
Other Articles

The Impact of Utilization Management on Readmissions Among Patients with Cardiovascular Disease

Daniel S. Lessler and Thomas M. Wickizer

Objective. To determine if prospective utilization reviews that lead to reduced hospital length of stay (LOS) relative to days requested by an attending physician affect the likelihood of readmission for privately insured patients with cardiovascular disease.

Data Sources. Data obtained from a private insurance company on utilization management decisions from 1989 through 1993. During this five-year period, 39,117 inpatient reviews were conducted, 4,326 (11.1 percent) on patients with cardiovascular disease. We selected for analysis all 4,326 reviews performed on patients with cardiovascular disease.

Study Design. We used proportional hazard analysis (Cox regression) to investigate the relationship between LOS reductions relative to days requested by a patient's attending physician and the likelihood of readmission within 60 days of discharge. Separate analyses were performed for medical and procedural admissions.

Principal Findings. There were 2,813 requests for medical admission, and 1,513 requests for procedural admission. Requests for admission were rarely denied. Length of stay was reduced relative to that requested by the treating physician for 17 percent and 19 percent of medical and procedural admissions, respectively. Cumulative 60-day readmission rates were 9.5 percent for medical admissions and 12.3 percent for procedural admissions. We found no relationship between LOS reduction and the likelihood of readmission for medical admissions. However, patients admitted for procedures who had their length of stay reduced by two or more days were 2.6 times as likely to be readmitted within 60 days as those who had no reduction in their length of stay (95% CI: 1.3–5.1; $p < .005$).

Conclusions. Utilization management (UM) rarely denies requests for inpatient treatment of cardiovascular disease. The association between LOS reduction and the likelihood of readmission for patients admitted for cardiovascular procedures raises concern that UM may adversely affect clinical outcome for some patients. Further research is needed to definitively elucidate any relationship that might exist between utilization review decisions and quality of care.

Key Words. Utilization management, cost containment, managed care, hospitalization utilization, quality of care

Health plans and insurers commonly manage hospital care by prospectively reviewing requests for admission and initially approving a specified number of days when inpatient care is considered appropriate. In addition, many health plans and insurers must approve requests for additional hospital days beyond those initially authorized. The processes of preadmission and concurrent review have been termed utilization review and constitute a prominent form of utilization management (UM). Over the past 15 years, UM activities have proliferated and are now used by nearly all health plans, including health maintenance and preferred provider organizations (Gold, Hurley, Lake, et al. 1995; Rice 1992; Sullivan et al. 1992) as well as indemnity (fee-for-service) groups (Wickizer 1990; Bailit and Sennett 1991; Ermann 1988).

Studies documenting high rates of unnecessary and inappropriate inpatient care (Restuccia, Kreger, Payne, et al. 1986; Siu, Sonnenberg, Manning, et al. 1986; Kemper 1988; Zimmer 1974) and wide variation in surgical and admission rates (Wennberg and Gittelsohn 1982; Chassin, Brook, Park, et al. 1986; Wilson and Tedeschi 1984) provided the initial rationale for the development of UM programs during the 1980s. Subsequent research showed that UM could reduce hospital use and expenditures (Wickizer, Wheeler, and Feldstein 1989; Feldstein, Wickizer, and Wheeler 1988; Wickizer 1992; Khandker, Manning, and Ahmed 1992; Scheffler, Sullivan, and Ko 1991) and decrease outpatient costs (Wickizer 1995). Despite its widespread use, surprisingly little is known about UM's effects on patterns of care. An Institute of Medicine (1989) report emphasized the need for research to analyze the effects of UM on the delivery of medical care, but with the exception of two recent limited studies (Rosenberg, Allen, Handte, et al. 1995; Kleinman, Boyd, and Heritage 1997), to our knowledge no reports have been published.

Cardiovascular disease appears to be an ideal area of clinical focus by UM because it comprises a set of common clinical conditions, the management of which is associated with considerable practice variation (Chassin, Kosecoff, Park, et al. 1987; Bernstein, Hilborne, Leape, et al. 1993; Guadag-

Supported by grant 19977 from the Robert Wood Johnson Foundation. The opinions and conclusions expressed are those of the authors and do not necessarily represent the views of the Robert Wood Johnson Foundation.

