PREDICTORS OF HOSPITAL READMISSION: A Meta-Analysis

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Abstract:
Summarizing the results of research related to identifying potential predictors of hospital readmissions has been difficult because of conflicting results across studies. Using the techniques of meta-analysis, the results from 44 studies were examined in the present study. Overall, the mean readmission rate was 27%, with significant differences based on patient diagnosis. Although diagnosis, age, initial length of hospital stay, and prior use of hospital resources were related to readmission, the strength of the relationship is trivial. Combining data from 12 intervention studies designed to reduce readmission indicated that the overall treatment effect was not significant. Further research is needed to determine demographic, clinical, and social predictors of readmission if strategies are to be developed to reduce readmission and the resulting health care costs.

Article:
National health expenditures have outpaced the growth in the economy in recent years, and in 1988, hospital expenditures totaled 39% of all health spending. One of the primary determinants of rising health care costs may be hospital readmissions, given that those repeatedly hospitalized account for a disproportionate share of both hospital days and costs. For example, Zook and Moore (1980) found that over half of hospital resources in a I-year period were used by about 13% of the patients and that these high-cost patients tended to experience repeated hospitalizations rather than one cost-intensive stay. Among Medicare beneficiaries, the level of inpatient expenditure for 1 year was correlated .88 with the probability of at least one hospital readmission during the next year, supporting the finding that high-cost patients tend to be rehospitalized (Anderson et al., 1990). For those Medicare patients readmitted within 60 days of discharge, the expenditures were estimated to be over $7.5 billion in 1984 (Anderson & Steinberg, 1984).

It may be that recent policy changes such as the prospective payment system (PPS) have influenced readmission rates because of the inherent cost-containment policies. Hospitals are discharging patients earlier than in the past in an attempt to conform to the length-of-stay guidelines for diagnosis-related groups (DRGs). While the effect of the PPS on hospital readmissions is not clear, the average length of hospital stay dropped from 7.2 days in 1982 to 6.6 days in 1988; for those over 65 years of age, the average length of stay dropped from 10.1 days to 8.8 days over the same period (Office of National Cost Estimates, 1990). These shorter lengths of hospital stay may be associated with higher rates of readmission. From 1974 to 1977, approximately 15.6% of Medicare beneficiaries were readmitted to a hospital within 30 days of discharge increasing to 18.2% for 1983-1984; readmissions within 1 year over the same period increased from 49.7% to 53.3% (Anderson et aI., 1990). For many of the patients, readmissions are for related problems that arose during the original hospitalization and are potentially preventable (Smith, Norton, & McDonald, 1985).

Given the impact of rehospitalization on health care costs, the slight increase in overall readmission rates, at least among Medicare patients, and the fact that readmissions are frequently preventable, there is a need to understand the characteristics of patients who are at risk for readmission to hospitals. If risk factors for readmission can be identified, then providers can focus on developing interventions aimed at reducing unnecessary and preventable readmissions.

Although numerous studies have been conducted to identify the predictors as well as to assess interventions designed to reduce readmission, summarizing the results of this research has been difficult because of conflicting results across studies as well as methodological differences among the studies. In one review of previous research, the National Health Interview Survey (NHIS) and five hospital-based studies were examined using information synthesis (Wray, DeBehnke, Ashton, & Dunn, 1988). The technique allows for the synthesis of findings from diverse studies that are essentially methodological replications of one another. The authors concluded from their synthesis that diagnosis, disease severity, prior hospital use, and disability appear to be strong predictors of hospital readmission, although the method of analysis did not provide an overall estimate of the strength of any of the predictors.

The present study used meta-analysis to quantitatively combine the results of research studies about hospital readmission for the purpose of identifying the predictors of rehospitalization. The method goes beyond that used by Wray et al. (1988) because it provides both a statistical method to resolve differences among research findings, by allowing the reviewer to determine whether and how methodological shortcomings affect the outcomes, and an estimate of the population parameter, in this case, the strength of the relationship of predictor variables to readmission.

