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HOUSE STAFF TURNOVER, RESOURCE UTILIZATION AND PATIENT OUTCOMES IN TEACHING HOSPITALS

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ABSTRACT

Context— The impact of the annual July turnover of house staffs in teaching hospitals—the so-called "July phenomenon" or "July effect"—has been examined in relatively small samples of hospitals. While these studies find some increases in resource utilization and hospital costs, few, if any, have identified changes in patient mortality following this turnover.

Objective— To determine whether the July turnover of house staffs leads to changes in risk-adjusted length of stay and risk-adjusted, in-hospital mortality within teaching hospitals relative to non-teaching hospitals.

Design— Case-control analysis, using monthly observations of risk-adjusted length of stay and in-hospital mortality for major teaching (i.e., residents per bed greater than or equal to 0.25), minor teaching, and non-teaching hospitals in the United States from January 1993 through December 1999. Study data is from the Healthcare Cost and Utilization Project (HCUP) of the Agency for Healthcare Research and Quality (AHRQ) and the American Hospital Association's *Annual Survey of Hospitals*.

Setting— A sample of roughly 20% of the general acute-care hospitals (i.e., nonfederal, short-term, general, and other specialty hospitals, excluding psychiatric hospitals, long-term hospitals, and chemical dependency treatment facilities) in the United States.

Main Outcome Measures— Length of stay and in-hospital mortality, both of which are risk-adjusted at the patient-level using demographic and diagnostic covariates.

Results— Relative to non-teaching hospitals, major teaching hospitals experience, on average, an increase in risk-adjusted LOS of approximately 0.10 days ($p<0.01$) from April-May (the final two complete months prior to the turnover) to July-August (the first two complete months following the turnover). This represents a 1.7% increase relative to the risk-adjusted average of 5.95 days for major teaching hospitals in the sample. For risk-adjusted mortality, we find an increase of 0.12 percentage points ($p<0.03$) for the same period. This represents a 4% increase relative to the risk-adjusted average of 2.89% for major teaching hospitals. Dividing major teaching hospitals into quartiles based on teaching intensity indicates that these effects are largest for the third quartile and may dissipate for the largest quartile. In later years, the effects for major teaching hospitals seem to dissipate, although this may be due to difficulty estimating precise results in smaller samples. The effects for minor teaching hospitals remain in the later years of our sample.

Conclusions— Our findings support the hypothesis that the annual turnover of house staff is accompanied by increases in length of stay and mortality, though these effects may be attenuated for the most intensive programs in the later years of our sample. These results suggest that alternative structures may warrant further discussion as hospitals, physicians, and policymakers examine the balance between training new physicians and ensuring medical quality.

Over the past several years, a robust debate has emerged concerning the impact of hospital staffing patterns on the cost and quality of care. Many studies have focused on efforts to limit the working hours of residents in teaching hospitals.[1,2,3,4,5,6,7,8,9,10] Others have considered whether physicians with different levels of experience or those exposed to different levels of supervision exhibit variations in practice patterns.[11,12,13] A third group specifically examines differences in care on weekends, when staffing levels—and, potentially, staffing quality—are presumed to be lower than during the week.[14,15,16]

In this study, we consider the implications of a fourth regular pattern in hospital staffing—the turnover of house staffs that occurs each July in teaching hospitals. A few studies have examined whether this turnover leads to systematic increases in cost or decreases in quality—creating the so-called "July phenomenon" or "July effect".[17,18,19] These papers, however, are limited either by the relatively small number of hospitals examined or by the lack of controls for seasonal changes that affect all hospitals, on average, regardless of teaching status.

We investigate the impact of the July turnover on resource utilization and quality using data on all discharges for a large, multi-state sample of American hospitals over the seven-year period from 1993 to 1999. Using our national sample, we are able to identify significant effects of house staff turnover not only on hospital utilization (as measured by risk-adjusted, average length of stay (LOS)), but also on the quality of care (as measured by risk-adjusted, in-hospital mortality). Further, by comparing the performance of hospitals with different levels of teaching intensity over the course of the calendar year, we are able to examine whether, and to what degree, the magnitude of these effects changes as house staffs gain experience in their new positions.

