patients with chronic cerebrovascular disease
Arthritis	Dummy = 1 for patients with arthritis
Nutritional disease	Dummy = 1 for patients with nutritional disease
Hemiplegia	Dummy = 1 for patients with hemiplegia
Blood disease	Dummy = 1 for patients with blood disease
Vascular disease	Dummy = 1 for patients with vascular disease
Kidney disease	Dummy = 1 for patients with chronic kidney disease
Other chronic disease	Dummy = 1 for patients with liver, pancreas or intestine disease
Obesity	Dummy = 1 for obese patients

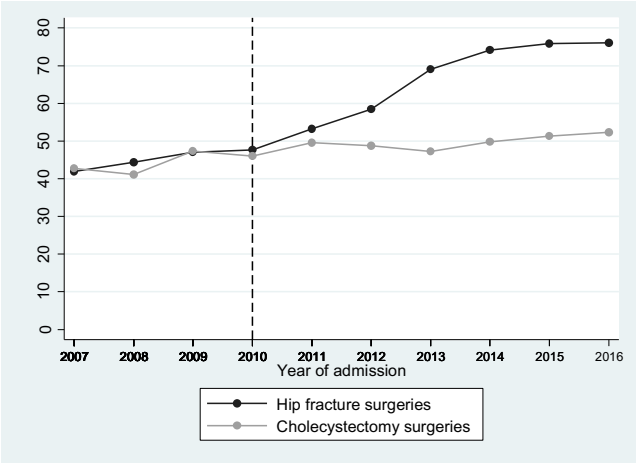
Table A2. Summary statistics of the dependent and control variables by policy periods for alternative control units.

	Alternative control group: patients with cholecystectomy				
	Pre-policy (n = 5,493)		Post-policy (n = 8,888)		Normalised difference
Variable name	Mean	SD	Mean	SD	
Dependent variables					
Pre-surgery wait time ≤ 2 days	0.443	0.497	0.498	0.500	0.078
Pre-surgery wait time	4.954	5.504	4.449	5.214	-0.067
Pre-surgery wait time ≥ 5 days	0.332	0.471	0.350	0.477	-0.063
Pre-surgery wait time ≥ 6 days	0.332	0.471	0.296	0.456	-0.055
Pre-surgery wait time ≥ 7 days	0.276	0.447	0.246	0.431	-0.048
Control variables					
Age	62.504	17.609	62.321	17.604	-0.007
Female	0.508	0.500	0.503	0.500	-0.007
Foreigner	0.080	0.271	0.097	0.297	0.044
CCI 0	0.795	0.404	0.818	0.386	0.040
CCI 1	0.137	0.343	0.120	0.325	-0.034
CCI 2	0.040	0.196	0.034	0.182	-0.021
CCI 3	0.016	0.126	0.017	0.129	0.005
CCI 4+	0.012	0.110	0.011	0.103	-0.010
Heart disease	0.029	0.169	0.032	0.175	0.010
Dementia	0.016	0.126	0.015	0.122	-0.006
Cerebrovascular disease	0.032	0.175	0.027	0.161	-0.021
Arthritis	0.003	0.054	0.003	0.056	0.003
Nutritional disease	0.002	0.049	0.002	0.042	-0.009
Hemiplegia	0.005	0.074	0.003	0.053	-0.029
Blood disease	0.043	0.203	0.037	0.188	-0.023
Vascular disease	0.039	0.194	0.036	0.187	-0.012
Kidney disease	0.027	0.162	0.028	0.164	0.002
Other chronic disease	0.023	0.151	0.024	0.153	0.004
Obesity	0.043	0.203	0.052	0.222	0.030

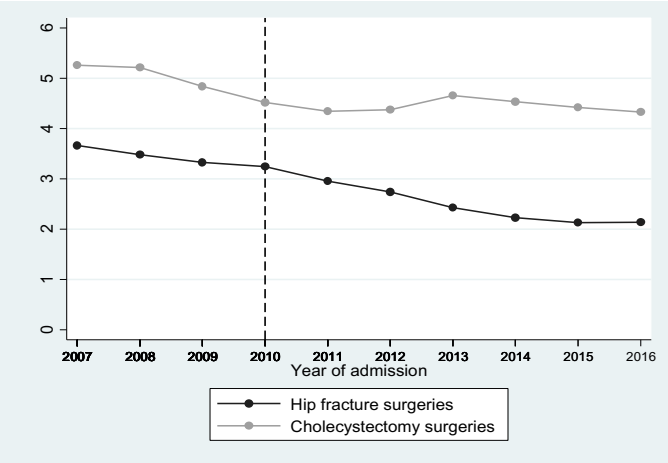
Notes. Pre- and post-policy years include 2007-2010 and 2011-2016, respectively. The normalised difference is defined as the difference in the variables' means between the post- and pre-policy periods, scaled by the square root of the sum of variances.

Appendix B

Figure B1. Time trends in (a) the average proportion of patients waiting within 2 days of hospitalisation, and (b) pre-surgical waiting times for hip fracture and cholecystectomy patients over years 2007-2016. The dashed vertical line is placed at year 2010, i.e. one year before policy implementation.

