Performance Measures

Does the Leapfrog Program Help Identify High-Quality Hospitals?

Ashish K. Jha, M.D., M.P.H.; E. John Orav, Ph.D.; Abigail B. Ridgway; Jie Zheng, Ph.D.; Arnold M. Epstein, M.D., M.A.

Quality of health care remains an ongoing concern for consumers, payers, and policy makers.[1,2] There are a number of national initiatives to measure quality and drive improvements in care. One initiative that has received significant attention is an effort by a group of purchasers known as the Leapfrog Group.[3] Founded in 2000, the Leapfrog coalition includes more than 65 employers and agencies that together purchase care for more than 34 million people. The Leapfrog Group has focused on measuring and reporting hospitals' adoption of evidence-based practices to improve patient safety. Through annual surveys, the program measures whether hospitals have adopted these practices and makes the data publicly available on the Leapfrog Group Web site (http://www.leapfroggroup.org). One goal of the program is to direct consumers to hospitals that have adopted Leapfrog's patient safety practices (PSPs).[4]

Despite the prominence of this program, there is surprisingly little known about the hospitals identified by the Leapfrog Group as having made efforts toward improving patient safety. There are few data on which hospitals are targeted and whether those who have adopted the Leapfrog practices provide better quality of care more broadly. Given that each of the Leapfrog recommendations is evidence based,[5–7] one could argue that adopting these practices is itself valuable. However, because Leapfrog only focuses on a narrow aspect of care (patient safety), understanding whether its measures are associated with other indicators of care such as process of care, or clinical outcomes, would be valuable.

The study described in this article was intended to answer three questions: First, what are the characteristics of hospitals that report having made some progress on Leapfrog's patient safety goals? Second, do those hospitals perform better on standard process of care metrics? Finally, do those hospitals have better patient outcomes as measured by risk-adjusted mortality rates?

Methods

Data

We used data from the most current version of the Leapfrog survey of hospitals (version 3.0), which was last updated in

Article-at-a-Glance

Background: Founded in 2000, the Leapfrog Group includes more than 65 employers and agencies that together purchase care for more than 34 million people. It has focused on measuring and reporting hospitals' adoption of evidence-based practices to improve patient safety. Whether this program helps identify high-quality hospitals is unknown. A study was conducted to determine whether hospitals that report patient safety practice activities have better quality of care or clinical outcomes.

Methods: Hospitals targeted by Leapfrog for implementation of three sets of patient safety practices—computerized physician order entry (CPOE), intensive care unit physician staffing, and evidence-based referrals (EBRs) for high-mortality surgeries—were examined. Data from the Hospital Quality Alliance (HQA) were used to determine quality of care and outcomes for acute myocardial infarction (AMI), congestive heart failure (CHF), and pneumonia.

Results: Among the 1,860 hospitals targeted by Leapfrog, those with substantive efforts implementing three sets of patient safety practices had better quality of care for all three conditions, although the differences were small for pneumonia. For example, hospitals with CPOE had better AMI quality scores than those that either did not have CPOE or those that chose not to report (95.2% versus 92.0% versus 90.1%, respectively; $p < .001$). Hospitals with CPOE and IPS had lower 30-day mortality rates for AMI and pneumonia. For example, the 30-day AMI mortality rate for hospitals with CPOE was 15.2% compared with hospitals without CPOE (16.7%) or nonreporting hospitals (17.8%; *p* value for difference = .002). The results for the six EBRs were similar.

Discussion: Consumers who choose hospitals identified by Leapfrog as having begun to implement patient safety practices will likely find hospitals with better process quality and lower mortality rates.

April 2006. This data set is based on surveys of 1,860 hospitals in 29 geographic regions targeted by the organization. Leapfrog attempts to survey all hospitals in the regions where it has coalition members (purchasers), so although the survey does not represent a random survey of all hospitals in the United States, it is representative of all regions in which Leapfrog has members. The Leapfrog survey focuses on the following three main safety practices:

1. The institution of computerized physician order entry (CPOE) systems
2. Use of intensivists (providers specially trained in critical care) staffing of intensive care units (ICUs)
3. Evidence-based referrals, which incorporate a combination of minimal thresholds of patient volume in six types of surgeries and other processes of care shown to improve surgical outcomes for those procedures[3]

The Leapfrog Group also collects data on 27 other patient safety practices that have been endorsed by the National Quality Forum (NQF), such as reducing the occurrence of surgical site infections or venous thromboembolism, although fewer hospitals report these data.