DATA AND METHODS

Data

The primary source of data for this analysis is the Healthcare Cost and Utilization Project (HCUP) National Inpatient Sample (NIS) for each year from 1993 (Release 2) to 1999 (Release 8). Collected by the Agency for Healthcare Research and Quality (AHRQ), NIS provides discharge-level data for all inpatient cases at an approximate sample of roughly 20% of the general acute-care hospitals (i.e., nonfederal, short-term, general, and other specialty hospitals, excluding psychiatric hospitals, long-term hospitals, and alcoholism/chemical dependency treatment facilities) in the United States. This approximate sample is based on discharge from between 17 (in 1993) and 24 (in 1999) states in the United States.

Among other variables, the NIS provides information on age and gender, expected payer type, LOS, total charges, and in-hospital mortality. In addition, NIS includes detailed data on a patient's principal and secondary diagnoses, principal and secondary procedures, and diagnosis-related group (DRG).

We link the NIS data with information from the American Hospital Association (AHA) *Annual Survey of Hospitals*, which includes data on the operating and financial characteristics for more than 6,000 hospitals each year. In addition to several other items, the AHA database provides information on the number of hospital beds and full-time residents and interns at each facility in a given year. We use this information to construct our measure of teaching intensity—full-time residents and interns per hospital bed.

Study Sample

Our sample of facilities includes those that appear in *both* the NIS and AHA databases in a given year. Most of the discrepancies between the matched sample and the NIS are due to the fact that certain states opted not to provide any identifying information for specific facilities, thus preventing linkage with the AHA data. In other rare cases, a hospital may appear in the NIS but not the matched sample because that facility did not appear in the AHA data for a given year.

Empirical Specification

The source of identification in our empirical analysis is the varying degree to which certain types of hospitals rely on residents for the provision of medical care. In our first specification, we divide hospitals into three discrete categories—non-teaching hospitals, minor teaching hospitals, and major teaching hospitals. Non-teaching hospitals are those that are not listed as teaching hospitals in the NIS. These facilities have few, if any, residents or fellows. As such, one would not expect them to be affected by the July changeover, and they provide a useful control for seasonal patterns in mortality caused by elements other than the structure of teaching programs. Studies of the seasonality of mortality suggest that, across entire populations, death rates are highest in the winter months and lowest in the summer.[20,21]

Those hospitals that are listed as teaching hospitals in the NIS data are subdivided into two categories. Minor teaching hospitals are those teaching hospitals that have resident intensities (i.e., full-time residents per inpatient hospital bed) that are less than 0.25 residents/bed. Similarly, major teaching hospitals are those facilities with teaching intensities that are greater than or equal to 0.25 residents/bed. This threshold for resident intensity is used by the Medicare Payment Advisory Commission (MedPAC) to distinguish minor and major teaching facilities.[22] Table 1 presents descriptive statistics for each of the three hospital categories as well as for the entire sample. The final two rows of the table compare the distribution of hospitals in our sample to that for all of the comparable hospitals in the AHA database from 1993 through 1999.

In our basic specification, we employ a difference-in-differences approach, which allows us to estimate the degree to which patients in teaching hospitals—relative to those in non-teaching hospitals—differentially experience changes in average LOS and mortality around the time of the house staff turnover. Specifically, our approach compares patterns in the dependent variables over the course of the year for teaching hospitals to those for non-teaching hospitals. Patterns for the non-teaching controls thus capture factors, such as changes in the average severity of illness, that may produce a seasonal pattern in mortality across the overall hospital population.

We analyze LOS and mortality rates for each of the three hospital groups across multi-month periods during the calendar year. These periods are: January through March, April through May, June, July through August, September through October, and November through December. Given that the house staff changeover begins in the second half of June for many hospitals, the LOS and mortality results for that month represent mixtures of pre- and post-turnover values. We thus isolate that month and compare the change in the dependent variable from April-May to July-August for teaching hospitals to the similar change for non-teaching hospitals to measure the impact of the July turnover.

Risk-Adjustment of Dependent Variables

As suggested by Table 1, the average severity of patients likely differs across the three types of hospitals. To the extent that the differences in patient severity for major teaching, minor teaching, and non-teaching hospitals are constant over the course of the year, one would predict that risk-adjustment would affect the average level of the dependent variables over time, but would not yield substantially different estimates in our fixed-effects models. Nonetheless, it is possible that the average severity differences between the three categories of teaching hospitals vary in magnitude systematically *over the course of the year*. Under these circumstances, proper identification of any July effect requires risk adjustment of the dependent variables. We risk-adjust outcomes using logistic regression with the following patient-level covariates: age, age squared, gender, an indicator for Medicaid as primary payer, indicators for each major diagnostic category (MDC), and the Charlson comorbidity index.[23] While we only present results using the risk-adjusted variables, we note that these results are substantially similar in magnitude and significance to analyses performed without risk adjustment.