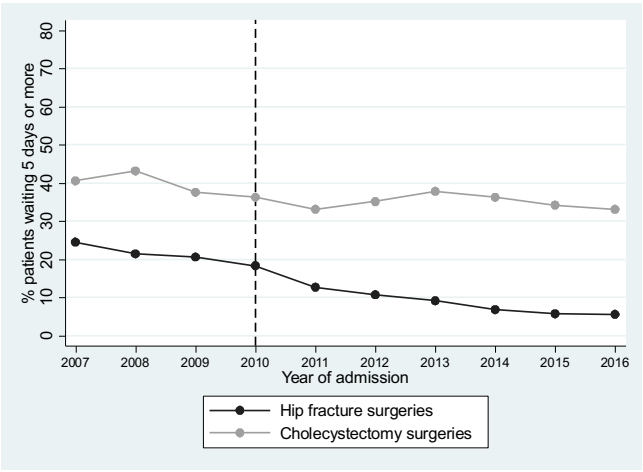


(a)

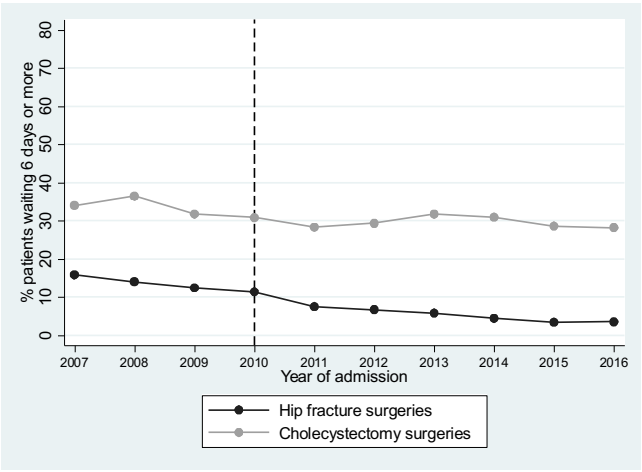


(b)

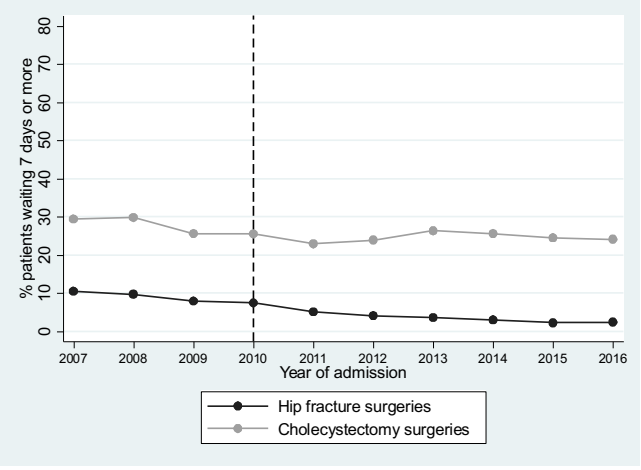
Figure B2. Time trends in the proportion of patients waiting at least: (a) 5 days, (b) 6 days, or (c) 7 days for hip fracture and cholecystectomy surgeries over years 2007-2016. The dashed vertical line is placed at year 2010, i.e. one year before policy implementation.



(a)



(b)



(c)

Table B1. DiD results (LPM). Dependent variable: dummy = 1 if pre-surgery waiting time ≤ 2 days.

Variable	LPM (1)		LPM (2)		LPM (3)		LPM (4)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Treated	0.019	(0.027)	0.024	-0.027	0.023	(0.026)	0.024	(0.027)
Treated × year 2007	-0.021	(0.051)	-0.022	-0.051	-0.023	(0.051)	-0.016	(0.052)
Treated × year 2008	0.024	(0.035)	0.023	-0.035	0.021	(0.035)	0.028	(0.036)
Treated × year 2009	-0.015	(0.029)	-0.014	-0.029	-0.014	(0.029)	-0.013	(0.029)
Treated × year 2011	0.022	(0.023)	0.022	-0.023	0.021	(0.023)	0.022	(0.022)
Treated × year 2012	0.080*	(0.029)	0.078*	-0.029	0.077*	(0.029)	0.076*	(0.030)
Treated × year 2013	0.203***	(0.041)	0.201***	-0.041	0.201***	(0.042)	0.200***	(0.042)
Treated × year 2014	0.224***	(0.040)	0.223***	-0.04	0.222***	(0.039)	0.215***	(0.038)
Treated × year 2015	0.233***	(0.054)	0.233***	-0.053	0.233***	(0.054)	0.227***	(0.054)
Treated × year 2016	0.224***	(0.043)	0.225***	-0.043	0.224***	(0.043)	0.215***	(0.041)
Age	-0.014***	(0.001)	-0.014***	-0.001	-0.013***	(0.001)	-0.013***	(0.001)
Age squared	0.000***	(0.000)	0.000***	-0.000	0.001***	(0.000)	0.000***	(0.000)
Female	0.028***	(0.006)	0.020***	-0.004	0.017***	(0.004)	0.018***	(0.004)
Foreigner	-0.032*	(0.013)	-0.030*	-0.014	-0.030*	(0.013)	-0.030*	(0.014)
CCI 1			-0.030***	-0.007	-0.028***	(0.007)	-0.027***	(0.007)
CCI 2			-0.058***	-0.01	-0.045***	(0.010)	-0.043***	(0.009)
CCI 3			-0.100***	-0.012	-0.074***	(0.013)	-0.074***	(0.012)
CCI 4+			-0.126***	-0.02	-0.076**	(0.021)	-0.072**	(0.019)
Heart disease					-0.116***	(0.017)	-0.116***	(0.016)
Dementia					0.037***	(0.007)	0.037***	(0.007)
Cerebrovascular disease					-0.019*	(0.007)	-0.019**	(0.006)
Arthritis					-0.049	(0.024)	-0.040	(0.025)
Nutritional disease					-0.007	(0.027)	-0.003	(0.028)
Hemiplegia					-0.011	(0.025)	-0.006	(0.024)
Blood disease					-0.016	(0.009)	-0.009	(0.009)
Vascular disease					-0.035**	(0.011)	-0.037**	(0.011)
Kidney disease					-0.020	(0.011)	-0.024*	(0.010)
Other chronic disease					-0.061**	(0.021)	-0.063**	(0.022)
Obesity					0.051	(0.036)	0.045	(0.034)
Constant	1.054***	(0.043)	1.055***	(0.042)	1.040***	(0.042)	1.118***	(0.038)
N	59,642		59,642		59,642		59,642	
Year FE	Y		Y		Y		Y	
Hospital FE	Y		Y		Y		Y	
Hospital time trends	N		N		N		Y	

Notes. See Tables 1-A1 for more information on the dependent and control variables. We define the treated group as patients undergoing a hip fracture surgery (ICD-9 CM codes 820.0-820.9), and the control units as patients undergoing urgent surgery for cholecystectomy (ICD-9 CM codes 51.21-51.24). Hospital cluster robust standard errors in parentheses. * P < 0.05. ** P < 0.01. *** P < 0.001.