To measure performance on quality measures, we used data from the October 1, 2006, public release of the Hospital Quality Alliance (HQA) program. These data include quality performance scores for 4,301 acute care hospitals during the calendar years 2004 and 2005 on acute myocardial infarction (AMI), congestive heart failure (CHF) and pneumonia. Because the federal government provides financial incentives for reporting HQA data, almost all hospitals that provide care for patients with these conditions participate. Although HQA now has data on a total of 20 process measures, we limited our analyses to the 10 that are known as the "starter set," because the Medicare Modernization Act of 2003 only provides financial incentives for reporting these 10 measures.[8] Therefore, although most hospitals report data on these 10 measures, a relatively small number of hospitals also report data on the other 10.

We linked Leapfrog and HQA data with the annual survey of the American Hospital Association to obtain information about hospital characteristics. Finally, we combined this data set with the 2004 MedPAR Part A data set (100% file), which has discharge-level data for all hospitalizations of Medicare beneficiaries enrolled in the Medicare fee-for-service program. The MedPAR data set provided patient demographic and clinical information for severity adjustment, as well as our primary outcome of 30-day mortality.

Leapfrog Measures. We categorized hospitals targeted by the Leapfrog Group survey into three groups: those that chose not to participate in the survey (labeled "nonreporters"), those that participated but did not have any substantial implementation efforts ongoing in a patient safety area (labeled "willing to report publicly"), and those that had begun to implement a specific patient safety practice (labeled "implementation started"). We examined each of the main patient safety focus areas individually: the implementation of CPOE, intensivist staffing of intensive care (IPS), and referral and clinical processes for six high-risk conditions (known as evidence-based referrals [EBRs]). The six high-risk procedures include coronary artery bypass graft surgery (CABG), percutaneous coronary intervention (PCI), abdominal aortic aneurysm repair (AAA), pancreatic resection (PANC), esophagectomy (ESOP), and high-risk deliveries (neonatal intensive care unit [NICU]). The details of the individual PSPs and the criteria for being classified as having begun implementation can be found at http://www.leapfroggroup.org.

Hospital Quality Measures. For each hospital, we used 10 HQA performance indicators to calculate a summary performance score for each of the three conditions: AMI, CHF, and pneumonia. There were five performance indicators for AMI: aspirin at arrival, aspirin at discharge, beta blocker at arrival, beta blocker at discharge, and angiotensin-converting enzyme (ACE) inhibitor for left ventricular systolic dysfunction; two indicators for CHF: left ventricular function assessment, and ACE inhibitor for left ventricular systolic dysfunction; and three indicators for pneumonia: initial antibiotic timing, pneumococcal vaccination, and oxygenation assessment. To create summary scores for each condition, we used a methodology prescribed by The Joint Commission.[9] In this approach, the summary score is the number of times a hospital performed the appropriate action across all measures for that condition divided by the number of opportunities the hospital had to provide appropriate care for that condition. Composite scores were only calculated if a hospital had at least 30 patients for that condition.

Patient Outcomes. Three subgroups of patients were chosen from the MedPAR database, and we limited our analyses to those 65 years of age or older. The first subgroup was composed of patients discharged with a primary diagnosis of AMI (using *International Classification of Diseases, Ninth Revision, Clinical Modification* [ICD-9-CM] codes 410.XX); the second subgroup was patients discharged with the primary diagnosis of CHF (ICD-9-CM codes 398.91, 428.0 to 428.9); and the third subgroup consisted of patients discharged with the primary diagnosis of pneumonia (ICD-9-CM codes 480 to 486).

These three common conditions are associated with significant morbidity and mortality and correspond directly to the HQA data. We used a patient-level Elixhauser comorbidity adjustment scheme to calculate a risk-adjusted 30-day mortality rate for each of the three conditions for each hospital.[10] This technique is now widely used and supported by the Agency for Healthcare Research and Quality (AHRQ) as the risk-adjustment method of choice.

Statistical Analyses

We used analyses of variance (ANOVA) to compare HQA summary scores for each condition (AMI, CHF, pneumonia) between hospitals on the basis of their state of implementation of patient-safety practices (did not report, public reporting only, or some implementation started). To determine if the state of implementing Leapfrog PSPs was associated with quality *independent* of other hospital characteristics, we built multivariable models that adjusted for teaching status, number of hospital beds, owner status, urban location, and geographic region. Because these results were similar in the magnitude, direction, and statistical significance of the relationship, we present findings only from the bivariate analyses.