Considered more efficient and objective than a traditional narrative literature review and synthesis, meta-analytic techniques are able to detect subtle relationships and trends by investigating whether study effects vary with characteristics of the study, and they offer a source of insight into directions for further research (Glass, McGaw, & Smith, 1981). Although originally developed in the social sciences, meta-analysis is increasingly encountered in the medical literature, especially as a formal approach for combining the results of multiple, randomized, controlled trials (Mann, 1990; Thacker, 1988). When small but consistent relationships or effects are found across studies, meta-analysis provides a method for summarizing the relationship with more confidence than that possible with anyone study. And when differences among results are found, meta-analysis enables the researcher to determine whether methodological differences account for the variability in findings. The advantages of meta-analysis, then, include increased statistical power as compared to anyone study, the potential to resolve apparent discrepancies in original studies by addressing questions across studies, and increased generalizability of findings. Among the criticisms of the technique are the problems of sampling bias because of a tendency to publish studies with positive results, the absence of desired statistics in any given report, and the small number of available studies. These limitations, however, apply to any literature review.

METHOD

Sample Selection

Study reports were located through a combination of computerized data base searches, hand searches, and personal contact with researchers. The MEDLINE data base served as the starting point for the search, using the keywords readmission, recidivism, and rehospitalization. Only articles written in English were considered, and only those which pertained to acute hospital medical or surgical readmissions of adults were selected. Articles specifically addressing psychiatric, alcohol, or drug readmissions were excluded, as were readmissions to nursing homes or other long-term care facilities. In addition, a search of Health Sciences Library (HSL), a computerized data base from 6,500 journals for the last 12 months, was conducted, a hand search of Index Medicus from 1984 to the present was undertaken, and Dissertation Abstracts was reviewed back to 1984. Any published studies referenced in articles and dissertations located through this process also were retrieved and their reference lists searched. The indices of journals containing articles already located also were reviewed.

As a final step, a bibliography of the pertinent articles that had been located was mailed to the primary authors of the most inclusive articles published since 1984 with a request that they supply other citations that may have been overlooked. Approximately half of those contacted responded; six contributed additional citations which were then examined for possible inclusion in the study. The search process located 63 articles which were then reviewed for relevance for the study.

Inclusion Criteria

As noted, the analysis was restricted to those articles that identified medical or surgical readmission of adults to an acute hospital following discharge from the same or another acute care hospital. Although a specific time limit for readmission was not a criterion for inclusion in the study (for example, within 3 months or 6 months), only those studies in which subjects had readmission identified within the same specified time frame were included. In some studies, for example, a time period for the study was given, say, 6 months, and readmissions were noted within that period. This meant that for subjects recruited into the study early, readmission was defined up to a 6-month period, whereas for those recruited into the study later, a shorter time was available for readmission. If this was the situation, the study was eliminated from the analysis.

Studies were included in the meta-analysis only if readmission was defined for the individual rather than on a per-patient-day basis to insure consistency in the unit of analysis across studies. Neither method of sampling nor study design was used for exclusion criteria. That is, studies were included if either probability sampling was used or a convenience sample of consecutive patients within the time period was used. And both experimental (randomized or quasi-experimental) and nonexperimental (survey and comparative) studies were included. Study design was then coded as a variable for analysis. Some studies meeting the criteria were excluded, however, if statistics were not reported in usable form, for example, if only proportions were reported and total sample size could not be determined. Also, in those instances where the same data in slightly different form were reported in more than one article, only one of the articles was used in the meta-analysis. See Table 1 for a summary of inclusion criteria.