Daniel S. Lessler, M.D., M.H.A. is Associate Professor, Section of General Internal Medicine, Dept. of Medicine, Harborview Medical Center and the University of Washington, Seattle. Address correspondence to Thomas Wickizer, Ph.D., M.P.H., Rohm and Haas Professor of Public Health Sciences, Department of Health Services, Box 357660, University of Washington, Seattle, WA 98195-7660. This article, submitted to *Health Services Research* on January 13, 1998, was revised and accepted for publication on February 2, 1999.

noli, Hauptman, Ayanian, et al. 1995; Pilote, Califf, Sapp, et al. 1995). In addition, the incidence of inappropriate or unnecessary procedures may be substantial. For example, Graboys, Biegelsen, Lampert, et al. (1992) concluded that 50 percent of coronary angiography in the United States either was unnecessary or could be postponed. On the other hand, the premature discharge of patients with cardiovascular illness may be associated with an increased risk of early hospital readmission. A recently published meta-analysis presented evidence of a strong link between lower quality and the risk of early readmission (Ashton, Del Junco, Soucek, et al. 1997).

Through the use of data from one well-established UM firm, we conducted an exploratory analysis of the effect of prospective utilization review on hospital inpatient care for patients with cardiovascular illness. This study is part of a larger ongoing investigation of UM and its effects on patterns of care among patients (Wickizer, Lessler, and Travis 1996; Wickizer and Lessler 1998a,b; Wickizer, Lessler, and Franklin 1999; Wickizer, Lessler, and Boyd-Wickizer 1999). For the current study, we focused on the following two questions: (1) What is the effect of preadmission and concurrent review on access to inpatient care and length of stay? and (2) How do restrictions imposed by UM on length of stay affect the likelihood of 60-day readmission?

METHODS

Review Procedures

UM was conducted as part of a managed fee-for-service plan offered by a large commercial insurance carrier. Over 600 insured groups, representing private companies, union trusts, and public organizations in 47 states, adopted UM as a benefit plan option. These groups ranged in size from 50 to over 500 employees. The groups had the same basic benefit plan, which covered 80 percent of allowed charges up to some designated (stop loss) level, usually \$2,500, and 100 percent thereafter. The majority of the groups were subject to an individual deductible of \$150 or \$200 and a family deductible of \$450 or \$600.

Two review procedures were used to examine and authorize requests for hospital care: preadmission authorization and concurrent (continued-stay) review. Preadmission review authorized the patient's admission and approved a specified number of days for the initial hospital stay. Concurrent review evaluated and approved requests for subsequent days beyond the initial stay. UM was compulsory for all patients. Patients failing to comply with the review

decision were subject to financial penalties, for example, 30 percent reduction in coverage for room and board expenses for the unauthorized treatment episode. Information needed to perform the reviews was provided over the telephone and by written communication.

The UM reviews were conducted by a well-established UM firm and were performed by trained nurse reviewers and physician advisers. Diagnosis-based criteria, developed by an external organization, were used by the UM program to evaluate the appropriateness of care; regional length of stay (LOS) profile data were used to assign the number of days of care approved. The same criteria and LOS profiles were used for all reviews. The criteria and LOS profiles were updated annually. If a patient was not authorized for admission or for an outpatient procedure, a physician advisor reviewed the case.

Data and Measures

From 1989 through 1993, 39,117 UM inpatient reviews were performed on our study population. Of these, 4,326 (11.1 percent) were on patients with cardiovascular disease requesting inpatient treatment; 1,513 (42 percent) requests were for surgery or some other procedure; and 2,813 (58 percent) were requests for medical admission. Some patients were reviewed more than once because they had multiple requests for admission. The 4,326 UM reviews were performed on 3,195 different patients. We obtained data on the number of days of inpatient treatment requested and approved at time of admission, and the number of days subsequently requested and approved for continued stay. In addition, data on patients' age, sex, geographic region, and primary admitting diagnosis were obtained.

All or some of the days requested by a patient's physician could be approved by UM. Since our objective was to determine the effect of restrictions imposed by UM on length of stay (LOS), we constructed a variable representing LOS reduction, measured as the difference between total days requested and total days approved by UM. In constructing this variable, we paid particular attention to the sequencing of requests and approvals over the treatment episode in order to avoid the potential problem of double counting the actual number of days for which LOS was restricted.

