Helping Nurses or Hurting Patients:

The Effect of Workplace Inspections in Nursing Facilities

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Abstract

This study evaluates the impacts of workplace inspections on workplace safety and service quality in nursing facilities. To identify the effect of inspections, I exploit a nationwide program of the Occupational Safety and Health Administration (OSHA), which prioritized establishments for workplace inspections if their injury rates exceeded a threshold. Using a regression discontinuity design and establishment-level data from OSHA and the Centers for Medicare & Medicaid Services (CMS), I find that inspections were associated with fewer nurse injuries, but worse healthcare quality. The results suggest that improving workplace safety may come at the expense of service quality.

Keywords: Workplace Safety, Healthcare Quality, Nursing Facilities

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1. Introduction

Workplace inspections and the associated penalties are the government's primary tools to reduce workplace injuries, which cost $206 billion annually in wage and productivity losses, medical expenditures, and administrative expenses (National Safety Council, 2015). While the goal of inspections is to reduce workplace injuries and improve workplace safety, improvements in safety may have an unintended impact on product quality. On one hand, improvements in safety may be achieved through enhanced production practice or technology, which may increase product quality. On the other hand, improvements in safety may require additional effort devoted to compliance and precautions (Krueger, 1990), which may subsequently decrease product quality. Theoretically, the net effect of workplace inspections on product quality is ambiguous.

This study provides empirical evidence on the effect of workplace inspections on workplace safety and service quality in nursing facilities. Nursing facilities have a workplace injury rate twice as high as the national average (BLS, 2019). More importantly, injuries among nurses come predominantly from nurses providing direct care to residents. In particular, 44 percent of the injuries in health care facilities come from patient handling and movement, and 37 percent come from slips, falls, and trips (Gomaa et al., 2015). Inspections and the associated financial penalties may incentivize the nursing facilities to reduce injuries. However, the effort to reduce injuries, such as adjustments in the practice of moving and handling patients, might directly affect the quality of healthcare in the inspected facilities.

To identify the causal effect of workplace inspections, I exploit the design of the Site-Specific Targeting (SST) plan, conducted by the Occupational Safety and Health Administration (OSHA). The SST plan is the first nationwide program that targeted establishments for inspection based on establishment-level injury case rates. From 1996 to 2011, OSHA surveyed

the workplace injury case rates of around 80,000 establishments annually through the OSHA Data Initiative (ODI). OSHA prioritized establishments for inspection if the reported case rates exceeded a threshold. Importantly, OSHA selected the targeting threshold after collecting the injury case rate data, preventing establishments from manipulating their injury case rates to avoid inspection. The SST plan generated a discontinuous increase in the likelihood of inspections at the targeting threshold. I estimate the effect of inspections with a fuzzy regression discontinuity design, which uses the targeting threshold as an instrument for whether an establishment received an inspection. The regression discontinuity design identifies the local average treatment effect among compliers with injury case rates close to the targeting threshold.

To implement the fuzzy regression discontinuity design, I construct a unique establishment-level dataset linking surveys on injury case rates, administrative records on workplace inspections, and a census of nursing facilities. The injury case rates of the facilities covered by the SST plan are from the OSHA Data Initiative. The inspection records are from OSHA's Integrated Management Information System (IMIS). The measures of healthcare quality are from a census of the nursing facilities compiled by the Centers for Medicare & Medicaid Services (CMS). The linked data include 11,832 facility-year observations from 2006 to 2011.

I find that the SST plan was associated with a 32 percentage point increase in the likelihood of inspections at the targeting threshold. After inspections, the number of injuries involving days away from work, work restrictions or transfer to another job (DART) decreased significantly by 5.7 cases per 100 full-time equivalent employees, representing a 39 percent decrease compared with the average at the threshold. The results suggest that inspections were effective in improving workplace safety in nursing facilities.

While inspections improved workplace safety, they negatively affected the quality of healthcare, particularly on the quality of care on activities of daily living (ADLs), such as transferring, eating, and bathing. ADL care involves intensive patient moving and handling, which account for nearly half of the nurse injures and might be prone to any effort to reduce nurse injuries. I find that inspections increased the number of deficiency citations on providing care on ADLs by 0.19 citations per facility, representing a more than two hundred percent increase. Additionally, I find that inspections led to more deficiencies on nursing aide training, and more skin rashes and behavioral symptoms among patients. The number and the composition of patients, as well as the number of nursing hours show small and insignificant changes after the inspections. Overall, the results imply a negative impact of inspections on the quality of care in nursing facilities.

This study provides the first evidence on the trade-off between workplace safety and healthcare quality in nursing facilities. Previous studies on workplace safety and worker output focus exclusively on firms in manufacturing, construction, and mining (Sider, 1983; Gray, 1987; Kaminski, 2001; Gowrisankaran et al., 2018). In 2018, the workplace injury rate in nursing facilities was 6.1 cases per 100 employees, much higher than 3.4 cases in manufacturing, 3.0 cases in construction, and 2.3 cases in mining (BLS, 2019). The safety and health of nurses have received more regulatory attention in recent years. Since 2005, eleven states have initiated legislation on promoting safe patient handling to address the high rate of musculoskeletal injuries in the health care sector (Weinmeyer, 2016). The results of this study highlighted the potential unintended effects of these legislations: improving the safety of nurses may come at the expense of the welfare of the patients.

This study also adds to the literature on the important role of nurses in providing high-quality health care. Previous studies have found that factors such as the number of nurses (Lin, 2014), the composition of the nursing team (Bartel et al., 2014), and the pay regulation of nurses (Propper and Van Reenen, 2010) affect the quality of care and patient outcomes significantly. This study added that regulatory effort on the safety of nurses might negatively affect the quality of care in nursing facilities.

2. Background

2.1. OSHA Inspections

The Occupational Safety and Health Administration (OSHA), created after the passage of the Occupational Safety and Health Act of 1970, is a federal agency with the mission of assuring safe and healthful working conditions for workers. OSHA developed a series of workplace health and safety standards that most employers are obliged to obey.[1] To enforce these standards, OSHA conducts about 80,000 workplace inspections annually.

OSHA inspections are likely to improve workplace safety for various reasons. First, OSHA conducts the majority of inspections without any advance notice, making it difficult for employers to act strategically before the inspections.[2] Second, OSHA finds violations of safety and health standards in more than 60 percent of the inspections, which may lead to penalties of up to $12,934 per violation.[3] OSHA mandates the employers to correct the violations within a

[1] The federal OSHA plan covers workers in the private sector and the federal government. Twenty-six states have their own state plans, which cover workers at state and local government agencies.
[2] OSHA may give notices for special circumstances, usually less than 24 hours in advance. In the analysis sample, 0.4 percent of establishments received advanced notices on inspections.
[3] Author's calculation based on the inspections from 1999 to 2014. Data are from OSHA's Integrated Management Information System (IMIS).

time limit. Each repeated violation is subject to penalties of up to $129,336. Lastly, in addition to detecting violations, inspections raise managerial attention to general occupational safety issues, even those not directly related to specific violations found in inspections (Mendeloff and Gray, 2005). Overall, OSHA inspections provide numerous incentives for employers to improve safety conditions and reduce workplace injuries.

OSHA conducts two types of inspections: programmed inspections and unprogrammed inspections. Programmed inspections, constituting 56 percent of OSHA inspections, are typically conducted based on industry, potential hazards, or injury case rates, and are mostly comprehensive inspections on all potential hazards. Unprogrammed inspections are conducted based on employee complaints, accidents, or referrals and only focus on hazards specific to the incidents.

In response to the high injury rate in nursing facilities, OSHA developed standards and programs targeting these facilities. The inspections conducted in nursing facilities target both the general OSHA standards and the specific safety and health hazards in nursing facilities. These hazards include musculoskeletal disorders related to patient or resident handling, workplace violence, blood-borne pathogens, tuberculosis, and slips, trips and falls as defined by OSHA guidelines (OSHA, 2015).

2.2 The Site-Specific Targeting Plan

To identify the effect of OSHA inspections, I exploit the design of OSHA's Site-Specific Targeting (SST) plan. The SST plan is OSHA's first nationwide program that conducted comprehensive inspections based on establishment-level injury case rates (OSHA, 2004). The establishment-level injury case rates were collected through the annual OSHA Data Initiative

(ODI) survey. OSHA requires most firms to keep a log of all recordable workplace injuries.[4] From 1996 to 2011, OSHA selected about 80,000 establishments each year in industries with historically higher injury rates[5] and required the employers to report the number of workplace injuries. While the injury case rates were self-reported by the employers, OSHA has rigorous standards on record-keeping: falsifying records could result in a criminal fine of $10,000 or up to 6 months in jail, or both.

After collecting data on injury case rates, OSHA selected the case rates to be used as the targeting thresholds for different industries.[6] OSHA uses DART as the case rate measure, which is calculated as the number of injuries involving days away from work, job transfer, or restrictions per 100 full-time equivalent employees. OSHA prioritized establishments for inspection if the DART case rates exceeded the corresponding targeting threshold. The thresholds were selected based on the anticipated number of inspections that OSHA would be able to conduct in the next cycle and the distribution of the DART case rates of the surveyed establishments. The thresholds were only announced after the establishments reported their injury rates to OSHA and were updated annually.