TABLE 1
Summary or Inclusion Criteria
Adult medical/surgical patients
Readmission to acute care hospital
Within given study, readmission for all patients defined for same time period
Readmission not defined on per patient day basis
Either probability or convenience sample
Either experimental or nonexperimental design

The 35 published articles or dissertations that met the inclusion criteria are listed in the appendix. In three articles, however, data were reported separately for diagnostic groups or for multiple hospitals (Gooding & Jette, 1985; Roos, Cageorge, Roos, & Danzinger, 1986; Zook & Moore, 1980). Consequently, these three articles were considered as contributing 12 studies to the analysis. Thus 44 studies were included in the meta-analysis. Some studies reported readmission information for more than one time period (for example, for 3 months and for 6 months), but only one period was used in the analysis. The time period data included was the one for which the most data were reported in the article. H the data for multiple time periods were comparable, the one closest to 6 months was chosen because the majority of studies used this time frame.

Coding of Data

Each article was coded for the following characteristics: year of publication, number and credentials of authors, country in which the study was conducted, type of study (prospective, retrospective, secondary analysis of an existing data file, or intervention), when the data were collected, sampling methodology, sample size, type of hospital, patient diagnosis, mean and minimum age of subjects, number of males and females, whether readmission was for elective reasons only and/or for same diagnosis only, and number of patients readmitted. These characteristics were selected because of their potential to explain variability in readmission rates or to account for the relationships between readmission and other variables.

If the relationship of readmission to other variables was reported or could be computed, it was also recorded for each article. Available most frequently in the articles were relationships of age, gender, previous admission, whether or not surgery was performed, initial length of stay, chronicity, number of secondary diagnoses, and intervention to readmission. Among the other predictor variables occasionally reported in articles were size of hospital, readiness for discharge, living arrangement of the patient after discharge, type of insurance, race, anxiety level, serum urea nitrogen (BUN), and $P0_2$. Unfortunately, for some studies, only multivariate results were reported; in these situations, only the readmission rate could be examined. To assess the reliability of the coding, both intrarater and interrater reliability were determined. Half of the studies were coded by both the primary author and a research assistant with complete coding agreement found for 89% of the studies. The remaining studies were recoded by the primary author with complete agreement achieved for 94% of the studies.

Data Analysis

The data analysis process consisted of three steps: examining differences in readmission rates based on study characteristics, testing the mean effect size for statistical significance, and testing the homogeneity of effect sizes to determine whether variation was due to mediating variables or simply to sampling error.

Differences in readmission rates. Readmission rates were computed for each study and tested for differences based on selected study characteristics. The characteristics examined included the type of study, whether the study was conducted in the United States or not, patient diagnosis group, and the time frame within which readmission was considered.

Testing the mean effect size. The relationships of readmission rate to other variables first were converted to an effect size, in this instance, to a correlation coefficient (Glass et aI., 1982; Hunter, Schmidt, & Jackson, 1982). Then, using the analytic procedures described by Hedges and Olkin (1985), Fisher's r-to-z transformation was applied, and the effect sizes were adjusted based on sample size. The result was to penalize those effects based on smaller-sized samples and to give a more conservative estimate of the overall mean effect size.

A chi-square test was used to determine if the effects were statistically equivalent to zero for all studies. If not, then a z test (with z^2 distributed as a chi-square with 1 degree of freedom) was used to determine if the mean effect size was significantly different from zero. It should be remembered, however, that when the sample sizes within studies are very large, even small effects can lead to large (and statistically significant) test statistics.

Testing the homogeneity of effect sizes. The homogeneity of effects within the set of studies was tested using the Q statistic which is distributed as a chi-square (Hedges & Olkin, 1985). Statistical significance implies a lack of homogeneity and would lead to a search for a homogeneous subset of studies based on diagnosis group, type of study, number of months at which readmission was measured, and whether the study was pre- or post-DRG.

RESULTS

Study Characteristics

Results were based on 44 studies (35 articles) published since 1973 (see appendix). Only 2 were dissertations, with the rest published in journal form. Over half (n = 26) were published after 1984, and 5 were published prior to 1980. Most (82%) had at least one physician author; 7 identified a nurse among the authors. In addition, 75% of the studies were conducted in the United States. Study designs included prospective (n = 17), retrospective (n = 10), secondary data analysis (n = 5), and intervention studies (n = 12), with the latter including both experimental and comparative designs.