In our calculation of LOS restriction, a given patient's hospital stay could be limited either by preadmission review or by concurrent review, but not by both. For example, if a physician requested four days and was denied authorization for admission, then the reduction in requested hospital days would equal four. Similarly, if a physician requested five days at admission, had three days approved, and did not request additional hospital days after the patient was admitted, then the reduction in days would equal two. But if

this same physician requested an additional five days beyond the number of days authorized at admission, and four of these days were approved through concurrent review, then the reduction in days would equal one, not three. In other words, once a patient was authorized for admission, the calculation of reduced days was based on the preadmission review decision only if the patient had no further (continued-stay) review. Otherwise it was based on the concurrent review decision, regardless of the number of days requested and approved initially by preadmission review. This method of calculating the reduction in requested days avoided the potential problem of double counting.

The validity of our measure of LOS reduction depends in part on whether patients followed the UM decision. If patients routinely ignored the decision by staying longer than the number of days approved, then our measure had less clinical relevance and empirical validity. We obtained data on date of admission and discharge for each patient and compared the actual LOS to the number of days approved by UM. For the vast majority of patients (>98 percent), the actual LOS was identical to the number of days approved by UM.

Statistical Analysis

To examine the effect of LOS restriction, we performed proportional hazard analysis (Cox regression) with the dependent variable specified as 60-day readmission (1 = yes, 0 = no). A small percentage of the patients (5.6 percent, accounting for 10.7 percent of the total requests) were readmitted more than once during the five-year study period, so we could not assume that all observations were independent. We therefore adopted the standard convention of identifying an index admission for each patient—the first admission—and then determined whether or not a readmission occurred within 60 days of this index admission. Two separate analyses were performed representing medical and procedural admissions. The former analysis included 2,117 medical admissions, the latter 993 procedural admissions.

We created a three-level categorical variable to measure LOS reduction, with the categories specified as follows: zero days reduction, one-day reduction, and two or more days reduction. This variable allowed us to compare the increase in readmission risk associated with a modest (one-day) reduction in LOS, and then to assess the effect on readmission of a more substantial (two-day or more) LOS reduction. For the multivariate analysis we re-coded this categorical variable into two dummy variables that measured the respective LOS reductions. Other covariates entered into the hazard analysis included age, sex, geographic region, year of review, whether or not the admission

was for cardiac catheterization, and number of treatment extensions granted through concurrent review. We controlled for cardiac catheterization because patients undergoing this procedure are commonly readmitted for angioplasty or bypass surgery. We also conducted a separate analysis that excluded all patients admitted for cardiac catheterization.

We further reasoned that patients with more severe illness would likely have longer LOS requests and experience greater need for ongoing treatment. However, we did not have detailed clinical data to allow us to control for case severity. Lacking this information, we chose to include two additional variables in the analysis to serve as proxy measures of severity: the total number of days requested for the index admission and the total number of reviews performed, for both inpatient and outpatient treatment requests, during the five-year study period.

To determine if our data conformed to the proportionality assumption of the hazards regression model, we plotted log-minus-log hazard plots for the three groups of patients with different LOS restrictions. The differences in readmission rates of the three groups were proportional over time, as indicated by parallel plots, suggesting that the model was specified appropriately. We present the adjusted hazard curves and report hazard ratios (relative risk) and 95 percent confidence intervals for the LOS-reduction variables.

RESULTS

Selected characteristics of the study population are shown in Table 1. The majority of patients reviewed were between the ages of 50 and 70. Almost two-thirds of the patients were male; seven out of ten patients resided in either the Midwest or the South. Approximately 87 percent of the reviews were performed in the last three years of the five-year study period. Information transmitted to the UM review resulted in nearly three-quarters of the cases being designated as an emergency admission, although it is unclear what clinical criteria were used to classify patients as such.

Only one of the 2,813 requests for medical admission was denied, while four of 1,513 procedural requests were denied. The median total lengths of stay requested for medical and procedural admissions were five days and four days, respectively. Ten percent of the medical admissions had stay reductions of one day, while 7 percent had reductions of two or more days. The corresponding percentages for procedural admissions were 11 percent and 8 percent, respectively. Table 2 shows the percentage of patients

Table 1: Descriptive Information on Study Population

<i>Number of Review Cases</i>	<i>Characteristic</i>	<i>Percent of Review Cases</i>
4326	Age (years)	
	< 40	11.8%
	41-50	17.5
	51-60	31.9
	61-70	29.5
	> 70	9.2
	Gender	
	Male	64.9
	Female	35.1
	Region	
	Northwest	11.5
	South	33.9
	West	16.3
	Midwest	38.2
	Year of Review	
	1989	1.7
	1990	11.7
	1991	26.4
	1992	31.3
1993	28.9	

experiencing one- and two-day or more reductions in LOS for the five most commonly requested medical and procedural admissions.