OSHA then conducted inspections during the corresponding inspection cycle, which started from around one year and a half after the initial collection of case rates and lasted for

[4] OSHA recordable injuries include any work-related fatality; any work-related injury or illness that results in loss of consciousness, days away from work, restricted work, or transfer to another job; and any work-related injury or illness requiring medical treatment beyond first aid.
[5] The industries include manufacturing and non-construction industries with injury rates above the national average.
[6] The SST plan had different thresholds targeting establishments in manufacturing, nursing and long-term care, and other industries. Starting from 2004, DAFWII (number of cases with days away from work per 100 employees) case rate is added as an additional factor used to select the target list. This study focuses on the DART threshold as about 90 percent of establishments on the target list have DART case rates above the DART threshold.

around one year. Table 1 shows the starting and closing dates of the SST plan from 2004-2011.[7] For example, the OSHA data initiative of 2003 collected the injury case rates of 2002, which were used to design the 2004 SST plan. The inspections of the 2004 SST plan were conducted from April 2004 to Aug 2005. Among the 45 states that participated in the data initiative, 35 states participated in the SST plan, and the ten non-participating states had state plans on occupational safety and health.[8]

This study focuses on inspections among nursing facilities, which were first included in the SST plan in 1999, removed from 2000 to 2003, and added back from 2004 to 2011. Figure 1 shows the DART thresholds that the SST plan used to target nursing facilities and the average DART case rates of facilities surveyed by ODI from 2004 to 2011. About 10 percent of the nursing facilities have DART case rates above the targeting threshold.

3. Methodology

The empirical objective of this paper is to estimate the causal effect of inspections on workplace safety and healthcare quality in nursing facilities. The effect is defined by the following equation:

$$\tau_{ijt} = Y_{ijt+1}(S_{ijt} = 1) - Y_{ijt+1}(S_{ijt} = 0) \quad (1)$$

[7] The OSHA Data Initiative (ODI) has been suspended since 2011 and the SST plan since 2014.
[8] States not participating the SST plan all have State Plans, which are OSHA-approved workplace safety and health programs operated by individual states. To obtain approval from OSHA for its own state plan, a state must go through extensive procedures. The majority of the state plans were initially approved in the 1970s to 1980s. States with State Plans have the option of not participating the federal SST plan, but are required to have their own inspection targeting systems, which might have different rules and criteria than the SST plan.

Y_{ijt+1} indicates the outcomes of nursing facility i in state j in year $t+1$; S_{ijt} indicates whether the facility received an inspection in year t. The effect of an inspection is defined as the difference between the outcome of the facility with an inspection and without an inspection.

Empirically, the challenge of identifying the causal effect of inspections is that inspections are not conducted randomly. Typically, inspections are conducted more frequently in more dangerous firms (Kniesner and Leeth, 2014), generating a negative correlation between inspections and workplace safety. In addition, inspections may be more frequently conducted in establishments with less efficient managers or lower quality workers, generating a negative correlation between inspections and product quality. These cross-sectional correlations would confound the estimates of the causal effect of inspections on safety and quality.

I exploit the design of OSHA's Site-Specific Targeting (SST) plan and use a fuzzy regression discontinuity design to estimate τ.[9] The key feature of the SST plan is that the likelihood of inspections increased right at the targeting threshold:

$$\lim_{X_{ijt}\downarrow 0} E[S_{ijt}|X_{ijt}] > \lim_{X_{ijt}\uparrow 0} E[S_{ijt}|X_{ijt}] \quad (2)$$

The running variable X_{ijt} is defined as $DART_{ijt} - SST_t$, the difference between the DART case rate and the corresponding targeting threshold. The likelihood of inspections among establishments with DART case rates above the targeting threshold is higher than the likelihood among those right below the threshold. Using this discontinuous increase in inspections, the effect of inspections, τ, is given by the following estimand:

$$\tau = \frac{\lim_{X_{ijt}\downarrow 0} E[Y_{ijt}|X_{ijt}] - \lim_{X_{ijt}\uparrow 0} E[Y_{ijt}|X_{ijt}]}{\lim_{X_{ijt}\downarrow 0} E[S_{ijt}|X_{ijt}] - \lim_{X_{ijt}\uparrow 0} E[S_{ijt}|X_{ijt}]} \quad (3)$$

[9] Lee and Lemieux (2010) provide a review of the regression discontinuity design.

The denominator measures the discontinuous change in inspections at the targeting threshold. The numerator measures the discontinuous change in the outcomes of nursing facilities at the targeting threshold. The fuzzy regression discontinuity design gives the local average treatment effect of inspections among the compliers with injury rates close to the targeting threshold. While the estimate may not be generalized to nursing facilities with lower injury rates, the effect of inspections among these relatively dangerous facilities is of the most policy interest.

The effect of inspections is estimated using the following three equations. First, the first stage model estimates the denominator of equation (3), which reflects the discontinuous increase in inspections at the targeting threshold. Specifically, the first stage model is as follows:

$$S_{ijt} = \alpha_0 + \alpha_1 T_{ijt} + \alpha_2 f(X_{ijt}) + \alpha_3 T_{ijt} g(X_{ijt}) + \alpha_4 Z_{ijt} + \delta_j + \theta_t + \epsilon_{ijt}. \quad (4)$$

The outcome S_{ijt} indicates whether nursing facility i in state j had any inspection during the SST plan of year t, which started from the middle of the second year after collecting the injury case rates and lasted for around one year. T_{ijt} is defined as $1\{X_{ijt} \geq 0\}$, which is an indicator of whether the DART case rate of facility i in year t was above the corresponding targeting threshold. $f(X_{ijt})$ and $g(X_{ijt})$ are flexible controls of the DART case rates, allowed to be different above and below the targeting threshold. Z_{ijt} includes control variables on the total number of beds, whether the facility is in a chain, whether it is for-profit, whether it is non-profit, the share of residents paid through Medicaid, the share paid through Medicare, and the ADL acuity index.[10] The model also includes state and year fixed effects, δ_j and θ_t. The coefficient of

[10] The ADL Acuity Index measures the physical functioning of patients. The index is the sum of the activities of daily living index (proportion of residents dependent in eating, toileting, transferring, and ambulation) and the proportion of residents that require special treatments, with higher values indicating a higher level of resident need.

T_{ijt}, α_1, identifies the effect of the SST plan on the likelihood of inspections at the targeting threshold. By design, α_1 should be positive and significant.

Second, the reduced form model estimates the numerator of equation (3), which reflects the discontinuous change in the outcomes of nursing facilities at the targeting threshold.

$$Y_{ijt+1} = \beta_0 + \beta_1 T_{ijt} + \beta_2 f(X_{ijt}) + \beta_3 T_{ijt} g(X_{ijt}) + \beta_4 Z_{ijt} + \delta_j + \theta_t + \epsilon_{ijt} \quad (5)$$

Y_{ijt+1} indicates the outcomes of facility i one year after the corresponding SST inspection cycle. The right hand side of the model is the same as the first stage. The coefficient of T_{ijt}, β_1, identifies the differential change in the outcomes of nursing facilities at the targeting threshold.

Lastly, the causal effect of inspections on the outcomes of nursing facilities is modeled using the following equation:

$$Y_{ijt+1} = \gamma_0 + \gamma_1 S_{ijt} + \gamma_2 f(X_{ijt}) + \gamma_3 T_{ijt} g(X_{ijt}) + \gamma_4 Z_{ijt} + \delta_j + \theta_t + \epsilon_{ijt}. \quad (6)$$

The endogenous variable of inspection, S_{ijt}, is instrumented with T_{ijt}, the indicator of DART case rate above the targeting threshold. The two-stage estimate of γ_1 gives the causal effect of OSHA inspections on the outcomes of nursing facilities at the targeting threshold.

The model is estimated using local linear regressions, first suggested by Hahn, Todd, and van der Klaauw (2001). Specifically, the optimal bandwidth is selected following the method suggested by Calonico et al. (2014) and Calonico et al. (2019). The standard errors presented are bias-corrected robust standard errors clustered at the facility level.[11] The advantage of estimating the model non-parametrically is that there is no need to specify functional forms of $f(X_{ijt})$ and $g(X_{ijt})$. If the functional forms are specified incorrectly, the estimates are likely to be biased.

[11] Calonico et al. (2014) find using a data-driven, asymptotically mean-squared error (MSE) optimal bandwidth and including a robust bias-correction term in the estimated confidence interval offer good finite-sample performance compared with the commonly used approach that assumes away the bias of the estimator.

Additionally, the estimates avoid using the commonly used high-order polynomials as proxies of the functional forms, which leads to poor inferences (Gelman and Imbens, 2014).

Additionally, I estimate a difference-in-differences model. The model uses the facilities with DART case rate below the threshold as a control group, and use 2000-2003 as pre-treatment period, during which the nursing facilities were not included in the SST program.

Specifically, I estimate the following equation:

$$Y_{ijt+1} = \beta_0 + \beta_1 T_{ijt} * \text{Period}_{ijt} + \beta_2 * T_{ijt} + \beta_3 X_{ijt} + \beta_4 T_{ijt} * X_{ijt} + \beta_5 Z_{ijt} + \delta_j + \theta_t + \epsilon_{ijt} \quad (7)$$

T_{ijt} is defined as $1\{X_{ijt} \geq 0\}$, which is an indicator of whether the DART case rate of facility i in year t was above the corresponding targeting threshold. $Period_{ijt}$ equals 1 if the observation is from 2004 to 2009, and equals 0 if from 2000 to 2003. X_{ijt} and $T_{ijt} * X_{ijt}$ controls the injury rate of facilities, separately for those above and below the SST threshold. The model includes the same control variables as the regression discontinuity model. The coefficient of interest is β_1, which measures the effect of the SST program on nursing facility outcomes.