Table B2. DiD results (OLS). Dependent variable: (log of) pre-surgery waiting time (days).

Variable	OLS (1)		OLS (2)		OLS (3)		OLS (4)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Treated	-0.128*	(0.047)	-0.136**	(0.047)	-0.132**	(0.046)	-0.133**	(0.047)
Treated × year 2007	-0.026	(0.079)	-0.025	(0.079)	-0.024	(0.078)	-0.030	(0.079)
Treated × year 2008	-0.072	(0.057)	-0.070	(0.057)	-0.069	(0.056)	-0.076	(0.057)
Treated × year 2009	0.004	(0.037)	0.003	(0.037)	0.002	(0.036)	0.001	(0.036)
Treated × year 2011	-0.013	(0.038)	-0.012	(0.038)	-0.011	(0.038)	-0.011	(0.038)
Treated × year 2012	-0.071	(0.051)	-0.069	(0.052)	-0.068	(0.052)	-0.067	(0.052)
Treated × year 2013	-0.199**	(0.069)	-0.196**	(0.069)	-0.195**	(0.069)	-0.194*	(0.070)
Treated × year 2014	-0.215**	(0.063)	-0.212**	(0.063)	-0.213**	(0.063)	-0.208**	(0.062)
Treated × year 2015	-0.207**	(0.063)	-0.207**	(0.063)	-0.207**	(0.063)	-0.203**	(0.063)
Treated × year 2016	-0.175**	(0.060)	-0.175**	(0.059)	-0.175**	(0.059)	-0.167**	(0.058)
Age	0.024***	(0.001)	0.023***	(0.001)	0.022***	(0.001)	0.022***	(0.001)
Age squared	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)
Female	-0.034***	(0.008)	-0.024**	(0.008)	-0.018*	(0.008)	-0.020*	(0.008)
Foreigner	0.049*	(0.019)	0.047*	(0.019)	0.045*	(0.019)	0.046*	(0.019)
CCI 1			0.054***	(0.008)	0.052***	(0.009)	0.051***	(0.008)
CCI 2			0.086***	(0.012)	0.067***	(0.013)	0.064***	(0.013)
CCI 3			0.135***	(0.019)	0.090***	(0.019)	0.089***	(0.018)
CCI 4+			0.179***	(0.027)	0.091**	(0.026)	0.086**	(0.025)
Heart disease					0.143***	(0.022)	0.144***	(0.021)
Dementia					-0.046***	(0.008)	-0.045***	(0.008)
Cerebrovascular disease					0.015	(0.009)	0.014	(0.008)
Arthritis					0.017	(0.032)	0.008	(0.032)
Nutritional disease					0.019	(0.035)	0.015	(0.033)
Hemiplegia					0.045	(0.036)	0.038	(0.033)
Blood disease					0.032*	(0.014)	0.024	(0.014)
Vascular disease					0.057**	(0.016)	0.059**	(0.016)
Kidney disease					0.047***	(0.011)	0.052***	(0.010)
Other chronic disease					0.188***	(0.025)	0.191***	(0.026)
Obesity					-0.079	(0.056)	-0.073	(0.053)
Constant	0.288***	(0.0624)	0.287***	(0.062)	0.309***	(0.062)	0.218**	(0.058)
N	59,642		59,642		59,642		59,642	
Year FE	Y		Y		Y		Y	
Hospital FE	Y		Y		Y		Y	
Hospital time trends	N		N		N		Y	

Notes. See Tables 1-A1 for more information on the dependent and control variables. We define the treated group as patients undergoing a hip fracture surgery (ICD-9 CM codes 820.0-820.9), and the control units as patients undergoing urgent surgery for cholecystectomy (ICD-9 CM codes 51.21-51.24). Hospital cluster robust standard errors in parentheses. * P < 0.05. ** P < 0.01. *** P < 0.001.

Table B3. DiD results (LPM). Dependent variable: dummy = 1 if pre-surgery waiting time ≥ 5 days.