RESULTS

Results Using Broad Categories of Teaching Intensity

Table 2 presents our primary results. The coefficients in the table are the changes in the dependent variable for major and minor teaching hospitals relative to non-teaching hospitals. In other words, we have used the temporal pattern of the non-teaching hospitals to “de-season” the trend for teaching hospitals. With April-May set as the baseline period, a positive value for a given month indicates that the hospital group in question (i.e., minor or major teaching) experienced a larger *increase* in the dependent variable than the control group of non-teaching hospitals over the same period of time. For example, the July-August coefficient of 0.10 for major teaching hospitals in Column 1 indicates that the change in LOS for major teaching hospitals from April-May to July-August was 0.10 days greater than that for non-teaching hospitals. We focus on the April-May period as the baseline for each group because it is the last complete period of the year prior to the turnover. We do not include June as part of the baseline period, as many programs begin their turnover of house staff by mid-June, making the LOS and mortality results for that month a mixture of pre-turnover and post-turnover values.

Risk-Adjusted LOS

For LOS (Column 1), the estimated July effect for major teaching hospitals is an increase of 0.10 days ($p<0.01$). The average risk-adjusted LOS among major teaching hospitals in our sample is 5.95 days. If one assumes that LOS is directly proportional to hospital costs, this result suggests an average increase in hospital costs at major teaching hospitals of 1.7% from the April-May period to the July-August period relative to the change for non-teaching hospitals. This effect lingers through the autumn, with the average LOS being 0.111 days ($p<0.01$) higher in September-October and 0.097 days ($p<0.01$) higher in November-December relative to April-May. The effect then dissipates in the early months of the calendar year. There is also an increase in LOS in June relative to April-May (0.069 days, $p<0.04$). Again, given that June represents a period straddling the house staff turnover at many hospitals, it is not surprising that one would find some impact occurring in that month. It is also not surprising that the effect for June is smaller than that for July-August—the first period that falls entirely after the turnover of the house staff.

The impact of the house staff turnover on LOS at minor teaching hospitals is smaller in magnitude, but consistent in pattern with that for major teaching facilities. Minor teaching hospitals experience an increase in length of stay of 0.031 ($p<0.05$) days in the July-August period relative to the change for non-teaching hospitals. The effect increases to 0.051 days ($p<0.01$) in September-October and remains at essentially the same level through the end of the year. The effect then dissipates in the first months of the calendar year. On a percentage basis, this effect in July-August is less than half the magnitude of that for major teaching hospitals during the same period—the increase of 0.05 implies an increase of 0.6% relative the average risk-adjusted LOS of minor teaching hospitals (5.30 days). This smaller effect is consistent with the lower reliance on house staff at minor relative to major teaching hospitals.

Risk-Adjusted Mortality

Major teaching hospitals also experience an increase in risk-adjusted mortality following the July turnover (Column 2). From April-May to July-August, the mortality rate increases by 0.120 percentage points ($p<0.02$), a 4.1% increase relative to the average, risk-adjusted mortality rate for major teaching hospitals (2.89%). The changes for major teaching hospitals from April-May to September-October (0.12, $p<0.04$) and from April-May to November-December (0.127, $p<0.02$) suggest that the increase in mortality lasts for several months following the July turnover. As with LOS, the effect of the turnover appears to begin in June. The estimated effect in June (0.074 percentage points, $p<0.06$) may again be due to the fact that the turnover begins late in that month at many hospitals.

Minor teaching hospitals experience an increase in risk-adjusted mortality of 0.051 percentage points ($p<0.07$) in June and 0.045 percentage points ($p<0.06$) in July-August. This effect is smaller in relative magnitude (an increase of 1.7% over the baseline mortality rate of 2.60 for minor teaching hospitals) and appears to dissipate faster than that for major teaching hospitals.