Sixty-day readmission rates were 9.5 percent for medical admissions and 12.3 percent for procedural admissions, overall. Table 3 shows the relationship between LOS reduction and 60-day readmission rates for the index medical and procedural admissions. Although not shown, the vast majority (>87 percent) of patients readmitted within 60 days of their index admission were readmitted with a cardiovascular medical diagnosis.

In order to help assess the clinical validity of our administrative database, we analyzed the admitting diagnoses for patients readmitted to the hospital within 60 days of cardiac catheterization. The most common reasons for readmission following catheterization were: 11 percent for coronary artery bypass surgery (CABG); 15 percent for other vessel operations (e.g., carotid endarterectomy and peripheral vascular surgery); 7.5 percent for stroke (CVA); and 6 percent for myocardial infarction (MI).

We found no association between restricting length of stay and 60-day readmission rates for medical admissions. On the other hand, patients

Table 2: Length of Stay Reductions Among Utilization Review Cases for Selected Diagnoses and Procedures

Diagnosis or Procedure (ICD-9 Code)	Number of Reviews	Median Total Days Requested	LOS Reduction (% of Utilization Reviews)		
			0 Days	1 Day	2 + Days
<i>Medical Admissions</i>					
Angina (411.1)	614	3.0	85.7%	9.9%	4.4%
Congestive heart failure (428.0-428.9)	416	7.0	81.5	9.9	8.7
Cerebral vascular accident (435.9, 436.0-436.2)	414	5.0	83.6	8.5	8.0
Arrhythmia/Conduction disturbance (426.0-427.9)	370	3.0	83.5	9.5	7.0
Myocardial infarction (410.0-410.9)	313	7.0	81.8	10.5	7.7
<i>All Medical Admissions</i>	2813	5.0	82.6	10.2	7.2
<i>Surgical/Procedural Admissions</i>					
Catheterization (37.21-37.23)	456	1.0	89.5	6.8	3.7
Coronary Bypass Surgery (36.10-36.16)	257	8.0	68.4	17.0	14.6
Valve replacement/Valvuloplasty (35.00-35.28)	88	9.0	77.3	14.0	8.0
Carotid endarterectomy (38.12)	69	5.0	71.0	13.0	15.9
Head/Neck vessel replacement (38.42)	47	10.0	83.0	2.1	14.9
<i>All Procedural Admissions</i>	1513	4.0	81.0	11.0	8.0

Note: The utilization reviews shown in the table do not represent individual patients, since some patients had multiple admissions, and hence had multiple reviews. The 4,326 reviews—2,813 for medical admissions and 1,513 for surgical admissions—represent 3,195 different patients.

admitted for a cardiovascular procedure whose LOS was restricted by UM exhibited a substantially greater rate of 60-day readmission. Excluding patients admitted for cardiac catheterization did not materially alter these results. The proportional hazard analysis performed showed a relative hazard of 1.4 (95% CI: 0.72-2.80, $p = .30$) for readmission associated with a one-day LOS reduction. The hazard ratio for a two-day or more LOS restriction was 2.6 (CI: 1.3-5.1, $p < .005$). In other words, patients whose stays were reduced by two or more days were 2.6 times as likely to be readmitted within 60 days of discharge as patients whose stay was not restricted by UM. Two covariate

Table 3: Sixty-day Readmissions by LOS Reduction for Index Admission

LOS Restriction (Days)	Number of Patients	Readmitted at 60 days	
		N	(%)
<i>Medical Admissions</i>			
0	1733	165	(9.5)
1	218	21	(9.6)
2+	166	15	(9.0)
<i>Procedural Admissions</i>			
0	805	100	(12.4)
1	106	10	(9.4)
2+	82	12	(14.6)

Note: See page 1,321 for a definition of index admission.

measures representing catheterization and total days requested at admission were statistically significant. Patients having a catheterization were 2.1 times as likely to be readmitted within 60 days as other patients ($p < .01$). Total days requested was inversely related to readmission ($p = .01$), but the magnitude of the effect was modest (relative hazard equaled 0.90).

Figure 1 shows a plot of adjusted cumulative readmission rates derived from the Cox regression for patients whose index admission was for a cardiovascular procedure against the elapsed time from discharge for each of the three levels of LOS reduction.

DISCUSSION

The effect of managed care on clinical outcomes has been the focus of several major studies published during the 1990s (Miller and Luft 1997). These studies have compared different systems of care (e.g., traditional fee-for-service versus HMOs), but have not focused on specific managed care activities, such as preadmission and concurrent review.

