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Prologue: Teaching hospitals are expensive places to treat patients. In the price competitive health marketplace of the 1980s, this high cost puts teaching hospitals at a disadvantage and has caught the attention of both industry analysts and policymakers in Washington looking to control the federal deficit. In this article, Frank Sloan and Joseph Vulvona delve into the costs of teaching hospitals, explaining how and where they differ from nonteaching hospitals. As the authors write: “Given this change in environment, identifying the cost of graduate medical education is now much more than an academic exercise. For there to be informed public policy making, it is necessary to know what the cost differentials are, why they occur, and then to assess the advantages and deficiencies of alternative funding mechanisms.” Professor Sloan, a well-respected health economist, is director of the Vanderbilt University Health Policy Center and chairman of the university’s department of economics. Sloan has a doctorate in economics from Harvard University and has been affiliated with Vanderbilt for over a decade. Vulvona is a research associate at the Vanderbilt Health Policy Center. He holds a bachelor of science degree in biology from Emory University, a master of science degree in genetics from the University of Arizona, and an M.B.A. in finance from Vanderbilt University. This article is drawn from a paper originally presented at a Vanderbilt Health Policy Symposium, “Providing and Paying for Medical Education: Past, Present, and Future.” This symposium was one of three such meetings on health care issues held at Vanderbilt within the past three years.
A n important minority of community hospitals in the United States provides opportunities for recent medical school graduates to acquire on-the-job training in various clinical specialties. In addition to their educational roles, these hospitals have often served as referral centers and have provided disproportionate amounts of care to the poor in relation to their total revenue.\(^1\)

In the past, the continued financial viability of these institutions has been assured because of the availability of subsidies from various public and private sources. Until recently, retrospective cost or charge-based reimbursement covered the cost of care at a high-cost hospital. With the growth of competition and the shift from retrospective to prospective payment, many purchasers are beginning to scrutinize the relative costliness of care at alternative treatment sites. Whereas previously, high cost was almost a badge of honor, an indication (albeit crude) that the hospital provided complex and high quality care, often to a disadvantaged segment of the population, being costly now is increasingly viewed as a sign of inefficiency. In the 1980s and beyond, high cost will be a competitive disadvantage. Before, subsidizing the training of physicians was seen as a legitimate cost of treatment. Now critics of such subsidies emphasize the prospect of a physician glut. Largely as a consequence of the physician supply increase, nonteaching hospitals now compete with teaching hospitals for at least the profitable referral patients.

Given this change in environment, identifying the cost of graduate medical education is now much more than an academic exercise. For there to be informed public policy making, it is necessary to know what the cost differentials are, why they occur, and then to assess the advantages and deficiencies of alternative funding mechanisms. By reviewing the literature and reporting some new statistical findings, this article deals with “what” and “why.” The analysis chips away at areas of uncertainty, leaving much for future research.

Differences in cost between teaching and nonteaching hospitals are thought to arise for several reasons. Patients treated by teaching hospitals are thought to be sicker on average. Some say that teaching hospitals pay higher wage rates and utilize a more intensive treatment approach that takes the form of more tests and more nursing hours per patient day. As a referral center, it may be necessary for major teaching hospitals to maintain excess capacity in a variety of specialized services. In certain situations, medical staff may be less productive as clinicians because of time spent in teaching.

**Hospital Teaching Status**

Hospitals vary greatly in their involvement in graduate medical education. We developed a hierarchy of teaching hospitals in descending order
of involvement in teaching with the number of hospitals in each category in 1982 in parentheses: flagship (116) other Council of Teaching Hospital (COTH) members (198), medical school affiliated (442) and approved residency program (107).

The American Association of Medical Colleges identified “flagship teaching hospitals” as institutions either owned by medical schools or as separate nonprofit and public hospitals but in which the medical school department chairs and hospital chiefs of service are typically the same person. Other Council of Teaching Hospital member hospitals also have a major commitment, but are not as integrally involved in medical education as the flagship hospitals. Other hospitals were affiliated with a medical school but were not COTH members. A final group of teaching hospitals had at least one approved residency program but none of the other formal teaching affiliations.

According to the American Hospital Association’s (AHA) 1982 Annual Survey of Hospitals, flagship hospitals had 42 percent of the nation’s physicians in residency programs, but accounted for only 2 percent of community hospitals and 12 percent of total labor and nonlabor expense incurred by hospitals in 1982. Other COTH hospitals also had a large share of residents, 3.5 percent, and 15 percent of the hospital and expense distributions respectively. By contrast, the remaining teaching hospitals combined had 18 percent of residents, but constituted 20 percent of community hospitals and 23 percent of expenses in such hospitals. Some 5 percent of residents were in hospitals without an approved program.