One potential alternative explanation for our results is that relatively healthy patients anticipate declines in performance at teaching hospitals in July and August and avoid having procedures done in those facilities over the summer. This would leave teaching hospitals with a relatively sicker population during the summer, which would naturally result in observed increases in LOS and mortality. If this explanation were true, then one should expect teaching hospitals to experience a decline in admissions in the summer relative to non-teaching hospitals.

Column 3 of Table 2 provides an empirical test of this proposition. These coefficients should be interpreted similarly to those in Columns 1 and 2, except that the dependent variable in the regression is now the number of admissions, rather than risk-adjusted LOS or mortality. These results do not provide any evidence of a decline in admissions for major teaching hospitals in the July-August period. In fact, there is a statistically significant increase in the number of admissions at major teaching hospitals during these months, suggesting that the selection of sicker patients—along dimensions that are not captured by our risk-adjustment methodology—does not seem to account for the identified July effect. There does appear, however, to be a significant decline in admissions for both major and minor teaching hospitals in the November-December period, suggesting some increase in patient severity at that time. This pattern might help explain the failure of the July effect to dissipate during November and December.

Another potential explanation of our results is that teaching hospitals receive more transfers from non-teaching hospitals during the summer because the occupancy rates at teaching hospitals are lower during those months. If that were true, and if transferred patients were, on average, sicker than the rest of the patient population, then one might expect an increase in the relative mortality rate in teaching hospitals during the summer months independent of house staff turnover. We test for this possibility in Column 4 of Table 3 by repeating our base regression with the transfer rate (i.e., transfers as a percentage of total inpatient admissions) as the dependent variable. If the "increased transfers" explanation were true, we would expect transfer rates to rise during July and August. We do not find support for this alternate explanation. For major teaching hospitals, there is no statistically significant seasonal pattern in transfer rates. For minor teaching hospitals, we find the opposite result, with transfer rates actually falling during the second half of the year.

Results Using Narrow Categories of Teaching Intensity

Our results thus far are consistent with the theory that as resident intensity increases, the impact of the July turnover increases. Alternatively, it is possible that the most intensive teaching programs have more substantial infrastructures to manage the turnover process. Thus at very high intensities, the negative impact of turnover may be muted to some extent. To test for this non-linear relationship, we estimate the models from the previous section but divide the major teaching category into four quartiles based on teaching intensity. The break between the first and second quartile occurs at 0.30 residents/bed, the break between the second and third quartile is at 0.43, and the final break is at 0.62.

Table 3 presents the results of this analysis. The effects for minor teaching hospitals are exactly as before. For the major teaching hospitals, the effect estimated in Table 2 is not uniform across all facilities within that group. With respect to LOS, the impact of the July turnover appears to peak in the third quartile and then decline for the most intensive hospitals. Many of the differences between quartiles are significant. The estimated July-August coefficient for the fourth quartile (0.084) is significantly lower than the third (0.199) at $p<0.05$. The coefficients for the first (0.070) and second (0.025) quartiles are not statistically different from each other, but each is significantly lower than that for the third quartile at $p<0.02$ and $p<0.06$, respectively. The estimated July effect for the third quartile (0.199, $p<0.01$) suggests an increase in hospital costs following the July turnover of 3.3% relative to the average, risk-adjusted LOS for major teaching hospitals.

With respect to mortality, the July effect is statistically insignificant for both the first and second quartiles, although the magnitude of the coefficient for the second quartile (0.173, $p<0.34$) is large. For the third quartile, the estimated July impact is the largest of any group (0.191 percentage points, $p<0.04$). For the most intensive hospitals, the estimated July impact is much lower and not significant at conventional levels (0.022 percentage points, $p<0.68$**)**. The July-August coefficient for the third quartile is higher than that for minor teaching hospitals, though this difference is only marginally significant at $p<0.13$. Further, the coefficient for the third quartile is not statistically different from either of the first two quartiles of major teaching hospitals. The decline from the third to the fourth quartiles, however, is marginally significant ($p<0.13$). This effect, in combination with the turndown in the effect for LOS, suggests that the most intensive of the major teaching hospitals may suffer less of an impact from house staff turnover than major teaching hospitals with slightly lower resident intensities.

Results on Changes in Effects Over Time

Given the recent changes in teaching hospitals—including an increased reliance on electronic record keeping and order entry, the renewed focus on work hours of hospital staff, and stricter regulations concerning Medicare reimbursement and supervision by attending physicians—it is certainly possible that the effect we have identified may have diminished through time. To test for this, we estimate our models for risk-adjusted LOS and risk-adjusted mortality using only the data from the last three years of our sample, 1997-1999. We present these results in Table 4.