Sample sizes ranged from 30 to over 21,000 with a mean sample size of 1,375 and a median size of356. Eighteen (41%) of the studies, however, reported a sample size of under 200, with another 13 studies (30%) using sample sizes between 200 and 700. Deleting the largest study, the mean sample size was 918. Sample sizes did vary significantly by the type of study, $F(3, 40) = 12.83$, $P < .0001$. Intervention

TABLE 2				
Sample Sizes and Percentage Readmission Rates, by Type of Study and Diagnosis				
			Readmission Rate	
	No. of Studies	Sample Size	Mean	Range
Type of Study				
Prospective	17	30-1,930	28.2	8.0-42.2
Retrospective	10	86-6,317	28.7	16.7-61.6
Secondary Analysis	5	2,810-21,043	11.5	3.0-66.2
Intervention	12	40-1,110	31.2	5.3-66.2
Diagnosis				
Mixed	23	123-21,043	25.5	5.3-53.6
Chronic	6	39-142	34.1	15.0-61.6
Cardiac	7	30-410	35.0	13.5-66.2
Surgical	3	2,810-6,922	5.6	3.0-9.5
Asthma	4	40-288	31.7	24.3-39.4
Hip Fracture	1	105	17.1	—
Overall	44	30-21,043	27.2	3.0-66.2

studies and prospective studies tended to use smaller samples (mean sizes of 350 and 363, respectively) as compared to retrospective studies or those conducting a secondary analysis of an existing data file (mean sizes of 1,024 and 7,980, respectively, see Table 2).

Patient Samples Used

Only 22 of the studies reported the mean age for the sample (mean = 67 years); in 24 of the studies, the minimum age was indicated, with 19 of the 24 reporting a minimum age over 59 years. About half of the studies (n = 23) described using a heterogeneous sample of patients in terms of diagnoses rather than patients from one specific diagnosis. For example, Collard (1988) presented a frequency distribution for her sample in terms of 28 major DRGs with the four top-ranked diagnoses being simple pneumonia and pleurisy, digestive diseases, cerebrovascular disorder, and bronchitis and asthma. Others, such as Hood and Murphy (1978), simply identified patients as being from medical surgical units. For purposes of analysis, diagnosis was recoded into five categories: mixed, chronic, cardiac, surgical, and asthma. Included in the chronic category were those studies in which the patients were identified as having a stroke, cerebrovascular diseases, diabetes, malignant neoplasms, or a chronic condition. Studies categorized as using cardiac patients described their samples as having congestive heart failure, myocardial infarction, and coronary artery bypass graft (CABG).

Readmission Rate

Readmission rates were reported based on 1 month to 24 months postdischarge. In over half the studies, however, readmission was reported either within 3 months (n = 9, or 20%) or 6 months (n = 18, or 40%) of discharge. Reported rates ranged from 3% for a surgical sample to 66% for a sample of patients with chronic congestive heart failure (Table 2). Overall, the mean readmission rate was 27%. The rate did not differ by type of study, $F(3, 40) = 2.54$, $P = .07$, or by whether the study was conducted in the United States or elsewhere, $F(l, 42) = 1.69, p = .21$. However, as expected, there was a significant difference in readmission rate by diagnosis, $F(4, 38) = 3.17, p = .02$. The mean rate was lowest for surgical patients (5.6%) and highest for cardiac patients (35%) or those with chronic illnesses (34.1 %). This latter figure is similar to that reported by Anderson et al. (1990) for diagnoses selected from among those that occur most frequently in the 1983-1985 period's Medicare population. For a random sample of 1,269 patients with a chronic condition, the readmission rate within 30 days was 37%. Anderson and Steinberg (1985) used a random sample of Medicare beneficiaries during the 1974-1977 period and reported that among those with a chronic disease, the readmission rate was only 23.2%.