To learn about distributions of patient case types and severity of illness by hospital teaching status, we analyzed data from the 1982 and 1983 National Hospital Discharge Surveys (NHDS) which are annual surveys of the National Center for Health Statistics. Combining the two years, the NHDS file consisted of about 450,000 hospital discharge records from a representative national sample of community hospitals. To protect confidentiality, the NHDS public use tapes only identified a few hospital characteristics, not teaching status. Fortunately, hospital bedsize and ownership information were provided. We therefore employed the following method for assigning hospital teaching status to each discharge on the NHDS tapes. All hospitals with fewer than 200 beds and all investor-owned hospitals, irrespective of bedsize, were classified as “nonteaching.” All private nonprofit and public hospitals with over 500 beds were called “teaching.” Hospitals that fell into neither group were classified as “may teach.”

Data from the AHA’s 1982 Annual Survey of Hospitals allowed us to validate this scheme. About 90 percent of the “teaching” hospitals fell into one of our four teaching hospital groups. Most were flagship and other COTH members. Virtually all the NHDS “nonteaching” hospitals (98 percent) were truly nonteaching. Thus, it appears that hos-
hospital bedsize and ownership are fairly good predictors of teaching status, and the National Hospital Discharge Surveys can be used for comparisons between teaching and nonteaching hospitals.

Patient Characteristics

Case-mix. Any meaningful comparison of the cost differential between teaching and nonteaching hospitals must adjust for case-mix variation between the two types of hospitals. Many types of case-mix measures have been developed. Only two have been used to compare large samples of teaching with nonteaching hospitals—the Resource Need Index (RNI) and diagnosis-related groups (DRGs).

The Resource Need Index, developed by the Commission on Professional and Hospital Activities, is based on charges associated with treatment of specific illnesses, defined by a matrix of 351 diagnoses, five age categories, and the presence of surgical treatment. To construct the RNI for a hospital, each hospital was assigned a cell-specific case weight. The sum of the weights for all patients, divided by the number of patients, yielded the RNI for the hospital. Separate RNI indexes were also made available by major clinical service.

Diagnosis-related groups, 467 in total, were defined from diagnosis, procedure, and patient age information from a nationally representative sample of discharge records. Groups were intended to be clinically similar and to require similar amounts of hospital resources. To construct a hospital-specific index, the frequency of cases in each DRG was multiplied by a cost weight. These weights were constructed by converting the mean charge per DRG to cost. Although charge- and cost-based case-mix measures are conceptually distinct, in practice, they yield almost identical results. Watts and Klastorin found the charge-based RNI to be almost perfectly correlated with a cost-based DRG-based case-mix measure.

Ament and coauthors compared RNIs for various hospital bedsize and teaching status groups. Teaching status was defined differently from any of the above classification schemes, but, given the data provided, it seems reasonable to infer that their highest teaching category mainly consisted of flagship and other COTH hospitals with over 500 beds. RNI values ranged from 1.17 for this group to 1.03 for nonteaching hospitals with 5,000 to 9,999 discharges per year. The authors also presented RNIs by major clinical service. The largest differentials in RNI values were for pediatric medicine and newborn; in contrast, RNIs for obstetrics-gynecology were almost identical for major teaching and nonteaching hospitals, and differentials for general medicine and general surgery were under 5 percent. We reran their analysis of the RNI using our teaching hospital classification and a national sample of 367 hospitals. Differentials in RNIs were quite similar to those Ament and coauthors reported.
Differences in the Medicare case-mix index, a DRG-based measure, by hospital type are close to those reported for the RNI by Ament and colleagues. In 1981-82, just before the new DRG system was implemented, flagship and other COTH hospitals had mean case-mix index values of 1.19 and 1.13, respectively. The mean value for nonteaching hospitals was 0.94.

With 1982-83 National Hospital Discharge Survey data and Medicare case weights, we computed the frequency distribution of case weights for all discharges and for discharges of persons over age sixty-four for both NHDS “teaching” and “nonteaching” hospitals. Both teaching and nonteaching hospitals had substantial numbers of discharges in the 0.51 to 1.0 range (47 and 60 percent of cases, respectively). Teaching status made the largest difference for cases with weights above 2.0. Ten percent of teaching hospital cases had weights above 2.0 versus 4 percent for nonteaching hospitals.

To examine within-DRG variation, we selected the ten most frequent DRGs and five DRGs with the highest case weights from our 1982-83 National Hospital Discharge Survey file. Among the most frequent ten, teaching hospitals had relatively high (more than a quarter of total discharges) percentages of Cesarean sections, other deliveries, newborns, and psychosis patients. Among highest weight DRGs, teaching hospitals performed over half of craniotomies and coronary bypass procedures.

