

## MIT Open Access Articles

*Do Strikes Kill? Evidence from New York State*

The MIT Faculty has made this article openly available. **Please share** how this access benefits you. Your story matters.

**Citation:** Gruber, Jonathan, and Samuel A. Kleiner. 2012. "Do Strikes Kill? Evidence from New York State." *American Economic Journal: Economic Policy*, 4(1): 127–57. DOI:10.1257/pol.4.1.127  
© 2012 AEA

**As Published:** <http://dx.doi.org/10.1257/pol.4.1.127>

**Publisher:** American Economic Association

**Persistent URL:** <http://hdl.handle.net/1721.1/71824>

**Version:** Final published version: final published article, as it appeared in a journal, conference proceedings, or other formally published context

**Terms of Use:** Article is made available in accordance with the publisher's policy and may be subject to US copyright law. Please refer to the publisher's site for terms of use.



## Do Strikes Kill? Evidence from New York State<sup>†</sup>

By JONATHAN GRUBER AND SAMUEL A. KLEINER\*

*Hospitals now represent one of the largest union sectors of the US economy, and there is particular concern about the impact of strikes on patient welfare. We analyze the effects of nurses' strikes in hospitals on patient outcomes in New York State. Controlling for hospital specific heterogeneity, the results show that nurses' strikes increase in-hospital mortality by 18.3 percent and 30-day readmission by 5.7 percent for patients admitted during a strike, with little change in patient demographics, disease severity or treatment intensity. The results suggest that hospitals functioning during nurses' strikes do so at a lower quality of patient care. (JEL H75, I11, I12, J52)*

Hospitals are one of the most important employers in the United States. Thirty-five percent of US health care workers, and 3.61 percent of all US workers, work in hospitals.<sup>1</sup> Due to the importance of hospitals in providing health care to our nation, and fears that work stoppages could place patient health in jeopardy, hospitals were excluded from collective bargaining laws for almost three decades after other sectors were allowed to unionize. Once allowed to do so in 1974, however, hospitals quickly became one of the most important sources of union jobs in the United States. Over fifteen percent of hospital employees are members of a union,<sup>2</sup> representing six percent of all union employees in the United States. While unionization has been declining in its traditional industrial home, it is growing rapidly in the hospital sector, with the number of unionized hospital workers rising from 679,000 in 1990 to nearly 1 million in 2008.<sup>3</sup> Despite the rapid unionization of the hospital sector, we know little about the original government concern that led to the long delay in permitting unionization: do strikes jeopardize patient health?

\* Gruber: Department of Economics, Massachusetts Institute of Technology, 50 Memorial Drive Building E52, Room 355 Cambridge, MA 02142-1347, and National Bureau of Economic Research (NBER) (e-mail: [gruberj@mit.edu](mailto:gruberj@mit.edu)); Kleiner: Department of Policy Analysis and Management, Cornell University, 108 Martha Van Rensselaer Hall, Ithaca, NY 14853, and National Bureau of Economic Research (NBER) (e-mail: [skleiner@cornell.edu](mailto:skleiner@cornell.edu)). We are grateful to David Chan for research assistance, to the New York Statewide Planning and Research Cooperative System, Barbara Schwartz and Robert Schwartz for data and details, Leo Lichtig and Laura L. Grassmann for the nursing intensity weights, and to John Cawley, Martin Gaynor, Lowell Taylor, two anonymous referees, the League of Voluntary Hospitals and Homes, and seminar participants at the 2009 NBER Summer Institute, the Congressional Budget Office, Cornell University, the University of Florida, Indiana University, the University of Kentucky, the University of Michigan, the Upjohn Institute, and Virginia Commonwealth University for helpful comments. Kleiner thanks the Labor and Employment Relations Association for financial support. The usual caveat applies.

<sup>†</sup> To comment on this article in the online discussion forum, or to view additional materials, visit the article page at <http://dx.doi.org/10.1257/pol.4.1.127>.

<sup>1</sup> <http://www.bls.gov/ocofcg/cgs035.htm> (accessed February 20, 2011), <ftp://ftp.bls.gov/pub/suppl/empstat.ceseeb1.txt> (accessed February 20, 2011).

<sup>2</sup> This figure represents the number of hospital employees that are union members. The percentage of hospital employees covered by a collective bargaining agreement is 17 percent (Source: Unionstats.com).

<sup>3</sup> Source: Unionstats.com.

In this paper, we carefully examine the effects of nurses' strikes at hospitals on patient care and health outcomes. Nurses are a crucial part of the hospital production function and are, as one hospital CEO said, "the heart and soul of the hospital."<sup>4</sup> They serve as the surveillance system of hospitals for detection and intervention when patients deteriorate, and are viewed by many patients as more important to their total recuperation process than their own attending physicians (Kruger and Metzger 2002). Thus, one might presume that strikes by nurses would be harmful to patients' health. Yet, at the same time, a large literature in health economics documents substantial overtreatment in hospitals in the United States; for example, Fisher et al. (2004) find no association between increased treatment intensity across medical centers and improved long-term survival. From this, one might infer that reduced treatment intensity due to nursing strikes might be innocuous. Thus, *ex ante*, the impact of nursing strikes on outcomes is ambiguous.

To address this question, we turn to one of the US states with the most hospital strikes in recent decades, New York State. A key advantage of this state for our analysis is that information on strikes can be matched to hospital discharge records which provide information on both treatment intensity and two key measures of outcomes: patient mortality and hospital readmission. We have gathered data on every hospital strike over the 1984 to 2004 period in New York State. We carefully match each striking hospital over this period with a set of control hospitals in their area, and use an event-study approach to examine the evolution of outcomes before, during, and after a strike in the striking versus control hospitals.

Our results are striking: there is a meaningful increase in both in-hospital mortality and hospital readmission among patients admitted during a hospital strike. Our central estimates suggest that the rate of in-hospital mortality is 18.3 percent higher, and rates of hospital readmission are 5.7 percent higher, among those admitted during a strike than among patients in nearby hospitals at the same time. We show that this deterioration in outcomes occurs only for those patients admitted during a strike, and not for those admitted to the same hospitals before or after a strike. And we find that these changes in outcomes are not associated with any meaningful change in the composition of, or the treatment intensity for, patients admitted during a strike.

We also find evidence of a more severe impact of these strikes on patients whose conditions require more intensive nursing inputs, and that outcomes are no better for patients admitted to striking hospitals who employ replacement workers. Overall, our findings suggest that strikes lead to lower quality medical care in hospitals.

Our paper proceeds as follows. Section I provides background on hospital unionization and on the literature on strikes and firm outcomes. Section II discusses our data on both strikes and patient outcomes. Section III discusses our empirical strategy and issues. Section IV presents the results on mortality and readmission, while Section V presents results on utilization measures. Section VI examines the heterogeneity in these strike effects, and Section VII concludes.

<sup>4</sup>Draper et al. (2008, 2).

## I. Background

### A. Hospital Unionization

Organized labor in the hospital industry is a relatively recent phenomenon when compared with the industrial sector. While initially covered under the pro-union Wagner Act of 1935, collective bargaining in hospitals was limited due to the passage of the National Labor Relations Act (NLRA) of 1947. This act, which outlined unfair labor practices on the part of unions, also excluded both government and nonprofit hospitals from the right to unionize.

This restriction was based on the Congress's belief that unionization could interfere with the delivery of essential health and charitable services.<sup>5</sup> One of the main arguments justifying the exclusion of nonprofit hospitals was the contention that allowing nonprofit hospital coverage would "open the way for strikes, picketing, and violence which could impede the delivery of health care" (Zacur 1983, 10). Hospital administrators argued for the importance of maintaining this exclusion, emphasizing that hospitals "absolutely cannot afford any interruptions in service caused by work stoppages. Healthcare facilities are not like assembly lines" (Fink and Greenberg 1989, 167).

After lobbying efforts by hospital-employee organizations, in 1974 President Nixon signed Public Law 93-360, reversing the 27-year exclusion. This law subjected all nongovernmental health care facilities to federal labor law, as governed by the NLRA. While this law allowed for union organization of health care facilities, the perceived vulnerability of health care institutions to strikes prompted Congress to add amendments to this legislation applying exclusively to nongovernmental health care institutions. Twomey (1977) notes that these amendments included longer government notification periods than would be required of a nonhealth care facility to the Federal Mediation and Conciliation Service (FMCS) in the event of a contract renewal (90 days versus the usual 60 days), or strike (10-day notice period versus no notice).

Huszczo and Fried (1988) show that the percentage of hospitals with collective bargaining agreements increased from 3 percent in 1961 to 23 percent in 1976, and conjecture that PL 93-360 played a significant role in this increase. Furthermore, in recent years, the health care sector has been the most active sector of the economy for new organizing.<sup>6</sup> Table 1 shows strike activity by industry for the years 1984–2004 as reported by the FMCS. The health care industry has experienced significant strike activity since 1984 with a greater number of strikes than all industries aside from manufacturing, construction and retail.<sup>7</sup>

<sup>5</sup>While this restricted the rights of most employees in the sector from unionizing, eight states passed legislation during this period that granted collective bargaining rights to not-for-profit hospitals. The eight states were Connecticut, Massachusetts, Michigan, Minnesota, Montana, New York, Oregon, and Pennsylvania.

<sup>6</sup>See NLRB, Sixty-Eighth Annual Report of the National Labor Relations Board (2004) for the fiscal year ended September 30, 2003, table 16.

<sup>7</sup>The FMCS data do not differentiate between types of health care facilities, such as hospitals and nursing homes.

TABLE 1—WORK STOPPAGES BY INDUSTRY, 1984–2004

Industry	Number of strikes
Manufacturing	6,575
Retail, wholesale, and service	1,973
Construction	928
Health care	730
Transportation	574
Local government	421
Food manufacturing/processing	362
Mining	144
Electricity & natural gas	120
Communications	112
Maritime	69
Petro chemicals	60
Food retail sales/distribution	46
State government	13
Federal government (postal service)	6
Other	119

Source: Federal Mediation and Conciliation Service.

### B. Strikes and Firm Performance

A substantial economics and industrial relations literature exists analyzing the occurrence, timing, size, duration, and economic impact of strikes. Kaufman (1992) provides an excellent survey of this literature and categorizes these studies into three main areas: theoretical studies identifying the root causes of strikes, empirical studies analyzing variation in strike activity, and empirical studies measuring the impact of strikes on firms and industry.

Our study is most closely related to the literature on the effects of strikes on firm and industry performance. This is a growing literature which focuses mostly on the effects of strikes in manufacturing industries. The outcomes of interest include measures such as firm output, profitability, and capital market reaction to strikes. Multi-industry studies such as Neumann (1980), Neumann and Reder (1984), Becker and Olson (1986), and Kramer and Vasconcellos (1996) find that strikes lead to a 2–4 percent decline in firm market value. McHugh (1991) examines the productivity of struck firms in nine manufacturing industries and finds a negative direct impact of strikes on average labor productivity. Similar findings are echoed in studies of specific industries such as the airline industry, where De Fusco and Fuess (1991) find stock market returns of negative 2.6–5.3 percent during strikes, and Kleiner, Leonard, and Pilarski (2002) find that productivity fell greatly at commercial aircraft manufacturing plants during strikes. These effects did not persist in the long-run, however, with their plant returning to pre-strike levels of productivity within one to four months. Schmidt and Berri's (2004) study of professional sports strikes indicates that strike costs are significant during the strike period, but are limited to the strike period, with almost immediate return to pre-strike levels of consumer demand for sporting events.

Two recent studies have examined the effect of strikes and labor relations on the quality of production. Krueger and Mas (2004) examined a long strike which involved the hiring of replacement workers at a tire plant between 1994 and 1996.