4. Data

4.1. Data Sources

I construct a unique establishment-level dataset linking the establishment-level injury case rates, administrative inspection records, and a census of nursing facilities from CMS. First, the data on injury case rates are from the OSHA Data Initiative (ODI). ODI is an annual survey covering about 80,000 establishments from 1996 to 2011. The establishments were sampled annually from those with 40 or more employees in 45 states.[12] Two measures of injury case rates

[12] In 1996, only establishments with 60 or more employees were included and in 1997, those with 50 or more were included. States that did not participate in ODI 2011 include Alaska,

are available: Total Case Rate (TCR) and Days Away, Restricted, and Transfer (DART) case rate.[13] The data also include basic information on the establishments, including name, street address, and industry. Nursing and personal care facilities were oversampled. From 1996 to 2011, 143,771 surveys were conducted on 23,917 nursing facilities.

Second, the administrative records on inspections are from OSHA's Integrated Management Information System (IMIS). IMIS contains records of all closed OSHA inspections since 1970. The data include the inspection type and open and close dates of the inspection, which are used to determine whether an inspection was conducted under the SST plan and if so, which year of the SST plan. The data also include a detailed list of the violations and the amount of penalty associated with each violation, if applicable. Additionally, the data include establishment name and street address, which are used to match the inspection records to the injury case rates from ODI. The details on the matching process and match rate are provided in the Appendix.

Lastly, the quality of care and other characteristics of nursing facilities is from the Online Survey, Certification and Reporting (OSCAR) database, compiled by CMS. OSCAR is the most comprehensive dataset at the facility level, containing information on operational characteristics, resident health outcomes, staffing level, and records on deficiency citations issued by state health agencies. The data were collected annually on average (Harrington et al., 2015). The data include about 16,000 Medicare and/or Medicaid certificated nursing facilities each year, representing more than 95 percent of long-term care facilities in the US. The empirical analysis

Oregon, South Carolina, Washington, Wyoming, and the District of Columbia. These states have their own state plans.

[13] Starting from 2002, the number of cases with days away from work (DAFWII) per 100 employees was also collected.

uses data from 2006 to 2011 since some outcomes are no longer available after a change of the system in 2012.[14] The OSCAR database is matched to ODI/IMIS based on the establishment name and address.

The quality of care is approximated by the number of deficiencies and the health outcomes of residents. The most relevant type of deficiencies are on the assistance with activities of daily living (ADLs). The majority of the residents in nursing facilities are in need of assistance with at least one ADL, such as moving, eating, bathing, etc. More importantly, assistance with ADLs involves extensive patient handling and moving activities, which contributes to nearly half of the workplace injuries in health care facilities (Gomaa et al., 2015). Thus, the quality of ADL care is likely to be affected by any effort in reducing nurse injuries. I use the number of deficiency citations on providing appropriate ADL care, which reflects the results of annual onsite evaluations conducted by state health agencies.[15]

Additionally, I supplement the number of deficiencies on ADLs with other types of deficiencies and resident health outcomes. The deficiencies include the number of deficiencies on training, patient transfer and discharge, quality of life, quality of care, and administration. The health outcomes include the fraction of residents with contractures, catheter, pressure sores, skin rashes, unplanned weight change, and behavioral symptoms.

[14] From July 2012 the system is transited to Certification and Survey Provider Enhanced Reports (CASPER) and some of the outcomes are no longer available

[15] The deficiencies regarding ADL care include violations of the following deficiency tags: f310 (make sure that each residents' abilities in activities of daily living do not decline, unless unavoidable), f311 (make sure that residents receive treatments/services to maintain or improve their ability to care for themselves), and f312 (assist those residents who need help with eating/drinking, grooming and personal and oral hygiene).

4.2. Analysis Sample

The main analysis sample includes nursing facilities surveyed by ODI from 2002 to 2007. These facilities are covered by the SST plan from mid-2004 to mid-2010 and the outcomes are from 2006 to 2011, around one year after the end of the SST inspection cycle. Facilities with fewer than 10 residents are excluded. Facilities with nursing aid hours higher than 16 hours per resident day, or licensed practical nurses, registered nurses, or nurses with administrative duties higher than 8 hours per resident day are excluded. The main analysis sample includes 11,832 nursing facility-year observations on 3,928 unique facilities.[16]

Table 2 shows the descriptive statistics of the analysis sample and the sample of facilities with DART case rates within five cases above or below the targeting threshold. The facilities in the analysis sample had on average 10.57 occupational injuries per 100 full-time equivalent employees (TCR) annually, among which 6.87 cases involved days away from work, job transfers or restrictions (DART). Although only 4.1 percent of the whole analysis sample was inspected, the SST plan dramatically increased the inspection likelihood among facilities with DART above the threshold. Among facilities with DART within five cases above the targeting threshold, 39 percent received an inspection during the SST inspection cycle, much higher than the 3 percent among those within five cases below the threshold.

To examine the effect of inspections on workplace safety, a subsample is constructed consisting of facilities with multiple surveys from ODI. ODI selected a different sample of establishments each year. Facilities were typically surveyed several times, but not every year. The subsample includes nursing facilities with another survey four years after the initial survey,

[16] Table A5 and A6 compares the characteristics of the facilities in the main analysis sample and all nursing facilities in OSCAR and ODI.

which is around one year after the SST inspection cycle. The subsample includes 4,707 facility-year observations.[17]

The key assumption of the regression discontinuity design is that facilities right above and below the targeting threshold should have similar observed and unobserved characteristics. The assumption is likely to be valid based on the design of the SST plan. OSHA selected and announced the targeting threshold after collecting the data on injury case rates and updated the threshold every year. The design of the SST plan makes it difficult to precisely predict the threshold ex-ante and limits the ability of facilitates to manipulate injury case rates and avoid inspections. Figure 2 shows the distribution of nursing facilities by DART case rates relative to the targeting threshold with the main analysis sample. Consistent with the assumption, the distribution shows no discontinuous change across the targeting threshold. The density test of McCrary (2008) gives a log density of 0.026 and a standard error of 0.101, confirming that the distribution is smooth across the targeting threshold.[18]

5. Results

5.1. The SST plan and Inspections

The SST plan prioritized nursing facilities for inspection if the DART case rate exceeded the targeting threshold. Figure 3, Panel A presents the graphical evidence on how the targeting

[17] Table A5, columns (2) and (3) present the summary statistics of the main analysis sample and the sample with a repeated ODI survey one year after the SST plan. All the characteristics are very similar.

[18] Table A7 examines whether the survival rate changes at the SST threshold. The outcome is one if a facility is active two, three, or four years after the initial survey, and is zero otherwise. The active status is similar for facilities above and below the threshold, which suggests that although some facilities exit during the analysis period, the pattern does not change due to the inspections.

plan affected the frequency of inspections. The x-axis is the DART case rate relative to the corresponding targeting threshold. The y-axis is the likelihood of any programmed inspections during the corresponding inspection cycle. The colored lines in Figure 3 show the fitted values using local linear smoothing. The grey lines show 90% confidence interval. Visually, the frequency of inspections showed a sizable increase at the targeting threshold: 39 percent of the nursing facilities with DART case rates within one case above the threshold received an inspection during the SST inspection cycle, and only 6 percent of those within one case below were inspected.

The first-stage results, estimated using equation (4), are presented in Table 3, Panel A. Column (1) reports the mean of the dependent variable at the targeting threshold. Column (2) reports the estimates of the discontinuity at the targeting threshold using local linear regressions, with state and year fixed effects and controls the number of beds, whether in a chain, whether for profit, whether non-profit, the share of Medicaid patients, the share of Medicare patients, and ADL acuity index. The SST plan increased the frequency of inspections by 32 percentage points, representing a five hundred percent increase compared with the average frequency right below the threshold. The SST plan also increased the frequency of detecting any violations of safety standards by 24 percentage points, suggesting many OSHA inspections identified violations of safety standards.[19]

The causal effect of inspections is identified using the discontinuous increase in inspections at the targeting threshold, which requires facilities near the targeting threshold to be similar. To test this assumption, I first examine the frequency of inspections in the year right

[19] The number of violations is coded as zero if a facility does not receive an inspection in the corresponding year.

before and after the SST inspection cycle. The graphical evidence is presented in Figure 3, Panel C and D. The frequency of inspections in the year before and after the SST inspection cycle was relatively low and showed no discontinuous change at the targeting threshold. The estimated differences are small and statistically insignificant (Table 3, Panel B). I also examine the balance of the operational characteristics and patient characteristics at the targeting threshold, including the number of beds, the number of residents, whether the facility was in a chain, whether for-profit, whether non-profit, the share of Medicaid patients the share of Medicare patients, and the ADL acuity index. The tests revealed no selection of nursing facilities as these observed characteristics showed small and insignificant changes at the threshold (Table 3, Panel C).

5.2. Workplace Injuries

To examine the effect of OSHA inspections on injury case rates, I plot the injury case rates one year after the SST inspection cycle by DART case rate relative to targeting threshold (Figure 4). While both DART and TCR one year after the targeting plan were positively correlated with DART in the initial survey year, both measures showed a discontinuous decrease right at the targeting threshold. Since nursing facilities with DART above the targeting threshold were more likely to be inspected, the discontinuous decrease in DART and TCR at the threshold suggests that inspections were associated with lower injury case rates.

Table 4, columns (2) and (3) present the reduced form estimates using equation (5), which measures the size of the discontinuity at the targeting threshold. Column (2) only include state and year fixed effects; column (3) include additional control variables on the number of beds, whether in a chain, whether for profit, whether non-profit, the share of Medicaid patients, the share of Medicare patients, and ADL acuity index. The facilities right above the threshold had 1.30 fewer injuries involving days away from work, job transfers or restrictions and 2.02

fewer injuries of any type per 100 employees. Columns (4) and (5) present the two-stage estimates of equation (6) using the targeting threshold as an instrument of the inspection, with column (4) including only state and year fixed effects and column (5) including additional control variables as in column (3). The estimates show little change when including additional control variables. After an inspection, DART decreased by 5.7 cases per 100 employees, representing a 39 percent decrease among nursing facilities close to the targeting threshold. TCR case rate decreased by 6.3 cases per 100 employees (33 percent). Overall, the results imply that OSHA inspections were effective in reducing workplace injuries among relatively dangerous nursing facilities. The results are consistent with Li and Singleton (2019) and Johnson, Levine and Toffel (2017), which find that the SST plan led to lower workplace injury case rates in manufacturing and other dangerous industries.

