ORIGINAL ARTICLES

Hospital Ownership and Preventable Adverse Events

Eric J. Thomas, MD, MPH, E. John Orav, PhD, Troyen A. Brennan, MD, JD

OBJECTIVE: To determine if type of hospital ownership is associated with preventable adverse events.

DESIGN: Medical record review of a random sample of 15,000 nonpsychiatric, non-Veterans Administration hospital discharges in Utah and Colorado in 1992.

MEASUREMENTS AND MAIN RESULTS: A two-stage record review process using nurse and physician reviewers was used to detect adverse events. Preventability was then judged by 2 study investigators who were blinded to hospital characteristics. The association among preventable adverse events and hospital ownership was evaluated using logistic regression with nonprofit hospitals as the reference group while controlling for other patient and hospital characteristics. We analyzed 4 hospital ownership categories: nonprofit, for-profit, major teaching government (e.g., county or state ownership), and minor or nonteaching government.

RESULTS: When compared with patients in nonprofit hospitals, multivariate analyses adjusting for other patient and hospital characteristics found that patients in minor or nonteaching government hospitals were more likely to suffer a preventable adverse event of any type (odds ratio [OR] 2.46; 95% confidence interval [CI], 1.45 to 4.20); preventable operative adverse events (OR, 4.85; 95% CI, 2.44 to 9.62); and preventable adverse events due to delayed diagnoses and therapies (OR, 4.27; 95% CI, 1.48 to 12.31). Patients in for-profit hospitals were also more likely to suffer preventable adverse events of any type (OR, 1.57; 95% CI, 1.03 to 2.38); preventable operative adverse events (OR, 2.63; 95% CI, 1.42 to 4.87); and preventable adverse events due to delayed diagnoses and therapies (OR, 4.15; 95% CI, 1.84 to 9.34). Patients in major teaching government hospitals were less likely to suffer preventable adverse drug events (OR, 0.38; 95% CI, 0.16 to 0.89).

CONCLUSIONS: Patients in for-profit and minor teaching or nonteaching government-owned hospitals were more likely to suffer several types of preventable adverse events. Further research is needed to determine how these events could be prevented.

KEY WORDS: iatrogenic injury; adverse events; quality of care; hospital ownership; error; patient safety.
J GEN INTERN MED 2000;15:211-219.

Different means of organizing, delivering, and financing health care can create conflicts of interest that affect the quality of patient care. For example, hospitals in the United States are owned by nonprofit and for-profit corporations and by government entities. Debate and research on how these types of ownership affect the quality of medical care have existed for years, and the growth during this decade of for-profit hospital chains^{1,2} and conversions of nonprofit to for-profit hospitals³ have infused the debate surrounding for-profit ownership with newfound urgency.⁴ There is also reason to be concerned about the quality of health care in government hospitals. Government-owned hospitals rely on tax revenues and face reductions in resources in times of fiscal austerity. As well, the growth of managed care decreased financial support for public hospitals during the 1980s and 1990s,^{5,6} thus raising concern about the quality of care.

Most of the literature on ownership and quality of care addresses for-profit and nonprofit hospitals. In the 1960s concerns about the effect of the free market on the practice of medicine were clearly elucidated by Arrow,⁷ and in the 1980s many prominent observers argued that for-profit hospitals operating under free market principles would erode the profession's ethic, place the financial health of stockholders and physicians above the health of patients, and thereby decrease the quality of medical care.⁸⁻¹² In essence, these authors believed that the interests of stockholders conflicted with patient interests.

Yet empirical research based on data from the early 1980s did not find differences in quality of care between for-profit and nonprofit hospitals,¹³⁻¹⁶ nor did research find that corporate influence encouraged management intervention in medical practice.¹⁷ Studies evaluating quality of care in government-owned hospitals also failed to demonstrate quality problems.¹³

Much of this research, however, was conducted prior to the 1990s—a decade characterized by aggressive

---

Received from the Division of General Medicine, Department of Medicine, Brigham and Women's Hospital, Boston, Mass (EJT, EJO, TAB); Harvard Medical School, Boston, Mass (EJT, TAB); and the Department of Health Policy and Management, Harvard School of Public Health, Boston, Mass (TAB).

Presented in part at The Enhancing Patient Safety and Reducing Errors in Health Care Conference, Rancho Mirage, Calif, November 8-10, 1998.

Address correspondence and reprint requests to Dr. Thomas: Division of General Internal Medicine and Section of Clinical Epidemiology, Department of Medicine, University of Texas-Houston Medical School, 6431 Fannin MSB 1.122, Houston TX 77030, (e-mail: ethomas@heart.med.uth.tmc.edu).

competition between hospitals and increasing pressure by employers and insurers on nonprofit and for-profit hospitals to decrease costs.^{18,19} In fact, one recent study did find that Medicare patients in teaching hospitals had a 25% lower mortality rate than Medicare patients in for-profit hospitals.²⁰ The financial support for some government-owned hospitals has also become less generous.⁶ These financial pressures are worrisome given that several studies have found an association between a hospital's financial characteristics and its quality of care as measured by negligent injuries,²¹ mortality rates,²² and peer review.²³

Given these concerns about hospital ownership, the changing hospital market, and the lack of recent research, we analyzed data on preventable adverse events from hospitals in Utah and Colorado in 1992 to determine their association with type of hospital ownership.