They found that tires produced during these years were more likely to be defective, with particularly pronounced increases in defective units coinciding with periods when replacement workers worked together with returning strikers. Mas (2008) found that workmanship for construction equipment produced at factories that experienced contract disputes was significantly worse relative to equipment produced at factories without labor unrest, as measured by the resale value of the equipment. His estimates indicate that equipment produced in facilities undergoing labor disputes were discounted in the resale market by approximately five percent.

### *C. Strikes and Outcomes in the Health Care Sector*

The effects of labor unrest in the health care industry may be particularly pronounced, given its labor-intensive production process, and the potentially serious consequences of substandard health care production. Health care production is particularly labor intensive, with labor's share of production accounting for nearly 60 percent of hospital costs.<sup>8</sup> Nurses in particular constitute the largest group of workers in a hospital, and often have a considerable impact on a hospital patient's experience. Hospital administrators acknowledge that "nurses are the safety net. They are the folks that are right there, real time, catching medication errors, catching patient falls, recognizing when a patient needs something [and] avoiding failure to rescue."<sup>9</sup> Consequently, work stoppages involving nursing personnel have the potential to significantly disrupt hospital operations, with potentially serious consequences for patients. Furthermore, the complex nature of health care delivery necessitates the close coordination of workers who exhibit a great degree of interdependence (Cebul et al. 2008) and whose tenure in a hospital unit can affect patient outcomes (Bartel et al. 2009). Healthcare institutions may thus be particularly susceptible to labor unrest that disrupts these complex processes.

A change in the intensity and quality of nursing inputs brought about due to strikes also has the potential to adversely affect patient outcomes. A number of studies have suggested that a decrease in the nurse-to-patient ratio is associated with increases in mortality and other adverse inpatient events (e.g., Aiken et al. 2002; Needleman et al. 2002), though recent work by Cook et al. (2010) suggests that legally mandated increases in nurse staffing at California hospitals had no discernable effect on patient safety. Moreover, even if staffing ratios are maintained during a strike through the use of replacement workers, the quality and familiarity of these replacement workers with hospital processes may affect the care delivered to patients during strikes. For example, the results in Aiken et al. (2003) suggest that higher quality workers (as measured by education level) are associated with lower mortality rates, while Phibbs et al. (2009) document increases in length of stay for hospitals employing temporary contract workers.

<sup>8</sup> American Hospital Association Trendwatch Report 2009. Available at: <http://www.aha.org/research/reports/tw/chartbook/2009/chapter6.pdf> (accessed March 9, 2010).

<sup>9</sup> Draper et al. (2008, 3). Failure to rescue is a situation where caregivers fail to notice or respond when a patient is dying of preventable complications in a hospital.

At the same time, a large body of research suggests that patients may be over-treated in the hospital. As a result, the reductions in care that result from strikes may not be particularly harmful on the margin. Fisher et al. (2003a, 2003b) show that in regions with high rates of inpatient care utilization, quality of care, functional status and patient satisfaction are no better than in low utilization regions. Baicker and Chandra (2004) control for within-state variation and find that states with higher Medicare spending per beneficiary have lower-quality care. Fisher et al. (2004) extend this analysis to academic hospitals and find no association between increased treatment intensity across medical centers and improved long-term survival for three of their measured outcomes, while finding a small increase in the risk of death as intensity increased for two other conditions analyzed.

Despite the increased role of organized labor in the health care industry, few studies have examined the role of labor unrest on health care production, and the results of these studies offer no clear conclusions as to the effect of these strikes on patients. Early work on health care strikes by James (1979) and Pantell and Irwin (1979) examines the effects of physician strikes on patient care. James (1979) investigates the impact of a physician work slowdown tied to increased malpractice rates in Los Angeles. He finds that causes of death shifted over the course of the slowdown, with decreases in deaths from elective surgery and increases in deaths associated with emergency room transfers. On the other hand, Pantell and Irwin (1979) find no significant effects on appendectomy outcomes during a one-month anesthesiologist strike in San Francisco.

In the only study of the impact of a nurses strike on patient care, Mustard et al. (1995) report a 15 percent decrease in the caesarian birth rate, as well as an increase in the rate of adverse newborn outcomes during a month-long Ontario nurses strike. They conjecture that the result “is most plausibly attributed to disruption in the normal standards of care rather than to the change in the rate of operative management” (Mustard et al. 1995, 636). Finally, Salazar et al. (2001) examine the effect of an emergency room residents strike at a Spanish hospital during which staff physicians filled in for the striking residents. They find decreases in the number of tests ordered, as well as a decrease in patient length of stay compared with the same hospital during a nonstriking period, with no significant changes in mortality or readmission rates.

## II. Data

### A. *Strike Data*

As a condition of the passage of PL 93-360, health care unions are required to submit written notice specifying the exact date and time of striking or picketing activity to both the potentially struck health care institution and the Federal Mediation and Conciliation Service (FMCS) 10 days prior to any work stoppage. The FMCS issues a monthly report showing work stoppages for all industries, and maintains an electronic database of these work stoppages for all industries dating back to 1984. This database contains information on the employer struck, employer location and industry, the union involved, the beginning and end dates of strikes, as well as the size of the bargaining unit struck. In some cases, the names of the types of workers that

struck (e.g., clerical workers, technicians, etc.) are also included. Our strike data were obtained from the FMCS via a Freedom of Information Request in January 2008, and contain all work stoppages in the health care industry from 1984–2004.<sup>10</sup>

The FMCS data show strike activity in the health care industry is concentrated in relatively few states, with four states accounting for nearly 60 percent of health care strikes. Because our strike data cover a period during which health care workers were allowed to organize (and thus the observed strikes are likely not due to union recognition), variation in state union concentration can likely explain a large portion of this variation. For analysis and discussion of the reasons for state variation in health care unionization rates see Freeman (1998) and Holmes (2006). Our analysis focuses on hospitals in New York State, which accounted for one in every six health care facility strikes in the United States during our sample period.

The focus of our study is hospitals providing inpatient care. The FMCS data does not distinguish hospitals from other health care facilities, nor does it report the names of the facilities struck in a uniform manner (i.e., a struck facility may be referred to as “Catholic Health Care” rather than St. John’s Hospital). Hospitals were thus identified manually in the data using both hospital name and facility address, and were checked using the New York State Hospital profile web site.<sup>11</sup>

Hospitals employ a diverse group of workers, ranging from those who provide little or no patient care (e.g., laundry workers and parking attendants) to those with whom the primary responsibility for the patient rests (e.g., physicians and nurses). Because we wish to focus on nurses strikes, we are particularly interested in identifying the group(s) of workers that struck at each hospital. Using only the data provided by the FMCS, we were able to identify the struck bargaining unit in 38 percent of the strikes using either the union name (e.g., New York State Nurses Association) or the name of the title of the union representative (e.g., Nursing Representative, RN Representative). For cases in which the bargaining unit was not clearly specified in the data (such as strikes with missing bargaining unit data or involving unions with diverse groups of workers), the construction of our dataset required searching news archives for articles detailing the bargaining unit involved in each strike. In the cases where we could not obtain this information from news archives, hospital administrators, as well as the listed union, were contacted for their input. If bargaining unit information could not be obtained, these hospitals were dropped from our sample.<sup>12</sup>

Our final sample covers 50 strikes at 43 hospital facilities during the years 1983–2004. Using this sample, the strike data were manually matched by hospital name and address to physical facility identifiers in the New York State hospital discharge data (see below), as were data on the exact dates of the hospital work stoppages. For

<sup>10</sup>Our 1983 strikes were found using a Lexis-Nexis search for hospital strikes in New York State for the year 1983. This search revealed five additional strikes that we incorporate into our analysis. We note that although our empirical specification contains outcome data for 6-months prior to the striking period, because 4 of the 1983 strikes begin in either April or May of 1983, our results contain only 4 or 5 pre-strike months for these strikes.

<sup>11</sup>See <http://hospitals.nyhealth.gov/>.

<sup>12</sup>There were only three strikes at two facilities that were dropped.



strikes which name a hospital with multiple campuses, all campuses under common ownership are classified as struck.<sup>13</sup>

The genesis of these strikes is varied; based on our newspaper research, most were over wages, while some were over nurse staffing ratios. For example, on July 1, 1999, Central Suffolk Hospital, a 153-bed facility in Riverhead Long Island, was struck by 253 registered nurses, technicians and other staff who were members of the New York State Nurses Association. The striking employees had been working without a contract for six months and were demanding a contract providing three percent raises for each year of the contract, retroactivity to the end of their previous contract, better staffing, and job security guarantees. Hospital management, claiming large losses from cuts in Medicare reimbursement, countered with two percent raises per year and refused to grant the union retroactive pay raises for the six-month period without a contract.

The strike lasted 17 days, during which the hospital hired replacement workers to fill in for the striking nurses. Hospital administrators claimed that all services functioned normally, with no disruption in care. Union members, on the other hand, claimed to have heard from Health Department inspectors that six medication errors were made, four of the replacement workers were sent home for incompetence, and that narcotics were missing in one department. The strike was ultimately settled with an agreement that granted union members a 2.5 percent raise, retroactive to April 1, and an acknowledgement from hospital spokeswoman Nancy Uzo that to work with the replacements is “not the same as working with people who have worked here for five or ten years.”<sup>14</sup>

Tables 2 and 3 show the characteristics of the sample of strikes we use over the 1984–2004 period. Our sample contains 43 different facilities, five of which were struck twice and one of which was struck three times, for a total of 50 strike-facility combinations.<sup>15</sup> Strike duration is right-skewed, with the median strike lasting 19 days, and a mean strike length of 32 days. Twenty-one of our 50 striking hospitals admitted fewer than 30 patients per day. Three-fourths of our strikes are concentrated in the downstate area (regions 5–11), though our sample is distributed across all regions,

<sup>13</sup>A unique feature of many metro-New York City hospitals is their participation in industry-wide contracts covering dozens of facilities through the League of Voluntary Hospitals and Homes (League), an association of nonprofit medical centers, hospitals, nursing homes and their affiliated facilities. The League acts as the bargaining agent for its members in labor contracts and represents them primarily in labor negotiations with 1199 Service Employees International Union (1199). Three of the strikes that occur during our sample period involve the League. Because League strikes sometimes involved dozens of facilities striking simultaneously, no publicly available sources explicitly documented the struck bargaining units at each individual hospital during League strikes. Therefore, we assumed knowledge of the correct group of striking workers at a League hospital only if we could find specific information on the bargaining unit struck at a particular hospital during a specified strike. For example, evidence of nurse representation at a League hospital in 1973 is not taken as evidence of representation in 1989 unless a specific document makes reference to nurses striking in 1989. Using these criteria, we include six struck League hospitals in our sample, dropping all hospitals without specific bargaining unit knowledge.

<sup>14</sup>Mitch Freedman, “Striking Nurses Approve Contract,” *Newsday*, July 15, 2009, A31. See also: Bill Bleyer, “Central Suffolk Hospital Nurses Approaching Strike Deadline,” *Newsday*, June 30, 2009, A48. Anonymous, “Central Suffolk Hospital Workers Go Out On Strike,” *Newsday*, July 2, 1999, A29. Tim Gannon, “No Cure in Sight for CSH Strike,” *The News Review Online*, July 8, 1999, accessed March 9, 2009, [http://www.timesreview.com/\\_nr\\_html/nr07-08-99/stories/news1.htm](http://www.timesreview.com/_nr_html/nr07-08-99/stories/news1.htm).

<sup>15</sup>Mitch Freedman, “OK’d Pact Ends Hospital Strike,” *Newsday*, July 17, 1999, A21.

<sup>15</sup>Though there were a total of 51 strikes in our initial sample, because one hospital closed completely during its strike and therefore admitted no patients while struck, it is excluded from the sample.