We note two aspects of these results. First, the July effect for major teaching hospitals does appear to attenuate in the last three years of our sample. Specifically, the coefficients for risk-adjusted LOS and mortality are not significant at conventional levels. While this finding is consistent with an attenuation, or even elimination, of the July effect in the latter part of our sample, it is possible that this it is simply due to the difficulty in precisely estimating effects on mortality and LOS in smaller samples (note that these regressions include only 37% of the observations in the full sample). Second, the July effect with respect to mortality is still present for minor teaching hospitals at a magnitude similar to that for the whole sample. Given that we have more minor teaching hospitals in our sample than major teaching hospitals, this is again a potential signal that large samples are important for precisely estimating these effects.

COMMENT

This study considers the impact of the July resident turnover on the productivity of teaching hospitals. We examine two measures of hospital performance—LOS and in-hospital mortality. We find that facilities with a relatively high concentration of residents per bed (i.e., major teaching hospitals) experience a significant decline in performance following the July turnover, and that this decrease in hospital productivity lasts for several months. The magnitude of this July effect begins to dissipate for teaching hospitals with very high resident intensities. The effect may also dissipate for major teaching hospitals in the later years of our sample. While this result may be consistent with changes in teaching hospitals that may have lead to overall increases in quality over time (e.g., requirements concerning the presence of attending physicians for procedures reimbursed by Medicare), it is also possible that this apparent attenuation of the July effect is simply the result of attempting to identify an effect from a relatively small sample of observations.

Previous studies have established a decline in some hospital productivity measures over the summer months, but those effects have been limited to increases in hospital costs and lengths of stay. To our knowledge, no previous study has identified a change in mortality rates as a result of turnover in teaching programs, though some have suggested the need for a multi-site analysis of the impact of the house staff training on medical outcomes.[24] Our difference-in-differences approach—with a large, national panel of hospitals over a multi-year period—offers a unique opportunity to identify effects on LOS and mortality while controlling for the underlying seasonal pattern in these variables.

A critical question is whether the decline in hospital productivity over the summer months is preventable. There do appear to be large residency programs that experience less of a performance decline following the summer turnover. Further research is required to understand the causes of the smoother transition at these hospitals and whether any "best practices" could be transferred to the less-intensive major teaching programs that currently suffer a decline.

We do not contend to know if potential changes in the turnover structure, such as additional supervision, graduated workloads, or staggered starts, would lead to outcomes that are better or worse than those under the current system. Rather, we believe that our findings should encourage experts in this area to consider the available options as part of the larger debate on changes in staffing patterns at teaching hospitals.

Table 1: Descriptive Statistics by Hospital Type

	Non-Teaching		Minor Teaching		Major Teaching		Full Sample	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Residents Per Inpatient Bed	0.01	0.03	0.09	0.07	0.50	0.23	0.10	0.19
Inpatient Hospital Beds	145	128	354	199	495	273	191	180
Inpatient Admissions/Year	5,133	5,457	13,951	7,692	20,846	10,181	7,119	7,529
Patient Age	48.7	9.8	45.6	8.2	40.2	8.1	46.6	9.6
Medicaid Admissions/Total Admissions	15%	13%	16%	14%	26%	16%	17%	14%
Medicare Admissions/Total Admissions	39%	15%	33%	11%	25%	10%	36%	14%
Observed Average Length of Stay								
Total	4.9	2.3	5.3	1.4	6.0	1.4	5.2	2.0
Age<65	3.8	2.0	4.3	1.3	5.5	1.4	4.2	1.8
Age 65+	6.6	3.2	7.1	1.9	7.7	2.3	6.9	2.8
Observed Mortality								
Total	2.6%	1.4%	2.4%	0.7%	2.4%	0.7%	2.5%	1.2%
Age<65	0.9%	0.8%	1.0%	0.4%	1.4%	0.5%	1.0%	0.7%
Age 65+	5.3%	1.9%	5.2%	1.2%	5.5%	1.6%	5.3%	1.7%
Observations (hospital-years)	4,015		653		256		4,924	
Distribution of Sample by Teaching Status	81.5%		13.3%		5.2%			
Distribution of All Hospitals Reporting to AHA (1993-1999) by Teaching Status*	79.6%		16.2%		4.2%			