Variable	LPM (1)		LPM (2)		LPM (3)		LPM (4)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Treated	-0.211***	(0.025)	-0.215***	(0.024)	-0.213***	(0.024)	-0.212***	(0.025)
Treated × year 2007	0.023	(0.049)	0.024	(0.049)	0.025	(0.049)	0.021	(0.048)
Treated × year 2008	-0.040	(0.0259)	-0.039	(0.025)	-0.038	(0.025)	-0.041	(0.025)
Treated × year 2009	0.007	(0.020)	0.006	(0.020)	0.005	(0.020)	0.007	(0.019)
Treated × year 2011	-0.024	(0.024)	-0.024	(0.024)	-0.024	(0.023)	-0.02	(0.024)
Treated × year 2012	-0.064*	(0.023)	-0.063*	(0.024)	-0.062*	(0.024)	-0.062*	(0.024)
Treated × year 2013	-0.106**	(0.029)	-0.104**	(0.029)	-0.104**	(0.029)	-0.104**	(0.029)
Treated × year 2014	-0.108**	(0.029)	-0.107**	(0.029)	-0.107**	(0.029)	-0.104**	(0.029)
Treated × year 2015	-0.101**	(0.033)	-0.101**	(0.033)	-0.101**	(0.033)	-0.098**	(0.033)
Treated × year 2016	-0.089*	(0.033)	-0.090*	(0.033)	-0.089*	(0.033)	-0.083*	(0.032)
Age	0.011***	(0.001)	0.011***	(0.001)	0.011***	(0.001)	0.011***	(0.001)
Age squared	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)
Female	-0.022***	(0.005)	-0.015**	(0.005)	-0.012*	(0.005)	-0.013*	(0.005)
Foreigner	0.020	(0.013)	0.019	(0.013)	0.018	(0.013)	0.019	(0.013)
CCI 1			0.028***	(0.004)	0.027***	(0.004)	0.026***	(0.004)
CCI 2			0.048***	(0.007)	0.037***	(0.007)	0.036***	(0.006)
CCI 3			0.080***	(0.012)	0.055***	(0.010)	0.054***	(0.009)
CCI 4+			0.111***	(0.015)	0.061***	(0.015)	0.057***	(0.014)
Heart disease					0.089***	(0.015)	0.089***	(0.015)
Dementia					-0.022***	(0.005)	-0.021***	(0.005)
Cerebrovascular disease					0.003	(0.005)	0.002	(0.004)
Arthritis					-0.003	(0.019)	-0.007	(0.019)
Nutritional disease					0.027	(0.021)	0.024	(0.020)
Hemiplegia					0.018	(0.019)	0.016	(0.020)
Blood disease					0.009	(0.009)	0.004	(0.009)
Vascular disease					0.040***	(0.010)	0.040***	(0.010)
Kidney disease					0.026**	(0.008)	0.029**	(0.008)
Other chronic disease					0.100***	(0.017)	0.100***	(0.018)
Obesity					-0.045	(0.024)	-0.041	(0.023)
Constant	-0.128**	(0.0367)	-0.128**	(0.0364)	-0.117**	(0.037)	-0.149***	(0.037)
N	59,642		59,642		59,642		59,642	
Year FE	Y		Y		Y		Y	
Hospital FE	Y		Y		Y		Y	
Hospital time trends	N		N		N		Y	

Notes. See Tables 1-A1 for more information on the dependent and control variables. We define the treated group as patients undergoing a hip fracture surgery (ICD-9 CM codes 820.0-820.9), and the control units as patients undergoing urgent surgery for cholecystectomy (ICD-9 CM codes 51.21-51.24). Hospital cluster robust standard errors in parentheses. * P < 0.05. ** P < 0.01. *** P < 0.001.

Table B4. DiD results (LPM). Dependent variable: dummy = 1 if pre-surgery waiting time ≥ 6 days.

Variable	LPM (1)		LPM (2)		LPM (3)		LPM (4)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Treated	-0.228***	(0.027)	-0.231***	(0.027)	-0.230***	(0.027)	-0.230***	(0.028)
Treated × year 2007	0.017	(0.040)	0.017	(0.040)	0.018	(0.040)	0.016	(0.039)
Treated × year 2008	-0.031	(0.026)	-0.030	(0.025)	-0.029	(0.025)	-0.032	(0.025)
Treated × year 2009	-0.002	(0.017)	-0.003	(0.017)	-0.003	(0.017)	-0.002	(0.016)
Treated × year 2011	-0.013	(0.025)	-0.013	(0.025)	-0.012	(0.024)	-0.012	(0.024)
Treated × year 2012	-0.031	(0.022)	-0.030	(0.022)	-0.030	(0.022)	-0.029	(0.022)
Treated × year 2013	-0.064*	(0.026)	-0.063*	(0.026)	-0.062*	(0.026)	-0.060*	(0.026)
Treated × year 2014	-0.064*	(0.025)	-0.063*	(0.024)	-0.063*	(0.024)	-0.059*	(0.024)
Treated × year 2015	-0.052	(0.029)	-0.052	(0.029)	-0.052	(0.029)	-0.048	(0.029)
Treated × year 2016	-0.045	(0.030)	-0.045	(0.030)	-0.045	(0.030)	-0.039	(0.030)
Age	0.009***	(0.001)	0.009***	(0.001)	0.009***	(0.001)	0.009***	(0.001)
Age squared	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)
Female	-0.016**	(0.004)	-0.012*	(0.004)	-0.009*	(0.004)	-0.009*	(0.004)
Foreigner	0.009	(0.011)	0.008	(0.011)	0.007	(0.011)	0.007	(0.011)
CCI 1			0.027***	(0.003)	0.026***	(0.003)	0.026***	(0.003)
CCI 2			0.036***	(0.005)	0.029***	(0.006)	0.028***	(0.006)
CCI 3			0.066***	(0.011)	0.049***	(0.011)	0.048***	(0.011)
CCI 4+			0.081***	(0.012)	0.042**	(0.013)	0.040**	(0.013)
Heart disease					0.057***	(0.013)	0.057***	(0.0130)
Dementia					-0.022***	(0.004)	-0.021***	(0.00466)
Cerebrovascular disease					0.005	(0.005)	0.005	(0.00459)
Arthritis					0.014	(0.018)	0.011	(0.0180)
Nutritional disease					-0.003	(0.022)	-0.006	(0.0213)
Hemiplegia					0.017	(0.024)	0.014	(0.0236)
Blood disease					0.012	(0.008)	0.009	(0.00788)
Vascular disease					0.042***	(0.009)	0.041***	(0.00863)
Kidney disease					0.018*	(0.007)	0.019*	(0.00733)
Other chronic disease					0.100***	(0.017)	0.100***	(0.0172)
Obesity					-0.047*	(0.020)	-0.044*	(0.0191)
Constant	-0.0962**	(0.0277)	-0.0964**	(0.0275)	-0.085**	(0.028)	-0.104***	(0.0273)
N	59,642		59,642		59,642		59,642	
Year FE	Y		Y		Y		Y	
Hospital FE	Y		Y		Y		Y	
Hospital time trends	N		N		N		Y	

Notes. See Tables 1-A1 for more information on the dependent and control variables. We define the treated group as patients undergoing a hip fracture surgery (ICD-9 CM codes 820.0-820.9), and the control units as patients undergoing urgent surgery for cholecystectomy (ICD-9 CM codes 51.21-51.24). Hospital cluster robust standard errors in parentheses. * P < 0.05. ** P < 0.01. *** P < 0.001.