TABLE 2—THE STRIKE SAMPLE

	(1)
Number of strike-facility combinations	50
Mean strike length (days)	32.1
Standard deviation strike length	39.2
Median strike length (days)	19.0
Distribution of struck hospital size (Average number of daily admissions 6-months prior to strike)	
5–14 admissions	11
15–29 admissions	10
30–45 admissions	17
45+ admissions	12
Distribution of facilities struck across regions	
Region 1	5
Region 2	1
Region 3	1
Region 4	4
Region 5	7
Region 6	5
Region 7	8
Region 8	2
Region 9	2
Region 10	8
Region 11	7

*Notes:* Region 1 includes Allegany, Cattaraugus, Chautauqua, Erie, Genesee, Niagara, Orleans, and Wyoming counties.

Region 2 includes Chemung, Livingston, Monroe, Ontario, Schuyler, Seneca, Steuben, Wayne, and Yates counties.

Region 3 includes Broome, Cayuga, Chenango, Cortland, Herkimer, Jefferson, Lewis, Madison, Oneida, Onondaga, Oswego, St. Lawrence, Tioga, and Tompkins counties.

Region 4 includes Albany, Clinton, Columbia, Delaware, Essex, Franklin, Fulton, Greene, Hamilton, Montgomery, Otsego, Rensselaer, Saratoga, Schenectady, Schoharie, Warren, and Washington counties.

Region 5 includes Dutchess, Orange, Putnam, Rockland, Sullivan, Ulster, and Westchester counties.

Region 6 includes Bronx county.

Region 7 includes Kings county.

Regions 8 and 9 include New York county.

Region 10 includes Queens and Richmond counties.

Region 11 includes Nassau and Suffolk counties.

with at least one strike from each of the 11 New York State regions. Table 3 reveals that 26 of our 50 strikes occurred in 1990 or earlier. For the pre-1991 strikes, 46 percent of these lasted four weeks or longer, and 19 percent a week or less. For the post-1990 strikes, fewer strikes last for an extended period of time, with only 29 percent lasting four weeks or longer and 42 percent for seven or fewer days, though this period saw a number of especially long strikes, such as those at Nyack Hospital in 1999 (180 days struck) and St. Catherine of Siena Hospital in 2002 (105 days struck).

### B. Hospital Discharge Data

Each short-term nonfederal hospital in New York State is required to submit discharge data to the New York State Department of Health through the Statewide

TABLE 3—HOSPITAL FACILITIES STRUCK IN NY STATE

Year	1983–1986	1987–1990	1991–1994	1995–1998	1999–2004
Length less than 1 week	1	4	6	3	1
1 week $\leq$ length $<$ 2 weeks	2	2	0	1	0
2 week $\leq$ length $<$ 4 weeks	2	3	2	1	3
4 weeks $\leq$ length	7	5	1	2	4

Planning and Research Cooperative System (SPARCS). SPARCS has collected, at the patient level, detailed data on patient characteristics (e.g., age, sex, race), diagnoses (several DRG and ICD-9 codes), treatments (several ICD-9 codes), services (accommodation), and total charges for every hospital discharge in New York State since in 1982. These data are reviewed for quality and completeness by the New York State Department of Health. Failure to submit these data can carry consequences for the hospitals, including the withholding of reimbursement.<sup>16</sup> Our data include the universe of discharges from New York State from 1983–2005.

We include for each discharge abstract record a three-digit Diagnosis Related Group (DRG) weight as reported for the years 1983–2005 by the Center for Medicare and Medicaid Services (CMS), matching each year of discharge data with the corresponding year provided by CMS. This enables the creation of a case mix index for each hospital-day. Case mix is commonly used in administrative data to measure overall illness severity and case complexity. As an additional illness severity control, we include for each administrative record the unweighted comorbidity illness components of the Charlson Index, an index shown to be strongly associated with mortality (Quan et al. 2005).<sup>17</sup>

As noted earlier, the strikes in our data typically last for a matter of days or weeks. Unless strike effects persist for a period long before and after a strike, identification of strike effects requires data collected at sufficiently precise time intervals so as to allow for outcome measurement at the weekly or even daily level. The standard issue, nonidentifiable SPARCS discharge files, however, allow only for the identification of the month and year of any given admission, discharge, or procedure. Our analysis makes use of restricted data elements not available in the public use data files, including the year, month and day of each admission, discharge, and procedure, as well as identifiers which enable the longitudinal tracking of patients within and across New York State facilities.<sup>18</sup> Approval for these restricted data elements required authorization from a Data Protection Review Board (DPRB) overseen by the state.

For our analysis, we use all data from each SPARCS region in which there is a strike during the one-year period surrounding the strike. The SPARCS region is a geographical subdivision of New York State, as defined by the New York Department

<sup>16</sup> <http://www.health.state.ny.us/statistics/sparcs/sysdoc/operguid.htm>.

<sup>17</sup> Our identification of these conditions utilizes code made available through the University of Manitoba Centre for Health Policy at: [http://mchp-appserv.cpe.umanitoba.ca/viewConcept.php?conceptID=1098#a\\_references](http://mchp-appserv.cpe.umanitoba.ca/viewConcept.php?conceptID=1098#a_references).

<sup>18</sup> Prior to 1995, patients in the New York State data could not be tracked longitudinally across facilities, due to the lack of a unique personal identification number which is consistent across hospitals (same-hospital readmission is identifiable prior to 1995). Beginning in 1995, New York hospitals began collecting an element consisting of a combination of a patient's last name, first name, and social security number which enabled the calculation of patient readmission. Accordingly, all strikes in our data occurring before 1995 contain no patient readmission measures.

of Health. These regions correspond closely to the Health Service Areas (HSA), measures commonly used to define hospital inpatient activity by New York State, though there are fewer HSAs, due mostly to the consolidation of the five boroughs as an HSA. For each region in the year surrounding the strike, we use all discharge records from hospitals providing short-term inpatient care.<sup>19</sup> Our sample therefore consists of all hospitals in any SPARCS region in the one-year time period surrounding the date of a strike in that region.

We consider two measures of patient outcomes that may be affected by strikes. Our primary outcome of interest is in-hospital mortality. This is a clear measure of hospital performance along a dimension with unambiguous welfare implications. Following Geweke, Gowrisankaran, and Town (2003), we consider an in-hospital mortality measure which records as mortality a death occurring within the first ten days of a patient's date of admission. This short follow-up period is chosen in order to prevent any bias that might arise from a strike-induced change in the length of stay, as well as to account for the fact that deaths occurring after the first ten days may not reflect initial management and care due to the transfer of terminally ill patients to other facilities.<sup>20</sup> Of course, a limitation of our analysis is that we only know within-hospital mortality, and not mortality following hospital stays. Thus, it is possible that any mortality increases that we find may reflect shifts in the timing of deaths; for example, Cutler (1995) finds that prospective reimbursement under Medicare led to a short-run rise in mortality but no long-run effect.

Our second major outcome measure is hospital readmission, which is defined in our data as an inpatient re-hospitalization to *any* New York State hospital, for *any* reason, which occurs within 30 days of the discharge. Hospital readmission is often an indicator of poor care or missed opportunities to improve quality of care during a hospital admission (MEDPAC 2007), and has been widely used by health economists as a proxy for the quality of hospital care (Cutler 1995; Ho and Hamilton 2000; Kessler and Geppert 2005). This measure has also recently been proposed by policymakers as a quality metric to which Medicare reimbursement could be tied (Bhalla and Kalkut 2010).<sup>21</sup>

We also consider as dependent variables two utilization measures of hospital inputs: the length of stay for the patient and the number of procedures performed while in the hospital. We subset the number of procedures performed by procedure type, since hospitals may differ in the distribution of major and minor procedures offered during a strike, as well as whether a procedure is intended for diagnostic (nonoperative) or therapeutic (operative) purposes. In addition, we explored using total charges incurred to the patient as a measure of total resource utilization, though the results were sufficiently imprecise that we could not rule out either very large or small effects.

<sup>19</sup>While this allows for the possibility of using some discharges from hospitals providing care that might be different than the striking hospitals (all of which are general hospitals), using American Hospital Association survey information from 1984 and 1999, the authors calculate within an HSA, the share of discharges from nongeneral hospitals in New York State is less than five percent.

<sup>20</sup>Our results are similar using full-stay in-hospital mortality as an outcome measure, though the significance level on the mortality coefficient decreases for our emergency subsample and increases for the nonemergency subsample.

<sup>21</sup>We considered both any-hospital readmission (as reported in the paper) as well as readmission excepting transfer to an acute care hospital. The results are similar using both measures of readmission.

We also control for a variety of patient characteristics. All models control for available patient demographics, including age, gender, race (white versus non-white), and the number of conditions with which each patient is diagnosed upon their hospital admission. In addition, we can use data on diagnosis codes to form measures of patient illness severity. Whether such measures should be included is unclear since severity codes may themselves be impacted by a strike. We find no such effect on severity, however, and our results are not affected by the inclusion of these controls, as we discuss below.

Since the relevant variation is at the hospital/day level, we aggregate our data to that level; our sample consists of 393,960 hospital/days of data from 288 hospitals for our 50 hospital-strike combinations. We use three measures of “exposure” of patients to a strike. The first is a dummy variable for whether the patient’s day of admission was during a strike. This is the most straightforward measure but suffers from the problem that patients may be impacted by strikes that occur after their admission to the hospital. We therefore consider two alternatives: the share of patients admitted in that day who are exposed at some point during their stay to a strike; and the share of the stay that was during a strike, among patients admitted that day. These are more complete “exposure” measures but may suffer from the fact that length of stay may be impacted by the strike. In fact, as we show, our results are very robust to the exposure measure used.

The means for our sample are presented in Table 4. The mean number of daily admissions for hospitals in our sample is 28, or approximately 10,220 yearly admissions. Using the AHA average number of discharges per bed for the US for 1994 (the mid-point of our sample), this translates to approximately 271 beds. The average daily case mix index of 1.01 reflects that hospitals in our sample treat patients with a resource need comparable to the average US hospital. The average 10-day in-hospital mortality rate is 1.9 percent. The average any-hospital readmission rate (available only post-1995) is 13.8 percent. The average number of procedures performed during a hospital stay is 1.65, 0.64 of which are diagnostic and 1.01 are therapeutic.<sup>22</sup> Fifty-eight percent of the patients in our sample are female, two-thirds are white, and the average age is 44.5. The number of conditions and number of Charlson comorbidities with which a patient is diagnosed are 3.4 and 0.56, respectively. Four-tenths of one percent of patients in our data are admitted during a strike.

Sample means for the striking hospitals are presented in columns 3 and 4 for the six-month period prior to the strike, while the same statistics over this same time period are presented for the nonstriking hospitals in the same region in columns 5 and 6. Struck hospitals over this period are larger on average, with an average of 35 daily admissions versus 32 for their nonstriking counterparts. Patients at struck hospitals are slightly less complicated to treat, as measured by the case mix index, but are older and more likely to be covered by Medicare than are patients at nonstriking

<sup>22</sup> Minor procedures are those not requiring the use of an operating room. HCUP’s classification system further categorizes these procedures by whether they are diagnostic (e.g., CT scan of head), or therapeutic (e.g., irrigate ventricular shunt) in nature. Major procedures are those that require the use of an operating room. HCUP’s classification system also categorizes these by whether a procedure is performed for diagnostic reasons (e.g., open brain biopsy) or therapeutic reasons (e.g., aorta-renal bypass). The classification system is exhaustive in that every procedure is assigned to one of these four categories.