To examine the relationship between adoption of each PSP and 30-day mortality rates, we then built multivariable regression models. We built separate models for AMI patients, CHF patients, and pneumonia patients with each discharge as the unit of analysis, adjusting for age, sex, race, and the presence or absence of 29 unrelated comorbidities as specified by the Elixhauser comorbidity adjustment scheme. All models were adjusted for the clustering of patients at the hospital level through the use of generalized estimating equations with an exchangeable correlation structure. We also reran these models adjusting for the hospital characteristics as described to determine if adoption of PSPs was independently associated with lower mortality. Once again, our results were nearly identical to those models that did not adjust for hospital characteristics and, therefore, only the original results are presented.

Results

Targeted Hospitals

Of the 4,552 hospitals listed as providers of "general medical and surgical care" in the American Hospital Association annual survey, there were 1,860 hospitals in the regions targeted by the Leapfrog Group for its 2005 annual survey. When we compared the characteristics of hospitals targeted by Leapfrog to all hospitals in the United States, we found that targeted hospitals were more likely to be large, urban, and teaching hospitals with medical or cardiac ICUs (Table 1, above).

Table 1. Characteristics of Hospitals Targeted by the Leapfrog Group*

Hospital Characteristics	All U.S. Hospitals† *N* = 4,552	Targeted for Survey *N* = 1,860
Hospital Size		
Small (< 100 beds)	46%	32%
Medium (100–399 beds)	45%	54%
Large (≥ 400 beds)	9%	14%
Teaching Hospitals	6%	10%
Urban Hospitals	53%	74%
Profit Status		
For Profit	15%	17%
Not for Profit-Nonpublic	61%	67%
Not for Profit-Public	24%	16%
Hospital region		
Northeast	13%	17%
Midwest	29%	17%
South	39%	42%
West	19%	25%
Presence of Cardiac ICU	34%	42%
Presence of Medical ICU	65%	74%

* ICU, intensive care unit.

† All hospitals in the United States listed in the 2005 American Hospital Association survey as providing "general medical and surgical care."

Of the 1,860 targeted hospitals, 790 chose not to disclose their PSP activities, whereas 1,070 hospitals were willing to report their activities publicly. Hospitals that had begun to implement at least one PSP were generally larger and more likely to be teaching hospitals than hospitals that did not report or were not implementing patient safety practices. Those implementing Leapfrog PSPs were also more likely to be private not-for-profit hospitals and were more often located in urban areas (Table 2, page 321).

Relationship Between Leapfrog Reporting and HQA Metrics

We were able to calculate at least one HQA summary score for 1,672 hospitals in the Leapfrog survey, 90% of the 1,860 of those targeted by the Leapfrog Group. Hospitals that had begun to implement CPOE had higher performance on AMI quality measures than those that either had no activity or those that chose not to report (95.2% versus 92.0% versus 90.1%; respectively; $p < .001$; Table 3, page 322) and followed a similar pattern for CHF (90.9% versus 84.8% versus 83.6%; respectively; $p < .001$). The differences between these three sets of hospitals for pneumonia care were much smaller and,

Table 2. Characteristics of Hospitals That Were Targeted by Leapfrog by Their Reporting Status*

Hospital Characteristics	Chose Not To Report *n* = 790	Reported No Implementation *n* = 388	Implementation Started *n* = 682
Hospital Size			
Small (< 100 beds)	44%	53%	5%
Medium (100–399 beds)	47%	46%	67%
Large (≥ 400 beds)	9%	1%	28%
Teaching Hospitals	6%	1%	20%
Urban Hospitals	62%	57%	95%
Profit Status			
For Profit	10%	24%	21%
Private, Not for Profit	67%	62%	71%
Public, Not for Profit	23%	14%	8%
Hospital region			
Northeast	23%	10%	15%
Midwest	42%	39%	27%
South	11%	30%	31%
West	24%	22%	28%
Presence of Cardiac ICU	33%	27%	62%
Presence of Medical ICU	65%	70%	86%
Total	42%	21%	37%

* *p* values for all comparisons < .001. ICU, intensive care unit.

although statistically significant, were of marginal clinical significance. In the same manner, hospitals that staff ICUs with intensivists had substantially better AMI and CHF performance, but differences in quality of pneumonia care were not clinically substantial (Table 3).