Hospital discharge data only permit variations in severity to be assessed indirectly. Given the limitations of the data, we selected three indicators of high severity: a long stay; a high inpatient death rate; and a high number of diagnoses per DRG. None of the three, taken in isolation, can yield conclusive findings on severity. Rather than reflect severity, lengthy stays may result if patients are kept longer for teaching purposes. The inhospital mortality rate could be lower in teaching settings if very sick patients are treated more aggressively in such institutions. The number of diagnoses per DRG may be lower in teaching hospitals if medical record-keeping is even worse in teaching than in nonteaching hospitals, as some have speculated.

To isolate the effect of teaching status on within-DRG differences for the fifteen DRGs in these three indicators, we performed regression analysis on the discharge data. With only teaching status entered as an explanatory variable, we found teaching hospitals had statistically significant longer stays than nonteaching hospitals for eleven of the fifteen DRGs. We then added a number of other pertinent explanatory variables to control for such factors as demographic differences and source of patient payment. Even with these controls, teaching hospital stays were higher for twelve DRGs. For many, the teaching/nonteaching hospital differential in stays widened after controlling for factors other than teaching status. Our analysis of inpatient mortality yielded very few statistically
significant differences between the two groups of hospitals. Counts of diagnoses per DRG tended to be lower for teaching than for nonteaching hospitals.

Based on our analysis, we cannot conclude that within-DRG severity is higher for teaching institutions. Some of the differences in length-of-stay undoubtedly reflect differences in treatment style. Why, for example, did our analysis show that the stay for a vaginal delivery without complicating diagnoses was longer in a teaching than in a nonteaching setting after we accounted for patient demographic and payer characteristics? Conversely, the much longer stays in such institutions we found for several of the high case weight DRGs may reflect greater severity of illness. Whether the longer stays are justified or not, they will place teaching hospitals at a competitive disadvantage in the new environment.

Payer mix. There were some important differences in patient payer mix by hospital teaching status in the early 1980s. Flagship hospitals, especially those under public sponsorship, had relatively high percentages of uninsured and Medicaid patients and lower percentages of private-pay patients than other types of hospitals.8

Treatment Approach

Lave listed four factors that may lead to higher use of ancillary services in teaching hospitals: residents’ inexperience may cause them to order extra tests; academic physicians may have a greater “need to know” (quotation from Lave); state-of-the-art testing facilities are more readily available; and severely ill patients may be treated more aggressively in such hospitals.9

Several studies have described ancillary use in a teaching versus nonteaching setting.10 In most, ancillary use on the teaching and nonteaching services for the same institution was compared. In a few, there were two to four hospitals in the sample. Without exception, the studies found appreciably higher ancillary use in a teaching environment, often 40 percent or more. The authors said that they adequately controlled for illness severity. Several concluded that such high levels of ancillary use were wasteful and should be controlled. One study, however, reported lower inhospital mortality for patients treated on the teaching service, but this reduction was offset by higher mortality of teaching service patients during the nine months after discharge.11

Using regression analysis, Becker and Sloan reported no differences in the number of consultations with physicians other than the admitting physician; cultures (urine, nose or throat, sputum, blood, wound, and other); function tests (electro-cardiogram, thyroid, electro-encephalogram, pulmonary, kidney, and gastric); and other tests (such as glucose tolerance, arterial blood gases, stool for blood).12 With the same sample, Sloan
and coauthors found higher rates of laboratory use in major teaching than in nonteaching hospitals, but lower rates of use of radiological services.\textsuperscript{13}

The advantage of the small-scale studies is that it may be possible to achieve better control for some confounding clinical factors when there is direct observation. However, patterns for one or two institutions may be dominated by institution-specific idiosyncratic factors. Also, would a case study which found no difference between teaching and nonteaching settings be published? Negative results are often difficult to publish. While the larger studies permit statistical inference, they look for behavioral differences hospitalwide. The case studies suggest there may be important variations within institutions. The effect of teaching on ancillary use and treatment style more generally is yet to be determined with an acceptable degree of precision.

Wages

Hospitals purchase some inputs, such as supplies, in national markets, and there is no reason to expect differences in price paid by hospital teaching status. But major teaching hospitals may be at a disadvantage in labor markets because they tend to be located in large cities, and sometimes within the central core of such cities. Payers, such as Medicare, vary payment by area, but there is some concern among major teaching hospitals that such adjustments do not adequately account for the location of major teaching institutions within cities.\textsuperscript{14}

To study this issue, we examined differences per full-time-equivalent employee in nursing and other occupations in hospitals located in the five largest metropolitan areas-New York, Los Angeles, Chicago, Philadelphia, and Houston.\textsuperscript{15} Large cities are likely to exhibit the most within-city variation in working conditions, cultural opportunities, and cost-of-living. We found no systematic differences in earnings in nursing, a category that includes professional nurses, licensed practical nurses, and nurses’ aides-orderlies. We looked for differences in mix of nurses by hospital teaching status and city. If anything, professional nurses were a higher fraction of total nursing personnel in major teaching hospitals. For this reason alone, such hospitals should have higher (not the same) nursing expense. In general, earnings of other personnel were higher in teaching institutions. The other personnel group is much more heterogeneous, and, for this reason, nurses’ earnings provide a better indication of wage rate differentials within large cities. Employee mix primarily reflects patient characteristics, treatment style, amenity levels, and efficiency.