METHODS

Sampling Strategy

We cooperated with the Utah Health Data Committee and the Colorado Hospital Association to sample hospital discharges in 1992. First, we characterized all hospitals in each state according to size (fewer than 8,000 discharges per year or 8,000 or more discharges per year), location (urban or rural), teaching status (major, minor, or nonteaching), and ownership (for-profit, nonprofit, or government). These characteristics came from the *American Hospital Association Guide to Hospitals*²⁴ and the Health Care Investment Analysts *Directory of U.S. Hospitals*²⁵ and were confirmed by coinvestigators from each state. Nonteaching hospitals had no interns or residents and were not affiliated with the Council of Teaching Hospitals (COTH); minor teaching hospitals had residency training programs but were not affiliated with COTH; and major teaching hospitals had residency programs and were members of COTH.

Next we created strata representing all possible combinations of these characteristics, and every hospital in each state was assigned to its appropriate stratum (12 hospitals in Utah and 15 in Colorado). At least one hospital was then chosen from each stratum on the basis of its potential interest in participating in a no-fault medical malpractice demonstration project. No hospitals refused to participate, and the investigators had no knowledge of the hospitals' adverse event rates. Psychiatric, rehabilitation, and drug or alcohol treatment diagnosis-related groups (DRGs) and hospitals that exclusively provide these services were excluded, as were Veterans Administration hospitals.

The Utah Health Data Committee randomly sampled 5,000 discharges from calendar year 1992, and the Colorado Hospital Association randomly sampled 10,000 discharges from calendar year 1992 in their comprehensive hospital discharge data sets. The number of records sampled for each hospital was proportional to the number of

that hospital's discharges relative to the total discharges of all hospitals in the study.

Record Review

First, 31 trained nurses reviewed the medical record for one of 18 criteria associated with an adverse event. Records screened positive were referred to one of 22 local physicians (board-certified family practitioners or internists) who were trained to use the Adverse Event Analysis Form.²⁶ This form uses a series of questions to facilitate reliable detection of adverse events.

The reviewers described the event, graded their confidence that an adverse event occurred, and classified the type of event by choosing one of 10 mutually exclusive categories: (1) incorrect or delayed diagnosis; (2) postoperative complication; (3) fracture-related event; (4) anesthesia-related event; (5) postpartum-related event; (6) neonatal-related event; (7) medical procedure; (8) adverse drug event; (9) incorrect or delayed therapy; and (10) fall-related event. Because the adverse events in categories 1 and 9 resulted from similar types of error, and relatively few events of these types were found, they were collapsed into one group. If more than one adverse event was found, the event that caused the most disability was counted and classified. Specialist consultation was available for the reviewing physicians by request. The review was conducted by a Colorado-based team of nurses and physicians in Colorado, and by a separate Utah team in Utah.

Because judgments about adverse events can be complex, we used a 6-point confidence scale in which 1 indicates little or no evidence that medical management caused the event; 2, slight evidence; 3, not quite likely (less than 50:50 but close call); 4, more likely than not (greater than 50:50 but close call); 5, strong evidence; and 6, virtually certain evidence. The reliability and validity of this process was evaluated during the Harvard Medical Practice Study.²⁶ We used forms identical to those used in New York except we added 2 screening criteria (numbers 17 and 18 in Appendix).

An analysis of the Harvard Medical Practice Study data found that much of the disagreement between reviewers occurred among those who had markedly low or high adverse event detection rates.²⁷ In this study, we addressed reliability in 3 ways. First, we standardized physician and nurse training by conducting only 2 training sessions for each group (one in each state), and the sessions were conducted by the same 2 investigators. The Harvard Medical Practice Study had several training sessions conducted by multiple trainers. Second, we conducted a quality control study to identify physicians with low or high adverse event detection rates. Third, we conducted an in-depth reliability study.

Definition of Variables

An adverse event was defined as an injury caused by medical management (rather than the disease process)

that resulted in either prolonged hospital stay or disability at discharge. We required a confidence score of 4 or greater from the reviewing physician to indicate the presence of an adverse event. Similar to other studies,²⁸ preventability was then independently judged by 2 study investigators who were blinded to all hospital characteristics using the same 6-point confidence scale and requiring a score of 4 or greater to indicate preventability. An adverse event was considered preventable if it was avoidable using any means currently available, unless those means were not considered standard of care. Preventable adverse events were a subset of all adverse events. For example, many adverse events, such as those related to idiosyncratic drug allergies of an individual, are not preventable.