When we examined hospitals' activities on Leapfrog's EBR practices for six high-risk surgeries, we found a similar pattern (Figures 1a–c, page 323). Hospitals that had begun to implement EBR practices (such as only performing surgeries if they had adequate volume) had better performance on AMI and CHF quality scores compared with hospitals that were only willing to report publicly or hospitals that chose not to participate, but the differences in terms of pneumonia quality scores were, again, inconsistent.

Relationship Between Leapfrog Reporting and Risk-Adjusted Mortality

We found that hospitals that had begun to implement Leapfrog practices had lower risk-adjusted mortality rates than others, at least for two of the three conditions. Patients admitted for an AMI to hospitals that had begun CPOE implementation were approximately less likely to die within 30 days compared with patients admitted to hospitals without CPOE or to nonreporting hospitals (absolute mortality rates 15.2% versus 16.7% versus 17.8%; respectively; $p = .002$). Similarly, hospitals that had begun to implement CPOE had lower pneumonia mortality rates compared with hospitals without CPOE or hospitals that chose not to report (11.5% versus 11.9% versus 12.5%; respectively; $p = .004$). Although hospitals that had begun CPOE implementation seemed to have slightly lower mortality rates for CHF, these differences were small and not statistically significant. When we examined hospitals on the basis of whether they had begun to implement intensivists staffing of ICUs, we found nearly identical results: substantially lower AMI mortality rates, modestly lower pneumonia mortality rates, but no statistically significant differences in mortality rates for patients admitted for CHF (Table 4, page 322, second set of rows). Finally, when we examined mortality rates for these three medical conditions based on hospitals' EBR practices (Figures 2a–c, page 324), we found a consistent pattern of lower AMI mortality, modestly lower pneumonia mortality, and generally comparable CHF mortality.

When we examined differences in process measures and outcomes comparing hospitals that had begun to implement PSPs with hospitals that had not (combining nonreporters and those willing to report publicly but without actual implementation), we found broadly similar results with a few important differences. Hospitals that had begun to implement CPOE, IPS, and the six EBRs had consistently better performance on AMI and CHF metrics (all *p* values < .05). However, although hospitals

Table 3. Hospital Quality Alliance (HQA) Performance by Targeted Leapfrog Patient Safety Practices*

	HQA Performance Score								
	Acute Myocardial Infarction			Congestive Heart Failure			Pneumonia		
Leapfrog Patient Safety Practice	*n*	Score Mean (SD)	*p* value	*n*	Score Mean (SD)	*p* value	*n*	Score Mean (SD)	*p* value
Computerized Physician Order Entry									
Did Not Report	422	90.1 (7.9)		459	83.6 (12.1)		461	77.9 (8.4)	
Public Reporting Only	814	92.0 (6.1)	< .001	875	84.8 (11.0)	< .001	871	79.6 (7.4)	< .001
Implementation Started	99	95.2 (3.7)		99	90.9 (7.0)		99	78.8 (7.3)	
Intensivists Staffing ICU									
Did Not Report	420	90.0 (7.9)		457	83.5 (12.1)		459	77.9 (8.4)	
Public Reporting Only	641	91.3 (6.4)	< .001	676	84.7 (9.7)	< .001	676	79.9 (7.3)	< .001
Implementation Started	267	95.2 (3.4)		270	90.0 (6.0)		259	78.0 (7.3)	

* SD, standard deviation.; ICU, intensive care unit.

Table 4. Adjusted 30-Day Mortality Rates by Targeted Leapfrog Outcomes*

	Acute Myocardial Infarction			Congestive Heart Failure			Pneumonia		
Leapfrog Outcomes	*n*	Rate†	*p* value	*n*	Rate†	*p* value	*n*	Rate†	*p* value
Computerized Physician Order Entry									
Did Not Report	491	17.8%		497	12.8%		498	12.5%	
Public Reporting Only	947	16.7%	.002	958	12.9%	.347	959	11.9%	.004
Implementation Started	106	15.2%		106	12.4%		106	11.5%	
Intensivists Staffing ICU									
Did Not Report	489	17.8%		495	12.8%		496	12.4%	
Public Reporting Only	718	17.2%	< .001	721	13.0%	.104	722	11.9%	.005
Implementation Started	271	15.3%		271	12.5%		271	11.6%	

* ICU, intensive care unit.