Note: Includes all hospitals listed in the AHA database as either general medical and surgical hospitals (service code=10) or children's general medical and surgical hospitals (service code=50). Teaching hospitals include facilities that either report a medical school affiliation to the AMA (MAPP5=1) or are members of the Council of Teaching Hospitals (COTH) of the Association of American Medical Colleges (MAPP8=1). Minor teaching hospitals are teaching hospitals with residents per bed less than 0.25 and major teaching hospitals are those with residents per bed greater than or equal to 0.25. These definitions are the same as those used in the study sample.

Source: NIS, 1993-1999 and AHA, 1993-1999.

Table 2: Changes in LOS, Mortality, and Admissions Using Broad Categories of Teaching Intensity

	Change in Dependent Variable Relative to Non-Teaching Baseline (Reference Period=April-May)			
	Risk-Adjusted LOS	Risk-Adjusted Mortality	Total Admissions	Transfer Rate (Transfers/Total Admissions*100)
Minor Teaching				
Jan-Mar	0.003 (0.015)	0.023 (0.022)	-1.5 (4.5)	-0.04 (0.06)
Apr-May				
June	0.011 (0.016)	0.051 (0.028) *	-5.8 (3.6) *	-0.08 (0.05) *
Jul-Aug	0.031 (0.016) **	0.045 (0.024) *	-2.4 (4.5)	-0.11 (0.05) **
Sep-Oct	0.051 (0.015) ***	0.034 (0.023)	-10.3 (4.8) **	-0.11 (0.06) *
Nov-Dec	0.043 (0.016) ***	0.035 (0.023)	-26.3 (5.5) ***	-0.14 (0.07) *
Major Teaching				
Jan-Mar	0.042 (0.024) *	-0.013 (0.029)	-0.5 (8.5)	0.02 (0.07)
Apr-May				
June	0.069 (0.033) **	0.074 (0.039) *	-1.2 (9.4)	0.05 (0.07)
Jul-Aug	0.100 (0.031) ***	0.120 (0.052) **	38.8 (9.8) ***	-0.11 (0.10)
Sep-Oct	0.111 (0.026) ***	0.120 (0.058) **	13.3 (10.0)	0.01 (0.09)
Nov-Dec	0.097 (0.023) ***	0.127 (0.050) ***	-20.0 (9.6) **	0.12 (0.08)
Mean of Dependent Variable				
Minor Teaching	5.30	2.60	1,261	4.36
Major Teaching	5.95	2.89	1,817	5.31
Observations	58,887	58,887	58,887	58,887
Adjusted R^2	0.750	0.444	0.986	0.832

,, and *** denote statistical signficance at the 10%, 5%, and 1% levels, respectively.*

Note: The level of observation is the hospital-month. All regressions include fixed effects for hospital, year, and multi-month period, though these coefficients are not shown in the table for ease of presentation. Standard errors (in parentheses) are heteroskedasticity robust and clustered by hospital. In regressions with risk-adjusted LOS and risk-adjusted mortality as the dependent variable, observations are weighted by the total number of cases for the relevant hospital-month.

Table 3: Changes in LOS and Mortality Using Narrow Categories of Teaching Intensity