Effects Of Graduate Medical Education On Hospital Cost

We have assessed variations in several hospital cost determinants that
may be expected to vary by hospital teaching status. Here, we evaluate the role of teaching status on cost.

Criteria for a “good” study. To isolate properly the influence of teaching on hospital costs, the empirical analysis should have the following methodological characteristics. First, the nature and level of teaching activity vary both among and within hospitals. Teaching measures should reflect varying degrees of hospital involvement in teaching. The sample should include a number of hospitals, not a handful, to gauge the impact of different levels of teaching activity accurately. There should be some analysis by department or special service to reveal why cost differences exist. However, generalizations to the universe of teaching hospitals based on one hospital cost center are likely to be misleading.

Second, the cost measures should reflect payments to physicians as well as to hospitals for care rendered hospital inpatients. Often because of data limitations, payments to doctors are excluded by cost analysts. Resident time probably affects the time involvement of medical staff at the hospital.\(^{16}\) To the extent that residents are substitutes for medical staff, the latter’s billings may be lower than at a nonteaching hospital. On the other hand, teaching can require extra time of medical staff. If so, medical staff’s charges may not be lower and could possibly be higher. Residents and medical staff are possibly substitutes in some fields but not in others.

Third, case-mix differences and other cost determinants should be held constant. Simple comparisons between teaching and nonteaching hospitals may show appreciable cost differences, but such gaps are properly attributed to a number of factors, only one of which is teaching. No single study ranks well on all of the above three criteria.

Previous evaluations. Several studies, none of which satisfy all the criteria of a “good” evaluation described above, conclude that teaching hospitals are no more costly than their nonteaching counterparts. A study at one hospital determined that the savings from terminating its teaching program would be equally offset by the added cost of replacing student-provided patient service with practicing physicians.\(^{17}\) Hosek and Palmer examined the effect of teaching on costs in radiology departments in Veteran’s Administration (VA) hospitals.\(^{18}\) They found that residents reduced total radiology department costs on average (including payment to physicians) for the VA hospitals in their sample. Neu analyzed data on all admissions of Medicaid patients to five Albuquerque, New Mexico hospitals from September 1971 through December 1974.\(^{19}\) One of the hospitals was a major university-affiliated teaching hospital; the other four had little or no teaching activity. Neu found that total costs of inpatient episodes, including Medicaid payments to physicians, were 10 to 12 percent lower in the teaching hospitals than in the nonteaching institutions. Payments for separately billed professional services were 33
percent lower on average in the teaching hospital.

Although these studies have some strengths, in particular, explicit consideration of payments to physicians, they provide an inadequate basis for generalization. Certainly the degree to which residents serve as substitutes for medical staff is largely dependent on teaching program content. Replacement cost will be higher the more residents serve in the role of practicing doctors rather than as students. Since content varies greatly among hospitals, an estimate from a single institution can at best be illustrative. Likewise there is a danger of generalizing about teaching impacts from a sample of radiology departments in VA hospitals. VA hospitals often share faculty with other teaching hospitals, and one cannot be sure that Hosek and Palmer captured all pertinent payments to physicians. Conclusions based on a Medicaid study may not be valid because Medicaid patients may receive fewer services from physicians because, Medicaid pays much less than other payers.

Three recent econometric studies concluded that hospital costs are higher in hospitals with major commitments to teaching. They are superior to the above evaluations in that they used larger samples of community hospitals and considered the influences of varying degrees of hospital involvement with teaching.

A national study of over 5,000 hospitals by Pettingill and Vertrees concluded that for each additional 0.1 increase in a hospital’s resident-to-bed ratio, hospital cost per Medicare case increases by 5.7 percent. However, the authors made a mistake in calculating the marginal effect of a change in the resident-to-bed ratio which resulted in their overstating the effect of the resident ratio on hospital cost.20

Sloan and coauthors reported that flagship and other Council of Teaching Hospital member hospitals were more than 10 percent more expensive than nonteaching hospitals in terms of pharmacy cost per adjusted patient day, dietary cost per adjusted admission, plant operations cost per adjusted patient day and adjusted admission, and housekeeping cost per adjusted patient day.21 The authors attributed higher plant operations and housekeeping expense to their finding that major teaching hospitals have a higher square footage allocated to each patient. Under retrospective reimbursement, hospitals had an incentive to load as much joint cost as possible into items such payers covered.