Table B5. DiD results (LPM). Dependent variable: dummy = 1 if pre-surgery waiting time ≥ 7 days.

Variable	LPM (1)		LPM (2)		LPM (3)		LPM (4)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Treated	-0.216***	(0.025)	-0.219***	(0.025)	-0.217***	(0.025)	-0.218***	(0.025)
Treated × year 2007	-0.003	(0.036)	-0.003	(0.035)	-0.002	(0.035)	-0.004	(0.035)
Treated × year 2008	-0.020	(0.021)	-0.018	(0.021)	-0.018	(0.021)	-0.020	(0.021)
Treated × year 2009	0.001	(0.017)	0.001	(0.017)	0.001	(0.016)	0.001	(0.016)
Treated × year 2011	0.003	(0.021)	0.004	(0.021)	0.004	(0.021)	0.005	(0.021)
Treated × year 2012	-0.016	(0.021)	-0.015	(0.021)	-0.015	(0.021)	-0.013	(0.021)
Treated × year 2013	-0.044	(0.026)	-0.043	(0.026)	-0.042	(0.026)	-0.040	(0.026)
Treated × year 2014	-0.041	(0.024)	-0.039	(0.024)	-0.040	(0.024)	-0.036	(0.023)
Treated × year 2015	-0.036	(0.025)	-0.036	(0.025)	-0.036	(0.025)	-0.032	(0.025)
Treated × year 2016	-0.027	(0.028)	-0.027	(0.028)	-0.027	(0.028)	-0.022	(0.028)
Age	0.009***	(0.001)	0.009***	(0.001)	0.008***	(0.001)	0.008***	(0.001)
Age squared	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)
Female	-0.012**	(0.004)	-0.008*	(0.004)	-0.006	(0.004)	-0.007	(0.004)
Foreigner	0.006	(0.009)	0.005	(0.009)	0.004	(0.009)	0.004	(0.009)
CCI 1			0.022***	(0.003)	0.023***	(0.004)	0.023***	(0.004)
CCI 2			0.028***	(0.005)	0.025***	(0.005)	0.025***	(0.005)
CCI 3			0.054***	(0.009)	0.046***	(0.009)	0.046***	(0.009)
CCI 4+			0.066***	(0.010)	0.044***	(0.011)	0.042***	(0.011)
Heart disease					0.044***	(0.010)	0.043***	(0.010)
Dementia					-0.021***	(0.005)	-0.021***	(0.005)
Cerebrovascular disease					0.003	(0.004)	0.003	(0.004)
Arthritis					-0.00	(0.016)	-0.002	(0.017)
Nutritional disease					0.009	(0.020)	0.008	(0.020)
Hemiplegia					0.022	(0.020)	0.021	(0.020)
Blood disease					0.011	(0.007)	0.010	(0.007)
Vascular disease					0.025**	(0.008)	0.025**	(0.008)
Kidney disease					0.004	(0.008)	0.005	(0.008)
Other chronic disease					0.102***	(0.014)	0.101***	(0.014)
Obesity					-0.034	(0.018)	-0.033	(0.017)
Constant	-0.115***	(0.024)	-0.115***	(0.0235)	-0.105***	(0.024)	-0.117***	(0.023)
N	59,642		59,642		59,642		59,642	
Year FE	Y		Y		Y		Y	
Hospital FE	Y		Y		Y		Y	
Hospital time trends	N		N		N		Y	

Notes. See Tables 1-A1 for more information on the dependent and control variables. We define the treated group as patients undergoing a hip fracture surgery (ICD-9 CM codes 820.0-820.9), and the control units as patients undergoing urgent surgery for cholecystectomy (ICD-9 CM codes 51.21-51.24). Hospital cluster robust standard errors in parentheses. * P < 0.05. ** P < 0.01. *** P < 0.001.

Appendix C

Table C1. DiD results (LPM). Dependent variable: dummy = 1 if pre-surgery waiting time ≤ 2 days.