While available evidence suggests that overall preadmission and concurrent review reduce hospital expenditures (Wickizer, Wheeler, and Feldstein 1989; Feldstein, Wickizer, and Wheeler 1988; Wickizer 1992; Khandker, Manning, and Ahmed 1992; Wickizer 1995), little is known about their impact on clinical outcomes. This study focused on patients with cardiovascular disease. We found that preadmission review rarely resulted in the denial of admission. On the other hand, utilization review did result in a reduction in

length of stay for a substantial number of cases, and in the case of procedural admissions, reduced length of stay was associated with an increased likelihood of 60-day readmission.

The lack of an effect of preadmission review on access to hospital care may result because physicians, by virtue of knowing that requests for care will be reviewed, are less likely to request inpatient care for patients with marginal indications for hospitalization. Nonetheless, given that previous studies have suggested a high rate of unnecessary cardiovascular procedures (Chassin, Kosecoff, Park, et al. 1987; Bernstein, Hilborne, Leape, et al. 1993; Graboys, Biegelsen, Lampert, et al. 1992), we would have expected a greater proportion to be denied. Indeed, a recent study of utilization review by Kleinman, Boyd, and Heritage (1997) indicates that the sentinel effect does not necessarily eliminate requests for unnecessary procedures. In this study, 28 percent of physician requests for tympanostomy tube insertion were initially screened as inappropriate when evaluated against relatively lenient criteria.

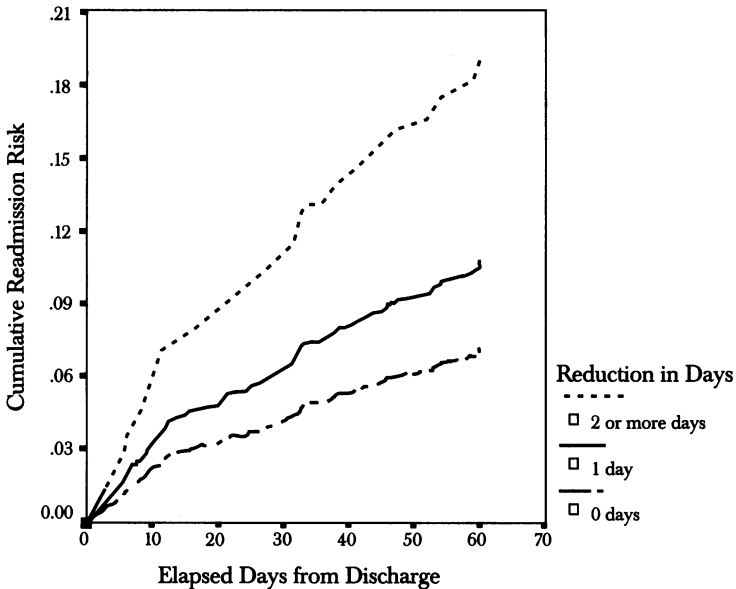
Procedures that are performed inappropriately both increase costs and subject patients to unnecessary risks. UM programs that require preadmission review and approval must be able to identify and prevent unnecessary procedures if they are to improve quality of care. The fact that the UM program we studied rarely denied any requested procedures suggests that it was unable to capitalize on this opportunity to reduce unnecessary care. We do not have detailed information about the criteria used for individual reviews, so it is unclear to us why so few procedures were denied. It may be that the criteria used by the UM RNs in this program were very lenient. On the other hand, as Kleinman, Boyd, and Heritage (1997) found in their study of tympanostomy tubes, it may be that procedures initially denied by UM RNs were subsequently approved on appeal by physicians.

Another objective of UM programs is to eliminate unnecessary hospital days among those patients who need inpatient treatment. Thus, preadmission and concurrent review may result in a shorter LOS than is requested by the treating physician. We found that patients admitted for cardiovascular procedures who had their LOS reduced by utilization review were more likely to be readmitted within 60 days than patients whose LOS was not reduced. Although the relationship between readmission and quality is not fully understood (Ludke, Booth, Lewis-Beck 1993; Holloway and Thomas 1989; Thomas and Holloway 1991), early readmission is considered to be an important quality of care indicator, and research has provided evidence of a link between lower quality and increased readmissions (Ashton, Del Junco, Soucek, et al. 1997; Ashton, Kuykendall, Johnson, et al. 1995; Brook and Lohr 1987; DesHarnais, McMahon, and Wroblewski 1991; Reed, Pearlman,

and Buchner 1991). Readmission rates are now used for quality assurance purposes by the National Committee on Quality Assurance (1995) as part of the Health Plan and Employer Data and Information Set (HEDIS). Moreover, 25 percent of Medicare expenditures for inpatient care are for readmissions within 60 days (Anderson and Steinberg 1984).