TABLE 4—SAMPLE MEANS

Sample	All hospitals, full sample		Struck hospitals, 6-months before strike		Nonstruck hospitals in same region as strike hospitals, 6-months before strike	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Hospital characteristics</i>						
Number of daily admissions	28.0	24.5	34.74	21.59	31.77	10.64
Daily case-mix index	1.01	0.34	0.96	0.15	1.00	0.14
<i>Outcome variables</i>						
10-day in-hospital mortality (percent)	1.86	2.99	2.02	0.82	1.85	0.27
Length of stay	7.58	4.61	7.44	1.98	7.78	0.89
Total procedures performed	1.65	0.73	1.51	0.47	1.66	0.34
Minor diagnostic procedures performed	0.61	0.42	0.55	0.29	0.61	0.15
Minor therapeutic procedures performed	0.58	0.41	0.51	0.26	0.58	0.25
Major diagnostic procedures performed	0.04	0.05	0.04	0.03	0.04	0.02
Major therapeutic procedures performed	0.43	0.23	0.41	0.12	0.43	0.08
Diagnostic procedures performed	0.64	0.42	0.59	0.29	0.65	0.15
Therapeutic procedures performed	1.01	0.46	0.92	0.25	1.01	0.24
30-day readmission rate (percent)	13.80	7.50	13.83	2.57	13.67	0.79
30-day readmission rate (percent, excluding transfers)	12.13	6.94	11.83	2.71	12.10	0.75
<i>Patient characteristics</i>						
Average age	44.46	11.14	46.49	8.20	43.75	3.90
Percent female	58.20	10.90	59.01	5.76	58.16	1.52
Percent white	66.55	29.34	67.44	27.98	61.95	22.56
Number of diagnoses	3.36	1.29	3.41	1.25	3.31	1.05
Charlson index	0.56	0.30	0.58	0.23	0.55	0.17
Percent covered by Medicare	30.14	15.78	32.24	12.19	28.93	6.36
Percent covered by Medicaid	18.69	18.70	20.45	16.94	21.17	12.68
Percent uninsured	6.53	7.75	5.89	4.68	6.95	3.05
Log income	10.57	0.39	10.48	0.36	10.49	0.33
<i>Strike exposure</i>						
Percent of patients admitted during strike	0.35	5.88	—	—	—	—
Percent of patients admitted exposed to strike	0.45	6.21	—	—	—	—
Percent of patient stay exposed to strike	0.36	5.25	—	—	—	—
<i>Distribution of admission type</i>						
Emergency (percent)	55.95	22.33	60.5	16.85	63.16	9.82
Non-emergency (percent)	44.03	22.32	46.45***	16.24	53.94	11.35

Notes: Case-mix index, outcome variables, patient characteristics and distribution of admission type are weighted by the total number of admissions. Readmission rates calculated for post-1995 strikes only. Individuals are recorded as uninsured if their discharge record specifies self-pay or exempt from charges. Income is imputed using the median income recorded for a given zip code in the 1990 census for individuals admitted in 1983–1994, and the median income for a given zip code reported in the 2000 census for individuals admitted in 1995–2004.

\*\*\*Significant at the 1 percent level.

hospitals. Patients at striking hospitals also have a slightly higher number of Charlson co-morbidities, and are diagnosed with more conditions than patients at nonstriking hospitals in the same region. Struck hospitals also have a lower length of stay and perform fewer procedures. The mortality rate at struck hospitals is higher than at nearby nonstriking hospitals, while 30-day readmission rates for the two groups are similar. The percent female and income of admitted hospital patients is similar for

both hospital groups, though struck hospitals admit a lower percentage of nonemergency patients than do struck hospitals.

### III. Empirical Strategy

Our basic empirical strategy is to examine the utilization and outcomes in striking hospitals during a strike, relative to outcomes the rest of the year in that hospital, and relative to the other hospitals in their region during this same period. In this event-study approach, the unit of observation is the hospital ( $h$ ), within region ( $r$ ), by date of admission ( $d$ ). Using this strategy, we run regressions of the form:

$$(1) \quad \text{OUTCOME}_{hrd} = \alpha + \beta \text{STRIKE}_{hrd} + \gamma \text{PDEM}_{hrd} + \delta_h + \eta_d \\ + \mu_y \times \sigma_r + \mu_m \times \sigma_r + \varepsilon_{hrd}.$$

In this equation, *OUTCOME* is one of our measures of outcomes that might be affected by the strike (average daily mortality rate or average daily rates of readmission), *STRIKE* is one of our three measures of strike impact/exposure, and *PDEM* is the mean characteristics of patients admitted that day (case mix index, number of diagnoses, Charlson comorbidities, age, share white and share female). We also include a full set of fixed effects for each hospital ( $\delta_h$ ) and a set of fixed effects for date of admission, which includes year effects, fixed effects for each of the 52 weeks, and fixed effects for each of the seven days of the week ( $\eta_d$ ). Finally, we include a full interaction of year dummies ( $\mu_y$ ) and month dummies ( $\mu_m$ ) with SPARCS region dummies ( $\sigma_r$ ) to account for any differential time trends by area.

With this specification, our identifying assumption is that the only reason for changing outcomes in striking hospitals, relative to others in their region, is the strike itself. We are able to rule out concerns about permanent differences between striking and nonstriking hospitals through the use of hospital fixed effects; we are only looking at differences that emerge during the strike, relative to the remaining period of the year when there is no strike.

There are two potential concerns with such an approach. The first is that there are underlying trends in hospital outcomes that are concurrent (or even causing) the strike. For example, deteriorating conditions in a hospital may cause both worsening outcomes over time and the desire to strike. As discussed above, we have found no evidence of this as a cause of strikes. Nevertheless, we carefully investigate the dynamics in outcomes around strike periods to see if there is any evidence of deteriorating outcomes preceding strikes.

The second concern is that the strike itself may change the composition of patients in the hospital, leading to changes in outcomes through composition bias and not real changes in treatment. For example, if strikes lead to admissions of only sicker patients, then this would be associated with both worse outcomes and more intensive treatment. Indeed, strikes are associated with reductions in hospital admissions. But we find no evidence that they are associated in any way with changes in patient demographics or case mix. Moreover, such a hypothesis would suggest that strikes would be associated with improved outcomes in nearby hospitals, or in striking

hospitals after the strike has ended. We find evidence for neither. Finally, we show in section VI that for strikes where replacement workers are used, there is no decline in admissions, yet we continue to see adverse effects on outcomes.

#### IV. Patient Outcome Results

In this section, we examine the impact of strikes on in-hospital mortality and hospital readmission. Table 5 presents our basic results for inpatient mortality. The first panel uses an indicator for the day of admission being during a strike as our measure of strike exposure. Column 1 shows a regression of average daily mortality for patients admitted that day on an indicator for whether that day was during a strike. This regression includes only the fixed effect for hospital, time, and region×time interactions, as well as the strike indicator. We find a highly significant increase in patient mortality associated with being admitted during a strike: among patients admitted during a strike, inpatient mortality is 0.34 percentage points higher than comparable patients admitted before or after a strike. This represents an increase of 18.3 percent relative to the baseline mortality rate of 1.86 percent, a sizeable increase.

The next column adds demographic characteristics, and the results are very similar, with the mortality coefficient rising to 0.36. The third column in this first panel adds indicators for patient severity, and the result is once again very similar, with a coefficient of 0.34. The coefficients on the case mix and Charlson comorbidity measures are positive and highly significant, as would be expected: mortality rates are higher for admission days with a sicker case mix. There is also a positive association with average age, and a negative association with percent female and percent white. Interestingly, controlling for these other characteristics, there is a negative association with the total number of conditions with which a patient is diagnosed.

The next two panels extend the results to consider our two alternative measures of strike exposure. When strike exposure is measured as the share of patients admitted that day who are exposed to a strike, the coefficient is slightly smaller; when it is measured as the share of the stay that occurs during a strike, the impact is slightly larger. Overall, our findings are not sensitive to either controls or the measure of strike exposure.

Table 5 repeats this exercise for our other measure of patient outcomes, hospital readmissions. As noted earlier, readmissions information is only available after 1995, so our sample is restricted to the 14 strikes that took place during that period. As with mortality, there is a highly significant and robust increase in readmissions associated with strikes. For our strike admission indicator, we find that strikes are associated with a rise in readmission rates of 0.78 percentage points in the richest specification, off a base of 13.8 percent, so this represents a roughly 5.7 percent increase. The results are once again very robust with respect to the inclusion of demographic and severity controls, and with respect to the measure of strike exposure used.

##### *A. Timing and Pre-existing Trends*

One concern noted above is that our difference-in-difference identification strategy may be unable to disentangle differential trends between treatment and



TABLE 5—IMPACT OF STRIKES ON 10-DAY IN-HOSPITAL MORTALITY

Independent variable: Mean of dependent variable	Indicator for admitted during strike			Proportion admitted exposed to strike			Proportion of stay that was during strike		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Strike	0.33968*** (0.11828)	0.35548*** (0.10823)	0.33733*** (0.10967)	0.25223** (0.10826)	0.27492*** (0.09758)	0.25915*** (0.09854)	0.40969*** (0.12849)	0.42944*** (0.11682)	0.41124*** (0.11728)
Average age	—	0.06840*** (0.00211)	0.04454*** (0.00232)	—	0.06840*** (0.00211)	0.04454*** (0.00232)	—	0.06840*** (0.00211)	0.04453*** (0.00232)
Average percent female	—	-0.00286*** (0.00066)	-0.00129** (0.00064)	—	-0.00286*** (0.00066)	-0.00129** (0.00064)	—	-0.00286*** (0.00066)	-0.00129** (0.00064)
Average percent white	—	-0.00294* (0.00154)	-0.00379** (0.00166)	—	-0.00294* (0.00154)	-0.00379** (0.00166)	—	-0.00294* (0.00154)	-0.00379** (0.00166)
Casemix index	—	—	0.23491*** (0.05714)	—	—	0.23481*** (0.05714)	—	—	0.23492*** (0.05713)
Average number of diagnoses	—	—	-0.08543*** (0.02634)	—	—	-0.08548*** (0.02634)	—	—	-0.08530*** (0.02634)
Average Charlson Index	—	—	1.47169*** (0.05994)	—	—	1.47194*** (0.05992)	—	—	1.47155*** (0.05992)
Observations	393,960	392,679	392,679	393,960	392,679	392,679	393,960	392,679	392,679

Notes: Specifications in columns 1–6 are weighted by total admissions. Specifications in columns 7–9 are weighted by patient days. All specifications include controls for week, year, region  $\times$  year, region  $\times$  month, day of week and hospital fixed effects. Robust standard errors are corrected for clustering within hospitals.

\*\*\* Significant at the 1 percent level.

\*\* Significant at the 5 percent level.

\* Significant at the 10 percent level.

TABLE 6—IMPACT OF STRIKES ON 30-DAY READMISSION

Independent variable Mean of dependent variable	Indicator for admitted during strike			Proportion admitted exposed to strike			Proportion of stay that was during strike		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Strike	1.04201*** (0.31743)	0.77013*** (0.31289)	0.77924** (0.31789)	0.98638*** (0.29080)	0.68876** (0.28272)	0.70336** (0.28600)	1.21246*** (0.34735)	0.91845*** (0.32087)	1.0557*** (0.3456)
Average age	—	0.19314*** (0.01170)	0.13746*** (0.01287)	—	0.19314*** (0.01170)	0.13746*** (0.01287)	—	0.19313*** (0.01170)	0.13745*** (0.01287)
Average percent female	—	-0.03950*** (0.00369)	-0.03673*** (0.00380)	—	-0.03950*** (0.00369)	-0.03673*** (0.00380)	—	-0.03950*** (0.00369)	-0.03673*** (0.00380)
Average percent white	—	0.00663* (0.00362)	0.00870** (0.00355)	—	0.00662* (0.00362)	0.00869** (0.00355)	—	0.00662* (0.00362)	0.00869** (0.00355)
Casemix index	—	—	-0.60192*** (0.10427)	—	—	-0.60233*** (0.10427)	—	—	-0.60217*** (0.10427)
Average number of diagnoses	—	—	0.14172* (0.07560)	—	—	0.14187* (0.07563)	—	—	0.14196* (0.07559)
Average Charlson Index	—	—	2.64499*** (0.16321)	—	—	2.64480*** (0.16324)	—	—	2.64467*** (0.16319)
Observations	109,721	109,721	109,721	109,721	109,721	109,721	109,721	109,721	109,721

Notes: Specifications in columns 1–6 are weighted by total admissions. Specifications in columns 7–9 are weighted by patient days. All specifications include controls for week, year, region × year, region × month, day of week and hospital fixed effects. Robust standard errors are corrected for clustering within hospitals.