† Adjusted by patients characteristics (age, sex, race, and the presence or absence of 31 comorbidities).

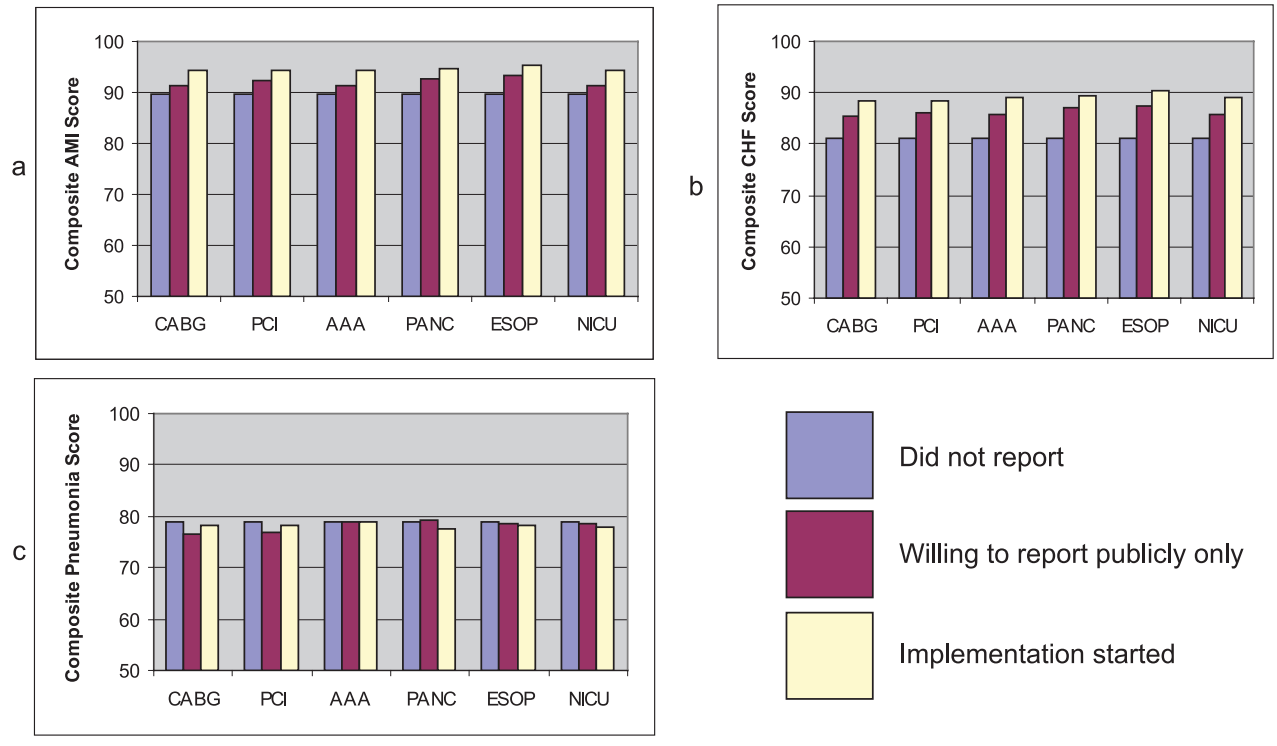
that had begun to implement PSPs generally had better pneumonia scores, the differences were small and often not statistically significant. Similarly, when we examined mortality rates among implementers compared with nonimplementers, we found lower mortality among those that had started implementing PSPs for both AMI and pneumonia, although the differences among CPOE hospitals were small and not statistically significant.

Discussion

We examined the relationship between a hospital's performance on the Leapfrog patient safety measures and its quality of care in terms of HQA process measures and risk-adjusted mortality outcomes. We found that hospitals that had begun to implement Leapfrog patient safety practices consistently had better quality of care for AMI and CHF on process indicators. Mortality rates for hospitals implementing the Leapfrog measures were also substantially lower for AMI compared with other hospitals and marginally lower for pneumonia. Overall, our findings reinforce the validity of the Leapfrog measures by demonstrating that if consumers use the Leapfrog rating system, not only will they likely choose hospitals with better patient safety practices—but also with modestly better process quality and lower mortality.