5.3. Healthcare Quality

Inspections were associated with fewer workplace injuries, but they might negatively affect the quality of healthcare in nursing facilities. As a highly labor-intensive industry, nursing facilities spend 74 percent of the total costs on labor (Gertler and Waldman, 1992). After inspections, nurses might devote extra effort to complying with OSHA regulations and preventing injuries, resulting in less effort on patient care and lower healthcare quality.

I first examine the effect of inspections on the quality of care with activities of daily living (ADLs). Assistance with ADLs is particularly relevant in studying the association between nurse safety and healthcare quality. ADL care is the most fundamental care provided in nursing facilities: 86 percent of the residents in need of assistance with at least one ADL.[20] ADL care also constitutes the major job responsibility of nursing aides, accounting for 63 percent of the

[20] Author's calculation based on 13,507 residents from the 2004 National Nursing Home Survey.

staff in nursing facilities.[21] More importantly, assistance with ADLs involves extensive patient handling and moving activities, which contribute to nearly half of the workplace injuries in health care facilities (Gomaa et al., 2015). Thus, after inspections, facilities may adjust the practice of ADL care, as part of the effort to reduce workplace injuries.

I use the frequency of deficiency citations on providing appropriate ADL care to approximate the quality of ADL care. The effect of inspections on the number of ADL related deficiencies are presented in Table 5. After inspections, the number of deficiencies on ADL care increased by 0.19 deficiencies per facility, which represents a more than two hundred percent increase, compared with the mean frequency of 0.09 deficiencies at the threshold. The results are consistent with the assumption that after inspections nurses reduced risky activities involving moving and handling patients to avoid workplace injuries.

Additionally, I examined other types of deficiencies that might be directly affected by inspections: deficiencies on nursing aide training and patient transfer and discharge. The number of deficiencies on training increased by 0.18 per establishment after an inspection. The training requirements are concerning nursing aids, including "ensure that all nurse aides who have worked less than 4 months are enrolled in appropriate training or have been deemed competent to provide nursing and nursing related services", "review the work of each nurse aide every year; and give regular in-service training based upon these reviews", and etc. The number of deficiencies regarding patient transfer and discharge showed little changes after inspections.[22] After inspections, facilities may have incentives to select easier residents, which may lead to

[21] Author's calculation based on nursing facilities in the Online Survey, Certification and Reporting (OSCAR) database from 2006-2011.
[22] The deficiencies on patient transfer and discharge include "no transfer or discharge without adequate reasons"; "providing timely notification and written records on transfer or discharge"; and "preparing each resident for a safe and easy discharge or transfer".

more citations regarding patient transfer and discharge. The lack of any sizable or significant changes in citations on patient transfer and discharge suggests that facilities are unlikely to selectively transfer or discharge residents after inspections.

The federal regulations have more than 100 specific standards for nursing facility. Following Harrington et al. (2000), I divide these deficiencies into three broad categories: quality of care (including tags on resident assessment, quality of care, nursing services, dietary services, physician services, rehabilitative services, dental services, pharmacy services, and infection control), quality of life (including tags on residents' rights, admission, transfer, and discharge rights, resident behavior and facility practices, quality of life, physical environment, and laboratory services), and administration. The results on these broad categories of deficiencies are presented in Table 5. Overall, the deficiencies show consistent increase across all categories, although the magnitudes are smaller and the estimates are statistically insignificant.

In addition to the results with a regression discontinuity model, I estimate the effect on deficiencies using a difference-in-differences model. The facilities with DART case rate below the threshold are used as a control group, and 2000-2003 as pre-treatment period, during which the nursing facilities were not included in the SST program. Table A1, column (2) presents the estimates with the whole sample and column (3) presents the estimates with facilities with DART within five units of the SST thresholds. As a comparison, column (1) shows the reduced form estimates from the regression discontinuity model, same as those in Table 5, column (3). The difference-in-differences model results suggest that the SST program increased the number of deficiencies on ADL care and nursing aid training. The program also increased the number of deficiencies on quality of care, quality of life, and administration significantly. The estimates from the regression discontinuity design model measures the local average treatment effect that

only applies facilities with DART case rate close to the SST threshold, while the estimates from the difference-in-differences model measures the average treatment effect among all facilities.

Changes in nurse behavior might also affect the health outcomes of the residents, which are widely used to approximate the quality of care in studies on nursing home quality (Matsudaira, 2014; Lin, 2014; Bowblis and McHone, 2013). Table 6 presents the results on the effect of inspections on resident outcomes. The inspections were associated with a 3.7 percentage point increase in the fraction of residents with skin rashes and a 9.9 percentage point increase in behavioral symptoms. The effect of inspections on the fraction of residents with contractures, catheter, pressure sores, and unplanned weight change was small and insignificant. In summary, inspections were associated with worse quality of care, evidenced by lower quality of ADL care and worse health outcomes among residents.

I provide several robustness checks on the results on the quality of care in the Appendix. Table A2 in Appendix presents the estimates with alternative bandwidths and polynomials, ranging from 75% to 125% of the optimal bandwidth suggested by Calonico et al. (2014) and Calonico et al. (2019), in combination with first and second order polynomials. Table A3 presents the estimates with additional control variables, including state level safe patient handling legislation, occupancy rate, nursing hours per resident, a dummy indicator on rural location and state by year fixed effects. Overall, the conclusions stay unchanged.

5.4. Inspections and Patient Composition

After inspections, the quality of ADL assistance worsened, which might be due to the effort to preventing injuries from moving and handling patients. Alternatively, nursing facilities might select patients in need of less ADL assistance after inspections, which might also lead to fewer nurse injuries from moving patients.

To examine any potential patient selection due to inspections, I estimate the effect of inspections on characteristics of patients that were newly admitted during the calendar year of the survey. If the nursing facilities were actively selecting easier patients, the characteristics of newly admitted patients are expected to change, particularly on measures regarding ADLs. The data are from LTCFocus, which include characteristics of patients admitted during the calendar year of the survey aggregated at the facility level.[23] The characteristics include the share of residents that are female, White, Black, Hispanic, under 65 years old, average ADL score (ranges from 0 to 28, with 0 indicating completely independent and 28 completely dependent), and average case mix index (the average Resource Utilization Group Nursing Case Mix Index, a measure of the relative intensity of care of different nursing home populations). Table A4 in Appendix presents the results. Overall, the demographic characteristics, the average ADL score and the case mix index of the newly admitted patients showed little change after inspections.

Additionally, nursing facilities can actively discharge or transfer residents in a limited number of scenarios, including the closure of a facility, lack of payment for the service, improvement of health that nursing home care is not necessary, or deterioration of health that nursing home care is not sufficient. The average length of stay in nursing facilities is 835 days and the median is 463 days.[24] In the previous analysis, I show that ADL acuity index and the share of residents financed through Medicaid showed no change after inspections (Table 3, Panel C). Medicaid residents generally have lower reimbursement rates and worse health outcomes (Cohen and Spector, 1996). If facilities actively selected patients in need of less intensive care

[23] LTCFocus is sponsored by the National Institute on Aging (1P01AG027296) through a cooperative agreement with the Brown University School of Public Health. The data is accessed through https://ltcfocus.org/data.

[24] Author's calculation based on 12,973 residents surveyed in the 2004 National Nursing Home Survey.

after inspections, they might selectively transfer or discharge the less profitable Medicaid residents or patients with worse ALD conditions. No change in the ADL index and the share of Medicaid residents appeared at the targeting threshold after inspections, which supports the assumption that the worse quality of care was unlikely to be driven by patient selection.

5.5. Inspections and Staffing

Thus far, the results show that OSHA inspections reduced workplace injuries, but worsened healthcare quality, evidenced by more deficiencies on ADL care and worse resident outcomes. In response to an inspection, nursing facilities might also increase the staffing level as an alternative strategy to reduce nurse injuries, as the availability of more nurses are related with fewer musculoskeletal injuries (Trinkoff et al., 2003).

I examine the effect of inspections on nursing hours on four different types of nurses. Among the nursing staff in the facilities in the analysis sample, about 63 percent of the staff are nursing aides, who typically assist residents with daily activities such as eating, dressing, and using the bathroom. Twenty-two percent are licensed practical nurses, who provide direct care to residents under the supervision of registered nurses. Ten percent are registered nurses, who assess the health conditions of the residents and create personal care plans for each person. Five percent are nurses with administrative duties, who coordinate with staff but do not provide direct care for the residents. I also include the hours of non-nursing staff, which account for about 34% of employee hours.[25]

Table 7 shows the estimates on the effect of inspections on nursing hours per patient day. Inspections led to small and insignificant changes in hours of nurses interacting directly with

[25] However, nursing staff contributes to about 87% of the injuries in nursing facilities, based on author's calculation from the statistics of the Bureau of Labor Statistics.

residents, including nursing aides, licensed practical nurses, and registered nurses. The change on non-nursing staff was also small and insignificant. An exception is the hours of nurses with administrative duties, which increase by 0.1 hours per patient day after inspections, representing a 37 percent increase compared with an average of 0.28 hours per patient day. Nurses with administrative duties implement nursing policies and oversee other nurses. The results may imply that facilities devote more effort to management and coordination of care and after inspections.