\*\*\* Significant at the 1 percent level.

\*\* Significant at the 5 percent level.

\* Significant at the 10 percent level.

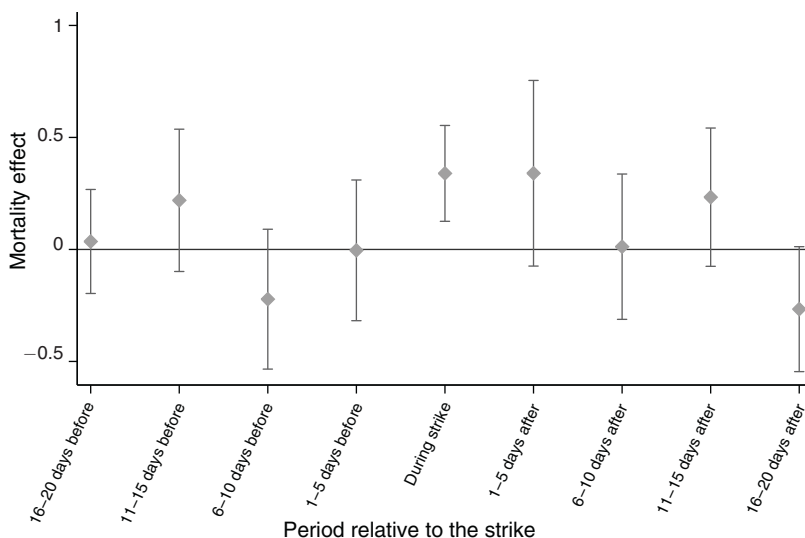


FIGURE 1. PRE-STRIKE AND POST-STRIKE MORTALITY TRENDS

+ - 1.96 standard error band shown with vertical bar.

control hospitals. If strikes occur at hospitals where quality is exogenously deteriorating, it could give the appearance of a negative causal impact of strikes on outcomes.

Figures 1 and 2 address this point by plotting the estimated coefficients and confidence bands on both of our outcome variables and each of eight dummy variables which equal one for those admitted 16–20 days before a strike, 11–15 days before, 6–10 days before, and 1–5 days before, as well as 1–5 days after, 6–10 days after, 11–15 days after, and 16–20 days after a strike. As we show for both of the outcome variables in these figures, there is no indication of any significant trend in outcomes before a strike; all of the dummy variables for the period beforehand are insignificant and, if positive, are small. The results are similar if we literally use 20 dummies to represent each day before a strike; three of the 20 dummies are significant for 10-day mortality, two negative and one positive, and two are significant for re-admission, one positive and one negative.

The lagged effects of a strike, showing the impact after a strike has concluded, also show no significant trend in outcomes. For both mortality and readmission, the coefficients on the lagged variables indicate that the deleterious impact of a strike may persist for up to 15 days after a strike, though none of the coefficients on these variables are precisely estimated. A slight improvement in outcomes is observed for the period spanning 16–20 days after a strike, however, again these coefficients are insignificant.

### B. Selection Bias Concerns

As noted earlier, another concern with our empirical strategy is that the nature of admissions may change when there is a strike. Indeed, there is a strong negative

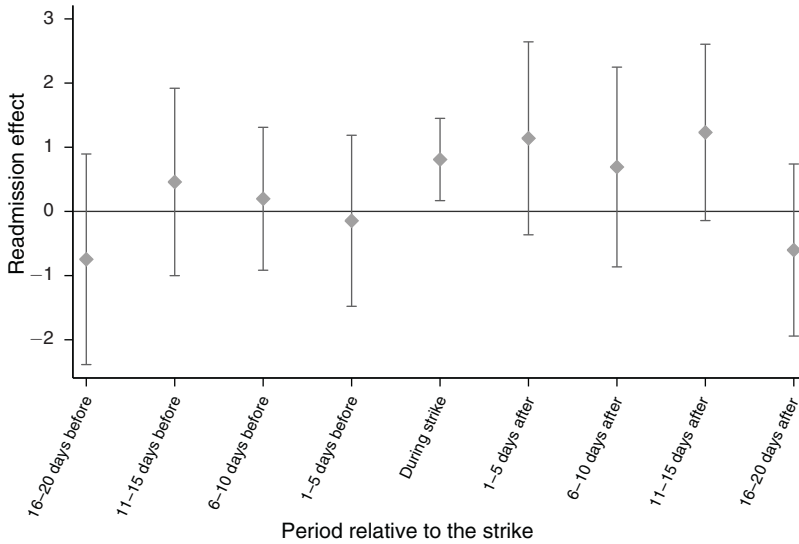


FIGURE 2. PRE-STRIKE AND POST-STRIKE READMISSION TRENDS

+ - 1.96 standard error band shown with vertical bar.

relationship between strikes and admission rates. However, the fact that admissions fall does not mean that there is a change in the mix of patients admitted during a strike. In this section we explore these compositional concerns further by directly examining whether there is a change in the observable characteristics of patients admitted during a strike. Of course, this approach cannot rule out that there were unobservable differences among those admitted during a strike. But it seems unlikely, if patients admitted during a strike are very similar along all observed dimensions, that they would be very different along unobserved dimensions.

Column 1 of Table 7 shows the magnitude of the decrease in admissions during strikes, while the other columns show the results of our basic specification where the dependent variable is the mean characteristics of patients admitted that day: average age, percent female, percent white, case mix index, number of Charlson comorbidities, and number of diagnoses. We also examine the change in insurance status for patients admitted during a strike using the daily percent enrolled in Medicare, percent enrolled in Medicaid, and uninsured individuals (those recorded as self-pay or exempt from charges). Furthermore, we analyze the change in income for patients admitted during strikes by imputing income at the zip code level. Column 1 shows a decrease in admissions during a strike of 26 percent. However, the remaining columns show an insignificant relationship between the average characteristics of patients and the strike indicator; that is, patients admitted during a strike are no different than those admitted in other periods. This should not be surprising given the insensitivity of the results to adding controls in our earlier tables.

These effects are not only insignificant; the confidence intervals are also very small. For example, we find that strikes are associated with a  $-0.016$  change in case mix index, off a mean of 1.01. This is a reduction of 1.6 percent. Given the standard

TABLE 7—EFFECT OF STRIKES ON DEMOGRAPHIC AND DIAGNOSIS CHARACTERISTICS

Dependent variable	Log [1+(# of admissions)]	Age	Percent female	Percent white	Casemix Index	Number of procedures	Total diagnoses	Charlson Index
Mean of dependent variable	2.99 (1)	44.46 (2)	58.20 (3)	66.55 (4)	1.01 (5)	1.65 (6)	3.36 (7)	0.56 (8)
Strike	-0.30597*** (0.07693)	-0.133 (0.559)	0.706 (0.514)	1.405 (1.275)	-0.016 (0.014)	-0.05601 (0.06570)	-0.036 (0.066)	0.011 (0.014)
N	393,960	392,679	393,960	393,960	392,679	392,679	392,679	393,960
<i>Effect of strikes on insurance status and income</i>								
Dependent variable	Percent Medicare	Percent Medicaid	Percent uninsured	Log of income				
Mean of dependent variable	30.14 (1)	18.69 (2)	6.53 (3)	10.57 (4)				
Strike	1.29897 (0.86425)	1.26877 (0.97688)	-0.37079 (0.41325)	-0.00306 (0.00501)				
Observations	393,960	393,960	393,960	393,518				

Notes: All specifications are weighted by total admissions, include controls for week, year, region  $\times$  month, day of week and hospital fixed effects. Robust standard errors are corrected for clustering within hospitals.

\*\*\* Significant at the 1 percent level.

\*\* Significant at the 5 percent level.

\* Significant at the 10 percent level.

TABLE 8—10 MOST FREQUENT DIAGNOSES AT STRUCK HOSPITALS

Admitted during the three week period before the strike		
Diagnosis related group (DRG)	Number of admissions	Percent of admissions
1 Normal newborn	2,890	8.02
2 Vaginal delivery without complicating diagnoses	2,534	7.04
3 Heart failure & shock	877	2.44
4 Cesarean section without complications or comorbidities	687	1.91
5 Cannot report due to provisions of data agreement	661	1.84
6 Simple pneumonia & pleurisy age >17 with complications or comorbidities	614	1.70
7 Alcohol/drug abuse or dependence, detoxification, w/o complications or comorbidities	588	1.63
8 Neonate with other significant problems	520	1.44
9 Angina pectoris	495	1.37
10 Psychoses	490	1.36

Admitted during strike		
Diagnosis related group (DRG)	Number of admissions	Percent of admissions
1 Normal newborn	3,264	8.75***
2 Vaginal delivery without complicating diagnoses	2,828	7.58***
3 Heart failure & shock	992	2.66
4 Cesarean section without complications or comorbidities	895	2.40***
5 Psychoses	838	2.25***
6 Simple pneumonia & pleurisy age >17 with complications or comorbidities	825	2.21***
7 Neonate with other significant problems	555	1.49
8 Intracranial hemorrhage or cerebral infarction	510	1.37
9 Chest pain	495	1.33***
10 Angina pectoris	487	1.31

\*\*\*Significant at the 1 percent level.

error, this implies that the most case mix could have fallen is 3 percent, which is very modest given our 5.7 percent to 18.3 percent outcome effects.

As an additional check on the characteristics of patients admitted during strikes, we include in Table 8 the distribution of diagnoses at struck hospitals for patients admitted during a strike versus the three-week period prior to a strike, classifying diagnoses by their diagnosis related group (DRG). The table shows little indication of the presence of a more severe patient population during a strike. Eight of the ten most frequently observed pre-strike diagnoses are also among the ten most frequently observed diagnoses during the strike period, and those diagnoses seen with greater frequency during a strike are not mortality intensive.<sup>23</sup> In addition, the four most frequently observed diagnoses are identical for both time periods, accounting for 19.4 percent of all admissions in the pre-strike period, and 21.4 percent during the striking period. Overall, the two panels in Table 8, which account for 28.8 percent and 31.3 percent of the pre-strike period and strike-period respectively, provide additional evidence that our results are not driven by a shift in the distribution of patients during the strike period.

<sup>23</sup>With the exception of simple pneumonia, the mortality rates for the diagnoses that occur more frequently during strikes are lower than the average mortality rate observed in our sample.

If striking hospitals are admitting only the sickest patients, then one of two things must be happening to the healthier patients: either they are delaying hospitalization or receiving treatment at other nearby hospitals. The former alternative is ruled out by our timing specification; delay in treatment by the healthiest patients would show up as negative lagged effects of the strike, which we do not see. The latter alternative can be tested by examining the impact of strikes on neighboring hospitals. We use two different methodologies to divide our control group into “very close” hospitals and “less close” hospitals within the region. These two methodologies follow methods used in the literature on hospital competition.