Variable	OLS (1)		OLS (2)		OLS (3)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE
Treated	0.048	(0.029)	0.048	(0.029)	0.048	(0.029)
Treated × year 2007	0.053	(0.032)	0.052	(0.032)	0.052	(0.032)
Treated × year 2008	-0.008	(0.027)	-0.007	(0.027)	-0.007	(0.027)
Treated × year 2009	0.011	(0.021)	0.011	(0.021)	0.011	(0.021)
Treated × year 2011	0.041	(0.035)	0.040	(0.035)	0.042	(0.035)
Treated × year 2012	0.090**	(0.032)	0.090**	(0.032)	0.090**	(0.032)
Treated × year 2013	0.140***	(0.032)	0.139***	(0.032)	0.140***	(0.032)
Treated × year 2014	0.197***	(0.041)	0.196***	(0.041)	0.197***	(0.041)
Treated × year 2015	0.201***	(0.037)	0.201***	(0.038)	0.201***	(0.037)
Treated × year 2016	0.248***	(0.036)	0.248***	(0.036)	0.248***	(0.036)
Age	-0.009***	(0.001)	-0.009***	(0.001)	-0.010***	(0.001)
Age squared	0.000***	(0.000)	0.000***	(0.000)	0.000***	(0.000)
Female	0.025***	(0.003)	0.025***	(0.003)	0.025***	(0.003)
Foreigner	-0.034*	(0.014)	-0.034*	(0.015)	-0.035*	(0.015)
CCI 1	-0.027***	(0.007)	-0.027***	(0.007)	-0.027***	(0.007)
CCI 2	-0.051***	(0.009)	-0.050***	(0.009)	-0.050***	(0.009)
CCI 3	-0.078***	(0.013)	-0.078***	(0.013)	-0.079***	(0.013)
CCI 4+	-0.086***	(0.021)	-0.086***	(0.021)	-0.086***	(0.020)
Chronic heart disease	-0.115***	(0.016)	-0.114***	(0.016)	-0.115***	(0.016)
Dementia	0.036***	(0.006)	0.036***	(0.006)	0.036***	(0.006)
Chronic cerebrovascular disease	-0.015*	(0.007)	-0.015*	(0.007)	-0.015*	(0.007)
Arthritis	-0.023	(0.023)	-0.022	(0.024)	-0.022	(0.023)
Nutritional disease	0.011	(0.027)	0.010	(0.027)	0.011	(0.027)
Hemiplegia	0.004	(0.019)	0.005	(0.019)	0.005	(0.019)
Blood disease	0.004	(0.009)	0.005	(0.009)	0.005	(0.009)
Vascular disease	-0.035**	(0.012)	-0.036**	(0.012)	-0.036**	(0.012)
Chronic kidney disease	-0.018	(0.010)	-0.018	(0.010)	-0.018	(0.010)
Other chronic disease	0.031	(0.029)	0.029	(0.029)	0.028	(0.029)
Obesity	-0.043*	(0.021)	-0.041	(0.020)	-0.041	(0.020)
Constant	0.931***	(0.049)	0.924***	(0.046)	0.940***	(0.047)
N	59,549		59,549		59,549	
Year FE	Y		Y		Y	
Hospital FE	Y		Y		Y	
Hospital time trends	Y		Y		Y	
Month FE	Y		N		N	
Winter	N		Y		N	
Weekend	N		N		Y	

Notes. See Tables 1-A1 for more information on the dependent and control variables. We define the treated group as patients undergoing a hip fracture surgery (ICD-9 CM codes 820.0-820.9), and the control units as patients operated on for a tibia or fibula fracture (ICD-9 CM codes 823.0-823.9). Hospital cluster robust standard errors in parentheses. * P < 0.05. ** P < 0.01. *** P < 0.001.

Table C2. DiD results (OLS). Dependent variable: (log of) pre-surgery waiting time (days).

Variable	OLS (1)		OLS (2)		OLS (3)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE
Treated	-0.037	(0.041)	-0.037	(0.041)	-0.038	(0.041)
Treated × year 2007	-0.070	(0.049)	-0.069	(0.049)	-0.071	(0.049)
Treated × year 2008	0.009	(0.033)	0.008	(0.033)	0.009	(0.033)
Treated × year 2009	-0.020	(0.017)	-0.021	(0.017)	-0.020	(0.017)
Treated × year 2011	-0.033	(0.037)	-0.032	(0.037)	-0.037	(0.036)
Treated × year 2012	-0.101**	(0.036)	-0.101*	(0.036)	-0.102**	(0.036)
Treated × year 2013	-0.114**	(0.033)	-0.114**	(0.033)	-0.117**	(0.033)
Treated × year 2014	-0.172***	(0.038)	-0.171***	(0.037)	-0.173***	(0.037)
Treated × year 2015	-0.180***	(0.043)	-0.180***	(0.043)	-0.180***	(0.042)
Treated × year 2016	-0.234***	(0.037)	-0.234***	(0.037)	-0.234***	(0.038)
Age	0.013***	(0.001)	0.013***	(0.001)	0.014***	(0.001)
Age squared	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)
Female	-0.029***	(0.006)	-0.029***	(0.006)	-0.029***	(0.006)
Foreigner	0.047**	(0.015)	0.048**	(0.015)	0.050**	(0.015)
CCI 1	0.042***	(0.009)	0.042***	(0.009)	0.041***	(0.009)
CCI 2	0.063***	(0.010)	0.062***	(0.010)	0.062***	(0.010)
CCI 3	0.091***	(0.017)	0.090***	(0.017)	0.091***	(0.017)
CCI 4+	0.098***	(0.022)	0.097***	(0.022)	0.098***	(0.022)
Chronic heart disease	0.126***	(0.014)	0.125***	(0.014)	0.126***	(0.014)
Dementia	-0.042***	(0.006)	-0.042***	(0.006)	-0.042***	(0.006)
Chronic cerebrovascular disease	0.013	(0.009)	0.013	(0.009)	0.013	(0.009)
Arthritis	0.005	(0.026)	0.0050	(0.026)	0.005	(0.026)
Nutritional disease	0.001	(0.030)	0.002	(0.030)	-0.000	(0.030)
Hemiplegia	0.010	(0.025)	0.009	(0.025)	0.009	(0.024)
Blood disease	0.001	(0.010)	0.000	(0.010)	-0.001	(0.010)
Vascular disease	0.055**	(0.016)	0.056**	(0.016)	0.057**	(0.016)
Chronic kidney disease	0.033**	(0.011)	0.033**	(0.011)	0.035**	(0.011)
Other chronic disease	0.005	(0.040)	0.008	(0.039)	0.010	(0.040)
Obesity	0.052*	(0.024)	0.051*	(0.024)	0.049*	(0.023)
Constant	0.585***	(0.089)	0.596***	(0.083)	0.542***	(0.080)
N	59,549		59,549		59,549	
Year FE	Y		Y		Y	
Hospital FE	Y		Y		Y	
Hospital time trends	Y		Y		Y	
Month FE	Y		N		N	
Winter	N		Y		N	
Weekend	N		N		Y	

Notes. See Tables 1-A1 for more information on the dependent and control variables. We define the treated group as patients undergoing a hip fracture surgery (ICD-9 CM codes 820.0-820.9), and the control units as patients operated on for a tibia or fibula fracture (ICD-9 CM codes 823.0-823.9). Hospital cluster robust standard errors in parentheses. * P < 0.05. ** P < 0.01. *** P < 0.001.