It should be noted that the diagnoses groups used in the U.S. studies were different from those used in studies conducted outside the United States $X^2(5) = 11.90$, $p < .05$. Specifically, all 3 studies involving surgical patients came from the same published report of research conducted in Canada, whereas 14 of the 15 studies with cardiac patients, chronic patients, or hip fracture patients were conducted in the United States. Thus differences in readmission rates based on where the study was conducted is confounded with diagnoses.

Based on a comparison of 41 studies, there was no significant difference in readmission rates when studies using pre-ORG data were compared to those using post-ORG data (F = 3.83, p = .068; n = 29 and 12, respectively). When the analysis was restricted to studies with common diagnoses, the mean pre-ORG rate was still not significantly different from the mean post-ORG rate (t = 1.20,p = .132). Nor was there a difference when only the 30 studies conducted within the United States were examined (t = 1.14,p = .264).

Age Effects

Age effects were computed or reported for 22 studies and ranged from r = -.303 to r = .320 (see Table 3). Overall, there was a significant relationship between age and readmission, X2(1) = 21.16, although the mean effect was trivial (r = .02), with significant variability within the set of studies, X2(22) = 321.66. Restriction of range appears to be a difficulty with respect to analyzing age effects. In 13 of the 22 studies reporting age effects, the minimum age for subjects was at least 59 years.

When examined by diagnosis, no age effects were found in any of the studies using chronic, surgical, or asthma patients. Although there was significant heterogeneity among the studies using cardiac patients, one study appeared to be an outlier. An outlier was determined by analyzing the homogeneity statistics when each study in turn was deleted from the analysis. The goal was not merely to identify which study was responsible for the variation within the set of studies but to determine why the study may have been an outlier. The study identified in this instance was a retrospective one in which readmission was measured at 3 months and the age effect was r = .17; for the remaining 3 studies, all prospective studies with readmission measured at 6 months postdischarge, there were no age effects. Methodological considerations appear to have resulted in the discrepancy in findings with respect to age effects among cardiac patients.

For mixed diagnosis samples, however, the mean age effect, although still small (r = .03), was significantly different from zero, with

TABLE 3

Summary of Effects Reported as Correlation Coefficients

Effect	Number of Studies	Minimum	Maximum	Mean	SD
Age	22	-.303	.329	.024	.130
Gender	17	-.086	.191	.030	.061
Length of stay	14	-.399	.411	.014	.173
Previous admission	9	.002	.372	.090	.114

no individual study identified as an outlier. When the variables of months to readmission and type of study were also included in the analysis, neither helped to explain the age effects found within the set of studies.

These findings concerning age as a predictor of readmission appear to be inconsistent with those of Wray et al. (1988), who examined the National Health Interview Survey (NHIS) data and three hospital-based studies in an information synthesis and concluded that "age is a predictor of readmission only because it is a marker of increased chronic disease prevalence. Available evidence does not support the belief that advanced age is an independent predictor of readmission" (p.1052).

Gender Effects

The mean gender effect based on 17 studies was also trivial (r = .03) but positive, suggesting increased readmission among males. Individual study effects ranged from -.086 to .191. Because several of the studies conducted in VA hospitals used samples consisting primarily of males, the proportion of males in the 17 studies was examined. The range was from 27% to 86%, with a median of 45%. The proportion was not related to the study effects found.

Although there was significant heterogeneity among the set of studies, when the largest study was deleted, the effects for each of the remaining studies was zero, X2(16) = 15.97. In the deleted study, based on a Medicare sample, males were only slightly more likely than females to be readmitted, but the subsequent weighting of the effect by sample size resulted in that study carrying more weight within the set of studies, leading to an overall significant gender effect. It appears, then, that overall gender is not a predictor of readmission. As noted by Wray et al. (1988), the NHIS data have been consistent since 1967, suggesting that among those less than 65 years of age, women tend to have multiple hospital stays, attributed in part to childbirth, but that among those over 65 years of age, men tend to have more multiple stays within a given year.