Cameron’s analysis of cost used 1977-79 data from the California Medicaid program (MediCal), California Health Facility Commission, and other sources.22 He found that university and other major teaching hospitals combined were 14 percent more expensive than other hospitals after adjusting for case-mix using a DRG-based measure. Direct cost (excluding overhead) of university teaching hospitals was 33 percent higher than nonteaching hospitals after adjusting for case-mix. Inclusion of the full cost of services by physicians to hospitalized patients reduced
this differential to 26 percent. This study shows the importance of excluding physician cost; yet, as previously noted, there is a danger in generalizing about physician use patterns from Medicaid data. Although Cameron only adjusted for case-mix, this was not quite as critical in this study since the sample was limited to California hospitals, and some potential cost determinants, such as the regulatory environment, do not vary within a state.

**New evidence.** We performed new empirical analysis of the role of hospital teaching status as a cost determinant for purposes of this study. The principal data base was the American Hospital Association’s 1982 Annual Survey of Hospitals.

There were substantial differences in cost per adjusted admission, cost per adjusted patient day, and the ratio of revenue to cost, our measure of profit, in 1982 (Exhibit 1). Cost per adjusted admission rose with the degree of hospital involvement in teaching. Cost per adjusted patient day increased with involvement in teaching with one exception; such cost was higher on average in nonteaching hospitals than in those with an approved residency program. On average, revenue exceeded cost by almost 3 percent. However, flagship hospitals operated at a loss.

<table>
<thead>
<tr>
<th>Hospital teaching status</th>
<th>Mean cost per adjusted admission</th>
<th>Mean cost per adjusted patient day</th>
<th>Mean revenue-to-cost ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flagship</td>
<td>$4,157</td>
<td>$467</td>
<td>0.958</td>
</tr>
<tr>
<td>Other Council of Teaching Hospital member</td>
<td>3,327</td>
<td>392</td>
<td>1.019</td>
</tr>
<tr>
<td>Medical school affiliated</td>
<td>2,781</td>
<td>356</td>
<td>1.015</td>
</tr>
<tr>
<td>Approved residency program</td>
<td>2,558</td>
<td>324</td>
<td>1.034</td>
</tr>
<tr>
<td>Nonteaching</td>
<td>2,345</td>
<td>338</td>
<td>1.035</td>
</tr>
<tr>
<td>All</td>
<td>2,540</td>
<td>348</td>
<td>1.028</td>
</tr>
</tbody>
</table>


There were some notable differences in cost in 1982 among hospitals by teaching status by type of cost (Exhibit 2). First, flagship and other COTH hospitals allocated relatively high percentages of total expense to staff physicians/dentists and residents/other trainees. Nevertheless, for no group did such cost average more than 6 percent of the total. The 3.5 percent of total cost spent by flagship hospitals on residents was small when compared with the differential in cost per unit of output shown in Exhibit 1. Second, teaching hospitals allocated higher percentages of total expense to personnel; flagship and other Council of Teaching Hospitals were the highest in this respect. Third, interest and depreciation were a smaller percentage of the total for flagship and other COTH hospitals than for the others.
## Exhibit 2
### Distribution Of Cost By Major Cost Category And Hospital Teaching Status (%)