Despite the national prominence of the Leapfrog Group and its profiling efforts, we are not aware of previous studies that

Quality of Care for Select Conditions Based on Reporting or Implementation of Leapfrog Evidence-Based Referral Practices



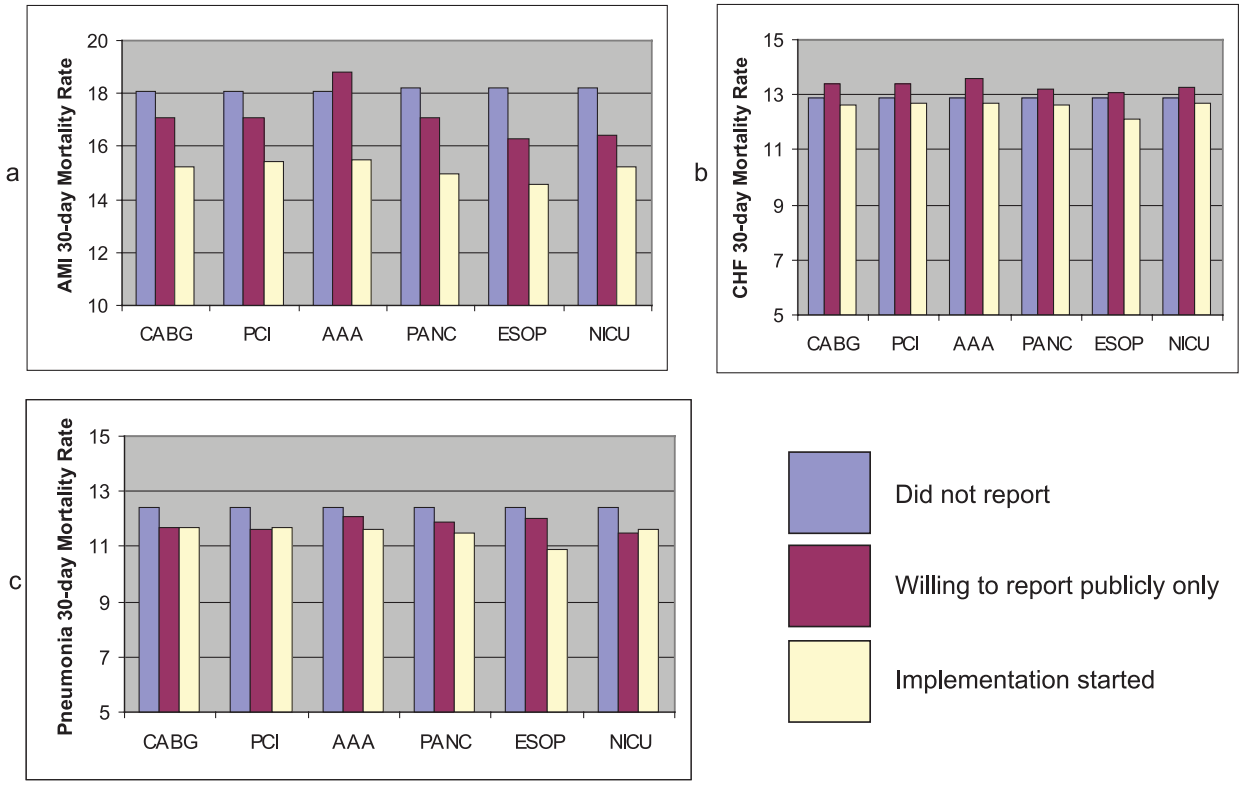
Figures 1a–1c. *Compared with hospitals that were only willing to report publicly or hospitals that chose not to participate, hospitals that had begun to implement evidence-based referral practices had better performance on (a) acute myocardial infarction (AMI) and (b) congestive heart failure (CHF)—within each procedure, the values are significantly different* ($p < .001$)*—as well as (c) pneumonia; within each procedure, the values for pancreatic resection (PANC) are statistically significant* ($p = .03$)*. CABG, coronary artery bypass graft; PCI, percutaneous intervention; AAA, abdominal aortic aneurysm repair; ESOP, esophagectomy; NICU, neonatal intensive care unit (high-risk deliveries).*

directly examined the relationship between Leapfrog measures and other quality measures. Much of the examination of the Leapfrog data has been to test whether its thresholds for referrals are optimal[11] or the impact of the adoption of Leapfrog standards on patient outcomes.[12] Although the PSP indicators are evidence-based, it is possible, even likely, that a hospital choosing to invest in this area would pay less attention to other aspects of quality. Our study suggests that the opposite seems to be happening: Although one might postulate ways in which greater use of intensivists and CPOE leads to better process of care for AMI or pneumonia and accounts directly for lower mortality, it seems equally likely that hospitals that have begun to implement these PSPs are also hospitals that pay greater attention broadly to providing high-quality care.