The patient characteristics used as covariates were gender, race (white and nonwhite), age (0–15 years, 16–44 years, 45–64 years, and over 65 years), and payer (uninsured, Medicare, Medicaid, private/other, and managed care). Comorbid illness was measured using the Charlson comorbidity index.²⁹ We also recorded DRG level as a measure of casemix. This variable was created by grouping DRGs into 4 levels according to the a priori clinical likelihood that they would be associated with an adverse event.²⁴ Age, gender, DRG, and payer were obtained from the state discharge databases and confirmed by the chart reviewers. Race and Charlson score were obtained using data from the medical record.

The hospital characteristics included teaching status, location, and size, as defined above. We classified ownership as nonprofit, for-profit, major teaching government, and minor or nonteaching government. The division of government-owned hospitals is explained in the “Statistical Analysis” section.

Quality Control

To identify physician reviewers with an unacceptably high false-negative rate, a study investigator (EJT) rereviewed 50 randomly selected records of physician reviewers whose adverse event detection rate was 2 SD below the mean for the group of reviewers in their respective state. If 10% or more of the records were classified as adverse events by the investigator, their reviews were substituted with rereviews by a different reviewer who was blinded to the purpose of the rereview. To address false-positive reviews, investigators EJT and TAB also reviewed all adverse event data forms and excluded adverse events that did not meet the study definition.

Reliability of Physician Judgments

After completion of the review, we rereviewed a random sample of 500 records referred by nurses to physicians on the basis of the 18 criteria, maintaining the original 2:1 ratio of Colorado records to Utah records (333 from Colorado and 167 from Utah). Four hundred of these records were previously judged to have no adverse event

and 100 were adverse events. This mix of records provided a sample with a proportion of adverse events similar to that in the original review. Six physicians in Colorado and 4 in Utah reviewed the records, none of which they had previously reviewed. As in the original review, investigators reviewed all adverse events detected during the review and eliminated any false-positive reviews.

Statistical Analysis

Preventable adverse event rates are reported as the observed percentage of discharges with preventable adverse events. We analyzed only the preventable adverse events whose management definitely occurred in a sampled hospital, as opposed to during an office visit prior to the hospitalization.

In our database, all major teaching hospitals were government owned, so that any multivariate models that only contained the three ownership categories (for-profit, nonprofit, and government-owned) would implicitly contain an interaction term that would be difficult to interpret. We chose to simplify the interpretation, without altering the fit of the models, by explicitly combining government ownership and major teaching status into a single composite predictor.

We examined the relations among hospital ownership (major teaching government, minor or nonteaching government, for-profit and nonprofit) and preventable adverse events using logistic regression. Our goal was to determine if patients' risk of suffering preventable adverse events depended on the ownership of the hospital to which they were admitted. Therefore, the unit of analysis was the patient, and we adjusted for other specific hospital and patient characteristics. Nonprofit hospital ownership was used as the reference group because this characteristic defines the largest group of hospitals in our sample (and in the United States). Other variables in each model included hospital teaching status, size, and location, and patient age, race, gender, insurance coverage (payer), and Charlson score. The adjustment for correlation of adverse events within hospitals was carried out using the generalized estimating equation approach.³⁰

RESULTS

Thirteen hospitals in Utah and 15 in Colorado participated in the study. There were 2 major teaching hospitals (1 from each state), 8 minor teaching hospitals (2 in Utah, 6 in Colorado), and 18 nonteaching hospitals (10 in Utah, 8 in Colorado); 7 government-owned hospitals (2 in Utah, 5 in Colorado), 8 for-profit hospitals (4 in Utah, 4 in Colorado), and 13 nonprofit hospitals (7 in Utah, 6 in Colorado); 20 urban hospitals (9 in Utah, 11 in Colorado), and 8 rural hospitals (4 in Utah, 4 in Colorado); and 15 small hospitals (7 in Utah, 8 in Colorado) and 13 large (6 in Utah, 7 in Colorado).

We reviewed 14,700 (98%) of the 15,000 sampled records. Among these, nurse reviewers referred 2,868 records (19.5%) to physicians for further review. Physicians reviewed 2,820 (98.3%) of the referred records. The remainder were classified as missing.

Twenty-two physicians reviewed records for the study (16 in Utah and 6 in Colorado). The mean adverse event detection rate for the records referred by nurses to physicians for review was 19.2% in Colorado (range of mean $\pm$ SD, 2.6% $\pm$ 4.9% to 27.9% $\pm$ 2.8%) and 15.0% in Utah (range, 3.2% $\pm$ 6.2% to 53.8% $\pm$ 27%). On the basis of the quality control criteria, the reviews of 1 physician in Utah and 2 in Colorado (a total of 739 records reviewed) were discarded and redone by different reviewers. After these records were rereviewed, the entire sample of adverse events was reviewed by investigators and 13 false-positive reviews were excluded.