Initial Length of Stay

Effects related to initial length of stay were computed or reported for 14 studies and ranged from -.399 to .411, with a small but statistically significant mean of r = .02. Significant variability was present within both the set of studies conducted pre-DRG, $x^2(8) = 21.14, p < .05$ and the set conducted post-DRG, $X^2(3) = 16.32, p < .05$, and also among studies involving mixed diagnoses, $X^2(7) = 139.22$, $P < .01$, and among those with cardiac patients, r(3) = 11.76, $p < .05$. None of the additional variables examined (type of study, whether study was conducted in the U.S., months to readmission, or mean length of stay) were able to account for the heterogeneity within the sets. Thus it appears that initial length of stay has a small but significant relationship to readmission; patients with a longer initial length of hospital stay are at increased risk for readmission.

Previous Admission

Significant variability also was present among the studies with respect to effects due to previous admission. All 9 studies, however, demonstrated a position relationship that ranged from .002 to .372, with the significant relationships present in those studies with mixed diagnoses (n = 5). The mean effect, although significantly different from zero, was again small (r = .05). Within the 5 studies, no homogeneous set could be found. Based on the studies in the meta-analysis, a patient's pattern of prior hospital use is a predictor of readmission.

TABLE 4

Log-Odds Ratios of Intervention Studies in Meta-Analysis

Study	Intervention	Design[a]	Follow-Up	Log-Odds Ratio[b]
Ashby (1988)	Home health teaching	R	6 months	-0.515
Barbarowicz et al. (1980)	In-hospital teaching	R	3 months	0.247
Campion et al. (1983)	Geriatric consultation	R	6 months	0.078
Collard (1989)	Geriatric special care unit	R	6 months	-0.268
Epstein et al. (1973)	Home health visitation	NR	3 months	0.198
Hood and Murphy (1978)	Pharmacological counseling	NR	6 months	-0.376
McPhee et al. (1983)	Structured discharge interview	NR	1 month	-0.688

Mor et al. (1983)	Home visitation	R	1 year	-0.309
Naylor (1990)	Comprehensive discharge plan for elderly	R	3 months	-2.031
Rubenstein et al. (1984)	Geriatric evaluation unit	R	1 year	-0.631
Saltz et al. (1988)	Geriatric consultation	R	6 months	0.506
Townsend et al. (1988)	Home health visits (elderly)	R	18 months	-0.168
a. R = randomized; NR = nonrandomized				
b. Mantel-Haentzel-Peto method: Negative log-odds ratio suggests lower readmission rate for experimental group.				

Interventions

Twelve of the studies included in the meta-analysis assessed an intervention designed to reduce hospital readmission (see Table 4). In 8 of the 12 studies, the readmission rate was lower for the intervention group than for the control group. One of the common measures used for comparing two groups, such as experimental and control groups, on a dichotomous outcome is the odds ratio. This measure is defined as the ratio of the odds for the experimental group to the odds for the control group. For analyzing odds ratios, it is typical to take the logarithm. Point estimates of the readmission log-odds ratio ranged from -2031 in the Naylor (1990) study to 0.506 in the Saltz, McVey, Becker, Teussner, and Cohen (1988) study. Combining the data across the 12 studies, the result was not significant, $X^2(1) = 2.21$, $p > .05$, although there was significant variation within the set of studies, $X^2(11) = 21.88$,$p < .05$.

To explore the heterogeneity, only those studies evaluating a program for the elderly were considered. Although the overall log-odds ratio was not significant, $X^2(1) = 3.55$,$p > .05$, variability was present due to the Naylor (1990) study. In none of the remaining studies was there a significant effect due to the intervention, $X^2(3) = 4.27$,$p > .05$. Also, when only the randomized intervention studies were combined, there was no overall effect on readmission, although significant variability continued due to the Naylor study. Described as a pilot study, it was a randomized clinical trial examining the effects of a comprehensive discharge planning protocol implemented by a gerontological nurse specialist for elderly medical and surgical patients. Readmission was measured at 3 months rather than the more commonly used 6-month time frame.