The first is to use a measure of geographical closeness: the three hospitals closest to the striking hospital as the crow flies. The second is to use a “patient flow” measure common in competition research, which finds the competitor hospitals to the striking hospital by: identifying the share of patients in the striking hospital that come from each zip code over the previous six months; ranking the zip codes from most common to least and counting down the list until we have accounted for 40 percent of the hospital’s discharges; and then choosing any hospital that has at least 3 percent of their discharges in this set of zip codes.

The results from using these two different approaches, for our key outcome variables, are shown in Table 9. Panel 1 reports the results from our specification (excluding our demographic and severity measures), using as our outcome variable the logarithm of the number of admissions at the nearby hospitals. The results indicate that nearby hospitals are admitting 2.5–4.7 percent more patients during a strike, though neither of these coefficients are significant at conventional levels. Panels 2 and 3 show that there are actually *positive* mortality and readmission effects on nearby hospitals in three of the four specifications, though in none of these are the coefficients statistically significant at conventional levels. However, if anything, these results suggest that nearby hospitals are admitting *sicker* patients, so that selection is not driving our findings.

To further address the possibility that our results are driven by a shift in the composition of patients, we examine the effects on outcomes at the regional level. If the observed strike effects are driven by a region-wide redistribution of patients across hospitals, then analysis at a regional level should reveal no change in outcomes. For this analysis, we run regressions of the form:

$$(2) \quad \text{OUTCOME}_{rd} = \alpha + \beta \text{STRIKE}_{rd} + \gamma \text{PDEM}_{rd} \\ + \eta_d + \delta_w + \mu_y \times \sigma_r + \mu_m \times \sigma_r + \varepsilon,$$

where the unit of observation is the region ( $r$ ) by date of admission ( $d$ ). As was done in our previous specification, we include a full set of year ( $\mu_y$ ), month ( $\mu_m$ ), week ( $\delta_w$ ), day ( $\eta_d$ ) and region ( $\sigma_r$ ) fixed effects, as well as a full interaction of year and month dummies with SPARCS region dummies. We measure our *STRIKE* variable as an indicator of whether a hospital is struck in a particular region on a specific day.

Table 10 presents our basic results for our outcome measures, using the specification in (2). Column 1 shows that admissions do not decline at the regional level during

TABLE 9—EFFECTS OF STRIKES ON NEARBY HOSPITALS

Outcome measures Method	Log admissions		In-hospital mortality		30-day readmission	
	RADIUS 3	FLOW 3	RADIUS 3	FLOW 3	RADIUS 3	FLOW 3
Mean of dependent variable	2.89	2.89	1.86	1.86	13.82	13.82
	(1)	(2)	(3)	(4)	(5)	(6)
Nearby strike	0.02519 (0.02369)	0.04657 (0.03660)	-0.01425 (0.04407)	0.04657 (0.03660)	0.13658 (0.20702)	0.10239 (0.15012)
<i>N</i>	374,495	373,223	373,223	373,223	104,179	104,179

*Notes:* All specifications are weighted by total admissions. Mortality and readmission specifications include controls for average age, average share female, average share white, casemix index, average number of diagnoses, average Charlson Index, week, year, region  $\times$  year, region  $\times$  month, day of week and hospital fixed effects. Log admissions specification includes controls for week, year, region  $\times$  year, region  $\times$  month, day of week and hospital fixed effects. Robust standard errors are corrected for clustering within hospitals.

\*\*\*Significant at the 1 percent level.

\*\*Significant at the 5 percent level.

\*Significant at the 10 percent level.

TABLE 10—REGION-LEVEL ANALYSIS

Dependent variable	Log admissions	In-hospital mortality	30-day readmission
Mean of dependent variable	6.43 (1)	1.75 (2)	14.33 (3)
Strike	-0.00712 (0.01122)	0.03976*** (0.00972)	0.75919** (0.30915)
Observations	92,410	92,410	44,164

*Notes:* All specifications include controls for week, year, region  $\times$  year, region  $\times$  month day of week and region fixed effects.

Columns 2 and 3 include controls for demographic and severity measures.

\*\*\*Significant at the 1 percent level.

\*\*Significant at the 5 percent level.

\*Significant at the 10 percent level.

a strike. Both of our strike measures, however, indicate that regions with a striking hospital have worse outcomes during the strike. Our mortality regression shows considerably smaller yet significant effects at the regional level, while our readmission measure also indicates that patients in a struck region experience worse outcomes. Given that the number of regional hospital admissions does not change during a strike, these results provide further evidence that the deterioration in outcomes is not simply due to a redistribution of admission severity across the region during a strike.

## V. Utilization Outcomes

The evidence in Section IV strongly suggests that patients admitted during strikes have significantly worse outcomes than patients admitted at other times. Is this because they receive less care, or because they receive worse care? To address this, we now turn to measures of patient treatment intensity.

Table 11 shows our basic results for our measures of treatment intensity: length of stay and number of procedures performed during the stay. Because the number



TABLE 11—IMPACT OF STRIKES ON UTILIZATION

Dependent variable	Number of procedures							
	Length of stay	All procedures	Minor diagnostic	Minor therapeutic	Major diagnostic	Major therapeutic	Diagnostic	Therapeutic
Mean of dependent variable	7.58 (1)	1.65 (2)	0.61 (3)	0.58 (4)	0.04 (5)	0.43 (6)	0.64 (7)	1.01 (8)
Strike	0.272 (0.220)	-0.05601 (0.06570)	-0.03313 (0.03934)	0.01836 (0.03162)	-0.01010*** (0.00340)	-0.03122*** (0.00948)	-0.04322 (0.04053)	-0.01286 (0.03192)
Observations	392,679	392,679	392,679	392,679	392,679	392,679	392,679	392,679

Notes: All specifications are weighted by total admissions, include controls for demographic and severity measures, week, year, region  $\times$  year, region  $\times$  month, day of week and hospital fixed effects. Robust standard errors are corrected for clustering within hospitals.

\*\*\*Significant at the 1 percent level.

of procedures performed during a strike could also vary depending on the type of procedure performed, we subset our procedures into four categories according to the procedure class database developed as part of the Healthcare Cost and Utilization Project (HCUP).<sup>24</sup> The procedure groups consist of nonoperating room procedures that are diagnostic (termed minor diagnostic procedures), nonoperating room procedures that are therapeutic (termed minor therapeutic procedures), operating room procedures performed for diagnostic reasons (termed major diagnostic procedures), and operating room procedures that are performed for therapeutic reasons (termed major therapeutic procedures).

For length of stay, we find a positive but insignificant impact of strikes, while for the number of procedures performed, our estimate is negative but insignificant. However, analysis of the procedure groups reveals that while the number of minor procedures performed remains stable and even increases for therapeutic procedures, the number of major procedures performed actually *decreases* during strikes. The number of major diagnostic procedures performed decreases by 25 percent from the (admittedly low) mean of 0.04 procedures, and the number of major therapeutic procedures decreases by 7 percent from the mean of 0.43 procedures. These findings suggest that strikes are associated with an intensity of treatment that involves fewer major procedures than during a nonstriking period. Given the observed deterioration in outcomes during a strike, this suggests that this change in treatment may be partially responsible for the strike effect, and also implies that these major hospital procedures are productive on the margin.

## VI. Heterogeneity in Strike Effects

In the section that follows, we examine specific subsets of our data in order to examine whether specific groups of patients are differentially impacted by the strikes. We first consider two patient subsamples from our data, grouping patients by both the treatment urgency and nursing inputs required for their specific conditions.

<sup>24</sup>Details on the procedure classification system and examples of each type are available at <http://www.hcup-us.ahrq.gov/toolsoftware/procedure/procedure.jsp>.

We then divide our strike sample according to information we collected concerning the use of replacement workers for each of our strikes.

### A. *Heterogeneity by Admission Urgency*

As noted above, a potential concern with our analysis is that healthier patients refrain from treatment at the striking facility. We showed previously that there is no evidence of a delay in hospital use by healthy patients or a shift to other hospitals in the area. A further means of addressing this potential concern is to split our sample into emergency patients who are indicated by the hospital as requiring immediate medical attention, and a nonemergency sample who are not indicated as such. If our results are driven by avoided care among healthy patients, then we should observe an increase in mortality and readmission for the nonemergency patients, who have the option of exercising discretion over the timing of treatment (and will thus seek treatment at a striking hospital only for more serious conditions) and no mortality effect for emergency admissions. In addition, such a distributional shift should produce a much sharper drop in the number of nonemergency patients admitted to the hospital during a strike.

To assess whether this is the case, we run our main regressions for both of our outcome variables and our demographic and severity measures, splitting our sample and allowing our strike coefficient to vary for each sample. Table 12 reports the strike coefficients from our full specification for the outcome, utilization, demographic, and severity variables. Each row contains only the strike coefficient from our full regressions (which includes our full set of fixed effects, severity controls, and demographic controls), while each column indicates a specific subsample for which we estimate our model. Means for each of the dependent variables are included in a one-by-six vector located below the name of the dependent variable being analyzed. Columns 1 and 2 report the results from our regressions for the emergency/nonemergency samples. These results indicate that the increase in mortality and readmission are likely not a result of a redistribution in admission urgency. Both the emergency and nonemergency subsamples show an increase in mortality during strikes. Mortality for patients in the emergency sample is a marginally significant 0.29 percentage points or 10.7 percent higher relative to the emergency baseline mortality rate of 2.7 percent. Mortality for patients in the elective sample is a statistically insignificant 0.18 percentage points or 19.6 percent higher relative to the nonemergency baseline mortality rate of 0.9 percent. Our readmission results are also stronger for the emergency sample, where we observe a statistically significant 1.14 percentage point increase off of our base readmission rate of 16.5 percent, with no significant readmission increase for the nonemergency sample.

We see no changes in utilization or severity measures for emergency patients, though the percent of white patients admitted does increase during strikes. For the nonemergency patients, we see evidence of a decrease in the case mix index of 0.04 points as compared to the nonemergency case mix mean of 0.9, and a  $-0.11$  point decrease in the number of procedures off of the sample mean of 1.5 procedures. This decline in procedure volume comes mostly from a reduction

in major procedures. Because the decline in patient outcomes is evident only in the emergency sample, however, this indicates that the decrease in the number of major procedures performed may play less of a role in the deterioration of patient outcomes than suggested by the results in Table 11. The last row in our table reports results from a specification which uses as a dependent variable the log number of daily admissions at each hospital for each type of admission. The decrease in admissions for both the emergency and nonemergency sample is quite similar, with the number of emergency admissions decreasing by 24 percent during a strike, and the number of nonemergency decreasing by 22.4 percent. Thus, these results provide further evidence that patient avoidance/selection is not driving our findings.

### B. Differences in Nursing Intensity

Because we are specifically examining the effects of strikes involving nurses, an additional dimension along which we should observe differential strike effects is the extent to which a patient's condition depends on nursing inputs. If the effects that we observe are in fact due to the striking nurses, then we should expect particularly pronounced outcome effects of strikes on patients whose care requires a high degree of nursing attention. To account for this, we acquired a set of weights designed specifically to quantify differences in the intensity of care required for acute care patients. These nursing intensity weights (NIWs) were developed by a panel of registered nurses assembled by the New York State Nurses Association and the New York State Department of Health, and its members are representative of the state's geographic and institutional diversity. The calculation of the weights was first instituted in 1983 and has been updated for changes in DRGs as they occur. The NIWs are derived by proposing a "typical" patient scenario for each DRG and measuring the predicted nurse workload for that patient stay. Using this measure, for each year in our data, we calculate the median NIW for each diagnosis and divide our sample into diagnoses which require above and below median nursing intensity.