Of the 500 records chosen for rereview as part of the reliability study, 488 were located and reviewed (97 of 100 adverse events and 391 of 400 nonadverse events). The percentage of agreement for adverse events was 79% and the κ was 0.4 (95% CI, 0.3 to 0.5). For the judgment of preventability, there was 91% agreement among the investigators with κ of 0.81. Disagreements were discussed and consensus was reached.

Owing to the large sample, there were statistically significant differences in most patient characteristics by hospital ownership (Table 1). Major teaching government-

owned hospitals cared for fewer patients older than 65 years, but more patients 45 to 64 years old than other types of hospitals. For-profit hospitals cared for fewer uninsured and Medicaid patients and more patients with private or other insurance. Major teaching government-owned hospitals had more patients with the highest Charlson scores, and nonprofit hospitals had more patients with the lowest Charlson scores.

We detected 587 adverse events in Utah and Colorado.³¹ Of these, 170 were judged preventable and also occurred in the sampled hospitals. Examples are listed in Table 2. The mean rates of preventable adverse events are shown in Table 3. Minor teaching or nonteaching government-owned hospitals had higher preventable adverse event rates (2.02% $\pm$ 0.29%) than for-profit (1.12% $\pm$ 0.18%), major teaching (1.15% $\pm$ 0.27%), and nonprofit hospitals (0.92% $\pm$ 0.12%) (P = .0001). There were also more operative preventable adverse events in minor or nonteaching government hospitals (1.09% $\pm$ 0.22%) than for-profit (0.53% $\pm$ 0.13%), major teaching government (0.46% $\pm$ 0.18%), and nonprofit hospitals (0.35% $\pm$ 0.07%) (P = .001).

When compared with patients in nonprofit hospitals, multivariate analyses adjusting for other hospital and patient characteristics demonstrated that patients in minor teaching or nonteaching government-owned hospitals were more likely to have preventable adverse events of any type (OR, 2.40; 95% CI, 1.39 to 4.15), preventable operative adverse events (OR, 4.78; 95% CI, 2.43 to 9.41), and

Table 1. Patient Characteristics by Hospital Ownership, %

Characteristic	Major Teaching Hospital	Minor Teaching or Nonteaching Hospital	For-Profit Hospital	Nonprofit Hospital
Age*				
Newborn	13.3	16.6	11.8	17.5
≤15 y	2.4	7.8	3.0	4.4
16–44 y	44.4	34.8	36.3	36.9
45–64 y	22.7	16.0	18.6	15.6
65+ y	17.2	24.8	30.4	25.6
Female	56.8	60.0	61.7	61.6
White	75.5	71.3	84.5	76.3
Payer*				
Uninsured	15.9	4.5	2.5	5.9
Medicare	20.3	30.2	29.3	24.1
Medicaid	31.8	18.9	9.8	12.5
Private/other	25.9	46.1	47.6	45.9
Managed care	6.1	0.3	10.8	11.6
Charlson morbidity score*				
0	56.8	63.8	67.5	70.8
1–2	21.3	23.6	20.2	17.2
3–4	5.5	6.2	6.8	5.3
5 or greater	9.7	6.1	5.0	4.6
Diagnostic related group level				
1	24.5	24.2	23.4	29.3
2	33.1	31.2	29.7	29.1
3	29.8	32.1	33.7	31.2
4	12.7	12.5	13.2	10.4

*All P values < .001.

Table 2. Examples of Preventable Adverse Events**Drug-related event**

- ◆ A 44-year-old woman was admitted with an asthma exacerbation. During the hospitalization she was given a nonsteroidal anti-inflammatory drug despite a previous history of an allergic reaction (bronchospasm) to this group of medications. This medication worsened her asthma.
- ◆ An 80-year-old woman developed digitalis toxicity due to inadequate monitoring.

Operative event

- ◆ A 39-year-old woman underwent a laparoscopic cholecystectomy and three days later developed fever and abdominal pain due to a bile leak.
- ◆ A 60-year-old man underwent coronary artery bypass surgery. Afterward he had a foot drop due to pressure placed on the perineal nerve during surgery.

Delayed or incorrect diagnoses and therapies

- ◆ A 34-year-old woman with history of inflammatory bowel disease was admitted with abdominal pain, disorientation, fever, and a white blood cell count of 26,000 with a left shift. Three days after admission she died, and the autopsy showed gangrenous bowel. She was in the hospital for three days without a clear diagnosis and without a surgical evaluation. No vital signs were recorded during the last 12 hours of admission.
- ◆ A 91-year-old woman was admitted for cholecystitis. For 2 days prior to surgery she was given intravenous fluids for presumed volume depletion without monitoring of pulmonary examinations, weight, or urinary output. She subsequently developed congestive heart failure that prolonged her hospital stay.

Medical procedure events

- ◆ A 55-year-old man underwent percutaneous transluminal coronary angioplasty and suffered dissection of the left main coronary artery.
- ◆ A 73-year-old woman with syncope due to arrhythmia had a pacemaker inserted. However, the syncope continued because the pacemaker wire was improperly placed.

preventable adverse events due to delayed or incorrect diagnoses and therapies (OR, 4.23; 95% CI, 1.45 to 12.26).