5.6. Non-Participating States

The empirical evidence suggests that the SST plan increased the inspections at the targeting threshold and worsened the quality of healthcare. Among the 45 states that participated in the data initiative, 35 participated in the SST plan and the other ten states had their own state plans on occupational safety and health. The non-participating states often have programs enforcing the safety and health standards in nursing facilities, but do not use the same targeting thresholds to select the inspection list. Thus, the quality of care should show no discontinuity at the targeting threshold in facilities in these states. Table 8 presents the results on the ten non-participating states. As expected, the number of deficiencies and the resident outcomes showed small and insignificant changes at the targeting threshold.

6. Conclusion

This study examines the effect of OSHA inspections on the workplace and healthcare quality in nursing facilities. I find that the inspections reduced workplace injuries among the nurses, but worsened the quality of care received by patients. The worsened quality of care may be a result that nurses avoid injuries by reducing patient handling and moving activities. The

results highlight the potential trade-off between the safety of nurses and the welfare of patients. While the enforcement of safety standards may contribute to the reduction of injuries and the associated costs, such enforcement might lead to a welfare loss of patients.

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Table 1. The Starting and Closing Dates of the Site-Specific Targeting (SST) Plan, 2004-2011

Injury Rates	OSHA Data Initiative (ODI)	SST Plan	Starting Date	Closing Date
2002	2003	2004	4/19/2004	8/5/2005
2003	2004	2005	8/5/2005	6/12/2006
2004	2005	2006	6/12/2006	5/14/2007
2005	2006	2007	5/14/2007	5/19/2008
2006	2007	2008	5/19/2008	7/20/2009
2007	2008	2009	7/20/2009	10/22/2010
2008	2009	2010	10/22/2010	9/9/2011
2009	2010	2011	9/9/2011	1/4/2013

Table 2. Summary Statistics on Injury Rates, Inspections, and Operational Characteristics of Nursing Facilities

	Whole Sample (1)	DART [-5, 0) (2)	DART [0, 5] (3)
Injury Case Rate			
TCR	10.566	15.653	21.334
	(7.409)	(5.377)	(6.065)
DART	6.868	11.815	16.683
	(5.197)	(1.695)	(1.695)
Inspections	0.041	0.030	0.393
	(0.199)	(0.170)	(0.489)
Violations	0.026	0.018	0.263
	(0.159)	(0.133)	(0.441)
Facilities			
Total Beds	120.606	122.026	116.137
	(64.761)	(61.206)	(60.778)
Total Residents	101.228	104.370	99.922
	(59.832)	(55.925)	(58.318)
In a Chain	0.494	0.543	0.569
	(0.500)	(0.498)	(0.496)
For-Profit	0.721	0.695	0.720
	(0.449)	(0.461)	(0.449)
Medicaid Patients (%)	0.626	0.630	0.637
	(0.178)	(0.155)	(0.151)
ADL Acuity Index	10.091	10.134	10.118
	(1.311)	(1.192)	(1.164)
N	11,832	1,839	643

Note: Data are matched from the OSHA Data Initiative (ODI), OSHA Integrated Management Information System (IMIS), and the Online Survey, Certification, and Reporting (OSCAR) database from the Centers for Medicare & Medicaid Services (CMS).

Table 3. The Effect of the SST Plan on Inspections, Violations, and Facility Characteristics

	(1) Mean at SST	(2) Local Linear
Panel A		
Inspections	0.055	0.322***
		(0.052)
Violations	0.043	0.242***
		(0.040)
Panel B		
Inspections Year Before	0.063	0.002
		(0.039)
Inspections Year After	0.047	0.019
		(0.030)
Panel C		
Total Bed	119.178	-6.084
		(6.714)
Total Residents	103.878	-5.462
		(6.414)
In a Chain	0.545	0.057
		(0.058)
For-Profit	0.735	-0.012
		(0.050)
Non-Profit	0.246	0.013
		(0.048)
Medicaid Patients	0.637	-0.004
		(0.018)
Medicare Patients	0.135	0.010
		(0.012)
ADL Acuity Index	10.153	-0.122
		(0.118)
N		11,832

Note: The analysis covers the SST plan 2004-2009. Each cell in column (1) shows the mean of the outcome at the SST threshold. Each cell in column (2) shows an estimate from local linear models with a triangular kernel, the optimal bandwidth and robust standard errors, suggested by Calonico et al. (2014) and Calonico et al. (2019). Models in Panels A and B include control variables on the number of beds, whether in a chain, whether for profit, whether non-profit, share of Medicare patients, share of Medicaid patients, ADL acuity index, and state and year fixed effects. Models in Panel C include state and year fixed effects.
* $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table 4. The Effect of Inspections on Injury Case Rates One Year After the SST Plan

	(1)	(2)	(3)	(4)	(5)
	Mean at SST	Reduced Form		Two-Stage	
DART	14.452	-1.272*	-1.294*	-5.333*	-5.673*
		(0.717)	(0.715)	(2.897)	(2.934)
TCR	19.348	-1.773*	-2.015**	-6.331*	-6.289*
		(1.031)	(1.023)	(3.441)	(3.294)
Control Variables		N	Y	N	Y
N			4,707		

Note: The analysis covers the SST plan 2004-2009 and the sample includes facilities received another survey around one year after the SST inspection cycle. DART is the number of cases involving days away from work, job restriction, or job transfer per 100 employees, and TCR is total case rate per 100 employees. Each cell in column (1) shows the mean of the outcome at the SST threshold. Each cell in columns (2) to (5) shows an estimate from local linear models with a triangular kernel, the optimal bandwidth and robust standard errors, suggested by Calonico et al. (2014) and Calonico et al. (2019). Columns (2) and (3) present the reduced form estimates, and columns (4) and (5) present the two-stage estimates using the targeting threshold as an instrument of the inspection. Estimates in columns (2) and (4) include state and year fixed effects. Estimates in columns (3) and (5) include control variables on the number of beds, whether in a chain, whether for profit, whether non-profit, share of Medicare patients, share of Medicaid patients, ADL acuity index, and state and year fixed effects.
* $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table 5. The Effect of Inspections on Deficiency Citations

	(1)	(2)	(3)	(4)	(5)
	Mean at SST	Reduced Form		Two-Stage	
ADL Care	0.087	0.056	0.059*	0.184*	0.193*
		(0.033)	(0.034)	(0.104)	(0.106)
Training	0.083	0.105**	0.111**	0.118	0.183*
		(0.044)	(0.044)	(0.095)	(0.100)
Transfer	0.028	0.014	0.014	0.031	0.035
		(0.023)	(0.023)	(0.062)	(0.062)
Quality of Care	4.579	0.146	0.179	0.250	0.381
		(0.388)	(0.384)	(1.056)	(0.948)
Quality of Life	7.111	0.244	0.252	0.086	0.085
		(0.639)	(0.629)	(1.633)	(1.577)
Administration	0.369	0.075	0.076	0.126	0.197
		(0.091)	(0.090)	(0.215)	(0.220)
Control Variables		N	Y	N	Y
N			11,832		

Note: The analysis covers the SST plan 2004-2009. The outcomes are the number of deficiency citations on each set of standards. Each cell in column (1) shows the mean of the outcome at the SST threshold. Each cell in columns (2) to (5) shows an estimate from local linear models with a triangular kernel, the optimal bandwidth and robust standard errors, suggested by Calonico et al. (2014) and Calonico et al. (2019). Columns (2) and (3) present the reduced form estimates, and columns (4) and (5) present the two-stage estimates using the targeting threshold as an instrument of the inspection. Estimates in columns (2) and (4) include state and year fixed effects. Estimates in columns (3) and (5) include control variables on the number of beds, whether in a chain, whether for profit, whether non-profit, share of Medicare patients, share of Medicaid patients, ADL acuity index, and state and year fixed effects.
* $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table 6. The Effect of Inspections on Resident Outcomes

	(1)	(2)	(3)	(4)	(5)
	Mean at SST	Reduced Form		Two-Stage	
Contracture	0.290	-0.014	-0.013	-0.028	-0.022
		(0.023)	(0.023)	(0.060)	(0.060)
Catheter Use	0.064	0.002	0.003	0.009	0.010
		(0.006)	(0.005)	(0.013)	(0.014)
Pressure Sores	0.069	-0.009	-0.008	-0.006	-0.008
		(0.006)	(0.006)	(0.011)	(0.011)
Skin Rashes	0.053	0.012*	0.014*	0.027	0.037*
		(0.007)	(0.008)	(0.022)	(0.023)
Weight Change	0.078	0.002	0.001	0.009	0.007
		(0.007)	(0.007)	(0.020)	(0.019)
Behavioral Symptoms	0.273	0.033	0.035*	0.087	0.099*
		(0.021)	(0.021)	(0.057)	(0.058)
Control Variables		N	Y	N	Y
N			11,832		

Note: The analysis covers the SST plan 2004-2009. The outcomes are the fraction of residents with each condition. Each cell in column (1) shows the mean of the outcome at the SST threshold. Each cell in columns (2) to (5) shows an estimate from local linear models with a triangular kernel, the optimal bandwidth and robust standard errors, suggested by Calonico et al. (2014) and Calonico et al. (2019). Columns (2) and (3) present the reduced form estimates, and columns (4) and (5) present the two-stage estimates using the targeting threshold as an instrument of the inspection. Estimates in columns (2) and (4) include state and year fixed effects. Estimates in columns (3) and (5) include control variables on the number of beds, whether in a chain, whether for profit, whether non-profit, share of Medicare patients, share of Medicaid patients, ADL acuity index, and state and year fixed effects.