Our results also highlight the long path ahead to improving health outcomes. Although the Leapfrog measures are among the most prominent, hospitals that had begun to focus on these measures had modestly better processes of care for AMI and CHF but not for pneumonia. It might be that the pneumonia measures, which are not based on evidence from randomized-controlled trials, have been less accepted by these hospitals. Similarly, the differences in outcomes were better for AMI and pneumonia but not for CHF. Although consumers and payers can take some comfort in knowing that hospitals identified by the Leapfrog Group seem to generally provide better care, the inconsistent effect across conditions suggest substantial work ahead for hospitals who wish to improve care across all conditions.

One important lingering question is why the differences among the groups of hospitals in AMI mortality were so much larger than for congestive heart failure (essentially none) and pneumonia mortality. Perhaps the substantially lower AMI

Thirty-Day Mortality Rates for Select Conditions Based on Reporting or Implementation of Leapfrog Evidence-Based Referral Practices



Figures 2a–2c. *Examination of mortality rates on the basis of hospitals' evidence-based referral practices indicated a consistent pattern of (a) lower acute myocardial infarction (AMI) mortality—within each procedure, the values are significantly different (*p <. *001); (b) generally comparable congestive heart failure (CHF) mortality—within each procedure, the values for abdominal aortic aneurysm repair (AAA;* p < *.009) and esophagectomy (ESOP;* p = *.014) are statistically significant; and (c) modestly lower pneumonia mortality—within each procedure, the values are significantly different (*p < *.001) except for pancreatic resection (PANC). CABG, coronary artery bypass graft; PCI, percutaneous intervention; NICU, neonatal intensive care unit (high-risk deliveries).*

mortality in these Leapfrog hospitals reflects the number of available processes that have been shown to improve outcomes, including therapy with aspirin,[13] beta-blockers,[14] thrombolysis,[15] primary angioplasty,[16] and better care in coronary care units. Similarly, the modest advantages seen in pneumonia mortality might be due to better nursing care or greater use of ICUs. The lack of differences in CHF outcomes might reflect the fact that these outcomes are less amenable to changes that hospitals can institute. Understanding how hospitals that have adopted CPOE or intensivists staffing of ICUs have achieved lower AMI and pneumonia mortality rates will be key to helping other organizations improve the care they provide their patients.

There are limitations to our study. First, the Leapfrog measures only allowed us to study hospitals in 29 regions, although these hospitals cover 45 of the 50 states and provide more than 50% of all hospital care in the United States. Second, it is possible that hospitals that chose not to report had instituted many of the PSPs that Leapfrog advocates. However, this would likely be true at most for a small number of hospitals: Given the importance of the Leapfrog initiative, it is unlikely that hospitals with advanced CPOE or intensivists staffing would opt out of participating in the survey.

Another important set of limitations concerns our process and outcomes measures. First of all, the process measures applied to all hospitalized patients, whereas the outcomes measures applied only to the elderly. However, these three conditions are very common among the elderly, who likely represent a majority of the patients hospitalized for these three conditions. Furthermore, the findings from these three conditions,

which represent 15% of all care for the elderly, cannot be generalized to all of the care that occurs in these hospitals. Fourth, hospitals reporting progress to the Leapfrog program were generally larger and more likely to be academic—and therefore more likely to have had a sicker patient population. Therefore, the use of administrative risk adjustment might have led to our inability to find a difference in mortality for CHF and pneumonia. Finally, because this was an observational study, we were unable to establish a causal relationship between a hospital's implementation of PSPs and the provision of high-quality care. Although we found that hospitals that have implemented Leapfrog's PSPs provide higher quality of care independent of other hospital characteristics, there are likely other factors that could have affected this relationship. Therefore, it is possible that Leapfrog measures may not lead directly to higher quality care but may simply be a marker of high-performing organizations.