Patients in for-profit hospitals compared with patients in nonprofit hospitals were more likely to suffer preventable adverse events of any type (OR, 1.54; 95% CI, 1.00 to 2.40), preventable operative adverse events (OR, 1.54; 95% CI, 1.43 to 4.99), and preventable adverse events due to delayed or incorrect diagnoses and therapies (OR, 4.05; 95% CI, 1.79 to 9.13). Patients in major teaching government hospitals were less likely to suffer preventable adverse drug events (OR, 0.37; 95% CI, 0.16 to 0.84). The results of 5 logistic regression analyses are presented in Table 4.

DISCUSSION

We found that the quality of inpatient medical care, as measured by the occurrence of preventable adverse

events, varied by type of hospital ownership in Utah and Colorado in 1992. Preventable adverse events of any type occurred more often to patients in minor teaching or non-teaching government-owned hospitals than to patients in nonprofit hospitals. These government-owned hospitals also experienced a higher frequency of adverse events in 2 specific categories—preventable operative adverse events, and preventable adverse events due to delayed or incorrect diagnoses and therapies. Similarly, for-profit ownership, compared with nonprofit ownership, was also significantly associated with preventable adverse events of any type, with preventable operative adverse events, and with preventable adverse events due to delayed or incorrect diagnoses and therapies.

Our results related to the existing literature on hospital ownership and quality of care in several ways. First, our study adds empirical data to the ongoing debate about whether government should intervene to protect

Table 3. Rates of Preventable Adverse Events by Hospital Ownership*

Adverse Events	Government -Owned		For Profit Hospital	Nonprofit Hospital
	Major Teaching Hospital	Minor Teaching or Nonteaching Hospital		
All preventable				
Drug events	1.15 ± 0.27 (20)	2.02 ± 0.29 (48)	1.12 ± 0.18 (38)	0.92 ± 0.12 (64)
Operative events	0.06 ± 0.10 (1)	0.17 ± 0.10 (4)	0.15 ± 0.07 (5)	0.12 ± 0.04 (8)
Delayed or incorrect diagnoses or therapies	0.46 ± 0.18 (8)	1.09 ± 0.22 (26)	0.53 ± 0.13 (18)	0.35 ± 0.07 (24)
Medical procedure events	0.23 ± 0.13 (4)	0.38 ± 0.14 (9)	0.26 ± 0.09 (9)	0.13 ± 0.05 (9)
Other	0.23 ± 0.13 (4)	0.17 ± 0.10 (4)	0.09 ± 0.06 (3)	0.14 ± 0.05 (10)
	0.17 ± 0.12 (3)	0.21 ± 0.11 (5)	0.09 ± 0.06 (3)	0.19 ± 0.06 (13)

*Values are presented as means ± SE, with number of events in parentheses.

Table 4. Multivariate Analysis of Hospital Characteristics Associated with Preventable Adverse Events*

Characteristic	Odds Ratio (95% Confidence Interval)
All preventable adverse events	
Major teaching government	1.44 (0.71 to 2.91)
Minor teaching or nonteaching government	2.46 (1.45 to 4.20)
For profit	1.57 (1.03 to 2.38)
Preventable adverse drug events	
Major teaching government	0.37 (0.16 to 0.89)
Minor teaching or nonteaching government	0.92 (0.26 to 3.27)
For profit	0.99 (0.48 to 2.02)
Preventable operative adverse events	
Major teaching government	2.30 (0.86 to 6.13)
Minor teaching or nonteaching government	4.85 (2.44 to 9.62)
For profit	2.63 (1.42 to 4.87)
Preventable adverse events due to delayed diagnoses and therapies	
Major teaching government	2.21 (0.61 to 8.03)
Minor teaching or nonteaching government	4.27 (1.48 to 12.31)
For profit	4.15 (1.84 to 9.34)
Preventable medical procedure adverse events	
Major teaching government	2.27 (0.57 to 9.05)
Minor teaching or nonteaching government	1.17 (0.31 to 4.46)
For profit	0.65 (0.29 to 1.46)

*Adjusted for patient age, race, gender, insurance types, Charlson comorbidity score, state, teaching status, size, and location, compared with nonprofit hospitals.

nonprofit hospitals.³² Proponents of government intervention argue that nonprofit hospitals yield important social benefits compared with for-profit hospitals including research, free care to the poor, and community-based education and disease prevention.³³ However, it is not clear whether these activities are inherently a part of nonprofit ownership and thereby generalizable to all nonprofit hospitals. Rather, these social benefits may be due to hospital characteristics such as teaching status or religious affiliation. Given this and other uncertainties, the potential costs of government intervention to encourage nonprofit ownership may outweigh the benefits.³² Our study suggests that quality of care as measured by preventable adverse events is another factor that should be considered in this debate.