Table C3. DiD results (LPM). Dependent variable: dummy = 1 if pre-surgery waiting time ≥ 5 days.

Variable	OLS (1)		OLS (2)		OLS (3)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE
Treated	-0.074***	(0.019)	-0.074***	(0.019)	-0.074***	(0.019)
Treated × year 2007	-0.045	(0.031)	-0.045	(0.031)	-0.044	(0.031)
Treated × year 2008	0.000	(0.019)	-0.000	(0.020)	-0.000	(0.020)
Treated × year 2009	-0.013	(0.016)	-0.013	(0.016)	-0.013	(0.016)
Treated × year 2011	-0.014	(0.018)	-0.014	(0.018)	-0.012	(0.018)
Treated × year 2012	-0.043	(0.025)	-0.043	(0.025)	-0.043	(0.025)
Treated × year 2013	-0.0225	(0.021)	-0.023	(0.021)	-0.022	(0.021)
Treated × year 2014	-0.066*	(0.025)	-0.066*	(0.025)	-0.066*	(0.025)
Treated × year 2015	-0.070**	(0.025)	-0.070**	(0.025)	-0.070*	(0.025)
Treated × year 2016	-0.114**	(0.032)	-0.114**	(0.032)	-0.115**	(0.032)
Age	0.006***	(0.001)	0.006***	(0.001)	0.005***	(0.001)
Age squared	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)
Female	-0.020***	(0.004)	-0.020***	(0.004)	-0.020***	(0.004)
Foreigner	0.024	(0.018)	0.025	(0.018)	0.024	(0.018)
CCI 1	0.025***	(0.005)	0.025***	(0.005)	0.025***	(0.005)
CCI 2	0.040***	(0.006)	0.040***	(0.006)	0.040***	(0.006)
CCI 3	0.055***	(0.009)	0.055***	(0.010)	0.055***	(0.010)
CCI 4+	0.066***	(0.014)	0.070***	(0.014)	0.066***	(0.014)
Chronic heart disease	0.085***	(0.013)	0.084***	(0.013)	0.084***	(0.013)
Dementia	-0.020***	(0.004)	-0.020***	(0.004)	-0.020***	(0.004)
Chronic cerebrovascular disease	0.000	(0.005)	0.000	(0.005)	0.000	(0.005)
Arthritis	-0.014	(0.015)	-0.014	(0.015)	-0.014	(0.015)
Nutritional disease	0.005	(0.018)	0.005	(0.018)	0.006	(0.018)
Hemiplegia	-0.001	(0.017)	-0.001	(0.017)	-0.001	(0.017)
Blood disease	-0.006	(0.008)	-0.006	(0.008)	-0.005	(0.008)
Vascular disease	0.038***	(0.009)	0.038***	(0.009)	0.038***	(0.009)
Chronic kidney disease	0.022*	(0.009)	0.023*	(0.009)	0.022*	(0.009)
Other chronic disease	0.030	(0.028)	0.032	(0.028)	0.031	(0.028)
Obesity	0.031	(0.017)	0.030	(0.017)	0.030	(0.017)
Constant	-0.042	(0.036)	-0.035	(0.035)	-0.021	(0.036)
N	59,549		59,549		59,549	
Year FE	Y		Y		Y	
Hospital FE	Y		Y		Y	
Hospital time trends	Y		Y		Y	
Month FE	Y		N		N	
Winter	N		Y		N	
Weekend	N		N		Y	

Notes. See Tables 1-A1 for more information on the dependent and control variables. We define the treated group as patients undergoing a hip fracture surgery (ICD-9 CM codes 820.0-820.9), and the control units as patients operated on for a tibia or fibula fracture (ICD-9 CM codes 823.0-823.9). Hospital cluster robust standard errors in parentheses. * P < 0.05. ** P < 0.01. *** P < 0.001.

Table C4. DiD results (LPM). Dependent variable: dummy = 1 if pre-surgery waiting time ≥ 6 days.