* $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table 7. The Effect of Inspections on Nursing Hours per Patient Day

	(1)	(2)	(3)	(4)	(5)
	Mean at SST	Reduced Form		Two-Stage	
Nursing Aides	3.417	0.065	0.059	0.204	0.169
		(0.090)	(0.094)	(0.274)	(0.272)
Licensed Practical Nurses	1.202	-0.023	-0.030	-0.036	-0.059
		(0.054)	(0.053)	(0.124)	(0.125)
Registered Nurses	0.541	-0.014	-0.017	-0.054	-0.078
		(0.035)	(0.035)	(0.085)	(0.084)
Nurses with Administrative Duties	0.275	0.028	0.036	0.092*	0.102*
		(0.020)	(0.026)	(0.063)	(0.055)
Non-Nursing Staff	2.781	0.123	0.098	0.399	0.284
		(0.232)	(0.221)	(0.634)	(0.645)
Control Variables		N	Y	N	Y
N			11,832		

Note: The analysis covers the SST plan 2004-2009. The outcomes are the number of hours per resident day in each type of staff. Each cell in column (1) shows the mean of the outcome at the SST threshold. Each cell in columns (2) to (5) shows an estimate from local linear models with a triangular kernel, the optimal bandwidth and robust standard errors, suggested by Calonico et al. (2014) and Calonico et al. (2019). Columns (2) and (3) present the reduced form estimates, and columns (4) and (5) present the two-stage estimates using the targeting threshold as an instrument of the inspection. Estimates in columns (2) and (4) include state and year fixed effects. Estimates in columns (3) and (5) include control variables on the number of beds, whether in a chain, whether for profit, whether non-profit, share of Medicare patients, share of Medicaid patients, ADL acuity index, and state and year fixed effects.
* $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table 8. The Effect of Inspections on Healthcare Quality, Non-Participating States

	(1) Mean at SST	(2) Reduced Form
Panel A: Deficiencies		
ADL Care	0.037	-0.013
		(0.056)
Training	0.112	0.013
		(0.063)
Transfer	0.009	-0.001
		(0.009)
Quality of Care	5.157	-0.248
		(0.777)
Quality of Life	8.303	-0.622
		(1.262)
Administration	0.449	-0.012
		(0.141)
Panel B: Health Outcomes		
Contracture	0.249	0.038
		(0.035)
Catheter Use	0.062	-0.007
		0.008
Pressure Sores	0.062	0.007
		(0.008)
Skin Rashes	0.070	-0.004
		0.014
Weight Change	0.071	0.020
		(0.014)
Behavioral Symptoms	0.317	-0.010
		(0.033)
N		3,509

Note: The analysis covers non-participating states from 2004 to 2009. Each cell in column (1) shows the mean of the outcome at the SST threshold. Each cell in column (2) shows a reduced form estimate from local linear models with a triangular kernel, the optimal bandwidth and robust standard errors, suggested by Calonico et al. (2014) and Calonico et al. (2019). Estimates in column (2) include control variables on the number of beds, whether in a chain, whether for profit, whether non-profit, share of Medicare patients, share of Medicaid patients, ADL acuity index, and state and year fixed effects.
* $p<0.10$, ** $p<0.05$, *** $p<0.01$

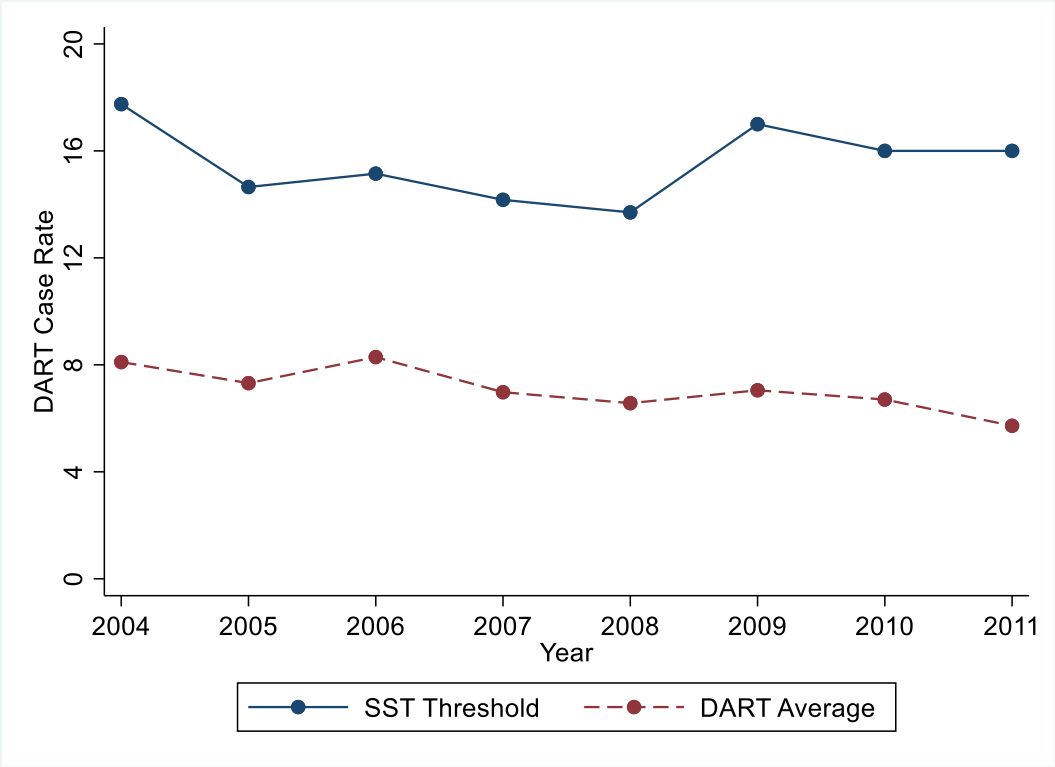

Figure 1. Days Away, Restricted, and Transfer (DART) Case Rate Threshold of the Site-Specific Targeting (SST) Plan and Average DART Case Rate, Nursing Facilities 2004-2011

Notes: DART case rate is calculated as (number of cases involving days away from work, job transfers or restrictions * 200,000) / total employee hours worked, which gives the case rate per 100 full time equivalent employees.

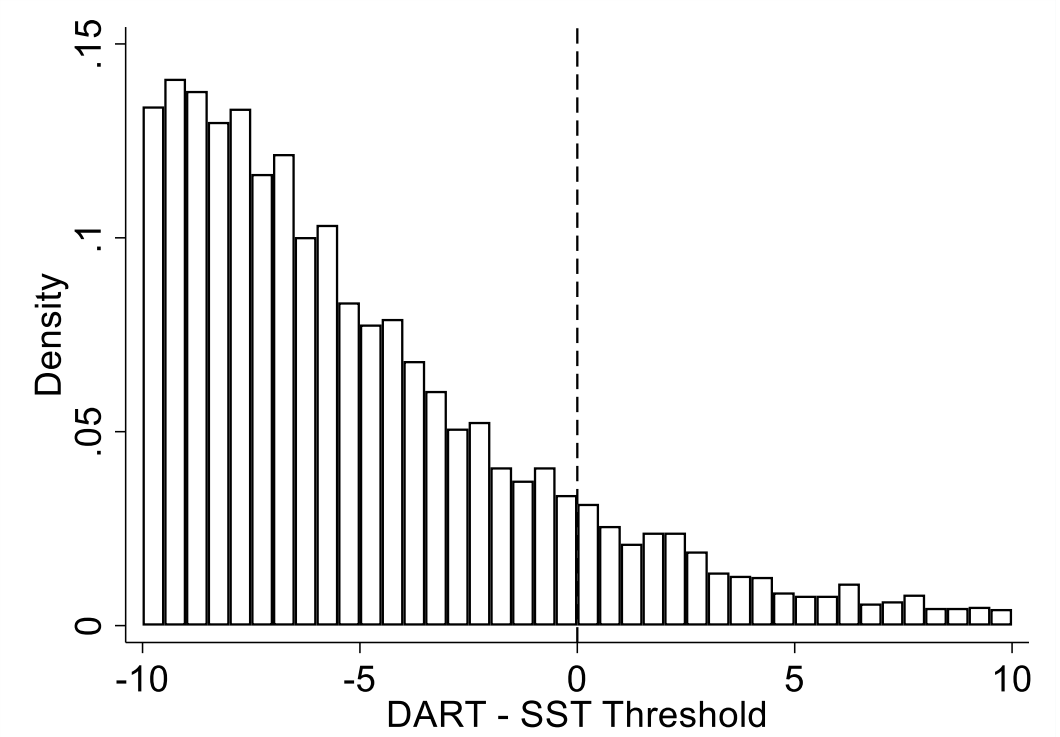

Figure 2. Distribution of Nursing Facilities by DART Case Rate Relative to the SST Threshold

Note: The sample is derived from OSHA Data Initiative (ODI) matched to OSHA's Integrated Management Information System (IMIS) and the Online Survey, Certification, and Reporting database (OSCAR) from the Centers for Medicare & Medicaid Services (CMS). N=6,827. McCrary's density test shows the difference of density at the threshold is small and insignificant (log density = 0.026, SE = 0.092).