<table>
<thead>
<tr>
<th>Cost category</th>
<th>Flagship</th>
<th>Other Council of Medical Approved Teaching Hospital member</th>
<th>Medical school affiliated</th>
<th>Approved residency program</th>
<th>Non-teaching</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physicians and dentists</td>
<td>2.3</td>
<td>2.3</td>
<td>1.5</td>
<td>1.3</td>
<td>0.8</td>
<td>1.4</td>
</tr>
<tr>
<td>Residents</td>
<td>3.5</td>
<td>2.2</td>
<td>1.1</td>
<td>0.8</td>
<td>0.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Other trainees</td>
<td>0.3</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Nurses</td>
<td>14.6</td>
<td>14.9</td>
<td>16.4</td>
<td>16.4</td>
<td>16.8</td>
<td>16.1</td>
</tr>
<tr>
<td>All other personnel</td>
<td>31.2</td>
<td>33.0</td>
<td>31.7</td>
<td>31.9</td>
<td>29.9</td>
<td>31.1</td>
</tr>
<tr>
<td>Nurse benefit</td>
<td>9.4</td>
<td>9.1</td>
<td>8.4</td>
<td>8.7</td>
<td>8.1</td>
<td>8.5</td>
</tr>
<tr>
<td>Subtotal</td>
<td>61.3</td>
<td>61.6</td>
<td>59.2</td>
<td>59.2</td>
<td>55.9</td>
<td>58.4</td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professional fees</td>
<td>2.7</td>
<td>3.6</td>
<td>4.4</td>
<td>4.9</td>
<td>5.5</td>
<td>4.6</td>
</tr>
<tr>
<td>Contract nursing</td>
<td>0.6</td>
<td>0.5</td>
<td>0.4</td>
<td>0.5</td>
<td>0.6</td>
<td>0.5</td>
</tr>
<tr>
<td>Depreciation</td>
<td>3.6</td>
<td>3.8</td>
<td>4.3</td>
<td>4.4</td>
<td>4.1</td>
<td>4.1</td>
</tr>
<tr>
<td>Interest</td>
<td>1.3</td>
<td>1.9</td>
<td>2.3</td>
<td>2.5</td>
<td>2.8</td>
<td>2.3</td>
</tr>
<tr>
<td>Utility</td>
<td>3.3</td>
<td>2.8</td>
<td>2.7</td>
<td>2.8</td>
<td>2.5</td>
<td>2.7</td>
</tr>
<tr>
<td>Rest</td>
<td>27.2</td>
<td>25.5</td>
<td>26.7</td>
<td>25.7</td>
<td>28.6</td>
<td>27.4</td>
</tr>
<tr>
<td>Subtotal</td>
<td>33.7</td>
<td>38.4</td>
<td>40.8</td>
<td>40.8</td>
<td>44.1</td>
<td>41.6</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Number of hospitals providing information on detailed expense: 70, 173, 349, 76, 1,714, 2,382


We used regression analysis to assess how hospital teaching status and other factors affected hospital cost per adjusted admission and adjusted patient day and hospital profitability. As above, profits were measured as the ratio of hospital revenue to cost. In addition to our four-way teaching status classification, we included thirty-seven other explanatory variables representing hospital case-mix, source of payment, hospital age and area wage rates, per capita income, and population density. All variables expressed in money terms were deflated by an area cost-of-living index.

Without the thirty-seven other variables, we found that flagship hospitals, on average, had a cost per admission 59 percent higher than nonteaching hospitals (“no other factors constant,” Exhibit 3); they were 36 percent higher on cost per adjusted patient day and 9 percent lower in terms of profit. Since the difference in cost per adjusted admission far exceeded that for cost per adjusted patient day, one may infer that length-of-stay was appreciably higher in flagship hospitals. Gaps between cost per adjusted admission for the other teaching hospitals and nonteaching hospitals were considerably less; there were no statistically significant
### Exhibit 3
**Percentage Difference Of Teaching Status On Hospital Cost And Profit**

<table>
<thead>
<tr>
<th>Teaching status</th>
<th>Cost per adjusted admission</th>
<th>Cost per adjusted patient day</th>
<th>Revenue-to-cost ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No other factors constant</td>
<td>Other factors constant</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N=2,382</td>
<td>N=2,382</td>
<td>N=1,181</td>
</tr>
<tr>
<td>Flagship</td>
<td>58.8</td>
<td>41.1</td>
<td>32.3</td>
</tr>
<tr>
<td>Other Council of Teaching Hospital member</td>
<td>36.8</td>
<td>22.8</td>
<td>20.9</td>
</tr>
<tr>
<td>Medical school affiliated</td>
<td>18.4</td>
<td>10.9</td>
<td>10.2</td>
</tr>
<tr>
<td>Approved residency program</td>
<td>9.1</td>
<td>7.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>35.5</td>
<td>32.9</td>
<td>30.2</td>
</tr>
<tr>
<td>Other Council of Teaching Hospital member</td>
<td>18.3</td>
<td>20.4</td>
<td>20.0</td>
</tr>
<tr>
<td>Medical school affiliated</td>
<td>8.0</td>
<td>9.4</td>
<td>10.0</td>
</tr>
<tr>
<td>Approved residency program</td>
<td>-0.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.6&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>-9.2</td>
<td>-9.0</td>
<td></td>
</tr>
<tr>
<td>Other Council of Teaching Hospital member</td>
<td>-1.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-3.2</td>
<td></td>
</tr>
<tr>
<td>Medical school affiliated</td>
<td>-1.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-3.0</td>
<td></td>
</tr>
<tr>
<td>Approved residency program</td>
<td>0.4</td>
<td>0.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
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</tbody>
</table>

<sup>a</sup>Difference between teaching and nonteaching hospitals not significant at 5 percent level or higher.