The effect of LOS reduction on readmission was “dose dependent.” Patients whose LOS was restricted by two or more days had higher rates of readmission than those with a one-day reduction in LOS. Although it is generally more common to use 30-day readmission rates as a quality of care indicator, because we analyzed a small number of cases, the numbers of patients readmitted 30 days after discharge were few. Thus, while cumulative adjusted readmission rates were substantially greater 30 days postdischarge for patients who had their care constrained by two or more days (Figure 1), these differences did not reach statistical significance.

Figure 1: Sixty-day Readmission Rates Among Patients Initially Admitted for a Procedure ($n = 993$)



Note: the lines shown in Figure 1 represent the cumulative readmission rate adjusted for the following variables: age, sex, geographic region, total days requested, catheterization requested, year of request, and total number of reviews performed.

The relative risk of 60-day readmission was statistically significant for the stratum representing a LOS restriction of 2+ days ($RR = 2.6; p < .005$), but not for the stratum representing a LOS restriction of one day.

It is unclear to us why reducing the LOS of patients admitted for cardiovascular procedures, on the one hand, was associated with an increased risk of readmission, but reducing the LOS of patients admitted for medical management of cardiovascular disease was not. Overall, patients were most commonly readmitted for angina, myocardial infarction, congestive heart failure, arrhythmias, and stroke; it is not clear from a clinical standpoint if these could have been avoided by allowing a longer LOS for the index hospitalization. In the specific case of cardiac catheterization, the most common reasons for readmission to the hospital were for CABG and other vessel operations, supporting the clinical validity of our analyses. On the other hand, while the readmission rates for CVA and MI (7.5 percent and 6 percent, respectively) may be reasonable, they could also reflect poor-quality care and suggest the need for further investigation.

Our finding that reducing the LOS of cardiovascular procedures was associated with an increased likelihood of readmission may indicate that some patients were discharged too soon. Moreover, the hazard ratio of readmission increased as the days of hospitalization denied increased, strengthening the concern that utilization review may have adversely affected quality of care. We do not believe that this result is confounded by severity of illness. Although sicker people are more likely to be readmitted, there is no reason to believe that sicker people would also have a greater number of hospital days denied by utilization review. In fact, the opposite may be true. Key informant interviews of hospital utilization management coordinators conducted by the second author at several large hospitals in the Seattle area confirmed that, within a given diagnosis, it is easier to justify and document the need for continued stay for more severely ill patients. If so, then our estimates of hazard ratios associated with LOS reduction may actually underestimate the true risk of readmission.

It is important to highlight the limitations of our study. We focused on a single UM program, analyzed a relatively small sample size, and did not have access to detailed patient-specific clinical information. In addition, we did not have access to the protocols used by RN reviewers in conducting preadmission and continuing stay reviews. Finally, the study was performed with data that are over five years old, and current clinical criteria may have changed in light of new clinical evidence. On the other hand, to our knowledge, the process of applying UM clinical protocols (i.e., nurse reviewers, remote from the site of care, making judgments about the appropriateness or necessity of clinical care) has changed little. Further research is needed that takes advantage of larger numbers and more detailed and recent clinical

information in order to definitively elucidate any relationship that might exist between utilization review decisions and quality of care.

We believe that because of the limitations just described, our study should be viewed as exploratory in nature. Nonetheless, our findings raise concern about a potential adverse effect of UM on clinical outcomes for some patients who experience reductions in the length of their hospital stays. Moreover, to the extent that average hospital LOS has continued to decline since the data for this study were collected, it is possible that LOS reductions imposed by UM today might have an even greater impact on clinical outcomes than we found in our study. Our findings also emphasize the need to make heretofore proprietary UM protocols available to physicians, patients, and healthcare purchasers, and to monitor the impact of these protocols on the delivery of healthcare services and on patient outcomes, as originally suggested by the Institute of Medicine (1989).