Other Findings

As noted earlier, other effects related to readmission could not be analyzed because either too few studies reported findings relative to a variable (e.g., only 2 studies reported findings relative to race) or individual studies did not report bivariate analyses. Four studies did report the results of multivariate analysis to develop a model to predict readmissions among elderly or Medicare patients using demographic, clinical, and social variables (Anderson & Steinberg, 1985; Collard, 1988; Holloway, Thomas, & Shapiro, 1988; Narain et aI., 1988). Although the sets of variables considered were not identical in these 4 studies, some of the same predictors emerged in two or more of the multivariate models: diagnosis (especially whether or not a chronic disease), whether or not surgery was performed, prior hospitalization, and type of care provider at home.

Three other studies (Holloway, Medendorp, & Bromberg, 1990; Smith, Norton, & McDonald, 1985; Stanton et al., 1985) developed multivariate models for other groups of patients: VA patients, medical patients, and CABG patients, respectively. Age was a significant predictor in two of the final models as were clinical characteristics: BUN, arterial $P0_2$, white blood cell count, anemia (Smith et al., 1985) and preoperative resting angina, insertion of intraaortic balloon, ICU (intensive care unit) length of stay, and months of preoperative symptoms (Stanton et al., 1985).

DISCUSSION

Based on the meta-analysis results, diagnosis, age, initial length of hospital stay, and prior use of hospital or emergency room resources are significant predictors of the medical or surgical readmissions of adults to an acute hospital, although age and diagnosis may be somewhat confounded. The relationships are trivial, however, and each of the predictors explained only a very small amount of the variability in readmission. One limitation to the application of meta-analytic techniques is the absence of desired statistics in published reports. Given the variation in what is included across studies, some variables could not be analyzed because too few studies included bivariate results relative to those variables. In individual studies, predictor variables are often chosen on the basis of availability. With such an eclectic selection of variables, there is no theoretically determined conceptual framework driving readmission research. Because the demographic variables explain so little of the variability in hospital readmission, other types of explanatory variables must be explored.

Preliminary results from multivariate models suggest that clinical, social, and demographic variables all need to be considered in identifying who is at risk for readmission. For example, the need for assistance at home (e.g., the ability to perform activities of daily living), and the type and availability of caregiver resources after discharge may be appropriate social variables to include, especially in light of the increasing elderly population. In addition to the clinical indicators identified earlier, general medical indicators (e.g., weight, blood pressure, and electrolyte levels) or other disease-specific indicators (e.g., triglycerides, low-density cholesterol, and blood glucose) may be useful to examine as potential risk factors for readmission. Additional personal characteristics, such as the perceived ability to care for self after discharge, also may be predictors of readmission. Further longitudinal research is needed to examine these sets of potential predictors of hospital readmission. Also, do the predictors change depending on the time frame used to define readmission?

In general, intervention studies have not demonstrated success in reducing hospital readmissions. The lack of a consistent and validated model to predict who is at risk for readmission may have resulted in incomplete intervention strategies or inappropriate timing for the intervention. The problem of using standardized interventions to meet diverse patient needs or the lack of a sufficient statistical power due to small sample sizes are alternative explanations for the general lack of success. Until there is a reasonably good model of the predictors of readmission, it is perhaps premature to design and test intervention strategies.

The time frame for determining readmission status needs further evaluation for its utility in providing meaningful data. In the only study with a significant intervention effect, readmission was measured at 3 months postdischarge rather than the more common 6 months. Also, among cardiac patients, age was a significant predictor of readmission only at 3 months. Examining cost data, such as the charges for initial hospitalization, rehospitalization, and the use of health services between initial discharge and subsequent readmission, may be necessary to determine at what point resource consumption levels off. This information might then be helpful in determining the relevant time frame to measure rehospitalization.

More descriptive work is needed to identify the predictors of hospital readmission, as the problem of readmission is costly and large. In particular, as noted earlier, it will be important in future research to expand the search for the predictors of readmission beyond demographic variables and to attempt to separate preventable readmissions from those attributed primarily to disease progression.

APPENDIX

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