Second, although we did not directly measure financial characteristics of our hospitals, from existing literature we hypothesize that government-owned, publicly supported hospitals may have been hampered by insufficient financial resources, a factor that previous studies have connected with substandard care.^{21–23} Because they are dependent on government allocations, public hospitals can face restric-

tions in funding when tax revenues decrease or other competing interests claim public support.³⁴ Data from Colorado suggest that many small government hospitals experienced financial losses in 1992.³⁵

Concerning for-profit hospitals, it is also possible that these events may be the result of fewer financial resources available for clinical care after profits are redirected to shareholders. For example, there are anecdotal reports about staff reductions, replacement of registered nurses with less-qualified personnel, less investment in equipment, and earlier discharges in for-profit hospitals.^{18,19,36,37} Empirical studies have found lower adverse event rates associated with an increased percentage of registered nurses, but these studies did not explicitly address the influence of hospital ownership.^{38,39} However, other studies have found no relation between nurse staffing and adverse events.^{40,41} In summary, it is possible that the availability of adequate funds for patient care activity is as important as the type of ownership.

It is probably simplistic, however, to believe that profit motive at the level of hospital ownership is uniformly harmful to patients. Moreover, for-profit hospital systems state they are committed to better-quality health care and believe that such commitment brings more profit.^{42–44}

Third, our results are consistent with current thinking about the effects of organizational characteristics and systems on the occurrence of errors. Leape has argued that errors committed by health care professionals are often the result of system failures rather than purely the fault of the individual who committed the error.⁴⁵ His reasoning arises in part from the experience of other industries, which has shown that accidents are often the end result of a chain of events due to “latent” errors that exist within a system.^{46,47} The exact nature of such latent system errors is in turn determined by overlying organizational features of the system, such as who owns the system and the regulatory environment within which it functions.⁴⁸ Although traditional efforts to control errors in medicine have focused on individual health care providers (e.g., peer review and medical malpractice),⁴⁹ these new theories recognize that humans will always make errors, that some errors are due to organizational characteristics, and that the best way to prevent errors and adverse events is to change the systems within which individuals work. Our findings lend empirical support to these ideas by linking an organizational characteristic (hospital ownership) to the occurrence of preventable adverse events.

The generalizability of our results is one important limitation. Our results reflect care provided to hospitalized patients in Utah and Colorado in 1992, and given the heterogeneity of for-profit hospital chains and state and local governments, our findings may only apply to the hospitals we studied. Nonprofit hospitals may be adopting some of the same cost-cutting practices that might have increased the incidence of some preventable adverse events

in for-profit and government-owned hospitals. In addition, some states more closely regulate their hospitals than Utah and Colorado, or simply have dramatically different economic and geographic features affecting hospitals.

The reliability of physician judgments about adverse events and reliance on medical records to detect events are other limitations. Reanalysis of the Harvard Medical Practice Study data has highlighted disagreement between reviewers, and we hypothesized that some of this disagreement could be due to individual reviewers who did not properly learn study criteria. Although the reliability of adverse event judgments was not perfect, it was similar to the reliability of commonly used diagnostic tests such as screening mammography ($\kappa = 0.47$),⁵⁰ and the RAND methodology for estimating overuse of hysterectomy ($\kappa = 0.52$).⁵¹

Furthermore, although disagreement in reviewers' judgments about adverse event affects the estimate of the absolute number of adverse events, any misclassification was likely to be randomly distributed among the patient and hospital characteristics.⁵² Therefore, associations between these characteristics and adverse events appear valid.

Our method of reviewing inpatient medical records to identify adverse events has other limitations. First, adequate documentation must be present in the record to identify adverse events. Second, we did not count adverse events that may have resulted in increased intensity of care if they did not prolong hospital stay or cause disability at discharge. Third, our hospital selection ensured a representative sample (for the characteristics size, location, teaching status, and ownership), but the hospitals within each stratum were not randomly selected. Therefore, selection bias could have lowered our estimates of the adverse event rates if hospitals with poor quality of care did not participate. However, all of the hospitals approached agreed to participate, and the investigators had no knowledge of any hospital's adverse event rates prior to the study.

Detection bias related to variation in documentation or reviewer bias was also possible, but we do not suspect that these types of events were better documented in for-profit or government-owned hospitals than in nonprofit hospitals. Although reviewers might have known the ownership status of the hospitals, they were not aware of this analysis' hypothesis.

Our results suggest several avenues for future research. We agree with Mitchell and Shortell, who in their recent review of adverse outcomes and organization of care delivery concluded that adverse events may be one of the more sensitive indicators of quality problems related to organizational factors.⁵³ We need to identify and better measure adverse events that are logically related to structures and processes of care,⁴⁹ in addition to considering psychological theories about why errors occur,⁴⁷ and systems analyses of adverse events.^{48,54}

To conclude, this study supports concerns about the rapidly growing for-profit hospital sector's effect on the

quality of medical care, while also finding significant quality problems in minor teaching or nonteaching government-owned hospitals in Utah and Colorado. Our findings should prompt more research into how hospital ownership affects quality of care. They might also be considered by regulators when considering conversions of nonprofit to for-profit hospitals, and they should encourage state and local governments to more thoroughly evaluate quality in their nonteaching government-owned hospitals.