	Change in Dependent Variable Relative to Non-Teaching Baseline (Reference Period=April-May)					
	Risk-Adjusted LOS		Risk-Adjusted Mortality		Admissions	
Minor Teaching						
Jan-Mar	0.003	(0.015)	0.023	(0.022)	-1.547	(4.517)
Apr-May						
June	0.011	(0.016)	0.051	(0.028) *	-5.839	(3.557)
Jul-Aug	0.031	(0.016) **	0.045	(0.024) *	-2.357	(4.487)
Sep-Oct	0.051	(0.015) ***	0.034	(0.023)	-10.315	(4.770) **
Nov-Dec	0.043	(0.016) ***	0.035	(0.023)	-26.317	(5.529) ***
Major Teaching						
First Quartile						
Jan-Mar	0.008	(0.033)	0.027	(0.044)	13.310	(11.918)
Apr-May						
June	0.101	(0.053) *	0.006	(0.056)	-20.172	(31.421)
Jul-Aug	0.070	(0.034) **	0.090	(0.064)	31.683	(15.734) **
Sep-Oct	0.072	(0.039) *	-0.015	(0.067)	4.984	(14.176)
Nov-Dec	0.094	(0.034) ***	0.144	(0.065) **	5.395	(17.314)
Second Quartile						
Jan-Mar	0.059	(0.072)	-0.143	(0.079) *	6.065	(14.581)
Apr-May						
June	-0.058	(0.075)	0.051	(0.096)	19.922	(12.947)
Jul-Aug	0.025	(0.086)	0.173	(0.180)	44.221	(13.484) ***
Sep-Oct	0.030	(0.073)	0.227	(0.199)	17.407	(13.477)
Nov-Dec	-0.008	(0.053)	0.130	(0.171)	-1.807	(17.681)
Third Quartile						
Jan-Mar	0.083	(0.033) **	0.034	(0.042)	-12.070	(16.358)
Apr-May						
June	0.123	(0.050) **	0.159	(0.060) ***	-12.734	(12.253)
Jul-Aug	0.199	(0.042) ***	0.191	(0.093) **	12.136	(17.649)
Sep-Oct	0.179	(0.034) ***	0.174	(0.087) **	-7.328	(13.444)
Nov-Dec	0.211	(0.038) ***	0.154	(0.093) *	-61.941	(18.386) ***
Fourth Quartile						
Jan-Mar	0.012	(0.030)	0.017	(0.058)	-9.687	(16.646)
Apr-May						
June	0.095	(0.046) **	0.063	(0.085)	7.843	(15.584)
Jul-Aug	0.084	(0.043) **	0.022	(0.052)	67.548	(20.533) ***
Sep-Oct	0.146	(0.031) ***	0.082	(0.088)	38.421	(24.739)
Nov-Dec	0.071	(0.027) **	0.078	(0.048)	-21.992	(13.877)
Mean of Dependent Variable						
Minor Teaching	5.30		2.60		1,261	
Major Teaching	5.95		2.89		1,817	
Observations	58,887		58,887		58,887	
Adjusted R^2	0.750		0.444		0.986	

,, and *** denote statistical signficance at the 10%, 5%, and 1% levels, respectively.*

Note: The level of observation is the hospital-month. All regressions include fixed effects for hospital, year, and multi-month period, though these coefficients are not shown in the table for ease of presentation. Standard errors (in parentheses) are heteroskedasticity robust and clustered by hospital. In regressions with risk-adjusted LOS and risk-adjusted mortality as the dependent variable, observations are weighted by the total number of cases for the relevant hospital-month.

Table 4: Changes in LOS and Mortality Using Broad Teaching Categories (Sample Restricted Only to Observations from 1997 through 1999)

	Change in Dependent Variable Relative to Non-Teaching Baseline (Reference Period=April-May)					
	Risk-Adjusted LOS			Risk-Adjusted Mortality		
Minor Teaching						
Jan-Mar	-0.017	(0.021)		0.009	(0.034)	
Apr-May						
June	0.030	(0.025)		0.068	(0.046)	
Jul-Aug	0.022	(0.023)		0.072	(0.039)	*
Sep-Oct	0.050	(0.025)	**	0.035	(0.038)	
Nov-Dec	0.018	(0.027)		0.031	(0.037)	
Major Teaching						
Jan-Mar	-0.019	(0.029)		-0.072	(0.040)	*
Apr-May						
June	0.039	(0.040)		0.050	(0.067)	
Jul-Aug	0.008	(0.051)		-0.010	(0.054)	
Sep-Oct	0.024	(0.051)		0.031	(0.058)	
Nov-Dec	-0.036	(0.051)		0.053	(0.050)	
Mean of Dependent Variable						
Minor Teaching	4.97			2.48		
Major Teaching	5.49			2.70		
Observations	21,918			21,918		
Adjusted R^2	0.728			0.508		

,, and *** denote statistical signficance at the 10%, 5%, and 1% levels, respectively.*

Note: The level of observation is the hospital-month. All regressions include fixed effects for hospital, year, and multi-month period, though these coefficients are not shown in the table for ease of presentation. Standard errors (in parentheses) are heteroskedasticity robust and clustered by hospital. In regressions with risk-adjusted LOS and risk-adjusted mortality as the dependent variable, observations are weighted by the total number of cases for the relevant hospital-month.

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