Our results split by nursing intensity are presented in the third and fourth columns of Table 12. These results reveal that our mortality effects are more pronounced for patients whose diagnoses require more nursing resources, as evidenced by our estimate indicating a 0.33 percentage point increase in mortality during strikes relative to the 2.8 percent baseline for the most nursing intensive patients. For this same subsample, the readmission effect of 1.06 percentage points relative to the sample mean of 16.9 percent implies a 6.3 percent increase in readmission, though this estimate is insignificant at conventional levels. For diagnoses with below median nursing intensity, we find little evidence of a mortality or readmission effect. We find little change in utilization or demographic characteristics for both subsamples, with the exception of a small increase in the length of stay and the percent female for the less nursing intensive sample, and a decrease in the number of diagnostic procedures for this same sample. Given that the observed mortality increase occurs only in the nursing intensive sample, this also suggests that the decrease in major procedures does not significantly contribute to the deterioration in patient outcomes.

TABLE 12—PATIENT AND STRIKE HETEROGENEITY

Subsample	Emergency (49 strikes) (1)	Nonemergency (49 strikes) (2)	Above median nursing intensity (3)	Below median nursing intensity (4)	Replacements used (13 strikes) ‡ (5)	No replacements used (36 strikes) ‡ (6)
<b>Dependent variable</b>						
<b>In-hospital mortality</b>	0.290*	0.180	0.331**	0.0610	0.310***	0.323*
<i>μ<sub>mortality</sub></i> = (2.7, 0.9, 2.8, 0.3, 1.8, 1.9)	(0.171)	(0.1124)	(0.147)	(0.056)	(0.115)	(0.172)
<b>30-day readmission</b>	1.141**	-0.016	1.066	0.426	0.814**	0.987
<i>μ<sub>readmit</sub></i> = (16.5, 8.6, 16.9, 8.8, 13.9, 13.6)	(0.541)	(0.373)	(0.668)	(0.516)	(0.373)	(0.779)
<b>Length of stay</b>	0.193	0.298	0.111	0.316**	0.168	0.328*
<i>μ<sub>los</sub></i> = (9.1, 5.7, 9.8, 5.0, 7.0, 7.8)	(0.260)	(0.364)	(0.306)	(0.129)	(0.143)	(0.183)
<b>Number of procedures</b>	0.005	-0.108**	-0.050	-0.022	0.043	-0.127***
<i>μ<sub>proc</sub></i> = (18.1, 5.1, 18.1, 6.1, 17.1, 6.1)	(0.083)	(0.080)	(0.080)	(0.056)	(0.038)	(0.049)
<b>Number of minor diagnostic proc.</b>	-0.030	-0.027	-0.057	-0.004	-0.002	-0.064**
<i>μ<sub>min diag</sub></i> = (0.8, 0.4, 0.7, 0.5, 0.6, 0.6)	(0.056)	(0.026)	(0.051)	(0.030)	(0.020)	(0.030)
<b>Number of minor therapeutic proc.</b>	0.031	-0.009	0.027	0.025	0.045**	0.016
<i>μ<sub>min ther</sub></i> = (0.6, 0.5, 0.7, 0.5, 0.6, 0.5)	(0.037)	(0.031)	(0.041)	(0.032)	(0.020)	(0.028)
<b>Number of major diagnostic proc.</b>	0.0010	-0.0202***	-0.0012	-0.0166**	0.0004	-0.0193***
<i>μ<sub>major diag</sub></i> = (0.3, 0.5, 0.3, 0.6, 0.2, 0.4)	(0.0022)	(0.0055)	(0.0013)	(0.0061)	(0.0014)	(0.0057)
<b>Number of major therapeutic proc.</b>	0.0021	-0.0527***	-0.0185	-0.0255	-0.0004	-0.0593***
<i>μ<sub>major ther</sub></i> = (0.3, 0.6, 0.4, 0.5, 0.4, 0.4)	(0.0138)	(0.0169)	(0.0125)	(0.0199)	(0.0092)	(0.0144)
<b>Number of diagnostic proc.</b>	-0.0287	-0.0467*	-0.0583	-0.0210	-0.020	-0.0837***
<i>μ<sub>diag</sub></i> = (0.8, 0.4, 0.7, 0.6, 0.6, 0.6)	(0.0567)	(0.0283)	(0.0514)	(0.0330)	(0.0204)	(0.0305)
<b>Number of therapeutic proc.</b>	0.0334	-0.0615**	0.0085	-0.0007	0.0447**	-0.0430
<i>μ<sub>ther</sub></i> = (0.9, 1.1, 1.1, 1.0, 1.1, 1.0)	(0.0378)	(0.0302)	(0.0354)	(0.0334)	(0.0205)	(0.0356)
<b>Average age</b>	0.907	-1.693**	-0.162	-0.383	0.503	-1.239
<i>μ<sub>age</sub></i> = (51.6, 34.7, 47.6, 40.2, 47.4, 43.1)	(0.566)	(0.899)	(0.792)	(0.569)	(0.503)	(0.836)
<b>Percent female</b>	0.865	1.308	0.455	1.732**	0.219	0.757
<i>μ<sub>female</sub></i> = (64.9, 62.1, 54.4, 60.7, 57.8, 58.4)	(0.621)	(1.331)	(0.494)	(0.880)	(0.571)	(0.623)
<b>Percent white</b>	2.530***	0.026	2.143*	1.925	0.224	1.658
<i>μ<sub>white</sub></i> = (68.1, 64.5, 70.4, 67.2, 71.3, 64.5)	(0.832)	(2.215)	(1.144)	(1.405)	(1.077)	(2.432)
<b>Casemix index</b>	-0.008	-0.036**	-0.020	-0.015*	-0.005	-0.047**
<i>μ<sub>case</sub></i> = (1.1, 0.9, 1.2, 0.7, 1.1, 1.0)	(0.016)	(0.016)	(0.023)	(0.009)	(0.011)	(0.017)
<b>Average number of diagnoses</b>	0.033	-0.110	-0.010	-0.073	0.018	-0.042
<i>μ<sub>diag</sub></i> = (4.0, 2.6, 4.0, 2.7, 4.1, 3.0)	(0.075)	(0.078)	(0.078)	(0.060)	(0.085)	(0.036)
<b>Average Charlson Index</b>	0.022	-0.005	0.015	-0.009	-0.008	-0.008
<i>μ<sub>charl</sub></i> = (0.8, 0.3, 0.8, 0.3, 0.7, 0.5)	(0.016)	(0.018)	(0.020)	(0.010)	(0.018)	(0.014)
<b>Log (1 + number of admissions)</b>	-0.2724***	-0.2536***	-0.2484***	-0.3185***	-0.0040	-0.5507***
<i>μ<sub>admit</sub></i> = (2.5, 2.3, 2.5, 2.2, 3.0, 3.0)	(0.0653)	(0.0792)	(0.0710)	(0.0788)	(0.0448)	(0.0798)

*Notes:* Regressions are weighted by the number of daily admissions at each hospital, with the exception of the regressions in the last row. Regressions control for day, week, year, region, region  $\times$  year, region  $\times$  month and hospital fixed effects. Outcome and utilization regressions (10-day in-hospital mortality, 30-day readmission, length of stay, and number of procedures) include controls for demographic and severity measures. Log(1 + number of admissions) is used to enable the inclusion of observations with zero admissions in the sample. Robust Standard Errors in parenthesis are cluster corrected at the hospital level.

‡ For the 30-day readmission result, because 30-day readmission is available only after 1995, this result includes only 8 replacement worker strikes, and 6 strikes without replacement workers.

\*\*\* Significant at the 1 percent level.

\*\* Significant at the 5 percent level.

\* Significant at the 10 percent level.

### *C. Replacement Worker Strikes*

A particularly relevant dimension over which the effects of these strikes may also differ involves the decision of the hospitals involved to hire replacement nurses. A number of New York hospitals are reported to have hired temporary replacement workers to fill in for striking nurses. This practice became particularly frequent beginning in the early 1990s, when temporary nursing agencies (e.g., US Nursing Corp., Health Source) began making available to hospitals engaged in contract disputes, teams of nurses to staff hospitals in the event of a strike. Our search of news archives enabled us to distinguish 13 strikes in which hospitals employed replacement workers. Using this information, we analyze separately the sets of strikes in which replacement workers were hired.

Previous literature is unclear as to whether replacement workers can substitute for striking workers. For example, Cramton and Tracy (1998) find that firms are more reluctant to use replacement workers when employees in a struck bargaining unit are more experienced. Their finding suggests that for professions which require specialized knowledge or firm-specific know-how, employers do not view replacement workers as direct substitutes for striking workers. Krueger and Mas (2004, 260), however, find that in the “highly complex, labor-intensive” tire industry, tire defects were relatively infrequent during a period in which replacement workers were employed in large numbers, with an increase in defects occurring when replacement workers and returning strikers worked together.

Our results are presented in columns 5 and 6 of Table 12. A key dimension over which these strikes clearly differ is the degree to which admissions decrease during these strikes. For our set of replacement strikes, there is no noticeable decrease in hospital admissions during the strike period, while for strikes with no indication of replacements, admissions decrease by over 42 percent. The mortality effects for these strike types are, however, similar in magnitude, with a 0.31 percentage point increase in mortality for the replacement-worker strikes on a base of 1.8 percent and a 0.32 percentage point increase for the nonreplacement-worker strikes on a base of 1.9 percent. We also observe similar impacts on readmission rates, but the effects are not statistically significant for the sample with no replacements used.

The results also show a difference in the utilization and severity of patients admitted to hospitals who choose to hire replacement workers. For the replacement-worker sample, there is very little change in the observable demographic and severity characteristics of patients admitted during a strike, while the number of each type of procedure performed during these strikes is either unchanged or increasing by a small magnitude. For the remaining strikes, however, we observe a decrease in severity, as measured by the case mix index, as well as a decrease in the number of procedures performed of  $-0.13$ , a 7.9 percent decrease compared to the baseline of 1.6 for this sample. Furthermore, this decrease in procedure intensity is evident across all procedure types, with the exception of minor therapeutic procedures. Overall, these results suggest that the use of replacement workers does not significantly alter our finding of worsening outcomes during the strikes. Thus, while these workers may

serve as a useful bargaining tool for the hospitals, they do not noticeably improve the quality of hospital care during a strike.

## VII. Conclusions

A long-standing concern with strikes as a means of resolving labor disputes is that they may be unproductive, and recent research in some production sectors has demonstrated reduced productivity during strikes. But a sector where strikes may be particularly pernicious is hospitals, where the consequences are not just lower quality products but life and death.

To address this question, this study utilizes a unique dataset collected on every nurses' strike over the 1984 to 2004 period in New York State. Our restricted-use dataset allows us to match our strike data with exact dates of patient admission, discharge and treatment, and allows for a rich set of demographic and illness severity controls. Each striking hospital over this period is then matched with the set of hospitals in their geographic area, and the evolution of outcomes is examined before, during, and after the strike in the striking versus nonstriking hospitals.

We find a substantial worsening of patient outcomes for hospitals struck by their nurses. Our mortality results show a 18.3 percent increase during strikes relative to their baseline values, and our estimates imply a 5.7 percent increase in readmission rates for patients initially admitted during a strike. Our results show no difference in the characteristics of patients admitted during strikes, and little difference in length of stay for these patients. The results do suggest that a reduction in major procedures performed during a strike may be partially driving the deterioration in outcomes, though our subgroup analysis cannot confirm this. We find that patients with particularly nursing-intensive conditions are more susceptible to these strike effects, and that hospitals hiring replacement workers perform no better during these strikes than those that do not hire substitute employees.