Funding for this work was provided by the Robert Wood Johnson Foundation.

REFERENCES

1. Eckholm E. While congress remains silent, healthcare transforms itself. *New York Times*. December 18, 1994:A1.
2. Tomsho R. Giant hospital chain uses tough tactics to push fast growth. *Wall Street Journal*. July 12, 1994:A1, A6.
3. Gray B. H. Conversion of HMO's and hospitals: what's at stake? *Health Aff (Millwood)*. 1997;16(2):29-47.
4. Ad Hoc Committee to Defend Health. For our patients, not for profits: a call to action. *JAMA*. 1997;278:1733-4.
5. Prospective Payment Assessment Commission. Annual Report. Washington, DC; 1991.
6. Andrulis DP. The public sector in health care: evolution or dissolution? *Health Aff (Millwood)*. 1997;16(4):131-40.
7. Arrow KJ. Uncertainty and the Welfare economics of medical care. *Am Econ Rev*. 1963;53:941-73.
8. Starr P. *The Social Transformation of American Medicine*. New York, NY: Basic Books; 1982.
9. Pellegrino E. In: Williams K, Donnelly P, eds. *Medical Care Quality and the Public Trust*. Chicago, Ill: Pluribus Press; 1982:ix-xiv.
10. Ginzberg E. For-profit medicine, reassessment. *N Engl J Med*. 1988;319:757-61.
11. Relman AS. The new medical-industrial complex. *N Engl J Med*. 1980;303:963-70.
12. Relman AS. Shattuck Lecture. The health care industry: where is it taking us? *N Engl J Med*. 1991;325:854-9.
13. Shortell SM, Hughes EF. The effects of regulation, completion, and ownership on mortality rates among hospitalized inpatients. *N Engl J Med*. 1988;318:1100-7.
14. Gray BH, McWerney WS. For-profit enterprise in health care. The institute of medicine study. *N Engl J Med*. 1986;314:1523-8.
15. Watt JM, Derzon RA, Renn SC, Schramm CS, Hahn JS, Pillari GD. The comparative economic performance of investor-owned chain and not-for-profit hospitals. *N Engl J Med*. 1986;314:89-96.
16. Pattison RV, Katz HM. Investor-owned and not-for-profit hospitals: comparison based on California data. *N Engl J Med*. 1983;309:347-53.
17. Campbell P, Kane N. Physician-management relationships at HCA: a case study. *J Health Polit Policy Law*. 1990;15(3):591-605.
18. Kuttner R. Columbia/HCA and the resurgence of the for-profit hospital business (first of two parts). *N Engl J Med*. 1996;335:446-51.
19. Kuttner R. Columbia/HCA and the resurgence of the for-profit hospital business (second of two parts). *N Engl J Med*. 1996;335(6):446-51.
20. Taylor DH, Whellan DJ, Sloan FA. Effects of admission to a teaching hospital on the cost and quality of care for Medicare beneficiaries. *N Engl J Med* 1999;340:293-9.
21. Burstin HR, Lipsitz SR, Udvarhelyi IS, Brennan TA. The effect of hospital financial characteristics on quality of care. *JAMA*. 1993;270:845-9.
22. Hartz AJ, Krakauer H, Kuhn EM, et al. Hospital characteristics and mortality rates. *N Engl J Med*. 1989;321:1720-5.