Summary

We analyzed Leapfrog Group data, including the number of hospitals that report implementation of Leapfrog's evidence-based measures, and the relationship between implementation of Leapfrog PSPs and performance on standard quality measures. We found that hospitals that report some level of activity in the PSP indicators had generally higher performance on standard quality process measures for AMI and CHF and marginally better performance for pneumonia. The hospitals that reported PSP activity had substantially better AMI mortality rates. As we seek to improve care in hospitals in the United States, these results suggest that improving safety and quality together is certainly possible. J

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Ashish K. Jha, M.D., M.P.H., is Assistant Professor, Department of Health Policy and Management, Harvard School of Public Health, Boston; Staff Physician, Boston Department of Veterans Affairs (VA) Health System, Boston; and a member of the Editorial Advisory Board of *The Joint Commission Journal on Quality and Patient Safety*. **E. John Orav, Ph.D.,** is Associate Professor of Medicine, Division of General Medicine, Brigham and Women's Hospital, Boston. **Abigail B. Ridgway** is Research Assistant, Department of Health Policy and Management, Harvard School of Public Health; **Jie Zheng, Ph.D.,** is Senior Statistical Programmer; and **Arnold M. Epstein, M.D., M.A.,** is Professor and Chair. Please address requests for reprints to Ashish K. Jha, ajha@hsph.harvard.edu.

References

1. McGlynn E.A., et al.: The quality of health care delivered to adults in the United States. *N Engl J Med* 348:2635–2645, Jun. 2003.
2. Institute of Medicine: *Crossing the Quality Chasm: A New Health System for the 21st Century*. Washington, DC: National Academy Press, 2001.
3. Milstein A., et al.: Improving the safety of health care: The Leapfrog Initiative. *Eff Clin Pract* 3:313–316, Nov.–Dec. 2000.
4. Galvin R.S., et al.: Has the Leapfrog Group had an impact on the health care market? *Health Aff (Millwood)* 24:228–233, Jan.–Feb. 2005.
5. Bates D.W., et al.: Effect of computerized physician order entry and a team intervention on prevention of serious medication errors. *JAMA* 280:1311–1316, Oct. 21, 1998.
6. Pronovost P.J., et al.: Organizational characteristics of intensive care units related to outcomes of abdominal aortic surgery. *JAMA* 281:1310–1317, Apr. 14, 1999.
7. Dudley R.A., et al.: Selective referral to high-volume hospitals: Estimating potentially avoidable deaths. *JAMA* 283:1159–1166, Mar. 1, 2000.
8. Jha A.K., et al.: Care in U.S. hospitals: The Hospital Quality Alliance Program. *N Engl J Med* 353:265–274, Jul. 21, 2005.
9. Kahn C.N. 3rd, et al.: Snapshot of hospital quality reporting and pay-for-performance under Medicare. *Health Aff (Millwood)* 25:149–162, Jan.–Feb. 2006.
10. Elixhauser A., et al.: Comorbidity measures for use with administrative data. *Med Care* 36:8–27, Jan. 1998.
11. Christian C.K., et al.: The Leapfrog volume criteria may fall short in identifying high-quality surgical centers. *Ann Surg* 238:447–455; discussion 455–457, Oct. 2003.
12. Birkmeyer J.D., Dimick J.B.: Potential benefits of the new Leapfrog standards: Effect of process and outcomes measures. *Surgery* 135:569–575, Jun. 2004.
13. Randomised trial of intravenous streptokinase, oral aspirin, both, or neither among 17,187 cases of suspected acute myocardial infarction: ISIS-2. ISIS-2 (Second International Study of Infarct Survival) Collaborative Group. *Lancet* 2:349–360, Aug. 13, 1988.
14. Metoprolol in acute myocardial infarction: Patient population. The MIAMI Trial Research Group. *Am J Cardiol* 56:10G–14G, Nov. 22, 1985.
15. The effects of tissue plasminogen activator, streptokinase, or both on coronary-artery patency, ventricular function, and survival after acute myocardial infarction. The GUSTO Angiographic Investigators. *N Engl J Med* 329:1615–1622, Nov. 25, 1993. Erratum in: *N Engl J Med* 330:516, Feb. 17, 1994.
16. A clinical trial comparing primary coronary angioplasty with tissue plasminogen activator for acute myocardial infarction. The Global Use of Strategies to Open Occluded Coronary Arteries in Acute Coronary Syndromes (GUSTO IIb) Angioplasty Substudy Investigators. *N Engl J Med* 336:1621–1628, Jun. 5, 1997. Erratum in: *N Engl J Med* 337:287, Jul. 24, 1997.