REFERENCES

- Anderson, G. F., and E. Steinberg. 1984. "Hospital Readmissions in the Medicare Population." *The New England Journal of Medicine* 311 (21): 1349-53.
- Ashton, C. M., D. Del Junco, J. Soucek, N. Wray, and C. Mansyur. 1997. "The Association Between the Quality of Inpatient Care and Early Readmission: A Meta-Analysis of the Evidence." *Medical Care* 35 (10): 1044-59.
- Ashton, C. M., D. Kuykendall, M. Johnson, N. Wray, and L. Wu. 1995. "The Association Between the Quality of Inpatient Care and Early Readmission." *Annals of Internal Medicine* 122 (6): 415-21.
- Bailit, H. L., and C. Sennett. 1991. "Utilization Management as a Cost-Containment Strategy." *Health Care Financing Review Annual Supplement*: 87-93.
- Bernstein, S. J., L. Hilborne, L. Leape, M. Fiske, R. Park, C. Kamberg, and R. Brook. 1993. "The Appropriateness of Use of Coronary Angiography in New York State." *Journal of the American Medical Association* 269 (6): 766-69.
- Brook, R. H., and K. Lohr. 1987. "Monitoring Quality of Care in the Medicare Program: Two Proposed Systems." *Journal of the American Medical Association* 258 (21): 3138-41.
- Chassin, M. R., R. Brook, R. Park, J. Keesey, A. Fink, J. Kosecoff, K. Kahn, N. Merrick, and D. Solomon. 1986. "Variations in the Use of Medical and Surgical Services by the Medicare Population." *The New England Journal of Medicine* 314 (5): 285-90.
- Chassin, M. R., J. Kosecoff, R. Park, C. Winslow, K. Kahn, N. Merrick, J. Keesey, A. Fink, D. Solomon, and R. Brook. 1987. "Does Inappropriate Use Explain Geographic Variations in the Use of Health Care Services? A Study of Three Procedures." *Journal of the American Medical Association* 258 (18): 2533-37.
- DesHarnais, S. L., L. McMahon, and R. Wroblewski. 1991. "Measuring Outcomes of Hospital Care Using Multiple Risk-Adjusted Indexes." *Health Services Research* 26 (4): 425-45.

- Ermann, D. 1988. "Hospital Utilization Review: Past Experience, Future Directions." *Journal of Health Politics, Policy and Law* 13 (4): 683-704.
- Feldstein, P. J., T. Wickizer, and J. Wheeler. 1988. "Private Cost Containment: the Effects of Utilization Review Programs on Health Care Use and Expenditures." *The New England Journal of Medicine* 318 (20): 1310-14.
- Gold, M. R., R. Hurley, T. Lake, T. Ensor, and R. Berenson. 1995. "A National Survey of the Arrangements Managed Care Plans Make with Physicians." *The New England Journal of Medicine* 333 (25): 1678-83.
- Graboyes, T. B., B. Biegelsen, S. Lampert, C. Blatt, and B. Lown. 1992. "Results of a Second-Opinion Trial Among Patients Recommended for Coronary Angiography." *Journal of the American Medical Association* 268 (18): 2537-40.
- Guadagnoli, E., P. Hauptman, J. Ayanian, C. Pashos, B. McNeil, and P. Cleary. 1995. "Variation in the Use of Cardiac Procedures After Acute Myocardial Infarction." *The New England Journal of Medicine* 333 (9): 573-78.
- Holloway, J. J., and J. Thomas. 1989. "Factors Influencing Readmission Risk: Implications for Quality Monitoring." *Health Care Financing Review* 11 (2): 19-32.
- Institute of Medicine. 1989. *Controlling Costs and Changing Patient Care? The Role of Utilization Management*. Washington, DC: National Academy Press.
- Kemper, K. J. 1988. "Medically Inappropriate Hospital Use in a Pediatric Population." *The New England Journal of Medicine* 318 (16): 1033-37.
- Khandker, R. K., W. Manning, and T. Ahmed. 1992. "Utilization Review Savings at the Micro Level." *Medical Care* 30 (11): 1043-52.
- Kleinman, L. C., E. Boyd, and J. Heritage. 1997. "Adherence to Prescribed Explicit Criteria During Utilization Review: An Analysis of Communications Between Attending and Reviewing Physicians." *Journal of the American Medical Association* 278 (6): 497-501.
- Ludke, R. L., B. Booth, and J. Lewis-Beck. 1993. "Relationship Between Early Readmission and Hospital Quality of Care Indicators." *Inquiry* 30 (1): 95-103.
- Miller, R. H., and H. Luft. 1997. "Does Managed Care Lead to Better or Worse Quality of Care?" *Health Affairs* 16 (5): 7-25.
- National Committee on Quality Assurance. 1995. *Report Card: Technical Report on Quality Indicators*. Washington DC: NCQA.
- Pilote, L., R. Califf, S. Sapp, D. Miller, D. Mark, W. Weaver, J. Gore, P. Armstrong, E. Ohman, and E. Topol. 1995. "Regional Variation Across the United States in the Management of Acute Myocardial Infarction." *The New England Journal of Medicine* 333 (9): 565-72.
- Reed, R. L., R. Pearlman, and D. Buchner. 1991. "Risk Factors for Early Unplanned Hospital Readmission in the Elderly." *Journal of General Internal Medicine* 6 (3): 223-28.
- Restuccia, J. D., B. Kreger, S. Payne, P. Gertman, S. Dayno, and G. Lenhart. 1986. "Factors Affecting Appropriateness of Hospital Use in Massachusetts." *Health Care Financing Review* 8 (1): 47-54.
- Rice, T. H. 1992. "Containing Health Care Costs in the United States." *Medical Care Review* 49 (1): 19-38.
- Rosenberg, S. N., D. Allen, J. Handte, T. Jackson, L. Leto, B. Rodstein, S. Stratton,