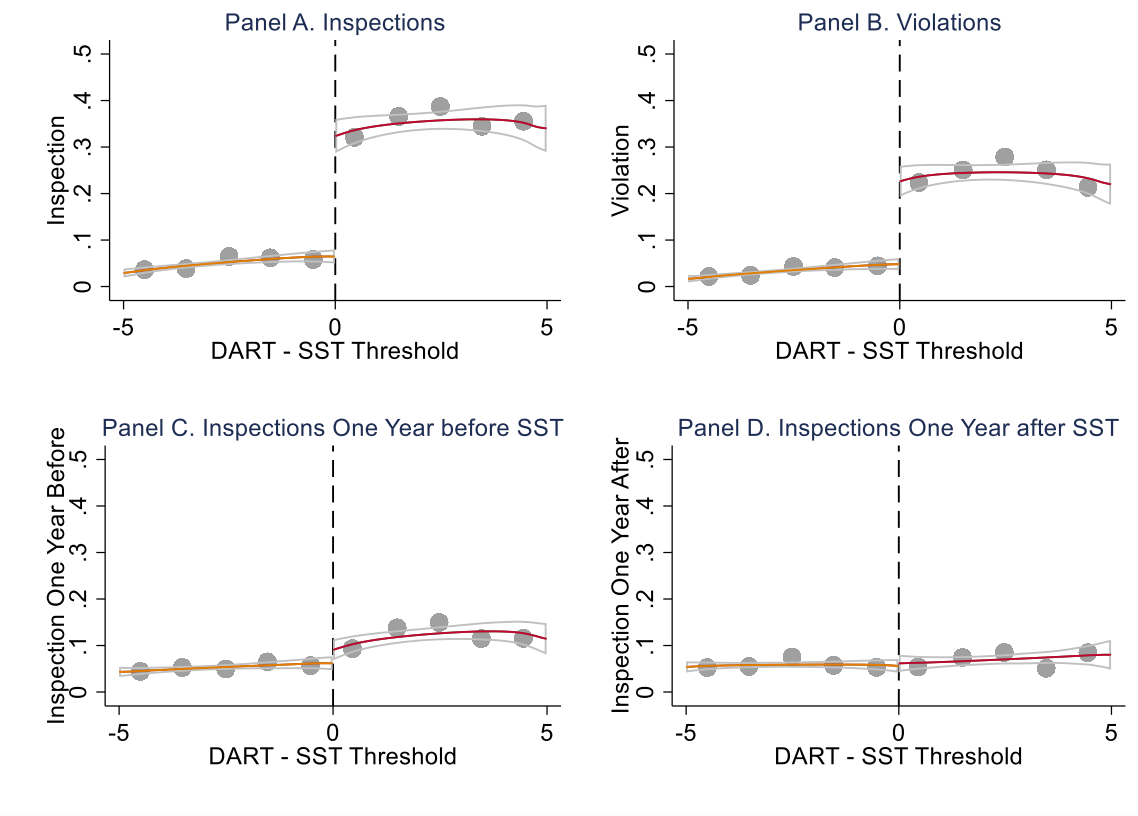

Figure 3. Frequency of Inspections and Violations by DART Case Rate Relative to the SST Threshold

Notes: The sample is derived from OSHA Data Initiative (ODI) matched to OSHA's Integrated Management Information System (IMIS) and the Online Survey, Certification, and Reporting database (OSCAR) from the Centers for Medicare & Medicaid Services (CMS). The graphs show the frequency of inspections and violations by (DART case rate– SST threshold). The markers denote the mean outcomes within intervals of one. The colored lines are fitted values from local linear regressions. The grey lines show 90% confidence interval. N=2,482.

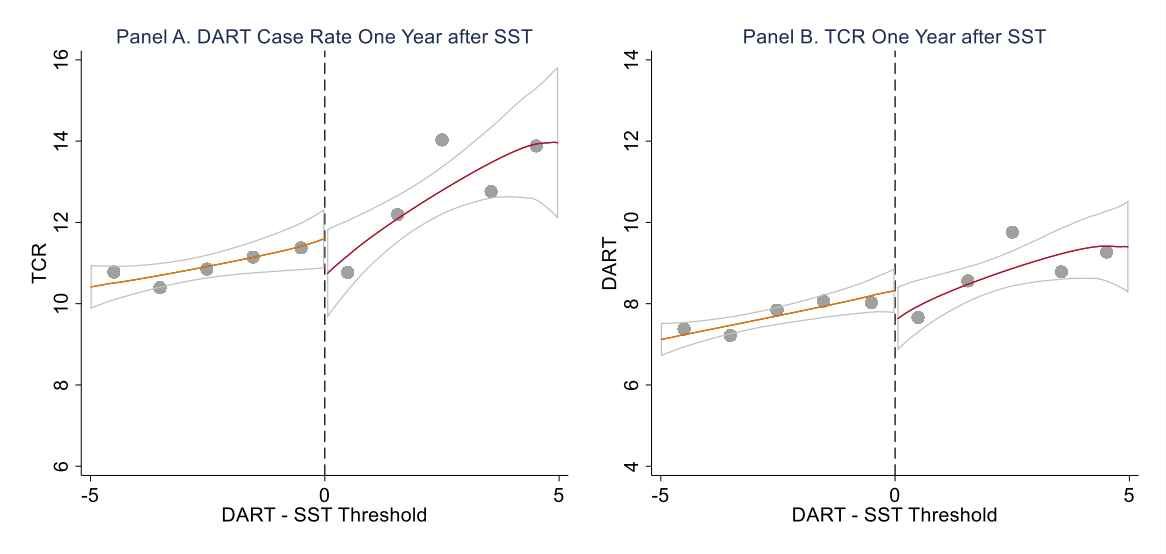

Figure 4. The Effect of the SST Plan on the Injury Case Rates One Year After

Note: The sample is derived from OSHA Data Initiative (ODI) matched to OSHA's Integrated Management Information System (IMIS) and the Online Survey, Certification, and Reporting database (OSCAR) from the Centers for Medicare & Medicaid Services (CMS). The sample includes nursing facilities with another ODI survey fours year after the initial survey. The outcomes represent injury rates around one year after the SST plan. DART is the number of cases involving days away from work, job restriction, or job transfer per 100 employees, and TCR is total case rate per 100 employees. The markers denote the mean outcomes within intervals of one. The colored lines are fitted values from local linear regressions. The grey lines show 90% confidence interval. N=1,328.

Appendix

A.1 Description of the Data Matching Process

This study uses establishment data from three main sources: data on the injury rates from the OSHA Data Initiative (ODI), inspections on nurse safety and health from the OSHA's Integrated Management Information System (IMIS), and quality of care and other characteristics of nursing facilities from the Online Survey, Certification and Reporting (OSCAR) database. Since no unique identifiers of facilities are available across the three datasets, they are linked using establishment name and detailed street addresses. Below I provide details on the matching process.

For all three datasets, first, I standardize the establishment names by removing the common words, for example, company and corporation. For street address, I remove the floor, suite, and room numbers and replace the common words, such as street, avenue, and road with the abbreviations. Second, I match the datasets based on the exact match of the establishment name and address. If an establishment has multiple names, all the names are checked until an exact match is achieved. Lastly, for establishments without an exact match, I match them based on the street address within the same city and state and manually verify if the establishment name matches, and on the establishment name, and manually verify if the street address matches. The last step identifies matches with spelling mistakes in the establishment names and streets.

Among establishments on the target list of the SST plan, 39% are matched to a programed inspection in IMIS during the corresponding inspection cycle. However, the match rate is not expected to be 100%. Because of OSHA's limited resources, not all establishments on the target list were inspected. To get an estimate of the match rate, I obtained a list of

establishments on the SST list from OSHA. Among establishments whose SST inspection status coded as “Completed”, 83% are matched to an inspection in IMIS based on name and address.

About 35% of the establishments in ODI are matched to OSCAR data one year after the corresponding inspection cycle. There are many reasons that a nursing facility in OSCAR data does not have a match in ODI: First, the facility might not be surveyed during the ODI analysis period. Second, the nursing facility might be certified after initial ODI survey or the nursing facility stops operating after the initial ODI survey. Lastly, there might be errors in establishment names and addresses, which are the essential information used in the matching process. Table A5 compares the characteristics of all nursing facilities with those matched to ODI. The matched sample is on average larger, less likely to be in a chain, more likely to be for profit, and have more Medicaid patients. Table A6 compares of the average injury rates of the whole ODI sample and the main analysis sample. The injury rates are very similar across the two samples.

A.2 Additional Robustness Checks

Table A1. The Effect of Inspections on Deficiency Citations, Difference-in-Differences

	(1) Regression Discontinuity	(2) Difference in Differences	(2) Difference in Differences [-5, 5]
ADL Care	0.059*	0.045**	0.042*
	(0.034)	(0.020)	(0.023)
Training	0.111**	0.029**	0.025**
	(0.044)	(0.013)	(0.013)
Transfer	0.014	-0.001	0.003
	(0.023)	(0.011)	(0.018)
Quality of Care	0.179	0.541***	0.378*
	(0.384)	(0.193)	(0.204)
Quality of Life	0.252	1.029***	0.682**
	(0.629)	(0.303)	(0.317)
Administration	0.076	0.084**	0.022
	(0.090)	(0.039)	(0.039)
Control Variables	Y	Y	Y
N	11,832	22,294	5,254

Note: Each cell in column (1) shows a reduced form estimate from the regression discontinuity model. Each cell in columns (2) and (3) shows an estimate from the difference-indifferences model. Column (3) only includes facilities with DART case rate within 5 units of the SST thresholds. All models include control variables on the number of beds, whether in a chain, whether for profit, whether non-profit, share of Medicare patients, share of Medicaid patients, ADL acuity index, and state and year fixed effects.
* p<0.10, ** p<0.05, *** p<0.01

Table A2. The Effect of Inspections on Quality of Care, Alternative Bandwidth and Order of Polynomial