After adjusting for influences on cost other than hospital teaching status, the gap between medical school affiliated and approved residency program hospitals and nonteaching hospitals fell to 11 percent or less. Substantial differentials remained in costliness for the flagship and other COTH member groups. The gap in cost per adjusted admission between flagship and nonteaching hospitals was still 30 percent to slightly over 40 percent. The difference between these two types of hospitals was slightly over 30 percent in terms of cost per adjusted patient day.

Among the other variables, several were particularly important in explaining differences in cost among hospitals. The present analysis substantially improved on past work by including several measures of hospital
intensive care output. Hospitals with high proportions of patients in medical-surgery and burn intensive care tended to have higher costs per day and per case. Hospital payer mix was generally more important in explaining differences in cost per case than in cost per day. Hospitals with high proportions of Medicare and Medicaid patients had much higher costs per case. Hospitals with higher fractions of self-pay patients had lower per diem cost. As anticipated, high real wages and high population density led to higher cost. Hospitals located in counties with high real personal per capita income had higher per diem cost, but this variable had no impact on cost per case, presumably because stays in such locations tended to be lower. Finally, we found statistically significant regional effects. Both types of cost were highest in the West.

The results of our analysis of hospital profits merit less attention here because the estimated teaching effects changed only slightly when other explanatory variables were added. Flagship hospitals had a 9 percent lower profit margin than nonteaching hospitals. Other COTH and medical school-affiliated hospitals had about 3 percent lower profits than did nonteaching institutions. Payer mix represented the most important set of variables affecting hospital profitability. Hospitals with high proportions of Medicare, Medicaid, and self-insured patients had lower profits.

Further Discussion And Implications

Given available information, empirical analysis raises as many questions as it answers. Yet work to date does offer some implications for policymakers.

Classification. The term teaching hospital has often been applied quite loosely, fortunately not by many policymakers in recent years. It is essential to arrive at some consensus about what is meant by a teaching hospital because results depend on the definition used. We considered alternative definitions and found considerable overlap among classification systems that allow for several gradations in hospital involvement in teaching. Hospitals with a few residency programs, even those affiliated with a medical school which are not COTH members, may well fit economists’ model of on-the-job training in which trainees pay for their general training in full in the form of reduced wages.23 Major teaching hospitals, the top two groups in the teaching hierarchy, are clearly very different. Teaching is more than “teaching” in such institutions. The patient mix tends to be more skewed toward less profitable case types, and markups over cost are much lower. Perhaps because of the multiplicity of roles they seek to perform, some may not be well-managed.

Unobserved reasons for cost differences. Especially since major teaching hospitals tend to be at the high end of the cost distribution, it would be useful to know why the differential arises. We have made quite a
number of adjustments for other cost determinants, but a 20 to 40 per-
cent cost gap between major teaching and nonteaching hospitals persists. 
We have controlled for many more “other factors” than past studies, and, 
rather than have the estimated effect of teaching on cost diminish when 
controls were added, if anything, it increased. Can the gap we measured 
be fully attributable to teaching or are there other factors not explicitly 
considered by our empirical analysis that would lead one to overstate the 
effect of teaching?

One possibility is that higher cost of hospital care is offset at least in 
part by savings in cost of services of nontrainee physicians in treating 
hospitalized patients. Unfortunately, data on this type of substitution are 
practically nonexistent. A major advantage alleged for some past studies 
was that they were able to account for payments to physicians for care 
rendered to hospitalized patients. It is doubtful that findings for a veter-
ans or Medicaid population can be correctly applied more generally. But 
suppose house staff do indeed substitute for medical staff, how large 
could the potential savings be? Spending on physicians’ services is about 
two-fifths of spending on hospital care. Suppose one-half of payments to 
physicians is for care provided to patients while hospitalized and that, by 
having house staff, payments to physicians for hospital care are reduced 
by a quarter. Then there would be a 5 percent saving in physicians’ 
expenditure. This saving would greatly reduce hospital cost differences 
attributed to the hospitals with relatively minor teaching roles, but would 
only provide a modest start in accounting for the gap between major 
teaching and nonteaching hospitals. Cameron found that when pay-
ments to physicians were included, the university hospital/nonteaching 
hospital cost differential fell from 33 to 26 percent.24

We have adjusted for case-mix complexity, but some have argued that 
measures, such as the Medicare case-mix index, are subject to apprecia-
ble errors and the high error rate results in an underestimate of teaching/ 
nonteaching hospital differences in case-mix complexity.25 Such 
measurement error could cause teaching effects on hospital costs to be 
overestimated. Several studies have found substantial numbers of errors 
in coding of diagnosis on hospital discharge abstracts.26 The fact that, as 
seen above, the number of diagnoses coded by teaching hospitals tended 
to be relatively low suggests coding may have been unusually inaccurate 
in teaching institutions.