- G. Westfall, and R. Yasser. 1995. "Effect of Utilization Review in a Fee-for-Service Health Insurance Plan." *The New England Journal of Medicine* 333 (20): 1326-30.
- Scheffler, R. M., S. Sullivan, and T. Ko. 1991. "The Impact of Blue Cross and Blue Shield Plan Utilization Management Programs." *Inquiry* 28 (3): 263-75.
- Siu, A. L., F. Sonnenberg, W. Manning, G. Goldberg, E. Bloomfield, J. Newhouse, and R. Brook. 1986. "Inappropriate Use of Hospitals in a Randomized Trial of Health Insurance Plans." *The New England Journal of Medicine* 315 (20): 1259-66.
- Sullivan, C. B., M. Miller, R. Feldman, and B. Dowd. 1992. "Employer-Sponsored Health Insurance in 1991." *Health Affairs* 11 (4): 172-80.
- Thomas, J. W., and J. Holloway. 1991. "Investigating Early Readmission as an Indicator for Quality of Care Studies." *Medical Care* 29 (4): 377-94.
- Wennberg, J., and A. Gittelsohn. 1982. "Variations in Medical Care Among Small Areas." *Scientific American* 246 (4): 120-34.
- Wickizer, T. M. 1995. "Controlling Outpatient Medical Equipment Costs Through Utilization Management." *Medical Care* 33 (4): 383-91.
- . 1992. "The Effects of Utilization Review on Hospital Use and Expenditures: a Covariance Analysis." *Health Services Research* 27 (1): 103-21.
- . 1990. "The Effect of Utilization Review on Hospital Use and Expenditures: a Review of the Literature and an Update on Recent Findings." *Medical Care Review* 47 (3): 327-63.
- Wickizer, T. M., D. Lessler, and J. Boyd-Wickizer. 1999. "Effects of Health Care Cost Containment Programs on Patterns of Care and Readmission Among Children and Adolescents." *American Journal of Public Health* 89 (9): 1353-58.
- Wickizer, T. M., D. Lessler, and G. Franklin. 1999. "Controlling Workers' Compensation Medical Care Use and Costs Through Utilization Management." *Journal of Occupational and Environmental Medicine* 41 (8): 625-31.
- Wickizer, T. M., J. Wheeler, and P. Feldstein. 1989. "Does Utilization Review Reduce Unnecessary Care and Contain Costs?" *Medical Care* 27 (6): 632-47.
- Wickizer, T. M., D. Lessler, and K. Travis. 1996. "Controlling Inpatient Psychiatric Utilization Through Managed Care." *The American Journal of Psychiatry* 153 (3): 339-45.
- Wickizer, T. M., and D. Lessler. 1998a. "Do Treatment Restrictions Imposed by Utilization Management Increase the Likelihood of Readmission for Psychiatric Patients?" *Medical Care* 36 (6): 844-50.
- . 1998b. "Effects of Utilization Management on Patterns of Care Among Privately Insured Adult Patients." *Medical Care* 36 (11): 1545-54.
- Wilson, P., and P. Tedeschi. 1984. "Community Correlates of Hospital Use." *Health Services Research* 19 (3): 333-44.
- Zimmer, J. G. 1974. "Length of Stay and Hospital Bed Misutilization." *Medical Care* 12 (5): 453-59.