Postoperative Adverse Events in Teaching and Nonteaching Hospitals

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Background and Objectives: With the recent attention on quality of care and residency training, teaching hospitals are coming under greater scrutiny. Despite several studies, there is still no consensus on whether teaching hospitals deliver higher quality of care than nonteaching hospitals.

Methods: This was a retrospective cross-sectional study, using national hospital data. The sample consisted of 3,818 acute care hospitals in the National Inpatient Sample from 1990–1996. The quality indicators were postoperative adverse events, including venous thrombosis/pulmonary embolism (DVT/PE), pulmonary compromise, pneumonia, and urinary tract infection (UTI). Hospitals were classified as major teaching, other teaching, and nonteaching. Quality indicator rates of hospital types were compared and multivariate regression performed to control for specific hospital characteristics.

Results: Teaching hospitals had higher rates of postoperative DVT/PE and pulmonary compromise but lower rates of UTI, compared with nonteaching hospitals. In the multivariate analysis, teaching hospitals were more likely to have higher postoperative DVT/PE rates, and other teaching hospitals had higher rates of pulmonary compromise and UTI. Postoperative pneumonia rates were higher in major teaching hospitals than nonteaching hospitals.

Conclusions: Rates of postoperative adverse events were higher in teaching hospitals compared to nonteaching hospitals. These findings suggest that quality of care, as measured by postoperative adverse events, may not be higher in teaching hospitals.

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Teaching hospitals have a central role in the US health care system. They provide training for medical students and resident physicians, conduct medical research, serve as referral centers for complex services and procedures, and many provide care for urban underserved populations. The provision of these “public goods” has been used to bolster teaching hospitals’ claims that they provide a higher quality of care than nonteaching hospitals. At the same time, teaching hospitals have higher costs of care than nonteaching hospitals. While some argue that higher costs at teaching hospitals occur because quality care is more expensive or that teaching hospitals have a higher complexity of cases and patient population, some suggest that higher costs are due to poor efficiency at teaching hospitals. As debate continues over Medicare GME funding to teaching hospitals, the questions of quality, value, and accountability of teaching hospitals persist.

Many studies have examined the quality of care in teaching hospitals, but there is little consensus as to whether they actually provide better care than nonteaching hospitals. A recent review by Ayanian et al demonstrated that most analyses of administrative data found mixed results, although more-rigorous analyses of clinical data seem to support claims of higher quality in teaching hospitals. In the past decade, analyses of administrative data have been limited to Medicare data or a small number of states.

Adverse events that are closely related to processes of care, such as postoperative complications, may be a better measure of quality than death rates or other intermediate outcomes. Postoperative complications can be identified from hospital discharge data using the Quality Indicator (QI) software developed by the Agency for Healthcare Research and Quality (AHRQ). We used 7 years of national Healthcare Cost and Utilization Project (HCUP) data to examine rates of post-
operative adverse events in teaching hospitals and to compare them to the rates in nonteaching hospitals.

Methods

Data Source

The data for this study were obtained from the National Inpatient Sample (NIS) of HCUP. The NIS is an annually collected dataset of all hospital discharge claims from a 20% stratified, probability sample of nonfederal US community hospitals included in HCUP. The database contains demographic, diagnostic, and treatment information for each discharged patient. The sample in this study included the 7-year period from 1990–1996 and consisted of 3,818 hospitals.

Identifying Adverse Events

The HCUP-3 QI software was used to identify adverse events and the corresponding at-risk population for calculating hospital-level adverse event rates. The software screens and flags predefined adverse events using International Classification of Diseases, Ninth Edition (ICD-9) codes and applies predetermined exclusion and inclusion criteria to identify discharges for which adverse events could occur. The four QIs used in this study were specific postoperative adverse events—venous thrombosis and/or pulmonary embolism (DVT/PE), pulmonary compromise, pneumonia, and urinary tract infection (UTI). These adverse events were selected because of potential relationships between these events and resident staffing identified in a previous study on nurse staffing. 

Hospital Characteristics and Teaching Status

The resident staffing and teaching status data were collected from the American Hospital Association (AHA) annual survey of hospitals, from 1990–1996. The AHA survey also provided other hospital characteristics, including number of beds, urban location, nurse staffing levels, geographic region, and ownership. These data were merged with HCUP NIS data.

Geographic region was defined as North East, North Central, South, and West. Ownership was divided into public (government), private nonprofit, and private investor owned. Nurse staffing data, derived from the AHA database, was measured as the number of full-time-equivalent registered nurses and licensed practical nurses working in the hospital and outpatient departments per adjusted patient day.