Our results imply that strikes were costly to hospital patients in New York. In our sample, there were 38,228 patients admitted during strikes, and we estimate that 129 more individuals died because of strikes than would have died had there been no strikes. By a similar calculation, 298 more patients were readmitted to the hospital than if there had been no strikes. Moreover, these poor outcomes do not reflect less intensity of care. So this is very clear evidence of a reduction in productivity; hospitals functioning during nurses' strikes do so at a lower quality of patient care.

The effects of these strikes must, however, be considered in the context of a total union effect on hospital output and patient outcomes. Our results reveal a short-run adverse consequence of hospital strikes. These strikes may, however, contribute to long-run improvements in hospital productivity and quality driven by union-related workplace improvement initiatives. Such improvements have been implied by both Register (1988) and Ash and Seago (2004) who respectively document both a hospital union output effect and lower heart-attack mortality rates in unionized hospitals. Future work could usefully incorporate these short-term costs and longer-term benefits in a full evaluation of hospital unionization.

## REFERENCES

- Aiken, Linda H., Sean P. Clarke, Robyn B. Cheung, Douglas M. Sloane, and Jeffrey H. Silber. 2003. "Educational Levels of Hospital Nurses and Surgical Patient Mortality." *Journal of the American Medical Association*, 290(12): 1617–23.
- Aiken, Linda H., Sean P. Clarke, Douglas M. Sloane, Julie Sochalski, and Jeffrey H. Silber. 2002. "Hospital Nurse Staffing and Patient Mortality, Nurse Burnout, and Job Dissatisfaction." *Journal of the American Medical Association*, 288(16): 1987–93.
- Ash, Michael, and Jean Ann Seago. 2004. "The Effect of Registered Nurses' Unions on Heart-Attack Mortality." *Industrial and Labor Relations Review*, 57(3): 422–42.
- Baicker, Katherine, and Amitabh Chandra. 2004. "Medicare Spending, the Physician Workforce, and Beneficiaries' Quality of Care." *Health Affairs*, W4: 184–97.
- Bartel, Ann P., Ciaran S. Pibbs, Nancy Beaulieu, and Patricia W. Stone. 2009. "Human Capital and Productivity: The Case of Nursing Teams." Columbia Business School Working Paper.
- Bhalla, Rohit, and Gary Kalkut. 2010. "Could Medicare Readmission Policy Exacerbate Health Care System Inequity?" *Annals of Internal Medicine*, 152(2): 114–17.
- Becker, Brian E., and Craig A. Olson. 1986. "The Impact of Strikes on Shareholder Equity." *Industrial and Labor Relations Review*, 39(3): 425–38.
- Cebul, Randall D., James B. Rebitzer, Lowell J. Taylor, and Mark Votruba. 2008. "Organizational Fragmentation and Care Quality in the U.S. Health Care System." National Bureau of Economic Research Working Paper 14212.
- Clark, Paul F., John T. Delaney, and Ann C. Frost, ed. 2002. *Collective Bargaining in the Private Sector*. Ithaca, NY: Cornell University Press.
- Cook, Andrew, Martin Gaynor, Melvin Stephens Jr., and Lowell Taylor. 2010. "The Effect of Hospital Nurse Staffing on Patient Health Outcomes: Evidence from California's Minimum Staffing Regulation." National Bureau of Economic Research Working Paper 16077.
- Cramton, Peter, and Joseph Tracy. 1998. "The Use of Replacement Workers in Union Contract Negotiations: The U.S. Experience, 1980–1989." *Journal of Labor Economics*, 16(4): 667–701.
- Cutler, David M. 1995. "The Incidence of Adverse Medical Outcomes under Prospective Payment." *Econometrica*, 63(1): 29–50.
- De Fusco, Richard A., and Scott M. Fuess Jr. 1991. "The Effects of Airline Strikes on Struck and Non-struck Carriers." *Industrial and Labor Relations Review*, 44(2): 324–33.
- Draper, Debra A., Laurie E. Felland, Allison Liebhaber, and Lori Melichar. 2008. "The Role of Nurses in Hospital Quality Improvement." Center for Studying Health System Change, Research Brief No. 3, March. <http://www.hschange.com/CONTENT/972/972.pdf>.
- Fink, Leon, and Brian Greenberg. 1989. *Upheaval in the Quiet Zone: A History of Hospital Workers' Union, Local 1199*. Urbana, IL: University of Illinois Press.
- Fisher, Elliott S., David E. Wennberg, Thérèse A. Stukel, and Daniel J. Gottlieb. 2004. "Variations in the Longitudinal Efficiency of Academic Medical Centers." *Health Affairs, Web Exclusive*, VAR19–32. <http://content.healthaffairs.org/cgi/reprint/hlthaff.var.19v1>.
- Fisher, Elliott S., David E. Wennberg, Thérèse A. Stukel, Daniel J. Gottlieb, F. L. Lucas, and Étoile L. Pinder. 2003a. "The Implications of Regional Variations in Medicare Spending. Part 1: The Content, Quality, and Accessibility of Care." *Annals of Internal Medicine*, 138(4): 273–87.
- Fisher, Elliott S., David E. Wennberg, Thérèse A. Stukel, Daniel J. Gottlieb, F. L. Lucas, and Étoile L. Pinder. 2003b. "The Implications of Regional Variations in Medicare Spending. Part 2: Health Outcomes and Satisfaction with Care." *Annals of Internal Medicine*, 138(4): 288–98.
- Freeman, Richard B. 1998. "Spurts in Union Growth: Defining Moments and Social Processes." In *The Defining Moment: The Great Depression and the American Economy in the Twentieth Century*, ed. Michael D. Bordo, Claudia Goldin, and Eugene N. White, 265–95. Chicago: University of Chicago Press.
- Geweke, John, Gautam Gowrisankaran, and Robert J. Town. 2003. "Bayesian Inference for Hospital Quality in a Selection Model." *Econometrica*, 71(4): 1215–38.
- Gruber, Jonathan, and Samuel A. Kleiner. 2012. "Do Strikes Kill? Evidence from New York State: Dataset." *American Economic Journal: Economic Policy*. <http://dx.doi.org/10.1257/pol.4.1.127>.
- Ho, Vivian, and Barton H. Hamilton. 2000. "Hospital Mergers and Acquisitions: Does Market Consolidation Harm Patients?" *Journal of Health Economics*, 19(5): 767–91.
- Holmes, Thomas J. 2006. "Geographic Spillover of Unionism." National Bureau of Economic Research Working Paper 12025.
- Huszczo, Gregory E., and Bruce J. Fried. 1988. "A Labor Relations Research Agenda for Health Care Settings." *Employee Responsibilities and Rights Journal*, 1(1): 69–84.

- James, James J.** 1979. "Impacts of the Medical Malpractice Slowdown in Los Angeles County: January 1976." *American Journal of Public Health*, 69(5): 437–43.
- Kaufman, Bruce E.** 1992. "Research on Strike Models and Outcomes in the 1980s: Accomplishments and Shortcomings." In *Research Frontiers in Industrial Relations and Human Resources*, ed. David Lewin, Olivia S. Mitchell, and Peter D. Sherer, 77–129. Madison: Industrial Relations Research Association.
- Kessler, Daniel P., and Jeffrey J. Geppert.** 2005. "The Effects of Competition on Variation in the Quality and Cost of Medical Care." *Journal of Economics and Management Strategy*, 14(3): 575–89.
- Ketter, Joni.** 1997. "Nurses and Strikes: A Perspective from the United States." *Nursing Ethics*, 4(4): 323–29.
- Kleiner, Morris M., Jonathan S. Leonard, and Adam M. Pilarski.** 2002. "How Industrial Relations Affects Plant Performance: The Case of Commercial Aircraft Manufacturing." *Industrial and Labor Relations Review*, 55(2): 195–218.
- Kramer, Jonathan K., and Geraldo M. Vasconcellos.** 1996. "The Economic Effect of Strikes on the Shareholders of Nonstruck Competitors." *Industrial and Labor Relations Review*, 49(2): 213–22.
- Krueger, Alan B., and Alexandre Mas.** 2004. "Strikes, Scabs, and Tread Separations: Labor Strife and the Production of Defective Bridgestone/Firestone Tires." *Journal of Political Economy*, 112(2): 253–89.
- Kruger, Kenneth F., and Norman Metzger.** 2002. *When Health Care Employees Strike: A Guide for Planning and Action*. San Francisco: John Wiley & Sons, Inc.
- Mas, Alexandre.** 2008. "Labour Unrest and the Quality of Production: Evidence from the Construction Equipment Resale Market." *Review of Economic Studies*, 75(1): 229–58.
- McHugh, Richard.** 1991. "Productivity Effects of Strikes in Struck and Nonstruck Industries." *Industrial and Labor Relations Review*, 44(4): 722–32.
- Medicare Payment Advisory Commission (MEDPAC).** 2007. *Report to the Congress: Promoting Greater Efficiency in Medicare*. Washington, DC, June. [http://www.medpac.gov/documents/Jun07\\_EntireReport.pdf](http://www.medpac.gov/documents/Jun07_EntireReport.pdf).
- Mustard, Cameron A., Christopher R. Harman, Philip F. Hall, and Shelley Derksen.** 1995. "Impact of a Nurses' Strike on the Cesarean Birth Rate." *American Journal of Obstetrics and Gynecology*, 172(2): 631–37.
- Needleman, Jack, Peter Buerhaus, Soeren Mattke, Maureen Stewart, and Katya Zelevinsky.** 2002. "Nurse-Staffing Levels and the Quality of Care in Hospitals." *New England Journal of Medicine*, 346(22): 1715–22.
- Neumann, George R.** 1980. "The Predictability of Strikes: Evidence from the Stock Market." *Industrial and Labor Relations Review*, 33(4): 525–35.
- Neumann, George R., and Melvin W. Reder.** 1984. "Output and Strike Activity in U.S. Manufacturing: How Large Are the Losses?" *Industrial and Labor Relations Review*, 37(2): 197–211.
- Pantell, Robert H., and Charles E. Irwin.** 1979. "Appendectomies During Physicians' Boycott." *Journal of the American Medical Association*, 242(15): 1627–30.
- Phibbs, Ciaran S., Ann P. Bartel, Bruno Giovannetti, Susan K. Schmitt, and Patricia W. Stone.** 2009. "The Type of Nurse Matters: The Effects of Nurse Staffing Levels, Non-RNs, and Contract Nurses on Length of Stay." <http://www0.gsb.columbia.edu/faculty/abartel/Type%20of%20Nurse%20Matters%20-NEJM.pdf>.
- Quan, Hude, Vijaya Sundararajan, Patricia Halfon, Andrew Fong, Bernard Burnand, Jean-Christophe Luthi, L. Duncan Saunders, Cynthia A. Beck, Thomas E. Feasby, and William A. Ghali.** 2005. "Coding Algorithms for Defining Comorbidities in ICD-9-CM and ICD-10 Administrative Data." *Medical Care*, 43(11): 1130–39.
- Register, Charles A.** 1988. "Wages, Productivity, and Costs in Union and Nonunion Hospitals." *Journal of Labor Research*, 9(4): 325–45.
- Salazar, Albert, Xavier Corbella, Hisao Onaga, Rosa Ramon, Roman Pallares, and Joan Escarribill.** 2001. "Impact of a Resident Strike on Emergency Department Quality Indicators at an Urban Teaching Hospital." *Academic Emergency Medicine*, 8(8): 804–08.
- Schmidt, Martin B., and David J. Berri.** 2004. "The Impact of Labor Strikes on Consumer Demand: An Application to Professional Sports." *American Economic Review*, 94(1): 344–57.
- Twomey, David.** 1977. "Health Care Institutions Under the National Labor Relations Act." *American Business Law Journal*, 15(2): 225–42.
- Zacur, Susan Rawson.** 1983. *Health Care Labor Relations: The Nursing Perspective*. Ann Arbor: UMI Research Press.