Some indication of the consequences of errors in the Medicare case-
mix index variable on our estimated teaching effects can be ascertained 
using sensitivity analysis. Even assuming a very high error rate, it is not 
possible to attribute even half of the observed cost differential in flagship 
versus nonteaching hospital cost to case-mix index errors.

Some previous research led us to believe that there may be systematic 
differences between major teaching and nonteaching hospitals in sever-
ity of illness within DRG. If so, this factor could cause us to overstate the role of teaching status on hospital cost. Except for the longer stays for particular DRGs for teaching hospitals, our analysis revealed no systematic within-DRG variation in severity. Some would say, however, that it is difficult to gauge case severity from hospital discharge data.

Part of the gap in cost per case may be attributable to a more aggressive approach to treatment in major teaching hospitals. Unfortunately, the empirical evidence in this regard is still weak and conflicting. New cost-containment measures, including Medicare’s prospective payment system, give hospitals of all types new incentives to curtail ancillary use.

Some portion of the cost difference may be attributable to waste rather than to teaching per se. However, given the other potential reasons for the difference, it would be inappropriate to attribute all or even most of the difference to inefficiency. A recent report by the Association of Academic Health Centers pointed to potential sources of inefficiency in some major teaching hospitals arising from inadequacies in: personnel and procurement policies, lines of authority and responsibility, policy planning, and in resolution of disagreements between faculty and hospital administrators.\(^{27}\)

**Implications for payment policy.** Hospitals with major commitments to teaching are far more expensive than their nonteaching counterparts for reasons not well understood. Moreover, in 1982, they were far less profitable; in fact, many major teaching hospitals operated at a loss. Since 1982, Medicare has raised its subsidy for graduate medical education, and profitability is undoubtedly different today than in 1982.

To date, third-party payers have paid the difference without asking why the difference exists. Times are changing. Virtually all payers, not only health maintenance organizations and preferred provider organizations, are beginning to insist that they pay for efficiently produced patient care and nothing else. If this change in policy becomes commonplace, major teaching hospitals will either have to radically alter the way they operate (including curtail their teaching programs), receive a subsidy in another form, or close. Since these institutions perform many socially desirable objectives, it is doubtful that society and its elected officials will permit large numbers of such hospitals to close or radically change their missions.

Some experts argue that by basing payment on more refined case-mix measures, major teaching hospitals will receive adequate compensation for the services they provide. As we have just suggested, errors in case-mix measurement cannot plausibly explain the entire cost gap or most of it. Therefore, while developing more sophisticated case-mix severity measures that can be implemented on a large scale may help, this alone will not be enough.

Another strategy is to enact various types of subsidies for uncompensated
hospital care since major teaching hospitals have relatively high charity and bad debt loads. Such an approach is probably worthy in its own right, and it could well improve major teaching hospitals’ profitability and reduce their charges in relative terms. But the cost per case difference would largely remain.

Some type of explicit subsidy for graduate medical education thus appears inevitable. The amount of the subsidy will depend in part on a social judgment concerning the relative responsibilities of students, payers—both public and private—and of taxpayers more generally. The other types of subsidies available and the adequacy of case-mix measurement for reimbursement purposes will also affect the size of the education subsidy provided. Whatever the amount, it will be necessary to decide whether the subsidy should be linked to the amount of patient care provided, the number of residents employed who satisfy certain prespecified criteria, or some other basis.

One final caveat is in order. Research to date has shown that major teaching hospitals are expensive places, both on a cost per diem and a cost per case basis. The extent to which such institutions reduce the readmission rate by rendering more effective treatment is unknown. If they do lower readmissions, major teaching hospitals may not have the disadvantage in the marketplace that this and several previous studies have suggested.
NOTES


2. For an excellent review of alternative case-mix measures, see Mark C. Hornbrook, “Hospital Case Mix: Its Definition, Measurement, and Use: Part I. The Conceptual Framework,” *Medical Care Review* 39 (Spring 1982):143; and Mark C. Hornbrook, “Hospital Case Mix: Its Definition, Measurement, and Use: Part II. Review of Alternative Measures,” *Medical Care Review* 39 (Summer 1982):73-123. Some of the measures are in the experimental stage and have not been widely implemented; in some cases, widespread implementation is unlikely.


13. A summary of wage rates for the five cities is available from the authors upon request.


20. See Pettengill and Vertrees, “Reliability and Validity in Hospital Case-Mix Measurement.” A technical explanation of the error may be found in the longer version of this paper.
21. Sloan et al., “Effects of Teaching on Hospital Costs.”
22. Cameron, “The Indirect Costs of Medical Education.”
24. Cameron, “The Indirect Costs of Medical Education.”
25. Lave, The Medicare Adjustment for Indirect Costs of Medical Education.