Hospital teaching status was defined by three categories: major teaching, other teaching, and nonteaching hospitals. Major teaching hospitals were defined as members of the Council of Teaching Hospitals (COTH), which is limited to organizations having a documented affiliation agreement with a medical school accredited by the Liaison Committee on Medical Education. These organizations must sponsor at least four approved, active residency programs. At least two of the approved residency programs should be in medicine, surgery, obstetrics-gynecology, pediatrics, family medicine, or psychiatry. The full criteria are available and can be reviewed at www.aamc.org/members/coth/membercriteria.htm. The other (or minor) teaching hospitals were defined as institutions that did not have COTH membership but did have interns and/or residents, as determined by an intern/resident-to-bed ratio (IRB)>0. Finally, nonteaching hospitals were those institutions that were not COTH members and had an IRB ratio=0. Previous studies have used COTH membership as well as IRB ratios to determine teaching status.

Severity of Illness

Previous studies have used a variety of severity indices to control for differences in case mix between teaching and nonteaching hospitals. The QI software adjust for case mix by excluding patients with comorbid conditions, patients admitted from the nursing homes, and transfers from other hospitals. In addition, we also adjusted for case mix by including in our multivariable analysis the Medicare Case Mix index and the proportion of patients for whom Medicaid or Medicare were the principal payors.

Data Analysis

The associations between hospital teaching status and postoperative adverse events were determined using one-way ANOVA. We conducted univariable analyses to detect relationships between adverse events and hospital characteristics including bed size, rural or urban location, ownership, nurse staffing levels, percent of patients with Medicare or Medicaid, and geographic region. We then created a multivariable model that included those hospital characteristics that had statistically significant relationships to the adverse events in univariate testing.

The hospital discharge data was analyzed as a simple random sample. Sampling weights were not used because we did not seek national estimates, and the multivariable models contained many of the variables used in determining the weights. The potential effect of autocorrelation due to the same hospital appearing in multiple years of the data was taken into account by choosing a higher level of significance testing, with P<.01. In a previous study, no significant temporal trend in QI rates was detected. All analyses were performed with STATA version 8 (Stata Corporation, 2003).

Results

The characteristics of the three types of hospitals are shown in Table 1. Major teaching hospitals had a greater number of beds, were more likely to be in an urban location, and were more likely to be nonprofit hospi-
tals than were nonteaching hospitals. As expected, major teaching hospitals had the highest mean number of full-time equivalent residents, followed by other teaching hospitals.

Rates of postoperative DVT/PE were higher in major and other teaching hospitals than in nonteaching hospitals (0.51 and 0.42 versus 0.35, \( P < .001 \)) (Figure 1). Rates of pulmonary compromise were also higher in the major and other teaching hospitals than nonteaching hospitals (1.01 and .94 versus .77, \( P < .001 \)) (Figure 2). However, rates of postoperative pneumonia were not significantly different between teaching and nonteaching hospitals (Figure 3). Major and other teaching hospitals had lower rates of postoperative UTI than nonteaching hospitals in the univariate analysis (\( P < .01 \)) (Figure 4).

In the multivariable analysis, the higher rates of DVT/PE in major and other teaching hospitals remained statistically significant (Table 2) even after considering bed size, rural or urban location, ownership, nurse staffing levels, percent of patients with Medicare or Medicaid, and geographic region. Other teaching hospitals had higher rates of postoperative pulmonary compromise than nonteaching hospitals. Major teaching hospitals had higher postoperative pneumonia rates in the multivariate model.

After adjusting for other variables, teaching hospitals had higher rates of postoperative UTI, although this was only statistically significant for other teaching hospitals (Table 2). This appears to contradict the univariable analysis, which demonstrated lower rates

Table 1

<table>
<thead>
<tr>
<th>Hospital Characteristics by Teaching Status</th>
<th>Major Teaching Hospitals</th>
<th>Other Teaching Hospitals</th>
<th>Nonteaching Hospitals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean number of beds</td>
<td>536.7</td>
<td>261.9</td>
<td>148.0</td>
</tr>
<tr>
<td>% in urban location</td>
<td>98.7</td>
<td>94.7</td>
<td>63.9</td>
</tr>
<tr>
<td>% in region (#):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North East</td>
<td>57.6 (175)</td>
<td>43.1 (236)</td>
<td>21.5 (638)</td>
</tr>
<tr>
<td>North Central</td>
<td>10.5 (32)</td>
<td>15.0 (82)</td>
<td>28.8 (855)</td>
</tr>
<tr>
<td>South</td>
<td>19.4 (59)</td>
<td>26.7 (146)</td>
<td>32.4 (960)</td>
</tr>
<tr>
<td>West</td>
<td>12.5 (38)</td>
<td>15.2 (83)</td>
<td>17.3 (514)</td>
</tr>
<tr>
<td>% ownership type (#):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public</td>
<td>21.3 (65)</td>
<td>7.7 (42)</td>
<td>15.2 (451)</td>
</tr>
<tr>
<td>Nonprofit</td>
<td>78.6 (239)</td>
<td>81.5 (447)</td>
<td>69.7 (2,067)</td>
</tr>
<tr>
<td>For profit</td>
<td>0.0 (0)</td>
<td>10.6 (58)</td>
<td>15.1 (449)</td>
</tr>
<tr>
<td>% Medicare discharges</td>
<td>33.3</td>
<td>41.4</td>
<td>48.8</td>
</tr>
<tr>
<td>% Medicaid discharges</td>
<td>18.3</td>
<td>13.1</td>
<td>10.0</td>
</tr>
<tr>
<td>Nurse staffing (hours per adjusted patient-day)</td>
<td>7.9</td>
<td>6.6</td>
<td>5.9</td>
</tr>
<tr>
<td>Residents (mean, full time)</td>
<td>174.4</td>
<td>24.1</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Figure 1