	(1)	(2)	(3)	(4)	(5)	(6)
		Polynomial: 1			Polynomial: 2	
		Bandwidth			Bandwidth	
	75%	100%	125%	75%	100%	125%
Panel A: Deficiency						
ADL Care	0.068*	0.060*	0.064**	0.085	0.083*	0.064
	(0.037)	(0.034)	(0.031)	(0.063)	(0.048)	(0.043)
Training	0.097*	0.111**	0.103***	0.090	0.082	0.101*
	(0.050)	(0.044)	(0.040)	(0.061)	(0.057)	(0.053)
Transfer	0.007	0.009	0.005	0.029	0.013	0.014
	(0.029)	(0.027)	(0.025)	(0.038)	(0.033)	(0.030)
Quality of Care	0.264	0.180	0.126	0.279	0.353	0.329
	(0.434)	(0.384)	(0.351)	(0.626)	(0.525)	(0.463)
Quality of Life	0.227	0.252	0.125	0.420	0.460	0.440
	(0.722)	(0.629)	(0.573)	(1.082)	(0.901)	(0.788)
Administration	0.046	0.076	0.084	0.089	0.025	0.043
	(0.106)	(0.090)	(0.082)	(0.148)	(0.127)	(0.112)
Panel B: Health Outcomes						
Contracture	-0.006	-0.013	-0.007	0.013	0.004	-0.010
	(0.026)	(0.023)	(0.020)	(0.034)	(0.030)	(0.028)
Catheter Use	0.005	0.003	0.003	0.011	0.008	0.004
	(0.006)	(0.005)	(0.005)	(0.008)	(0.007)	(0.006)
Pressure Sores	-0.005	-0.008	-0.006	0.001	-0.002	-0.008
	(0.006)	(0.006)	(0.005)	(0.009)	(0.008)	(0.007)
Skin Rashes	0.018**	0.014*	0.011	0.013	0.018*	0.019**
	(0.008)	(0.008)	(0.007)	(0.011)	(0.009)	(0.008)
Weight Change	-0.002	0.001	0.003	0.000	-0.003	-0.003
	(0.008)	(0.007)	(0.007)	(0.011)	(0.010)	(0.009)
Behavioral Symptoms	0.033	0.035*	0.028	0.058*	0.044	0.045*
	(0.024)	(0.021)	(0.019)	(0.035)	(0.030)	(0.026)
N			11,832			

Note: The analysis covers the SST plan 2004-2009. The outcomes in Panel A are number of deficiency citations on each standard. The outcomes in Panel B are the fraction of residents with each health condition. Each cell shows an estimate from a local linear/second order polynomial model with a triangular kernel, 75%/100%/125% of the optimal bandwidth and robust standard errors, suggested by Calonico et al. (2014) and Calonico et al. (2019). All the models include controls on the number of beds, whether in a chain, whether for profit, whether non-profit, share of Medicare patients, share of Medicaid patients, ADL acuity index, and state and year fixed effects. * $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table A3. The Effect of Inspections on Quality of Care, Additional Control Variables

	(1)	(2)	(3)
Panel A: Deficiency			
ADL Care	0.059*	0.061*	0.085**
	(0.034)	(0.034)	(0.040)
Training	0.111**	0.112***	0.126***
	(0.044)	(0.043)	(0.040)
Transfer	0.014	0.010	0.007
	(0.023)	(0.027)	(0.026)
Quality of Care	0.179	0.206	0.208
	(0.384)	(0.377)	(0.386)
Quality of Life	0.252	0.343	0.219
	(0.629)	(0.626)	(0.858)
Administration	0.076	0.085	0.073
	(0.090)	(0.091)	(0.087)
Panel B: Health Outcomes			
Contracture	-0.013	-0.007	-0.003
	(0.023)	(0.021)	(0.023)
Catheter Use	0.003	0.003	0.004
	(0.005)	(0.005)	(0.005)
Pressure Sores	-0.008	-0.006	-0.006
	(0.006)	(0.005)	(0.005)
Skin Rashes	0.014*	0.016**	0.012*
	(0.008)	(0.008)	(0.007)
Weight Change	0.001	0.035	0.032
	(0.007)	(0.022)	(0.021)
Behavioral Symptoms	0.035*	0.001	-0.001
	(0.021)	(0.007)	(0.008)
N		11,832	

Note: The analysis covers the SST plan 2004-2009. The outcomes in Panel A are number of deficiency citations on each standard. The outcomes in Panel B are the fraction of residents with each health condition. Each cell shows a reduced form estimate from a local linear model with a triangular kernel, the optimal bandwidth and robust standard errors, suggested by Calonico et al. (2014) and Calonico et al. (2019). All the models include controls on the number of beds, whether in a chain, whether for profit, whether non-profit, share of Medicare patients, share of Medicaid patients, ADL acuity index, and state and year fixed effects. Column (2) includes additional control variables on state-level safe patient handling legislation, occupancy rate, nursing hours per resident, and a dummy indicator on rural location. Column (3) includes additional state by year fixed effects.

* $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table A4. The Effect of Inspections on Characteristics of Newly Admitted Patients

	(1)	(2)	(3)	(4)	(5)
	Mean at SST	Reduced Form		Two-Stage	
Female	0.641	-0.018	-0.016	-0.032	-0.042
		(0.012)	(0.011)	(0.030)	(0.028)
N			11,528		
White	0.897	-0.006	-0.008	-0.021	-0.039
		(0.017)	(0.017)	(0.045)	(0.044)
N			11,551		
Black	0.008	-0.006	-0.007	-0.024	-0.008
		(0.023)	(0.021)	(0.054)	(0.055)
N			7,559		
Hispanic	0.004	0.009	0.016	0.032	0.047
		(0.013)	(0.013)	(0.039)	(0.040)
N			7,302		
Under 65	0.157	0.002	0.012	0.005	0.035
		(0.016)	(0.013)	(0.044)	(0.036)
N			7,337		
ADL	0.161	0.002	0.003	0.006	0.008
		(0.002)	(0.002)	(0.007)	(0.006)
N			11,691		
CMI	0.011	0.000	0.000	0.000	0.000
		(0.000)	(0.000)	(0.000)	(0.000)
N			11,688		
Control Variables		N	Y	N	Y

Note: The analysis covers the SST plan 2004-2009. The outcomes are the characteristics of newly admitted patients. Each cell in column (1) shows the mean of the outcome at the SST threshold. Each cell in columns (2) to (5) shows an estimate from local linear models with a triangular kernel, the optimal bandwidth and robust standard errors, suggested by Calonico et al. (2014) and Calonico et al. (2019). Columns (2) and (3) present the reduced form estimates, and columns (4) and (5) present the two-stage estimates using the targeting threshold as an instrument of the inspection. Estimates in columns (2) and (4) include state and year fixed effects. Estimates in columns (3) and (5) include control variables on the number of beds, whether in a chain, whether for profit, whether non-profit, share of Medicare patients, share of Medicaid patients, ADL acuity index, and state and year fixed effects.
* $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table A5. Characteristics of Nursing Facilities by Matching Status

	(1) All Nursing Facilities	(2) Main Analysis Sample	(3) Sample with Repeated Surveys
Total Beds	109.507	120.606	120.832
	(65.726)	(64.761)	(66.113)
Total Residents	90.557	101.228	103.044
	(57.597)	(59.832)	(60.720)
In a Chain	0.538	0.494	0.472
	(0.499)	(0.500)	(0.499)
For-Profit	0.674	0.721	0.697
	(0.469)	(0.449)	(0.460)
Non-Profit	0.262	0.251	0.278
	(0.440)	(0.433)	(0.448)
Government	0.064	0.029	0.025
	(0.245)	(0.167)	(0.156)
Medicaid Patients	0.609	0.626	0.629
	(0.228)	(0.178)	(0.170)
Medicare Patients	0.151	0.136	0.131
	(0.154)	(0.105)	(0.098)
Other Patients	0.240	0.238	0.239
	(0.179)	(0.153)	(0.151)
ADL Acuity Index		10.091	10.087
		(1.311)	(1.280)
N	90,085	11,832	4,707

Note: Data are matched from the OSHA Data Initiative (ODI), OSHA Integrated Management Information System (IMIS), and the Online Survey, Certification, and Reporting (OSCAR) database from the Centers for Medicare & Medicaid Services (CMS). Column (1) shows the characteristics of all nursing facilities, column (2) shows main analysis sample, and column (3) shows the sample with repeated surveys four years after the initial ODI survey.

Table A6. Characteristics of Nursing Facilities by Matching Status

	(1) Whole ODI Sample	(2) Main Analysis Sample
TCR	10.782	10.566
	(10.587)	(7.409)
DART	6.922	6.868
	(6.153)	(5.197)
N	64,942	11,832

Note: Data are matched from the OSHA Data Initiative (ODI), OSHA Integrated Management Information System (IMIS), and the Online Survey, Certification, and Reporting (OSCAR) database from the Centers for Medicare & Medicaid Services (CMS). Column (1) shows the characteristics of all nursing facilities in ODI, and column (2) shows main analysis sample.

Table A7. The Effect of Inspections on Survival of Nursing Facilities

	(1) Mean at SST	(2) Reduced Form
Active 2 Years After	0.908	-0.011
		(0.032)
Active 3 Years After	0.841	0.023
		(0.027)
Active 4 Years After	0.754	0.007
		(0.034)
N		11,832

Note: The analysis covers the SST plan 2004-2009. Each cell in column (1) shows the mean of the outcome at the SST threshold. The outcome equals 1 if a facility is active two, three, or four years after the initial ODI survey, and equals zero otherwise. Each cell in column (2) shows an estimate from local linear models with a triangular kernel, the optimal bandwidth and robust standard errors, suggested by Calonico et al. (2014) and Calonico et al. (2019). All the models include controls on the number of beds, whether in a chain, whether for profit, whether non-profit, share of Medicare patients, share of Medicaid patients, ADL acuity index, and state and year fixed effects.

* $p<0.10$, ** $p<0.05$, *** $p<0.01$