Variable	OLS (1)		OLS (2)		OLS (3)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE
Treated	-0.047***	(0.012)	-0.047***	(0.012)	-0.047***	(0.012)
Treated × year 2007	-0.031	(0.031)	-0.030	(0.031)	-0.030	(0.0311)
Treated × year 2008	-0.001	(0.014)	-0.001	(0.014)	-0.001	(0.014)
Treated × year 2009	-0.015	(0.015)	-0.015	(0.015)	-0.016	(0.014)
Treated × year 2011	-0.011	(0.017)	-0.010	(0.017)	-0.009	(0.017)
Treated × year 2012	-0.032	(0.021)	-0.031	(0.021)	-0.031	(0.021)
Treated × year 2013	-0.009	(0.016)	-0.009	(0.016)	-0.008	(0.016)
Treated × year 2014	-0.014	(0.017)	-0.014	(0.017)	-0.014	(0.017)
Treated × year 2015	-0.050	(0.030)	-0.050	(0.030)	-0.050	(0.031)
Treated × year 2016	-0.079*	(0.030)	-0.079*	(0.030)	-0.079*	(0.030)
Age	0.004***	(0.001)	0.004***	(0.001)	0.004***	(0.001)
Age squared	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)
Female	-0.015***	(0.003)	-0.015***	(0.003)	-0.015***	(0.003)
Foreigner	0.012	(0.012)	0.013	(0.011)	0.012	(0.011)
CCI 1	0.021***	(0.005)	0.021***	(0.005)	0.021***	(0.005)
CCI 2	0.028***	(0.006)	0.028***	(0.006)	0.028***	(0.006)
CCI 3	0.042**	(0.013)	0.042**	(0.013)	0.041**	(0.013)
CCI 4+	0.038*	(0.015)	0.038*	(0.015)	0.038*	(0.015)
Heart disease	0.046***	(0.010)	0.046***	(0.010)	0.046***	(0.010)
Dementia	-0.015**	(0.004)	-0.015**	(0.004)	-0.015**	(0.004)
Cerebrovascular disease	0.002	(0.005)	0.002	(0.005)	0.002	(0.005)
Arthritis	0.007	(0.013)	0.007	(0.014)	0.007	(0.013)
Nutritional disease	-0.008	(0.020)	-0.008	(0.020)	-0.007	(0.020)
Hemiplegia	0.001	(0.017)	0.0006	(0.017)	0.001	(0.017)
Blood disease	-0.000	(0.007)	-0.000	(0.007)	0.000	(0.007)
Vascular disease	0.033**	(0.009)	0.033**	(0.009)	0.033**	(0.010)
Kidney disease	0.017*	(0.008)	0.017*	(0.008)	0.017*	(0.008)
Other chronic disease	0.013	(0.024)	0.015	(0.024)	0.014	(0.023)
Obesity	0.024	(0.012)	0.022	(0.012)	0.023	(0.012)
Constant	-0.046	(0.030)	-0.038	(0.028)	-0.024	(0.028)
N	59,549		59,549		59,549	
Year FE	Y		Y		Y	
Hospital FE	Y		Y		Y	
Hospital time trends	Y		Y		Y	
Month FE	Y		N		N	
Winter	N		Y		N	
Weekend	N		N		Y	

Notes. See Tables 1-A1 for more information on the dependent and control variables. We define the treated group as patients undergoing a hip fracture surgery (ICD-9 CM codes 820.0-820.9), and the control units as patients operated on for a tibia or fibula fracture (ICD-9 CM codes 823.0-823.9). Hospital cluster robust standard errors in parentheses. * P < 0.05. ** P < 0.01. *** P < 0.001.

Table C5. DiD results (LPM). Dependent variable: dummy = 1 if pre-surgery waiting time ≥ 7 days.

Variable	OLS (1)		OLS (2)		OLS (3)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE
Treated	-0.041***	(0.011)	-0.041***	(0.011)	-0.041***	(0.011)
Treated × year 2007	-0.018	(0.023)	-0.018	(0.023)	-0.017	(0.023)
Treated × year 2008	0.008	(0.015)	0.008	(0.015)	0.008	(0.015)
Treated × year 2009	0.000	(0.013)	-0.000	(0.013)	-0.000	(0.013)
Treated × year 2011	0.015	(0.012)	0.016	(0.012)	0.016	(0.012)
Treated × year 2012	-0.012	(0.019)	-0.011	(0.019)	-0.011	(0.019)
Treated × year 2013	0.000	(0.012)	0.001	(0.012)	0.001	(0.012)
Treated × year 2014	0.001	(0.015)	0.001	(0.015)	0.001	(0.015)
Treated × year 2015	-0.026	(0.023)	-0.026	(0.023)	-0.026	(0.023)
Treated × year 2016	-0.047	(0.028)	-0.047	(0.028)	-0.047	(0.028)
Age	0.002***	(0.001)	0.002***	(0.001)	0.002**	(0.001)
Age squared	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)
Female	-0.010**	(0.003)	-0.010**	(0.003)	-0.010**	(0.003)
Foreigner	0.004	(0.006)	0.005	(0.006)	0.005	(0.006)
CCI 1	0.016***	(0.004)	0.016***	(0.004)	0.016***	(0.004)
CCI 2	0.022***	(0.005)	0.022***	(0.005)	0.022***	(0.005)
CCI 3	0.038**	(0.011)	0.037**	(0.011)	0.037**	(0.011)
CCI 4+	0.036**	(0.012)	0.036**	(0.012)	0.036**	(0.012)
Heart disease	0.030***	(0.007)	0.030***	(0.007)	0.030***	(0.007)
Dementia	-0.014**	(0.004)	-0.014**	(0.004)	-0.014**	(0.004)
Cerebrovascular disease	0.002	(0.004)	0.002	(0.004)	0.002	(0.004)
Arthritis	0.001	(0.013)	0.001	(0.014)	0.001	(0.013)
Nutritional disease	0.007	(0.018)	0.006	(0.018)	0.007	(0.018)
Hemiplegia	-0.00	(0.015)	-0.000	(0.015)	-0.000	(0.015)
Blood disease	0.002	(0.005)	0.002	(0.005)	0.002	(0.005)
Vascular disease	0.022*	(0.009)	0.0225*	(0.009)	0.022*	(0.009)
Kidney disease	0.003	(0.008)	0.004	(0.008)	0.003	(0.008)
Other chronic disease	0.025	(0.022)	0.026	(0.022)	0.025	(0.022)
Obesity	0.027*	(0.013)	0.026*	(0.013)	0.026*	(0.013)
Constant	-0.011	(0.024)	-0.008	(0.022)	-0.002	(0.022)
N	59,549		59,549		59,549	
Year FE	Y		Y		Y	
Hospital FE	Y		Y		Y	
Hospital time trends	Y		Y		Y	
Month FE	Y		N		N	
Winter	N		Y		N	
Weekend	N		N		Y	

Notes. See Tables 1-A1 for more information on the dependent and control variables. We define the treated group as patients undergoing a hip fracture surgery (ICD-9 CM codes 820.0-820.9), and the control units as patients operated on for a tibia or fibula fracture (ICD-9 CM codes 823.0-823.9). Hospital cluster robust standard errors in parentheses. * P < 0.05. ** P < 0.01. *** P < 0.001.