Rates of Postoperative Venous Thrombosis and/or Pulmonary Embolism Per 100 Major Operation Discharges Among Teaching and Nonteaching Hospitals

* \( P < .001 \)

Figure 2

Rates of Postoperative Pulmonary Compromise Per 100 Major Operation Discharges Among Teaching and Nonteaching Hospitals

* \( P < .001 \)
of UTI in teaching hospitals. The univariate finding appears to have been confounded by hospital ownership, with a large proportion of nonteaching hospitals being privately owned.

**Discussion**

These results show that teaching hospitals have higher rates of postoperative DVT/PE and pulmonary compromise, postoperative pneumonia, and postoperative UTI than do nonteaching hospitals. These results suggest that the quality of care in teaching hospitals is, at best, no better than nonteaching hospitals. There was no clear difference between major and other (minor) teaching hospitals.

Previous studies on postoperative adverse events have found mixed results. Sloan and colleagues found that teaching hospitals had higher postoperative complications in four of six different surgical procedures.\(^\text{11}\) Pearce et al, on the other hand, demonstrated no difference between teaching and nonteaching hospitals in mortality and other postoperative complications for vascular procedures.\(^\text{14}\) A recent study of VA hospitals found no difference in mortality rates but higher rates of postoperative morbidity in certain types of operations at teaching hospitals.\(^\text{24}\) Larger studies of administrative data have examined mortality rates in teaching and nonteaching hospitals. One study of 3,782 hospitals found lower mortality rates among Medicare patients in private teaching hospitals.\(^\text{25}\) Yuan et al found lower 30-day mortality rates in nonprofit teaching hospitals among 16.9 million Medicare patients but also found that public teaching hospitals had the highest mortality rates.\(^\text{26}\) Using a large national, administrative dataset, our study confirms findings in the literature on adverse events.

**Limitations**

There are several limitations to this study. Administrative data, while generally accurate, is subject to coding biases and are not as detailed as reviewing medical records for identifying specific markers for quality of
care. Thus, although we used the QI software and the Medicare case-mix index, it is possible that we were unable to capture the entire scope of comorbidity within teaching hospitals. Alternately, the QI software excludes patients with any comorbid conditions, resulting in a limited sample of discharges. On the other hand, this dataset represents a national sample of hospitals and is one of the largest analyses of teaching hospitals and adverse events to date.

While this study confirms some association between adverse events and teaching hospitals, the underlying causes for these findings is difficult to discern using these data. Subsequent analyses can use specific process measures and electronic medical record data to confirm these findings. Process-of-care quality indicators, such as ones recently developed by AHRQ, may be able to measure quality more accurately in health care institutions than adverse events. 27-28

Conclusions

The findings from this study and the body of literature on teaching hospitals should not be seen as an indictment of teaching hospitals. They do, however, raise concerns that medical students and residents may be learning the practice of medicine in settings that do not necessarily reflect the highest levels of care. With the ongoing emphasis on quality of care, the role of teaching hospitals needs to be carefully scrutinized. The recent guidelines put forth by the ACGME on resident work hours may also shift some attention toward the question of overworked residents and subsequent effects on quality of care. Certainly the implementation of the 80-hour work week offers an opportunity to examine the effects of this policy on quality of care and adverse events.

Understanding differences in the processes of care between teaching and nonteaching hospitals offers a more difficult challenge. Teaching hospitals, especially major teaching hospitals, have a complex structure involving multiple levels of providers, including medical students, interns, residents, fellows, and attending physicians, as well as support staff with different levels of training. The deleterious effects of multiple transfers of care may indeed affect the rates of adverse events in these settings. Teaching hospitals deserve greater scrutiny into their systems of care to ensure that they can be models for delivering and teaching a higher quality of medical care to the nation.

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References


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