23. Hartz AJ, Gottlieb MS, Kuhn EM, Rimm AA. Relationship of hospital characteristics and the results of peer review in six larger states. *Med Care*. 1991;291:1028-38.
24. Hospital Association Guide to Hospitals. Chicago, Ill: American Hospital Association, 1993.
25. Health Care Investment Analysts. Directory of U.S. Hospitals. Baltimore, Md: HCIA; 1993.
26. Brennan TA, Leape LL, Laird NM, et al. Incidence of adverse events and negligence in hospitalized patients: results of the Harvard Medical Practice Study I. *N Engl J Med*. 1991;324:370-6.
27. Localio AR, Weaver SL, Landis R, et al. Identifying adverse events caused by care: degree of physician agreement in retrospective chart review. *Ann Intern Med*. 1996;125:457-64.
28. Bates DW, Cullen DJ, Laird N et al., for the ADE Prevention Study Group. Incidence of adverse drug events and potential adverse drug events: implications for prevention. *JAMA*. 1995;274:29-34.
29. Charlson ME, Pompei P, Ales KL, Mackenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis*. 1987;40:373-83.
30. Diggle PJ, Liang K, Zeger SL. *Analysis of Longitudinal Data*. Oxford, UK: Clarendon Press; 1995.
31. Thomas EJ, Studdert DM, Burstin HR, et al. Incidence and types of adverse events and negligent care in Utah and Colorado in 1992. *Med Care*. 2000. In press.
32. Bloche MG. Should government intervene to protect nonprofits? *Health Aff (Millwood)*. September/October 1998:7-25.
33. Schlesinger M, Gray BH, Bradley E. Charity and community: the role of non-profit ownership in a managed health care system. *J Health Polit Policy Law*. 1996;21:697-751.
34. Andrulis D, Acuff KL, Weiss KB, Anderson RJ. Public hospitals and health reform: choices and challenges. *Am J Public Health*. 1996;86:162-5.
35. Colorado Hospitals Reference Guide. Denver, Colo: Colorado Hospital Association; 1997.
36. Ginzberg E. The patient as profit center: Hospital Inc. comes to town. *The Nation* November 1996:18-22.
37. Cherry RL. Agents of nursing home quality of care: ombudsmen and staff ratios revisited. *Gerontologist*. 1991;31(3):302-8.
38. Iezzoni LI, Daley J, Heeren T, et al. Using administrative data to screen hospitals for high complication rates. *Inquiry*. 1994; 31(1):40-55.
39. Munro DJ. The influence of registered nurse staffing on the quality of nursing home care. *Res Nurs Health*. 1990;13:263.
40. Silber JH, Rosenbaum PR, Schwartz JS, Ross RN, Williams SV. Evaluation of the complication rate as a measure of quality of care in coronary artery bypass graft surgery. *JAMA*. 1995;274(4):317-23.
41. Wan TT, Shukla RK. Contextual and organizational correlates of the quality of hospital nursing care. *QRB Qual Rev Bull*. 1987; 13(2):61-4.
42. Limbacher PB. Another hit for Columbia. *Mod Healthcare*. 1998;28:2-4.
43. Limbacher P. Columbia: year in review—Federal probe, new management leave their mark. *Mod Healthcare*. 1998;28:26-30.
44. Hasan M. Let's end the non-profit charade. *N Engl J Med*. 1996;335:1057-8.
45. Leape LL. Error in medicine. *JAMA*. 1994;272:1851-7.
46. Perrow C. *Normal Accidents: Living with High Risk Technologies*. New York, NY: Basic Books; 1984.
47. Reason J. *Human Error*. New York, NY: Cambridge University Press; 1990.
48. Moray N. Error reduction as a systems problem. In: Bogner MS, ed. *Human Error in Medicine*. Hillsdale, NJ: Erlbaum; 1994.
49. Brennan TA, Berwick DM. *New Rules: Regulation, Markets and the Quality of American Health Care*. San Francisco, Calif: Jossey-Bass Inc; 1996.
50. Elmore JG, Wells CK, Lee CH, Howard DH, Feinstein AR. Variability in radiologists' interpretations of mammograms. *N Engl J Med*. 1994;331:1493-9.
51. Shekelle PG, Kahan JP, Bernstein SJ, Leape LL, Kamberg CJ, Park RE. The reproductibility of a method to identify the overuse and underuse of medical procedures. *N Engl J Med*. 1988;338:1888-95.
52. Brennan TA, Hebert LE, Laird NM, et al. Hospital characteristics associated with adverse events and substandard care. *JAMA*. 1991;265:3265-9.
53. Mitchell PH, Shortell SM. Adverse outcomes and variations in organization of care delivery. *Med Care*. 1997;35:NS19-NS32.
54. Leape LL, Bates DW, Cullen DJ, et al. Systems analysis of adverse drug events: ADE prevention group. *JAMA*. 1995;274(1):35-43.

APPENDIX

Screening Criteria Used by Nurse Reviewers

-
1. Prior hospitalization within 1 year and patient less than 65 years old, or prior hospitalization within 6 months and patient at least 65 years old.
  2. Subsequent admission to any hospital after this discharge.
  3. Was there any hospital-incurred trauma?
  4. Was there an adverse drug reaction while in the hospital?
  5. Was the patient transferred from a general care unit to a special care unit?
  6. Was the patient transferred to another acute care hospital?
  7. Did the patient return to the operating room during this admission?
  8. Was the treatment or operation performed because of damage to organ or organ systems subsequent to an invasive procedure?
  9. Did the patient have a myocardial infarction, stroke, or pulmonary embolism during or after an invasive procedure?
  10. Did the patient have a new neurological deficit at the time of discharge?
  11. Did the patient die?
  12. Was the patient's temperature greater than 101°F (38.3°C) on the day prior to discharge?
  13. Did the patient have a cardiac/respiratory arrest?
  14. Was there injury or complication related to abortion, amniocentesis, or labor and delivery?
  15. Were there other undesirable outcomes?
  16. Was there correspondence in the medical record suggesting litigation?
  17. Was there an injury or complication related to ambulatory surgery or an invasive procedure that resulted in admission or emergency department evaluation?
  18. Was there an unplanned open surgical procedure or admission following a planned ambulatory laparoscopic or closed procedure?